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Satellite Earth Stations and Systems (SES); Possible European standardization of certain aspects of Satellite Personal Communications Networks (S-PCN); Phase 2: Objectives and options for standardization

ETSI

European Telecommunications Standards Institute

ETSI Secretariat

Postal address: F-06921 Sophia Antipolis CEDEX - FRANCE
Office address: 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE
X.400: c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

Tel.: +33 92 94 42 00 - Fax: +33 93 65 47 16

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Foreword

This ETSI Technical Report (ETR) was produced by the Satellite Earth Stations and Systems Technical Committee of the European Telecommunications Standards Institute (ETSI).

This ETR has been developed by ETSI in response to a Mandate from the European Commission. The allocated resources were divided into two phases. The work of Phase 1 may be found in ETR 093 [1]. The present document is the outcome of Phase 2.

ETRs are informative documents resulting from ETSI studies which are not appropriate for European Telecommunication Standard (ETS) or Interim European Telecommunication Standard (I-ETS) status. An ETR may be used to publish material which is either of an informative nature, relating to the use or the application of ETSs or I-ETSs, or which is immature and not yet suitable for formal adoption as an ETS or an I-ETS.

Introduction

Following growing technical and commercial interest in the establishment of Personal Communications Networks (PCNs) for the provision of telecommunications services direct to users through small hand-portable equipment, much work has been undertaken world-wide to develop standards, systems and technologies capable of supporting such networks. Satellite links will form a natural part of most, if not all, PCNs and in addition Satellite Personal Communications Networks (S-PCNs) are able to provide PCN services either as a separate overlay network or as an integral part of the terrestrial network.

The Phase 1 work in this area was originally dedicated to "Low Earth Orbit Communications Satellite Systems", but during the development of the work this categorisation was found to be too limiting and the scope was broadened to encompass the new concept of Satellite Personal Communications Networks (S-PCN). The Phase 1 work was in the main part encyclopaedic in nature, providing an overview of the technology, including limitations and constraints, systems and proposals for S-PCN. The Phase 1 concluded, however, with a general review of the outline framework for possible standardization of areas of S-PCN and a summary of this framework is shown in figure 1 of this ETR.

The Phase 2 includes further study on the subject with the objective to provide a basis for the definition of the standardization which might be useful in Europe before the implementation of S-PCN. At this stage ETSI was not asked by the Commission to do the actual definition of the standardization, but instead to provide a report exploring the options.

The fact that both the S-PCN concept and the technology are being developed very fast by industry, and the global impact that such new infrastructures could have, have urged the European Commission to look to ETSI for a study on the actions that could be taken (and consequences of these actions) regarding the possible standardization of S-PCN in Europe.

The Phase 2 work represents the logical consequence of the conclusions of the Phase 1 work and has been based on more guided lines because:

- the matter was defined and partially clarified by the Phase 1 work (ETR 093 [1]);
- a more close liaison with the European Commission was established in the Phase 2 work.

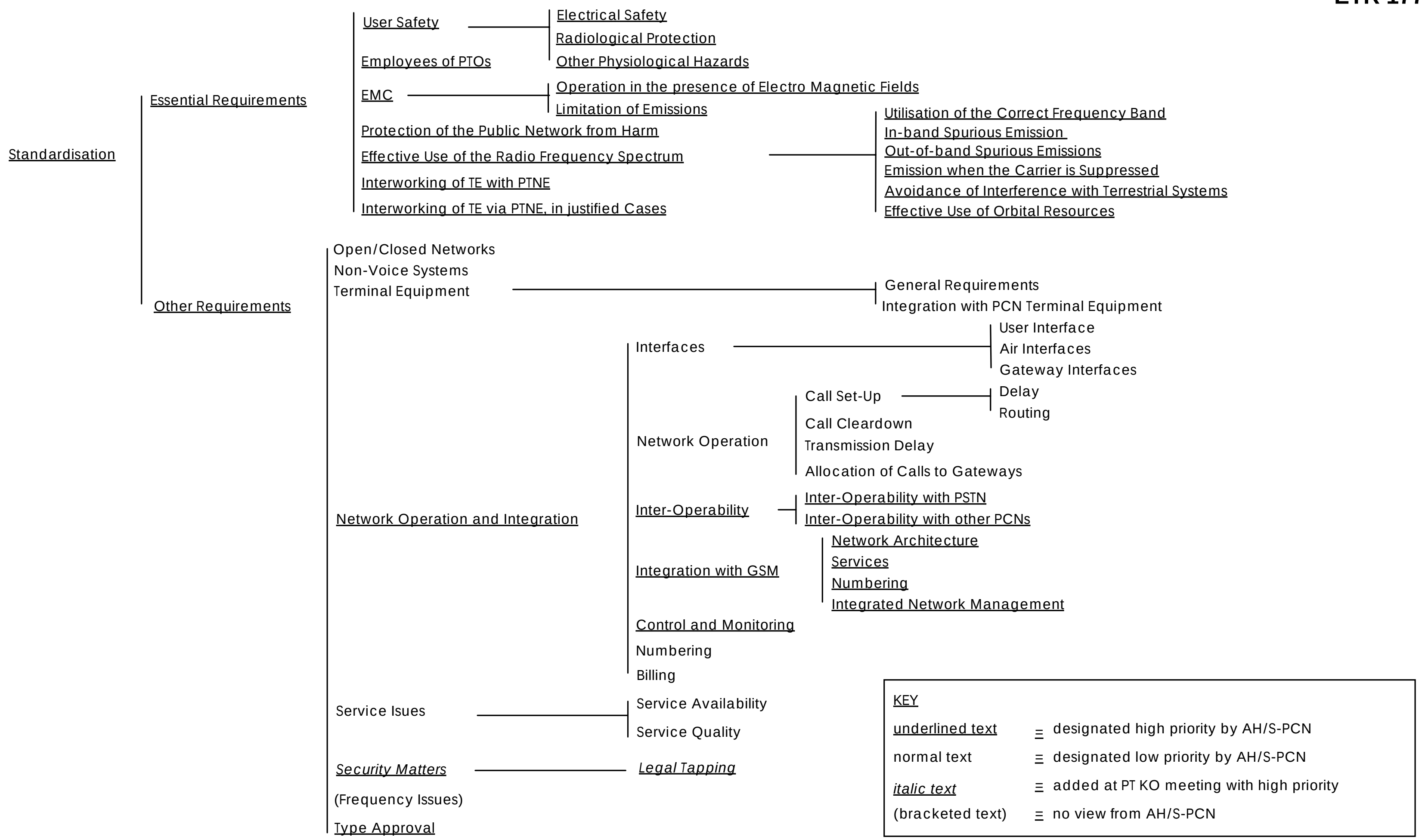

Figure 1: Framework for possible standardization from Phase 1 work (ETR 093 [1])

The main output of this process is a report addressed to the policy makers as well as to the industry needs. The usefulness of the report could be to save time to both policy makers and industries, having the ETSI study as a catalyst, avoiding the need for them to carry on their investigations independently, by providing a common basis for discussion.

Most of the current global S-PCN proposals are originated from outside of Europe. They are generally being subjected to national licensing and regulatory procedures which could lead de facto to these national approaches becoming adopted as global "standards". Europe should rightly be concerned to ensure that the development of such global networks is not undertaken in a way that is prejudicial to European interests and is compatible with established and developing European policy (e.g. in areas such as competition, licensing, free movement of equipment within the European Union, etc.) and technology (e.g. GSM, DCS-1800, ERMES, UMTS, etc.). One way to achieve this compatibility is by the establishment of a standardization framework that will ensure that systems are developed and implemented in a way that meets the European objectives.

Standardization is not an objective by itself. Standardization is a means to achieve objectives of a technical, commercial, political, or regulatory nature, whereby the different aspects cannot always be completely separated.

This ETR is intended to be a comprehensive "tool" for the initiation of the standardization process; while addressing the "basic" standardization approach, it looks well beyond this to consider what else might be done, i.e. what standards could be used to achieve specific objectives and what the implications of these actions might be. In presenting the range of objectives and possible options for standardization, as a tool for decision making, the ETR also addresses the possible impacts of such decisions on the different interested communities such as industry, users, regulators, etc. In analysing options this ETR has been prepared taking a point of view independent from system proposals presented in the Phase 1 work (ETR 093 [1]), defining S-PCN features separated from the consequences on actual proposals.

To assist the European Commission in its process to develop a view on the standardization that could be needed in Europe, this ETR presents options for standardization with likely associated consequences in various fields (particularly those for which the European Commission explicitly expressed its concern - see references [29] and [17]) as far as they could be identified at this stage.

This ETR, while not making any specific recommendations itself on what aspects of S-PCN should be standardized, nor on any objective that could be achieved by standardization in this field, presents decision makers with what is hopefully a comprehensive review of the options open to them, the decisions that they might need to take to implement their chosen options and the implications of those decisions on the promotion of S-PCN within Europe.

Structure and content of this ETR

This ETR has been structured so as to be a "tool" useful for standards developers, regulators and policy makers alike. The consideration of the need or otherwise for technical standards has not been approached in isolation, but rather in a well structured manner and from a number of different directions, so as to ensure that the review presented herein is comprehensive. To achieve this objective, this ETR has been developed and presented in a number of parts:

- an introductory part, providing a background to the work and setting the frame within which European S-PCN standards will be developed;

- an objective oriented review of what might be achieved with standards; here the approach has not been "what could or should be standardized" but rather "what are the possible European objectives for S-PCN and how could technical standards help these to be achieved;"

- a technical standards oriented review, cross referenced to the objective oriented review, in which the technical areas which might be considered for possible European standardization are addressed in a coherent way, so that it is possible to see what standards could be considered for application to each technical area;

- a concluding part, bringing together the results of the other parts so as to present the options for standardization that might be considered.

Guidance for the reader

Readers with differing interests may find it of use to concentrate on specific elements of this ETR for a:

- general review of the background to the establishment of this study .... clauses 1, 5 and 6;
- general review of the work related to S-PCN standardization being undertaken outside of the frame of this study... clause 7;
- objective-oriented approach to possible standardization of S-PCN....................................... clause 8;
- technically-oriented approach to possible standardization of S-PCN .... clauses 9 and 10;
- summary of the views expressed by various interested communities on the need for and scope of S-PCN standardization .... clause 11;
- for an overall conclusion to the work, presenting possible approaches, options and a time frame for standardization .... clause 12.

1 Scope

This ETSI Technical Report has been developed in the second phase of a comprehensive review by ETSI of Satellite Personal Communications Networks (S-PCN) and the aspects of these networks that might be considered for European standardization.

The work has been undertaken under a mandate from the European Commission as part of their process for the formulation of policy, standards and regulatory framework in the field of S-PCN as established in the Communication from the European Commission on S-PCN [29]:

> "...[the Commission]...asked [ETSI] to provide [an] assessment of the required standardization strategy"

and in the Council Resolution 93/C 339/01 [17] of 7 December 1993 on the introduction of satellite personal communication services in the Community:

> "[the Council invites the Commission to]...reinforce co-operation with ETSI... in examining the related standardization issues".

This ETR defines possible frameworks for technical standardization that might lead to benefits for Europe in the area of S-PCN systems, networks and services. This ETR does not itself try to propose final solutions instead, the ETR addresses the end objectives which standardization might be expected to achieve and then considers the different standardization approaches which might be implemented to achieve those objectives.

At a basic level, this ETR addresses the areas in which technical standards will be needed, to meet the essential requirements under the Council Directive 91/263/EEC [19] (the TTE Directive), Council Directive 93/97/EEC [20] (the SES Directive), or other Directives, and also, where considered appropriate, to go beyond these Directives to consider additional voluntary standardisation that might be regarded as useful.

In order to be useful to the policy and decision makers, ETSI has also canvassed the views of the key interested communities, who are expected to have a position regarding the way in which the standards and regulatory framework for S-PCN might develop. These positions have been analysed and summarised with a view on the findings of this ETR, in a non-attributable way, in clause 11 of this ETR.

2 References

This ETR incorporates by dated and undated reference, provisions from other publications. These references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETR only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

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3 Definitions and abbreviations

3.1 Definitions

For the purposes of this ETR, the following definitions apply:

Base Station System (BSS): The equipment managing S-PCN radio resources and providing functions such as additional mobility management, operation & maintenance and transcoding & encryption as a part of the gateway.

common conformity specification: A conformity specification used in all the European Community (EC) Member States by the authority competent for testing the conformity of terminal equipment. It also includes, where appropriate, requirements made necessary in a given State by historical network peculiarities or established national provisions concerning the use of radio frequencies.

conformance test: The tests, carried out by a laboratory as indicated in Art. 7.2 of the Council Directive 86/361/EEC [11], for the purpose of verifying the conformity of terminal equipment with the common conformity specifications.

Common Technical Regulation (CTR): Is a regulation, established under the TTE Directive 91/263/EEC [19] or the SES Directive 93/97/EEC [20] for the purposes of harmonizing in Europe the conditions for placing on the market of telecommunications terminal equipment and satellite earth station equipment. This will establish a single European market for equipment approved to a CTR.

EMC Directive: Council Directive 89/336/EEC [24].

gateway: The equipment comprising the Land Earth Station (LES) providing the S-PCN feeder links, the Base Station System (BSS) or Base Earth Station (BES) and the associated Mobile services Switching Centre (MSC) and network registers.

gateway earth station: The Land Earth Station (LES) connected to or forming part of the gateway.

gateway MSC: The Mobile services Switching Centre (MSC) connected to or forming part of the gateway.

handset: A Mobile Earth Station (MES) which is sized so as to be hand portable.

harmonized standard: Is a standard prepared and adopted on a European basis, with any conflicting national standards being withdrawn; a TBR is an example of such a standard.

identification: The procedure by which a unique identity is assigned to a mobile station within a network.

legal tapping: Legal access to user data transported by the (S-PCN) network and other information relevant to trace (S-PCN) mobile communications including user location and subscription profile.

Low Voltage Directive: Council Directive 73/23/EEC [23].

Network Termination Point (NTP): "Means all physical connections and their technical access specifications which form part of the public telecommunications network and are necessary for access to and efficient communication through that public network," [70].

numbering: The procedure by which numbers are assigned to mobile stations for different applications and mobile systems within a network.

ONP Directive: Council Directive 90/387/EEC [70].

Personal Communications Service (PCS): Telecommunications services providing the ability to communicate anywhere, at any time, with anyone or anything according to individual needs. A personal communications service is characterised (see ETR 093 [1]), generally speaking, by its capacity to respond universally to a wide range of communications needs. This leads to a user oriented approach adopted in developing the PCN concept in contrast to the network oriented approach adopted in the development of the communications networks so far.

Procurement Directive: Council Directive 90/531/EEC [89].

Public Telecommunications Network (PTN): "The public telecommunications infrastructure which permits the conveyance of signals between defined network termination points by wire, by microwave, by optical means or by other electromagnetic means." [19].

SES Directive: Council Directive 93/97/EEC supplementing the TTE Directive in respect of Satellite Earth Station (SES) equipment [20].

Satellite Personal Communications Network (S-PCN): The definition is given and discussed in some detail in clause 5 of this ETR.

service providers: "Offer services to end users involving the use of mobile networks and services. The role of service providers may vary between that of airtime re-seller to the provision of sophisticated value added services. Service providers may be independent or form part of a mobile network operation"; from the Mobile Green Paper [27].

specification: "... a document which lays down the characteristics required of a product such as levels of quality, performance, safety or dimensions, including the requirements applicable to the product as regards terminology, symbols, testing and test methods, packaging, marking and labelling" [11].

standard: "... a technical specification relating to a product or an operation which is recognised by a large number of manufacturers and users. Council Directive 83/189/EEC lays down the following definition ... ‘standard ... (means) a technical specification approved by a recognised standardizing body for repeated and continuous application compliance with which is in principle not compulsory" [6].

Technical Basis for Regulation (TBR): A special type of ETSI deliverable with the formal status of a harmonized standard that draws together requirements from various ETSs or other base standards to form a complete set of specifications and tests for certification and type approval of terminal equipment, and which forms the technical basis of a CTR.

Telecommunications Terminal Equipment (TTE): "... equipment directly or indirectly connected to the termination of a public telecommunications network to send, process or receive information. A connection is indirect if equipment is placed between the terminal and the termination of the network. In either case (direct or indirect), the connection may be made by wire, optical fibre or electromagnetically." [10].

TTE Competition Directive: Council Directive 88/301/EEC [10].

TTE Directive: Council Directive 91/263/EEC on TTE and mutual recognition of conformity [19].

type approval: "of TTE means the confirmation delivered by the competent authority of a Member State that a particular TTE type is authorised or recognised as suitable to be connected to a particular public telecommunications network" [11].

user: The person who uses an S-PCN to access and control a telecommunication session. The session may be with one or more users on any telecommunications network, or with the S-PCN or another telecommunications service. The distinction between the user and the terminal is fundamental to allow mobility of the user across several networks (ETR 093 [1], subclause 4.1).

3.2 Abbreviations

For the purposes of this ETR, the following abbreviations apply:

AFC	Automatic Frequency Control
AMPS	Advanced Mobile Phone System
AP	Advance Publication
ASE	Application Service Elements
ATDMA	Adaptive TDMA
AUC	Authentication Centre
AUSTEL	Australian Telecommunications Authority
B-ISDN	Broadband ISDN
BES	Base Earth Station
BSS	Base Station System
CC	Country Code
CCIR	Comité Consultatif International des Radiocommunications (International Radio Consultative Committee) former ITU committee; its functions are now embodied within ITU-R and ITU-T
CCITT	Comité Consultatif International Télégrafique et Téléphonique (International Telegraph and Telecommunications Consultative Committee) former ITU committee; its functions are now embodied within ITU-T
CDMA	Code Division Multiple Access
CEC	Commission of the European Communities
CEN	European Committee for Standardisation (acronym of the French name)
CENELEC	European Committee for Electrotechnical Standardisation (acronym of the French name)
CEPT	Conférence Européenne des Administrations des Postes et des Télécommunications (European Conference of Postal and Telecommunications Administrations)
CES	Coast Earth Station
CIS	Commonwealth of Independent States
COST	European Co-operation in the field of Scientific and Technical research
CPG	Conference Preparatory Group of the ERC
CPM	Conference Preparatory Meeting of the ITU
CTR	Common Technical Regulation
D-AMPS	Digital Advanced Mobile Phone System
DCS	Digital Cellular System
DECT	Digital European Cordless Telecommunications
DRIVE	Dedicated Road Infrastructure for Vehicle safety in Europe
DSS	Digital Signalling System
DTX	Discontinuous Transmission flag
EA	Early Assignment
EC	European Commission (Commission of the European Communities)
ECTRA	European Committee of Telecommunications Regulatory Authorities
ECU	European Currency Unit
EEA	European Economic Area
EEC	European Economic Communities
EIRP	Equivalent Isotropically Radiated Power
EMC	Electro-Magnetic Compatibility
EN	European Norm (standard by CEN/CENELEC)
ENO	European Numbering Office (a part of ETO)
ENS	European Numbering Space
ERC	European Radiocommunications Committee
ERMES	European Radio Message System
ERO	European Radiocommunications Office, of the ERC
ESA	European Space Agency
ETO	European Telecommunications Office
ETR	ETSI Technical Report

ETS	European Telecommunication Standard
ETSI	European Telecommunications Standards Institute
EU	European Union
FACTS	Federation of Australian Commercial Television Stations
FCC	Federal Communications Commission (of the USA)
FDMA	Frequency Division Multiple Access
FPLMTS	Future Public Land Mobile Telecommunication System (now IMT-2000)
FS	Fixed Service
FSS	Fixed Satellite Service
GA	Geographical Area
GR	Geographical Region
GSM	Global System for Mobile Communications
GSO	Geostationary Satellite Orbit
GW	Gateway
HEO	Highly Inclined Elliptical Orbit
HLR	Home Location Register
HPLMN	Home PLMN
IC	Incoming Circuit
IMSI	International Mobile Station Identity
IMT-2000	International Mobile Telecommunications system 2000, new name for FPLMTS
IPR	Intellectual Property Rights
ISC	International Switching Centre
ISDN	Integrated Services Digital Network
ISL	Inter-Satellite Link
ISUP	ISDN User Part
ITU	International Telecommunications Union
ITU-R	Radiocommunications Sector of the ITU
ITU-T	Telecommunications Standardisation Sector of the ITU
JTC	Joint Technical Committee
LA	Location Area
LAC	Location Area Code
LAI	Location Area Identification
LEO	Low-Earth Orbit
LES	Land Earth Station
MBS	Mobile Broadband Systems
MCC	Mobile Country Code
MES	Mobile Earth Station
MGP	Mobile Green Paper [27]
MGT	Mobile Global Title
MID	Maritime Identification Digits
MIFR	Master International Frequency Register
MNC	Mobile Network Code
MS	Mobile Station
MSC	Mobile Switching Centre
MSIN	Mobile Subscriber Identity Number
MSISDN	GSM Mobile Subscriber ISDN number
MSS	Mobile Satellite Service
MSSC	Mobile Satellite Switching Centre
MTP	Message Transfer Part
N	Notified
NCI	Nature of Circuit Indication
NDC	National Destination Code
NGSO	Non-Geostationary Satellite Orbit
NMSI	National Mobile Station Identity
NMT	Nordic Mobile Telephone
NN	National Network
NPRM	Notice of Proposed Rulemaking (part of licensing process of US FCC)
NRA	National Regulatory Authority
NTP	Network Terminating Point
NTRAC	New Technical Regulations Approval Committee (formerly TRAC)
OACSU	Off-Air Call Set-Up
OBP	On-Board Processing
OJ	Official Journal, of the EEC

OMC	Operation and Maintenance Centre
ONP	Open Network Provision
OSI	Open Systems Interconnection
PABX	Private Automatic Branch Exchange
PCN	Personal Communications Network
PCS	Personal Communications Services
PFD	Power Flux Density
PLMN	Public Land Mobile Network
PSTN	Public Switched Telecommunications Network
PT	Project Team
PTN	Public Telecommunications Network
PTNE	Public Telecommunications Network Equipment
RAS	Radioastronomy Service
RC	Request for Co-ordination
RDSS	Radiodetermination Satellite Service
RE	Radio Equipment
RF	Radio Frequency
RR	Radio Regulations
RR	Radio Resource
RRM	Radio Resource Management
RSS	Radio Station Subsystem
S-PCN	Satellite Personal Communications Network
S-PCS	Satellite Personal Communications Services
SCCP	Signalling Connection Control Part
SE	Spectrum Engineering
SES	Satellite Earth Station
SG	Study Group
SIM	Subscriber Identity Module
SMA	Australian Spectrum Management Agency
SMG	Special Mobile Group (of ETSI)
SN	Subscriber Number
SS	Switching and control System
SSI	Ship Station Identity
ST/P	Satellite Tracking and Positioning
TACS	Total Access Communications System
TBR	Technical Basis for Regulation
TC/E	Transcoding / Encryption
TCAP	Transaction Capabilities Application Part
TCR	Telemetry, Command and Ranging
TDMA	Time Division Multiple Access
TG	Task Group
TRAC	Technical Recommendations Application Committee (now NTRAC)
TT&C	Telemetry, Tracking and Command
TTC&M	Telemetry, Telecommand, Control and Monitoring
TTE	Telecommunications Terminal Equipment
TUP	Telephony User Part
TVRO	Television Receive Only antenna
UMTS	Universal Mobile Telecommunications System
UPT	Universal Personal Telecommunications
VLR	Visitor Location Register
VPLMN	Visitor PLMN
VPN	Virtual Private (mobile) Networks
VSAT	Very Small Aperture Terminal
WARC	World Administrative Radio Conference (former name for WRC)
WP	Working Party
WRC	World Radiocommunications Conference (new name for WARC)

4 Clause number not used

5 A definition of S-PCN for standardization purposes

This clause provides a working definition for S-PCN that can be used in the process of standards development and application.

5.1 The need for a definition of S-PCN

If standards for S-PCN are to be developed in Europe and perhaps more importantly, if such standards are to lead to the implementation of a regulatory regime, it is important to ensure that a clear definition exists for S-PCN to ensure that the way in which the standards and resulting regulations are applied to systems is also well defined. If this definition is not made explicit then there is a risk that disputes might arise about the applicability of such standards or regulations to a specific telecommunications system that might, or might not, be S-PCN.

Currently, it is not felt by ETSI that a clear definition of S-PCN does exist which is suitable for the use in applying standardization or regulation in Europe. There are many activities involving satellites and mobile / personal communications, ranging from the "conventional" mobile satellite services (e.g. INMARSAT-M), through the work defining the satellite component of PLMNs which might be regarded in part as S-PCN (e.g. UMTS, FPLMTS) to the soon to be implemented S-PCNs (e.g. those resulting from proposals considered in ETR 093 [1]).

5.2 Scope of S-PCN standards and regulations

The scope of the application of standards and regulations for S-PCN naturally depends on the options selected to meet the identified objectives. Nevertheless, the selection of standards to be developed and implemented needs to be undertaken in conjunction with the development of a definition for S-PCN. The aim should be to achieve a definition which is generally applicable and is independent of the use to which it is put, but from which can be derived definitions for particular uses (e.g. defining the scope of an envelope standard). This definition would be used to "test" networks and systems to determine whether or not the standards and regulations are applicable and, more important for ETSI, which standards and regulations apply to which parts of the network or system.

5.3 A working S-PCN definition for the application of standards and regulations

One approach might be to require that the standards apply to all mobile service networks using particular classes of orbit (e.g. LEO) but this kind of definition leads to inconsistencies in the potential application of standards to systems for which they were not originally intended.

In ETR 093 [1], S-PCN was introduced originally to identify "the public direct access to the satellite from portable or pocket size(d) terminals (as) the new and distinguishing feature of PCN via satellite."

In the study report from the European Commission [3] an alternative, but not incompatible, definition is made: "a satellite PCN is the satellite specific elements of a network suitable for provision, operation and support of a mobile or personal communications service", but this definition seems much too broadly based and does not really define something that can only be S-PCN for standardization purposes (e.g. all existing INMARSAT networks appear to fall within this definition).

These definitions may not, however, be fully sufficient for a clear application of the possible standards and regulations that might be developed. Consider, for example, some scenarios which, depending upon how the definitions are drafted, may or may not fall within the scope of S-PCN standardization and regulation or fall within different aspects of such standardization and regulation:

- a PSTN originated call from Europe to an S-PCN mobile user located outside of Europe via a gateway outside of Europe;

- a PSTN originated call from Europe to an S-PCN mobile user located outside of Europe via a gateway inside Europe;

- a PSTN originated call from Europe to an S-PCN mobile user located inside Europe via a gateway outside of Europe;

- a PSTN originated call from Europe to an S-PCN mobile user located inside Europe via a gateway inside Europe;

- an S-PCN mobile originated call inside of Europe to an S-PCN mobile user located outside of Europe via a gateway outside of Europe;

- an S-PCN mobile originated call outside of Europe to an S-PCN mobile user located outside of Europe via a gateway inside Europe.

Consider also that separate S-PCN networks may be configured very differently from each other, providing different approaches to, and levels of, integration and interworking with terrestrial networks and different roaming possibilities. Also that the S-PCN satellite networks may be used, in certain circumstances, to provide what are effectively Fixed Satellite Services (albeit still in the MSS bands) to, for example, a satellite-connected telephone booth (in a remote or rural area where there is no terrestrial infrastructure available to support telecommunications). It becomes clear, from these considerations, that defining a set of standards (and possible regulations derived from those standards) that can be applied in a consistent manner may lead to some difficulties.

Several possibilities for defining S-PCN have been found in other sources:

a) a very restricted definition based only on the technology of the handset and without consideration of orbits (see ETR 093 [1]):

   "the public direct correspondence to a satellite system from portable or pocket sized terminals for personal communication purposes";

b) a less limited definition still without consideration of orbits (see [3]):

   "the satellite-specific elements of a network suitable for provision, operation and support of a mobile or personal communications service";

c) more broadly based definitions, considering less the handset or even the services, but focusing on the orbit (e.g. [18]):

   "Terminal Equipment to be used with Low Earth Orbiting (LEO) satellite networks".

Two points have to be made here:

- a definition related to the type of orbit brings as a consequence the need for a definition of the type of orbit. At present the only defined is the GSO and, to some extent, other classes of inclined orbits. A proposal for LEO definition is also included in ETR 093 [1].

- a definition related to the hand-held terminal (and therefore to the service) is consistent with what has been discussed in ETR 093 [1], where the subscriber unit is recognised as the driving part of the S-PCN design (see ETR 093 [1], subclause 4.2).

The following is proposed as a possible approach for use in technical standards that might be developed by ETSI:

a) where the standard is an "envelope standard" relating to the S-PCN handset, a definition derived from the general S-PCN definition for this purpose only might be applicable, e.g.:

   i) "This standard provides specifications for S-PCN Mobile Earth Stations (S-PCN / MES) [with both transmit and receive capabilities], providing direct access to either geostationary or non-geostationary satellites within the mobile satellite service (MSS). The S-PCN / MES operate as part of a satellite personal communications network providing voice and / or data Personal Communications Services (PCS) directly to the users' hand-held or portable terminals. The frequency bands of operation for S-PCN / MES to which this standard applies should be within the following bands: ..... MHz to ..... MHz and ..... MHz to ..... MHz."

   NOTE: It should also be considered whether a definition of PCS is needed to support this definition of S-PCN, or if reference should be made to "voice and / or data services"; a definition of PCS is included in subclause 3.2.

   ii) Where the S-PCN network also permits the use of, for example, transportable, vehicle-mounted or fixed terminals then either the same standards and regulations will apply, in which case the above definition could be expanded to include them, or different standards and regulations will apply in which case the above definition could be altered to cover the particular type of terminal being considered.

b) where the standard is a "system specification" the definition is less critical; it is to be expected that the system standard will define in a comprehensive manner a particular piece of equipment and thus it will be clear that if an S-PCN system is built to the standard then there is no uncertainty about whether or not the standard applies to the system. It is not expected that the definition will substitute for the specification or vice versa. However, should conformance with such a specification become a mandatory part of any European regulation or legislation then it is of critical importance that such regulation or legislation contains a detailed definition for an S-PCN network in order to ensure that all such S-PCN networks that might be licensed or implemented in Europe could be brought under the appropriate regulatory control.

It is also necessary to consider the satellite components of the third generation networks that may well provide a much wider portfolio of services, especially broadband and multimedia applications. These are being developed in the context of the RACE project and elsewhere, and again it needs to be clear if and how the standards might possibly apply to these kinds of networks.

5.4 Service frequency band and the definition of S-PCN

The definition of S-PCN, per se, is not affected by the choice of frequency band for S-PCN operation (i.e. it is possible to envisage S-PCNs operating, in principle, at any frequency), although the standards that might be developed could be different for S-PCNs utilising different frequency bands, as an example because of the different requirements in the envelope part.

The most pressing need for an S-PCN definition is for the purposes of the development of conformance test specifications "envelope standards" to be used for type approval purposes. These conformance test specifications are required most urgently for the case of the soon to be implemented S-PCN systems that are already proposed, and which have been described in detail in ETR 093 [1].

Whilst a long term view might require the development of a comprehensive set of standards across a wide range of frequency bands that might be used for S-PCN, a more immediate position to meet the needs of the soon to be implemented S-PCN would be to develop conformance test specifications to cover S-PCNs operating at frequencies between 1 and 3 GHz in the bands allocated to the MSS, where, in all cases, S-PCN is as defined in a) i) in the previous subclause. This approach is, in principle, the methodology being adopted by STC-SES5 in its development of "envelope standard" ETSs for S-PCN (see subclause 7.1.1).

Certainly other ETSs will be required to cover S-PCN satellite earth stations operating in other bands, particularly as these bands become defined, e.g. by ERC, but there seems to be little doubt that the bands described above will be used in their entirety, or at the very least in part for S-PCN systems, and it therefore seems to make sense to develop ETSs now for these bands. Once other bands have been specified, it might become possible to extend the scope of the already developed ETSs, or it might prove to be necessary to develop new ETSs to cover these bands or radio technologies.

It should be considered whether different standards are needed for TDMA / FDMA systems and for CDMA systems, or whether the same standard could be used, or could be prepared in such a way as to encompass both technologies.

It is significant to ETSI standardization activities whether the radio access technique is CDMA or FDMA / TDMA and what will be the decision concerning the service band sharing among systems within Europe. Certain features are not possible to be standardized completely independently of the technology used in the radio interface.

It is also necessary to consider the possible requirement of standards to cover the gateway earth station, which is possibly to be regarded as both SES equipment in the context of [20] and as TTE in the context of [19] (see subclause 9.1.1.5).

Note finally the possibility of S-PCN in FSS frequency bands - for example, a recent multi-satellite proposal (not included in ETR 093 [1]) to operate a LEO network in FSS bands, whilst not targeting mobile users, seems to include the possibility for the use of hand-held mobile terminals, despite the use of the 20 / 30 GHz FSS bands. Thus it may be useful to consider that the definition of S-PCN should be wide enough to encompass this kind of network, in the event that it is required to standardize and regulate networks of this class in a manner similar to or the same as the S-PCNs. Care must be taken here, however, since the VSAT standards and regulations might also be regarded as appropriate in this case and the situation could arise where two, possibly conflicting, sets of standards and regulations might be regarded as applying to a single class of network.

When terms of reference are drafted to start the possible ETSI standardization process, attention would have to be given to potential areas of conflict / clarification with respect to current standardization activities also in the FSS bands.

5.5 General definition of S-PCN

This subclause develops an approach that results in the expression of a general definition for an S-PCN, with the aim that it could be used without the need for any consideration of the use to which the definition will be put.

In trying to do this, it is necessary first to pose a number of questions. The most important consideration is to address what it is that makes a network an S-PCN. Some requirements, drawing particularly on the work of the ETR 093 are:

- direct correspondence with the satellite;
- the provision of Personal Communications Services (PCS);
- the mobile user should be reachable without the caller knowing his location;
- the terminal should be hand-held;
- that the user may have some expectations on power, battery life, etc.;
- that the orbit supporting the S-PCN should not be a consideration;
- that the specific frequency band used should not be a consideration;
- that voice should not be essential;
- that world-wide coverage should not be essential;
- that there may be some considerations of public availability at reasonable cost.

The definition needs to be expressed so as to make it clear, when considering a satellite network, if it is S-PCN or if it is not. This will not necessarily be easy, as many networks will have "S-PCN like" qualities, but it may not be the case that they should be regarded as S-PCN. The definition must be expressed narrowly enough so that networks that would not generally be regarded as S-PCN are not included (e.g. INMARSAT-M) but widely enough so that all S-PCNs are included. Also it must be considered whether the satellite components of other mobile networks (e.g. UMTS) be included in the definition or not.

On the basis of these considerations, ETSI proposes the following definition:

"A Satellite Personal Communications Network is a network in which earth-orbiting satellites are used to convey telecommunications transmissions to and from users' terminals, and in which:

- the network is operated through the use of geostationary satellites and / or non-geostationary satellites";

- the network operates its service links in frequency bands allocated to the Mobile Satellite Service (MSS) in Article 8 of the Radio Regulations;

- the network is designed principally to support hand-held user terminals, although larger terminals and mobile (vehicle-mounted) terminals are not precluded;

- the user terminals are capable of supporting a telecommunications service when corresponding directly with or through the satellite for both reception and transmission (when required) without the need for any intermediate, ground-based retransmission or amplification, although the use of ground-based transparent transponders (non-regenerative) for signal amplification purposes is not precluded. The use of receive-only user terminals is not precluded;

- the world-wide coverage is not essential but availability over the defined coverage, in relation to the kind of service, should match the objectives of personal communications;

- the network provides personal communications services directly to users' terminals. The provision of voice telephony is not a requirement;

- the network provides advanced mobility management for users, either through roaming or through the provision of a wide-coverage service area (regional or world-wide) that is a single network;

- mobile-terminated calls do not require the calling party to have any knowledge of the location of the called party within the network. The called party can be reached through a single number that is independent of his location;

- the network does not require the user manually to update the location information related to him (unless the terminal is receive-only);

- the network does not require the user to perform manually acquisition of satellite to establish a call or to receive a page, although system-prompted user co-operation to maximise the link margin is not precluded.

It is recognised that this definition is somewhat complex, but it is not felt to be possible to have a brief definition that will not then be found to have some shortcomings in its application. It should further be noted that, as currently drafted, the satellite component of UMTS / FPLMTS would be regarded as S-PCN. If this definition is generally accepted, then as the UMTS / FPLMTS satellite component becomes better defined it might be necessary to review certain points of this S-PCN definition to ensure that it either excludes the UMTS / FPLMTS satellite component or includes it in an appropriate way.

The general definition above is proposed to be used as the baseline test against which networks should be judged to determine if they are in fact S-PCN and if standards apply.

6 Existing regulatory framework

Addressing standards without first considering the framework of regulations within which those standards will have to be developed and operate seems not to be a useful approach. In consequence, this clause provides a review of the European and international regulations that are likely to have an impact on S-PCN and the standards that might be developed to support it.

This clause is relevant to the standardization activities which ETSI will need to undertake because these activities will be influenced by, and must conform to, the requirements of the regulatory framework.

6.1 European regulatory position

The European Commission has been active over most of the last decade in establishing within the European Union a policy and regulatory framework to ensure the open development of telecommunications markets and networks.

The following subclauses tabulate the appropriate documentation so that the framework established within the European Union may be taken into account in the standards making process. Readers should note that this is not intended to be a fully comprehensive list, rather to indicate those documents that ETSI has found to be of use in understanding the regulatory framework applying to S-PCN in the European Union. For a full list, readers should consult the publication "The Official Journal of the European Union" (the OJ) or the useful collection of reprints from the OJ, issued by Directorate General XIII of the Commission [43].

The regulation of S-PCN would in fact be based on some guidelines arising from existing telecommunications policy in certain areas such as open network provision, market of telecommunications terminal equipment, satellite communications and land-based mobile communications which are set out in the documents listed.

The documents have been grouped into a number of areas; it is recognised that different groupings might also be considered and the groupings used herein are simply for convenience and do not imply any particular application or interpretation of the documents themselves.

6.1.1 Matters related generally to technical standardization

19/2/73	73/23/EEC	Council Directive on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits
7/5/85	85/C 136/01	Council Resolution on a new approach to technical harmonization and standards
3/5/89	89/336/EEC	Council Directive on the approximation of the laws of the Member States relating to electromagnetic compatibility
27/10/92	COM(92) 445 final	Communication from the Commission on Intellectual Property Rights and Standardization

6.1.2 Matters related to competition and liberalisation

16/5/88	88/301/EEC	Commission Directive on competition in the markets in telecommunications terminal equipment
28/6/90	90/387/EEC	Council Directive on the establishment of the internal market for telecommunications services through the implementation of open network provision
28/6/90	90/388/EEC	Commission Directive on competition in the markets for telecommunications services
17/9/90	90/531/EEC	Council Directive on the procurement procedures of entities operating in the water, energy, transport and telecommunications sectors
1/12/93	SEC(93) 1891 final	Draft Commission Directive amending Directives 88/301/EEC and 90/388/EEC with regard to satellite communications

6.1.3 Matters related to licensing

18/8/92	COM(92) 254 final	Proposal for a Council Directive on the mutual recognition of licences and other national authorisations to operate telecommunications services, including the establishment of a single Community telecommunications licence and the setting up of a Community Telecommunications Committee (CTC)
4/1/94	COM(93) 652 final	Proposal for a European Parliament and Council Directive on a policy for the mutual recognition of licences and other national authorisations for the provision of satellite network services and/or satellite communications services [28]

6.1.4 Matters related to general telecommunications

24/7/86	86/361/EEC	Council Directive on the initial stage of the mutual recognition of type approval for telecommunications terminal equipment
29/4/91	91/263/EEC	Council Directive on the approximation of the laws of the Member States concerning telecommunications terminal equipment, including the mutual recognition of their conformity
10/5/93	Draft common position	Council Directive on the application of Open Network Provision (ONP) to voice telephony

6.1.5 Matters related to space and satellite communications

20/11/90	COM(90) 490 final	Communication from the Commission: Towards Europe-wide systems and services - Green Paper on a common approach in the field of satellite communications in the European Community [42]
23/9/92	COM(92) 360 final	Communication from the Commission to the Council and the European Parliament: The European Community and space: challenges, opportunities and new actions
29/10/93	93/97/EEC	Council Directive supplementing Directive 91/263/EEC in respect of satellite earth station equipment

6.1.6 Matters related to mobile communications

27/4/94	COM(94) 145 final	Towards the Personal Communications Environment: Green Paper on a common approach in the field of mobile and personal communications in the European Union

6.1.7 Matters related to satellite personal communications

27/4/93	COM(93) 171 final	Communication from the Commission on satellite personal communications, Draft Council Resolution on the introduction of satellite personal communications services in the European Community
7/12/93	93/C 339/01	Council Resolution on the introduction of satellite personal communications services in the Community

6.2 Frequency co-ordination process within the ITU

Before any S-PCN system (or indeed any type of radiocommunications system) can be brought into use it is necessary for the relevant procedures of the Radio Regulations [9] to be observed. For the S-PCN systems currently proposed, this process is being, or is about to be, undertaken. In consequence, the Radio Regulations procedure forms an essential part of the regulatory framework for S-PCN and it is important to consider it here.

6.2.1 Radio regulatory procedures applying to S-PCN

Probably the most important radio regulatory consideration for the S-PCN systems is their frequency co-ordination with other mobile and fixed satellite systems with which they must share spectrum in service and feeder links, and this issue is addressed first in this subclause. It is, however, also important to consider the radio regulatory problems that might also arise because of the need for the S-PCN systems to share spectrum with other, non-satellite-based radiocommunications systems, and this is discussed at the end of this subclause.

6.2.1.1 Inter-satellite co-ordination

Historically, when applied to satellite networks, the Radio Regulations provided a process by which frequency assignments for proposed geostationary satellite systems could be co-ordinated with existing geostationary satellite system assignments and, at the end of the period of co-ordination, the details of the new assignment would be entered onto the Master International Frequency Register (MIFR) and would thereafter receive some degree of protection.

Because many S-PCNs address non-geostationary orbits, it is important to address their treatment in terms of the Radio Regulations [9].

The frequency assignments of non-geostationary satellite systems were not subjected to this procedure. Instead, they were required, by Radio Regulation 2613, to avoid causing interference to geostationary systems, even if they pre-dated those geostationary systems:

"Non-geostationary space stations shall cease or reduce to a negligible level their emissions, and associated earth stations shall not transmit to them, whenever there is insufficient angular separation between non-geostationary and geostationary satellites, and whenever there is unacceptable interference to geostationary-satellite space systems in the fixed satellite service operating in accordance with these Regulations." [9].

This was modified (changes shown in bold) by WARC-92:

"Non-geostationary space stations shall cease or reduce to a negligible level their emissions, and their associated earth stations shall not transmit to them, whenever there is insufficient angular separation between non-geostationary **satellites** and geostationary satellites **resulting in** unacceptable interference to geostationary-satellite space systems in the fixed-satellite service operating in accordance with these Regulations." Final Acts of WARC-92 [8].

The small change results in NGSO systems only being required to protect GSO systems when there is actually the occurrence of unacceptable interference, rather than simply the possibility of it, as was the case before the change. In principle though, RR 2613 still requires NGSO networks to protect all GSO networks, without frequency co-ordination or the consideration of operating priorities and thus it makes the operation of NGSO networks problematical. Interestingly, the FCC in the USA is seeking to place an interpretation on the revised RR 2613 that would introduce an element of frequency co-ordination (see subclause 6.3.1.1.3.2) but it remains to be seen if this will find favour internationally.

The regime of RR 2613, even as modified by WARC-92, does not lead to a situation where it seems likely that significant investments will be made to NGSO systems in bands where there is no radio regulatory protection. Primarily for this reason, WARC-92 established an interim procedure for the co-ordination of MSS networks (both geostationary and non-geostationary) within certain frequency bands (principally those newly allocated to the MSS at the WARC). This procedure is set out in ITU Resolution 46 of WARC-92 (Res. 46) which appears in the published Final Acts of WARC-92 [8] and will, in due course, be incorporated into a future edition of the Radio Regulations [9].

For those bands to which it applies, Res. 46 provides a procedure similar in nature to the process of co-ordination under Radio Regulations Articles 11 and 13 for geostationary networks, but adds the requirement for non-geostationary networks to be taken into account. For those bands where Res. 46 does not apply, the geostationary networks are protected by Radio Regulation Number 2613 (MOD WARC-92), which effectively affords no protection to services utilising non-geostationary satellites, and an absolute right to geostationary networks to be protected against interference from non-geostationary networks.

As a consequence of footnotes in RR Article 8, the generic MSS service links from non-geostationary and geostationary satellites operating in the bands above 1 GHz, listed in table 1, are subject to the interim procedures set out in Res. 46. In practice, this means that all of the bands generically allocated to MSS in the 1 - 3 GHz region are subject to the interim notification and co-ordination procedures in Res. 46.

The application of the interim procedures of Res. 46 to these bands has a quite significant impact in that it removes the non-interference obligation of RR 2613 from the non-geostationary networks and provides a protection under the Radio Regulations for duly co-ordinated and notified non-geostationary networks. This priority and protection is given to non-geostationary networks even over geostationary networks which might come into existence after them. This is a significant reverse to the previous RR 2613 regime.

Table 1: Generic MSS frequency allocations between 1 and 3 GHz subject to the application of Res. 46

Band (MHz) from	to	Link	Bandwidth (MHz)	Availability	RR footnote applying Res. 46
1 492	1 525	down	33	Reg. 2	723C
1 525	1 530	down	5	Reg. 2 / Reg. 3	726D
1 610	1 626,5	up	16,5	world-wide	731E
1 613,8	1 626,5	down (secondary)	12,7	world-wide	731F
1 626,5	1 631,5	up	5	Reg. 2 / Reg. 3	726D
1 675	1 710	up	35	Reg. 2	735A
1 970	1 980	up	10	Reg. 2	746B
1 980	2 010	up	30	world-wide	746B
2 160	2 170	down	10	Reg. 2	746B
2 170	2 200	down	30	world-wide	746B
2 483,5	2 500	down	16,5	world-wide	753F
2 500	2 520	down	20	world-wide	760A
2 670	2 690	up	20	world-wide	764A
2670	2690	up	20	world-wide	764A

NOTE 1: ITU continental regions are broadly the following 1: Europe, CIS and Africa; 2: the Americas; 3: Asia and Australasia (see RR 392 [9]).

NOTE 2: Res. 46 also applies to certain MSS bands below 1 GHz, intended primarily for the "Little LEO" systems also to non-generic MSS bands in the range 1 530 - 1 559 MHz and 1 631,5 -1 660,5 MHz, but these are of less significance in the context of this ETR and are not listed here.

6.2.1.1.1 Radio regulatory protection for NGSO systems

The interim regulatory procedures applicable to the majority of the potential S-PCN service link bands established under Res. 46 of WARC-92 have some implications for the regulatory protection that might be expected for the S-PCN systems, and these points are considered here:

- the Res. 46 interim procedures have only been applied to MSS bands (i.e. between 1 and 3 GHz to those bands listed in table 1;

- specifically, the feeder links for non-geostationary MSS, almost certain to be located in FSS bands, fall outside of the provisions of Res. 46 and thus are still subject to RR 2613;

- perhaps more importantly, any S-PCN system that tries to operate service or feeder links outside of the bands specifically referencing Res. 46 through footnotes is not subject to Res. 46 and thus is also still subject to RR 2613. This means, for example that S-PCN systems that might be proposed with feeder links in the 20 / 30 GHz band do not have any radio regulatory protection provided by the Res. 46 interim procedures and thus must operate in accordance with RR 2613 to protect GSO systems, even those GSO systems which post-date the S-PCN systems. This is likely to be a severe constraint on their operation and may make the systems non-viable, unless national regulations are used to provide regulatory protection to the S-PCN systems. Even so, the almost certain likelihood of NGSO to GSO interference outside of the regime of these possible national regulations must make the use for NGSO S-PCN systems of bands not subject to Res. 46 almost impossible;

- Res. 46 does not provide any technical basis for sharing, nor for determining interference levels, nor for identifying if interference is excessive; this work is proceeding in ITU and will not be completed at least until WRC-95;

- Res. 46 still embodies the traditional "first come, first served" (although some regard the term as rather contentious) concept of co-ordination as established in RR Article 11. It is to be expected that after the first one or two non-geostationary networks have been co-ordinated and notified in a particular band it will be very hard, maybe almost impossible, for further non-geostationary networks to be successfully co-ordinated in that band. The INMARSAT and the US generic filings, HIBLEO-2 and HIBLEO-5, exist with "first priority" dates in the co-ordination process (see table 2); if these networks are successfully co-ordinated with each other, there may be little opportunity for other, perhaps European, systems to achieve co-ordination.

The procedures discussed above relate to satellite networks sharing an equal primary allocation status in the Radio Regulations. WARC-92 allocated 12,7 MHz of spectrum in the 1,6 GHz band for MSS downlinks with secondary status (see table 1) in the same band where there is a primary allocation to MSS uplinks. In these bands, the following should be noted:

- that systems operating with secondary status shall protect systems operating with primary status from harmful interference and shall not request any protection from harmful interference due to systems operating with primary status;

- as a consequence, satellites operating secondary status downlinks may interfere, through their antenna back-lobe and side-lobes, with satellites operating primary status uplinks in the same band and should protect the primary status transmission;

- also, mobile earth stations receiving secondary status downlinks may be interfered with by mobile earth stations transmitting primary status uplinks, without the possibility to request protection from the primary status transmission;

- these facts notwithstanding, it should be noted that in the US licensing process (see subclause 6.3.1.1.3.1) a band-segmentation approach is being adopted which will help in overcoming these problems. The applicability of such a regime in Europe awaits decisions which will be made outside of ETSI, e.g. in CEPT / ERC.

6.2.1.1.2 Systems currently involved in RR procedures

It is worthwhile to make a brief review of those networks currently undergoing the co-ordination process under Res. 46, described above, as this will give some indication of the scale of the problem to be overcome.

Table 2 shows the networks currently involved in the ITU Res. 46 procedures, either because they are networks that were already notified on the Master Register prior to the implementation of the Res. 46 procedures, or because they are now involved in the co-ordination process. The table shows both geostationary and non-geostationary networks, but for brevity has been limited to the generic MSS bands allocated on a world-wide basis.

Table 2a: GSO networks currently in the ITU co-ordination procedures under Res. 46 (in generic MSS bands allocated for world-wide use)

Admin	Satellite Name	S	GSO Long. / NGSO	Adv. Publ. Date	Rq. C. Pb. Date	46 9	46 12	46 13	46 14	46 15	46 18
USA	USRDSS WEST	N	130.00 W	30/06/87					14		
USA	USASAT-27D	AP	116.00 W	24/05/94			12	13			
CAN	MSAT-1A	AP	106.50 W	10/08/93					14		
USA	USASAT-27E	AP	101.00 W	24/05/94			12	13			
USA	USRDSS CENTRAL	N	100.00 W	30/06/87		9					
USA	USASAT-27C	AP	96.00 W	24/05/94			12	13			
G INM	INMARSAT GSO-1A	RC	90.00 W	23/06/92	04/05/93	9			14		
G INM	INMARSAT GSO-2A	RC	90.00 W	23/06/92	04/05/93		12	13			
USA	USASAT-27B	AP	76.00 W	24/05/94			12	13			
USA	USRDSS EAST	N	70.00 W	28/07/87					14		
G INM	INMARSAT GSO-1B	RC	55.00 W	23/06/92	04/05/93	9			14		
G INM	INMARSAT GSO-2B	RC	55.00 W	23/06/92	04/05/93		12	13			
BLRIK	INTERSPUTNIK-32.5W	AP	32.50 W	07/06/94						15	18
BLRIK	INTERSPUTNIK-23W	AP	23.00 W	07/06/94						15	18
BLRIK	INTERSPUTNIK-16W	AP	16.00 W	07/06/94						15	18
G INM	INMARSAT GSO-1C	RC	15.50 W	23/06/92	04/05/93	9			14		
G INM	INMARSAT GSO-2C	RC	15.50 W	23/06/92	04/05/93		12	13			
BLRIK	INTERSPUTNIK-6W	AP	6.00 W	07/06/94						15	18
BLRIK	INTERSPUTNIK-3W	AP	3.00 W	07/06/94						15	18
F	LOCSTAR OUEST	RC	0.00 E	03/10/89	10/11/92	9			14		
F	LOCSTAR CENTRE	RC	10.00 E	03/10/89	10/11/92	9			14		
BLRIK	INTERSPUTNIK-17E	AP	17.00 E	07/06/94						15	18
G INM	INMARSAT GSO-1D	RC	20.00 E	23/06/92	04/05/93	9			14		
G INM	INMARSAT GSO-2D	RC	20.00 E	23/06/92	04/05/93		12	13			
ARS	SAUDI-FMSS-2	AP	20.10 E	23/03/93		9			14		
F	LOCSTAR EST	RC	22.50 E	03/10/89	10/11/92	9			14		
BLRIK	INTERSPUTNIK-27E	AP	27.00 E	07/06/94						15	18
IND	INSAT-2M(48)	AP	48.00 E	22/03/94						15	18
ARS	SAUDI-FMSS-1	AP	52.00 E	23/03/93		9			14		
IND	INSAT-2M(55)	AP	55.00 E	22/03/94						15	18
BLRIK	INTERBELAR-1	AP	59.50 E	12/10/93						15	18
G INM	INMARSAT GSO-1E	RC	64.00 E	23/06/92	04/05/93	9			14		
G INM	INMARSAT GSO-2E	RC	64.00 E	23/06/92	04/05/93		12	13			
BLRIK	INTERSPUTNIK-64.5E	AP	64.50 E	07/06/94						15	18
BLRIK	INTERSPUTNIK-67.5E	AP	67.50 E	07/06/94						15	18
IND	INSAT-2M(74)	AP	74.00 E	22/03/94						15	18
BLRIK	INTERBELAR-2	AP	75.00 E	12/10/93						15	18
INS	GARUDA-4	AP	80.50 E	05/04/94		9			14		
IND	INSAT-2M(83)	AP	83.00 E	22/03/94						15	18
IND	INSAT-2M(93.5)	AP	93.50 E	22/03/94						15	18
G INM	INMARSAT GSO-1F	RC	110.00 E	23/06/92	04/05/93	9			14		
G INM	INMARSAT GSO-2F	RC	110.00 E	23/06/92	04/05/93		12	13			
BLRIK	INTERSPUTNIK-114.5E	AP	114.50 E	07/06/94						15	18
INS	GARUDA-1	AP	118.00 E	05/04/94		9	12	13	14		
INS	GARUDA-2	AP	123.00 E	05/04/94		9	12	13	14		
INS	GARUDA-3	AP	135.00 E	05/04/94		9			14		
BLRIK	INTERSPUTNIK-153.5E	AP	153.50 E	07/06/94						15	18
AUS	AUSSAT B 156E R	RC	156.00 E	21/06/88	01/06/93	9					
AUS	AUSSAT B 160E R	RC	160.00 E	21/06/88	01/06/93	9					
AUS	AUSSAT B 164E	RC	164.00 E	18/12/90	30/06/92	9					
G INM	INMARSAT GSO-1G	RC	179.00 E	23/06/92	04/05/93	9			14		
G INM	INMARSAT GSO-2G	RC	179.00 E	23/06/92	04/05/93		12	13			

Table 2b: NGSO networks currently in the ITU co-ordination procedures under Res. 46 (in generic MSS bands allocated for world-wide use)

Admin	Satellite Name	S	GSO Long. / NGSO	Adv. Publ. Date	Rq. C. Pb. Date	46 9	46 12	46 13	46 14	46 15	46 18
D	QUASIGEO-L2	AP	NGSO	27/07/93		9			14		
D	QUASIGEO-L3	AP	NGSO	27/07/93			12	13		15	18
F	F-SAT ICO	AP	NGSO	17/5/94		9	12	13	14		
F	FSAT LEO	AP	NGSO	17/5/94		9	12	13	14		
G INM	INMARSAT-LEO 1C	RC	NGSO	23/06/92	27/04/93	9			14		
G INM	INMARSAT-LEO 2C	RC	NGSO	23/06/92	27/04/93		12	13			
HOL	PETALRING 30C-S	AP	NGSO	31/5/94			12	13		15	18
HOL	PETALRING 60E-S	AP	NGSO	31/5/94			12	13			
RUS	ELEKON-STIR	AP	NGSO	26/7/94		9			14		
TON	TONGASAT-ELL-1	AP	NGSO	27/10/92		9	12	13	14		
TON	TONGASAT-LEO-10000	AP	NGSO	13/10/92		9	12	13		15	
TON	TONGASAT-LEO-1200	AP	NGSO	13/10/92		9	12	13		15	
TON	TONGASAT-LEO-1300	AP	NGSO	13/10/92		9	12	13		15	
URS	GLONASS	N	NGSO	08/06/82		9					
URS	GLONASS-M	AP	NGSO	14/04/92		9					
USA	HIBLEO-2	RC	NGSO	28/04/92	15/06/93	9					
USA	HIBLEO-5	RC	NGSO	28/04/92	29/06/93	9			14		
USA	MSSLEO-1	AP	NGSO	17/5/994			12	13			
USA	MSSLEO-2	AP	NGSO	17/5/94			12	13			
USA	MSSLEO-2	AP	NGSO	17/5/94			12	13			

NOTE 1: The information in table 2 is obtained from ITU documents; the information is correct as of 27 July 1994.

NOTE 2: ITU codes for Res. 46 Bands are:
46.9 = 1 610 - 1 626,5 MHz 46.14 = 2 483,5 - 2 500 MHz
46.12 = 1 970 - 2 010 MHz 46.15 = 2 500 - 2 520 MHz
46.13 = 2 160 - 2 200 MHz 46.18 = 2 670 - 2 690 MHz

Networks shown in table 2 have a status of one of three possibilities:

- networks under Advance Publication (AP) are newly proposed and the Administration responsible will have provided to the ITU the information indicated in Appendix 4 of the Radio Regulations. This outline information is not a detailed description of the proposed network, but is sufficient for the Administrations responsible for other networks to make an initial assessment of the potential for interference to their systems from the AP network and will give them the opportunity to indicate to the proposing Administration that formal co-ordination must be requested. The date shown in the "Adv. Publ. Date" column of table 2 is the date on which the ITU published the AP information, the date on which the information was received by the ITU (which has a significance in the application of the regulations) must be established by consulting the ITU published filing about a specific network;

- networks at the Request for Co-ordination (RC) stage will have already completed the AP stage and received indications of the Administrations with whom co-ordination is required. The Administration responsible for the new network will then submit to the ITU the information indicated in Appendix 3 of the Radio Regulations which will enable detailed carrier-to-carrier interference assessments to be made with the networks identified at the AP stage. These detailed calculations will generally be made in the course of a bilateral, formal co-ordination meeting between the Administrations concerned, and will aim to find accommodations and operating modes to enable the networks to co-exist. Only once all problems have been resolved will the new network be able to proceed to the third and final stage of the process (this is in fact a slight simplification). The date shown in the "Rq. C. Pub. Date" column of table 2 is the date on which the ITU published the RC information. Once again, the date on which the information was received by the ITU (which is of prime significance in determining which network in a co-ordination formally takes priority) must again be established by consulting the ITU published filing about a specific network;

- networks that are Notified (N) will have completed the formal co-ordination process and the Administration responsible will have informed the ITU accordingly. The parameters of the network will be entered by the ITU onto the Master International Frequency Register (MIFR) and the network will thereafter receive protection against interference from new networks under the RR procedures.

It is important to note that the Radio Regulations procedures applying to both GSO and NGSO satellites require (in RR 1550 and 1.7 of Res. 46) that the notified date of bringing into use the first assignment (i.e. co-ordinated frequency) of any satellite network shall not be later than six years after the date of publication of the AP (Appendix 4) information, although this date may be extended by no more than three years at the request of the Administration concerned. This means that the initial S-PCN systems, Advance Published in the middle of 1992, must complete their co-ordinations, notify their assignments and bring into use their first assignment by the middle of 1998, which date may be extended to the middle of 2001 at the request of their Administration. This places some bounds on the date by which the S-PCNs are expected to become operational, and this is reflected in the standardization timeframe set out in figure 43, clause 12).

The table shows that the co-ordination situation facing the new S-PCN operators is by no means simple. The Res. 46 bands, especially the main bands of interest to S-PCN (bands 46.9, 46.12, 46.13 and 46.14) already contain a number of notified geostationary networks and a single notified non-geostationary network, which have co-ordination priority over the S-PCN filings. Moreover there is a growing number of networks which have made new fillings since WARC-92, all of which must be co-ordinated against each other with priority being determined by the date of receipt of the Appendix 3 information by the ITU. Considering that the procedure indicated in the above paragraphs must, for each proposed S-PCN system, be completed for all notified networks and all networks at the RC stage with an Appendix 3 information receipt date earlier than the co-ordinating S-PCN and it becomes clear that RR co-ordination is a significant difficulty for the S-PCNs.

National regulatory decisions may assist in this process (e.g. it is not expected that the US filings will need to formally co-ordinate against each other, see subclause 6.3.1.2, and in fact the RR procedures assume that all networks under the responsibility of a single Administration are compatible and does not require them to co-ordinate with each other under the RRs), but the co-ordination of S-PCN systems in non-geostationary orbits is still likely to be problematical.

6.2.1.2 Sharing with other radiocommunication services

The generic MSS bands in the range 1 - 3 GHz that have been identified above as being of prime interest to S-PCN are not allocated to the MSS exclusively. Generally MSS systems will have to share spectrum with a range of different radiocommunication services, on a co-primary basis, which means that neither the MSS nor the sharing services have an automatic right to claim protection from interference from each other.

Two approaches exist to deal with this frequency sharing problem:

- firstly the definition of sharing criteria or operational limits on systems of a particular type, compliance with which should ensure compatible operation with other systems, without the need for further actions; and

- secondly the use of frequency co-ordination approaches, in which the compatibility of systems has to be demonstrated, and operational parameters modified if necessary to ensure compatible operation.

For the S-PCNs operating in the principle bands of interest sharing issues are principally as follows:

- in the band 1 610 - 1 626,5 MHz, sharing with aeronautical navigation, radiodetermination satellite, radio astronomy, and fixed services;

- in the band 2 483,5 - 2 500 MHz, sharing with fixed, mobile, radiodetermination satellite, radiolocation and ISM services.

The feeder links, assumed to be in the FSS bands, will require sharing with, for example, the fixed satellite and the fixed services. If reverse band working is considered for S-PCN feeder links, then there will be different sharing problems to be considered (see subclause 7.2.1.3.4).

These sharing problems are being addressed internationally, within ITU-R, and in Europe within CEPT, with the objective of developing both methods to quantify interference and approaches to facilitate sharing.

6.2.2 Standardization implications

The interim procedures established in Res. 46 do not include any technical basis for determining the mutual interference between NGSO networks and between NGSO and GSO networks and for establishing sharing criteria etc. Although work is in hand within ITU-R and other fora to establish this technical basis (see subclauses 7.2.1.1 and 7.2.1.3), this is unlikely to be ready in time to meet the co-ordination timetable objectives of the most active S-PCN system proponents. In consequence, it is likely that the co-ordinating parties may develop their own technical basis for co-ordination, used internally within the bilateral co-ordination meetings that will take place. This may have some implications on standards development in the frequency sharing area, as networks which have already achieved co-ordination are unlikely to be interested in adopting new standards that might, in their application, prejudice their already completed co-ordinations.

6.3 Developments outside of international standards bodies

As well as the activities being undertaken with the various international standards bodies, the international developments outside of these bodies, primarily within national administrations, are also of importance to ETSI. Decisions taken within these national bodies could well have an impact on the standards options within Europe.

6.3.1 Developments in USA

Outside of the international bodies, most work in the S-PCN area is being undertaken in the USA, and this activity is reported in the following subclauses.

6.3.1.1 Results of FCC licensing process

The Federal Communications Commission (FCC) in the USA has, over the last few years, been undertaking a process of considering the issuing of licences to, and determining the sharing procedures for, systems proposing to offer services including personal communications services via satellite.

This process has been monitored by the European Commission (through an American law firm who have reported on the developments in the FCC) [5]; in addition a study for the Commission [3] has provided, inter alia, a comprehensive review of the background to the process and the results of the activities within the FCC. Both studies were carried out prior to the publication by the FCC of their proposed rules for the so-called "MSS above 1 GHz" [32]. It is not the intention of this ETR to duplicate the work of the US law firm nor of the study, nor even to provide a detailed summary of their reports. Nevertheless, in view of the importance to Europe of the licensing process currently under way in the USA, it is important for ETSI to review here what has happened in the USA, to report on the current status of the process and, more importantly, to go on to review the potential impact on the European standardization process of these developments in the USA, especially on the criteria used to carry on the preliminary work leading to the "rules" in USA.

The principles and methods used by FCC in determining the "rules" shows important points for the European standardization initiatives even if the regulatory and licensing regime in USA is different from that in Europe.

6.3.1.1.1 General

The process currently being undertaken in the USA is a national licensing review, essentially for a licence to operate a domestic system.

Whilst the licensing process in the USA does not have a formal direct impact on the S-PCN standardization development process in Europe, it is still necessary for Europe to maintain a close check on what is happening in the USA in this regard. The outcome of the S-PCN licensing process in the USA will have a potential influence on at least the following aspects of S-PCN development and standards in Europe:

- Frequency allocations - there is limited bandwidth available for S-PCN; a decision in the USA to allocate particular sub-bands to particular systems or to systems meeting particular technical criteria (e.g. multiple access method) is almost certain to limit the freedom of Europe to determine its own frequency allocations, particularly if those US systems are also to be used in Europe.

- International co-ordination - related to the first point, the ability to ensure successful co-ordination of USA and European networks under the RR procedures could be compromised if the USA "domestic" systems are licensed (nationally) first. Under the procedures of Resolution 46 (WARC-92) there is now RR protection (in specific bands only) for first coming NGSO systems (see subclause 8.6.4), so in these bands, the first systems will have a reduced co-ordination hurdle (although this is not a negligible task - see subclause 6.2.2). Once these first systems have co-ordinated, the later systems in the same bands may find it almost impossible successfully to co-ordinate with the first systems. Note that as part of the licensing process, the FCC is likely to determine that US systems agree not to subject each other to the requirements of the RR co-ordination process for which there is in any case no international obligation, but instead to use the sharing approach set out in the FCC rules.

- International "roaming" - at this stage it seems uncertain how the concept of international "roaming" will be treated within the boundaries of states such as the USA, where a long domestic licensing process has already been undertaken. A major question in this regard is the issue of how users with S-PCN handsets belonging to a system that is not part of the US licensing procedure will be treated. Presumably this will be a different treatment to those users who have non-US subscriptions on an S-PCN system that is, nevertheless, one of the US licensees. Operation of an S-PCN in a country other than that where it is licensed may not be true roaming in the GSM sense, as the user may still remain in his home network. However, this point is still applicable, even when the concept of "roaming" is only taken to be operation outside of the country in which the S-PCN user is licensed.

- US licensing of European S-PCN - it is also important to consider how the US might treat an S-PCN proposal of European origin. The US licensing process seems to discriminate against systems that are not (at least substantially) US owned and this might make it difficult for a European system to obtain a licence to operate in the USA. However, most (if not all) of the US system proponents expect to obtain licences to operate their systems in Europe, and it might be considered that a reciprocal regime ought to apply.

- Treatment of single and dual- or multi-mode handsets at national borders - this is a potentially significant consideration, if the free world-wide circulation and use of S-PCN systems is to be achieved. Even in the case where a global S-PCN system manages to achieve world-wide licensing, so its use is not subject to restrictions, there will still be difficulties arising out of the transport of handsets across national borders. Unless there is a general agreement amongst national Administrations relating to the mutual recognition of type approval of handsets the possibility will arise that either nationally approved versions of S-PCN equipment will exist with little possibility of use outside those countries (which makes no sense in the context of S-PCN) or the handset will have to be type approved in each country individually and each national type approval mark shown on the equipment (which is clearly impractical). A particular difficulty is likely to arise out of the use of dual- or multi-mode handsets. These multi-mode handsets will incorporate, in addition to the S-PCN functionalities, sub-systems to enable their use in one or more other mobile systems, most probably the terrestrial PLMNs within their country or region of origin, although potentially other S-PCNs as well. It is necessary to consider how the licensing process and other national regulations (e.g. customs or border controls) will deal with multi-mode handsets, and particularly whether they will be able to cross national borders without restrictions. A user with, for example, a dual-mode S-PCN / GSM handset may find that it is seized by the US customs as he enters the USA, and only returned to him when he leaves, because the GSM component is not licensed or otherwise authorised for use in the USA. A similar problem might face a US user with a dual-mode S-PCN / D-AMPS handset attempting to enter the European Union.

- Technical standards for air interface, etc. - this is another area where decisions made in the USA will have a definite impact on work in Europe. The likelihood of a proprietary air interface becoming the de facto "standard" seems high, and even in the event that a number of proprietary S-PCNs are implemented, the chances are that their air interfaces will remain proprietary and result in several de facto "standards". Under these circumstances, Europe may have little choice other than either to accept these proprietary "standards" or to make its own voluntary specification for the air interface, developed by ETSI.

6.3.1.1.2 Background to the FCC process

Most of the S-PCN proponents had made their national US filings for permission to construct, launch and operate their satellite networks prior to the allocation of frequencies at WARC-92 in March 1992. The dates of these original filings (i.e. those for systems participating in the formal FCC rulemaking procedure) were:

- AMSC: information not known to ETSI
- Aries: 3 June 1991
- Celsat: information not known to ETSI, but after the first round filing deadline
- Ellipso: November 1990, June 1991
- Globalstar: 3 June 1991
- Iridium: 3 December 1990, 10 August 1992 (minor amendment)
- Odyssey: 31 May 1991

Activities within FCC to conclude the process for licensing of S-PCN systems began approximately six months after WARC-92 (which ended in March 1992), at which the new frequency allocations were made to the MSS. The FCC issued a "Notice of Proposed Rulemaking" to allocate the new generic MSS frequency bands from WARC-92 (1 610 - 1 626,5 MHz and 2 483,5 - 2 500 MHz) to the MSS within the USA, and then to implement a formal process in which effectively the rules for sharing the frequency would be determined.

Under US law, the FCC may organise a committee of the interested parties to assist it in defining what consensus might exist around particular rules which might be proposed by the FCC or from within the committee itself. This is known as the "Negotiated Rulemaking Committee". The FCC has an obligation to take into account the deliberations of this Committee, although these deliberations are not automatically implemented by the FCC. It should be noted that, where the Committee fails to reach a consensus, then the FCC must still develop its own rules taking into account the views expressed by the Committee. The risk of legal challenge through the courts from a disaffected party is always present.

6.3.1.1.3 Current status of the FCC process

The "Negotiated Rulemaking Committee", although reaching consensus in many areas, failed to reach an agreement in the key area of how the service links would share spectrum [31]. The dispute was effectively between those proponents advocating CDMA for the service links and those advocating TDMA. Because the parties were unable to reach a consensus, the FCC was forced to develop its own proposed rules which were published in January 1994 in a Notice of Proposed Rulemaking (NPRM) [32].

The NPRM has inter alia proposed rules in two important areas: the way in which the service link spectrum will be allocated to the applicants and the approach that will be adopted to deal with the feeder link sharing. Both of these proposed rules have considerable impact for Europe, and are examined in the following subclauses.

6.3.1.1.3.1 Service link sharing

The FCC has proposed the following basic approach:

- to assign 11,35 MHz of shared spectrum (1 610 - 1 621,35 MHz) to CDMA system service uplinks;

- not at present to assign any downlink spectrum for CDMA systems, although proposing that the CDMA systems will share the same amount of downlink spectrum as uplink spectrum. The appropriate downlink frequencies for CDMA systems will be considered when those systems are licensed;

- to assign 5,15 MHz of dedicated spectrum (1 621,35 - 1 626,5 MHz) to the single TDMA system for bi-directional use (service uplinks and downlinks).

The proposed rules then go on to consider how the spectrum assignments might be modified in the event that not all systems will be implemented.

Note that no spectrum has been reserved for use by future systems, for expansion by the currently proposed systems or for use by systems licensed outside of the USA (e.g. European S-PCNs). How these assignments would be accepted in Europe and what criteria would be used to allow different assignments is a primary issue. Because the FCC process has no formal meaning outside the USA, the assignments in other ITU regions can be different (e.g. different portions of MSS assigned to CDMA or TDMA exclusively) and based on different rules. The S-PCN systems may be required to be flexible enough to provide spectrum service bands according to a semi-permanent or dynamic frequency plan.

6.3.1.1.3.2 Feeder link sharing

The approach proposed by the FCC to deal with the sharing of the feeder link spectrum could be quite significant for Europe, as the FCC are suggesting a revised interpretation of Radio Regulation 2613 (see subclause 6.2.1) which is currently the regulatory process by which GSO networks are protected from interference from NGSO networks.

The FCC accepts the view of the "Negotiated Rulemaking Committee" that the operator of an NGSO system should be afforded "some protection against a demand from future FSS / GSO system operators that the (NGSO) system cease operating or reduce transmissions" [32]. The Committee suggested that the USA "seek international agreement that RR 2613 will not be invoked to require (an NGSO) system to terminate operations unless: (1) the affected administrations reach agreement as to a level of "accepted interference", (2) the (NGSO) system is operating in excess of these levels, and (3) the excess interference is caused by the (NGSO) satellite's failure to maintain sufficient angular separation between the satellites."

The FCC also accepted the view of the Committee that NGSO feeder links could be shared with the GSO through co-ordination, but did not propose any specific co-ordination methods or procedures. It was accepted, however, that "it does not appear feasible to seek to implement (NGSO) feeder links in bands that are heavily used by GSO systems (as co-ordinating) an (NGSO) system with every GSO satellite throughout the world would simply be too burdensome."

6.3.1.1.4 Implications for European standardization

In spite of the problems facing the FCC in developing their sharing rules for the MSS networks, it must be expected that the rulemaking process will reach its conclusion reasonably soon, and that FCC will grant licences to systems for USA domestic operation. These systems will then begin construction, launch and operation. Some indication on the schedule is provided in ETR 093 [1]. The operators of these systems will presumably then seek licences for operation in countries outside of the USA, but the proposed basis for operation, particularly standards and sharing principles, will almost certainly arise out of the USA licensing process.

European administrations and regulators will have to consider how to treat these applications for operation of non-European systems in Europe, and this is perhaps more of a matter of policy making than standards.

There are two main options when considering what technical basis should be adopted to deal with the applications:

- to adopt in total the principles and deriving "rules" of FCC;

- to adopt an original set of principles, developed on the basis of the interests of European Union.

The first approach has the consequence of making the technical acceptance of the application almost an automatic process, being based on rules already met elsewhere.

However, the problem must be faced that there may well be some areas in which the approaches adopted by the FCC in their licensing process will not be in alignment with the technical standards or other technical factors developed for Europe. As examples, consider the following scenarios:

- limits on, for example, out of band unwanted emissions could be adopted in Europe on the basis of technical requirements in the European region, but these limits could be more severe than those required in the USA and in consequence could be difficult for USA handsets to meet;

- a decision could be made in Europe, (e.g. within CEPT / ERC), to utilise S-PCN frequency bands that do not align with those determined by the FCC. Even if the same bands are proposed, the division or sharing of the bands in Europe (e.g. between TDMA and CDMA systems) might not be the same as in the USA;

- other requirements could be incorporated in European standards, e.g. network control functions or special requirements to protect other spectrum users, which again might be different from what is required in the USA or what is implemented in the USA systems.

To some extent, the problem of incompatible regimes between Europe and the USA can be overcome by action at two levels: (1) the political level discussions which are presumed to occur regularly between European and USA officials, and which are assumed to cover these points, and (2) the active participation of the European subsidiaries and partners of the USA corporations proposing the S-PCN systems within the standards development process in Europe which should result in a harmonization of technical matters to a large degree.

Nevertheless, the European regulators and the S-PCN proponents will still be faced with a common problem, namely how to deal with the remaining differences that might arise. It is not easy at this stage to propose approaches for dealing with this problem. Nevertheless, it is felt to be worthwhile to raise it as a possible concern at this early stage so that it may be taken into account.

6.3.1.2 Joint Technical Committee (JTC) on PCS

6.3.1.2.1 Establishment

In the USA standardization in the field of Personal Communications Systems (PCS) started in two standardization committees in parallel:

- T1 the carriers;
- TIA Telecommunication Industry Association, the committee of the industry.

Both these committees are part of ANSI (American National Standards Institute). Originally both these committees started their developments in an independent way. When this independent approach started to raise considerable concern as to the status of the result of the works the "Joint Technical Committee" (JTC) was established. The JTC co-ordinates the USA contribution to TG 8/1 and develops the ANSI standard for PCS. The JTC reports via both T1 and TIA in parallel. Any standard originating from the JTC will be reviewed by both T1 and TIA before it can be issued as an ANSI standard.

6.3.1.2.2 Activities

The JTC is the body that should co-ordinate the USA activities in the field of FPLMTS. In practice it is a body where standardization takes place for the second generation of USA mobile telecom systems, that will be launched in the frequency bands that are intended for use (according to ITU, RR 746A) by FPLMTS on a global scale. The background is that the USA industry does not have a standard for a system that is comparable to GSM and experiences the competition from GSM manufacturers on the world market for land mobile telecommunication systems and terminals.

Substantially, the standardization focuses more on the radio interface than on network aspects. However, as the GSM experience shows, the network aspects are essential to form a standard for international mobile systems, consistently developed.

Implementation of systems in the FPLMTS bands in the USA may not wait until the ITU has completed the standard for FPLMTS. From that moment onwards a global standard will only be possible if the FPLMTS committee (TG 8/1) will then accept for not yet standardized issues the USA standardization as de facto standard, however IPR problems may make this unacceptable.

A big problem is caused by the fixed links that are present in these bands and that must not be interfered with. The best solution would be to move those fixed links to a higher frequency (e.g. 6 GHz) but that solution will probably not be forced by the FCC. If it is not enforced, then those who have an interest in operating a mobile communication system in the FPLMTS band will need to plan the use of frequencies very carefully around the existing fixed links. Alternatively, interested parties may come to a deal with the user of such a fixed link for evacuating those frequencies.

6.3.1.2.3 IPR issues

As the JTC does not address IPR issues, it is highly questionable whether a resulting standard would be commercially viable. For the standard to be commercially viable, manufacturers would need access to the IPR on acceptable commercial conditions, operators would require the availability of multiple compatible sources for the networks behind the radio interface.

6.3.2 Developments in Australia

In Australia the development of personal communications is being considered with interest for the prospects expected to be offered by the emerging technologies. An investigation on wireless personal communications technologies and services, and consequences for Australian industry and user community has been conducted by the Australian Telecommunications Authority, resulting in a recent report to the Minister for Communications [4]. It is useful to review briefly the main issues arising from this work because it is one of the few publicly available examples of the study of S-PCN from outside of the USA and Europe that could be found by ETSI.

The report [4] identifies the following issues as relevant to the development of the personal wireless service:

- licensing;
- technologies;
- standards;
- spectrum;
- numbering;
- radio emissions;
- privacy;
- interceptability (defined as the capability of "listen(ing) or record(ing), by any means, ... a communication in its passage over (the) telecommunications system without the knowledge of the person making the communications").

Several recommendations arise from the discussion of the issues identified which are of importance in a general international context.

The Australian Spectrum Management Agency (SMA) will consider the introduction of S-PCN in the frequency bands 1 610 - 1 626,5 MHz and 2 483,5 - 2 500 MHz where there are a number of other radio systems operating in Australia. These two bands are used by Radio Astronomy sites, Radiodetermination service, Electronic News Gathering and low power radio systems including radio LANs. The segment 2 400 - 2 500 MHz is characterised by unlicensed use by industrial, scientific and medical applications. Because of this situation and the concern expressed by the Federation of Australian Commercial Television Stations (FACTS) about the use of the News gathering band, AUSTEL and SMA have recommended a careful frequency planning by S-PCN systems operating in Australia.

A mobile communications GSO system (AUSSAT - B) has been filed in the 1 610 - 1 626,5 MHz band and is under co-ordination procedure as it is possible to see in table 2a of this ETR.

With respect to the S-PCN proposals, particularly those providing voice service, AUSTEL considers them to be at an initial stage of development making any conclusion about the actual capabilities, market consequences and foreseeable system availability of such S-PCN systems premature. Developments in satellite personal communications services offered in Australia are not a main issue of the AUSTEL analysis. In 1994 an Australian operator is planning to introduce a "mobilesat" service anticipated to have some PCS features.

In the standards area AUSTEL has taken a position that does not directly address the S-PCN systems proposed. Development of standards for terrestrial elements of PCNs will be based on the DECT / DCS technology and, although regarding the satellite component of PCNs as needed in Australia, the development of standards for a foreseen national Australian satellite system, to be introduced by the year 2000, has to be based on a standard yet to be identified.

Licensing of S-PCN services in Australia anticipates fundamental issues on the national carriers rights:

> "the introduction, probably by foreign operators, of Low Earth Orbit (LEO) satellites and the services they will support, will raise new telecommunications issues pertaining to...the Telecommunications Act 1991 which gives the existing carriers exclusive rights in the provision of satellite facilities" [4].

The issues of privacy and interceptability are explicitly addressed in the AUSTEL position statement and report and show that there is actual concern on the implications of the new personal communications services in general. In particular it is interesting the clear distinction made by AUSTEL between information held by telecommunications carriers (fixed network operators) and information related to the provision of services by PCNs (mobile network operators).

Telecommunications carriers operations involve the handling of data including:

- customer information (including name and address for service and billing);
- traffic data; and
- traffic itself.

that could be delivered to third parties for provision of services (e.g. Calling Line Identification (CLI)), marketing purposes (telemarketing is brought as an example), directories etc.

Mobile network operations involve handling of data including:

- information on the user location;
- customer information;
- traffic data;
- traffic and related "encryption safeguards".

7 Current S-PCN activities relevant to standardization

7.1 Work within ETSI

In addition to the activities within ETSI's TC SES that have lead to the development of this ETR, a number of other standardization tasks, of direct relevance to S-PCN, are being undertaken within ETSI at the present time.

7.1.1 ETSI / SES5 - Conformance test standards for S-PCN

The ETSI technical sub-committee responsible for standardization matters related to satellite services for mobile communications is STC SES5. As part of its work programme, SES5 has, in addition to other matters, two responsibilities of direct relevance to S-PCN standardization.

SES5 is responsible for developing ETSs for NGSO MSS TTE (i.e. effectively S-PCN). These ETSs are expected to cover the "envelope" standards for conformance testing and would concentrate basically on interference and safety aspects of S-PCN handsets operating in the 1,6 / 2,4 GHz band and the 2 GHz band and also certain essential Network Control Functions (NCF) for S-PCN networks. Regarding the EMC and safety aspects, SES5 has put a liaison statement to ETSI technical sub-committee RES9 requesting the development of suitable standards, as these aspects are outside of the responsibility of SES5. Effectively, the ETSs developed by SES5 for S-PCN handsets will define only aspects related to essential requirements under European Directives.

ETSI Technical Assembly (TA) has decided that the work on developing these "envelope" standards should begin before the completion of the work leading to this ETR and, through TC SES, has directed SES5 to begin its work accordingly. In consequence, this ETR is forced to address matters related to these "envelope" standards in parallel to work on their development, currently being undertaken within SES5. The approach taken in this ETR, therefore, regarding the "envelope" standards is to address what is required under the essential requirements as set out in Directives, particularly reviewing how the Directives are interpreted by ETSI to apply to S-PCN. A number of difficulties and possible inconsistencies with the interpretation of the Directives are also identified, and these are discussed in subclause 9.1.

SES5 is also responsible for developing standards for mobile earth stations in the satellite component of UMTS (see subclause 7.2). SES5 is also responsible for dealing with matters related to the UMTS satellite component raised by ETSI technical sub-committee SMG5 and addressed to SES5 in liaison statements.

7.1.2 ETSI / SMG1 - GSM interworking with satellite mobile systems

An ETSI TC SMG Phase 2+ work item (on "satellite systems interworking"), studying the "total global mobility to GSM subscribers", is of specific relevance to the issue of S-PCN dual / multi-mode handset.

The work item is structured into Service aspects, Man-Machine-Interface (MMI) aspects, some preliminary transmission and charging aspects.

Service aspects identified are:

- service integration (see ETR 093 [1]);
- SIM roaming between systems;
- terminal roaming between systems (dual-mode);
- handover both (GSM-to-satellite and reverse direction).

MMI aspects include:

- automatic / manual network selection;
- indications on the terminal dedicated to the satellite access.

It is critical that such a work item is developed in a co-ordinated way with other possible standardization activities carried on by ETSI, further to the envelope standards previously mentioned.

7.1.3 ETSI / SMG5 - Satellite component of UMTS

Technical sub-committee STC SMG5 of ETSI is the body that co-ordinates the European contributions to the work of ITU TG 8/1 on FPLMTS (or IMT 2000). SMG5 drafts its contributions to TG 8/1 by working towards a European standard for FPLMTS, called UMTS (the Universal Mobile Telecommunications System).

UMTS will observe FPLMTS rules but the standardization of UMTS will be deeper than for FPLMTS because UMTS will be a full system specification including conformance test specifications.

A considerable interest in satellite communications has arisen. SMG5 addresses satellite communications as an integral part of UMTS. SMG5 established a subgroup working on satellite communications (WG SAT) to make sure that the aspect received sufficient attention.

There is a strong interaction between the work in SMG5 and in TG 8/1. In general SMG5 works to remain ahead of TG 8/1, and from this position it contributed with many documents to TG 8/1, normally via its Region 1 rapporteur.

Permanent reference documents:

SMG5 is in the process of drafting a number of ETRs in numerous series. These series address similar issues to the documentation that is being built up by TG 8/1, but the number of Recommendations is much greater. SMG5 has set-up a structure of series of reports for a completely defined system, including specifications that are necessary to establish the type approval.

The satellite aspects are covered by the 12-series of reports. These contain:

12.01: Framework for satellite integration within the Universal Mobile Telecommunication System;
12.02: Technical characteristics, capabilities and limitations of mobile satellite systems applicable to the Universal Mobile Telecommunications System (UMTS).

12.01 reflects the view of SMG5 on how the satellite should form an integral part of UMTS. Whereas 12.02 covers background information.

7.2 Work in other organisations

In addition to activities within ETSI, a number of other international bodies are working on standardization matters related to S-PCN. This work may be of direct application to ETSI activities and it is important to report on what is happening in these other organisations, how things might develop there and how these developments might affect the possible standardization work of ETSI.

7.2.1 Activities within the ITU

The International Telecommunications Union (ITU) is addressing a number of matters in the area of S-PCN and related subjects. Most of this work is being undertaken within the Radiocommunications Sector of the ITU, (abbreviated as ITU-R), which embodies much of the work of the former CCIR.

The ITU-R is tasked, in Article 11 of the International Telecommunications Convention [83], with meeting the objectives of the ITU in matters relating to radiocommunication, by:

- ensuring the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including those of the geostationary-satellite orbit;

- carrying out studies without limit of frequency range and adopting Recommendations on radiocommunication matters.

To meet its objectives, the ITU-R is structured into a number of permanent Study Groups (e.g. SG4, the fourth study group of ITU-R), which take the overall responsibility for developing Recommendations (that may contain standards) within their area of responsibility. To assist them in their work, the Study Groups have reporting to them a number of effectively permanent Working Parties (e.g. WP4B, the second Working Party of SG4), each tasked with undertaking work in specific areas of responsibility and preparing texts for input to the Study Group for formal consideration and adoption as agreed ITU-R texts. In parallel with the structure of permanent Working Parties, the Study Groups may also form less permanent Task Groups (e.g. TG 4/5, the fifth Task Group of SG4) which are focused on a specific task and would usually be dissolved once it is completed. The group structure is represented in figure 2.

The ITU Telecommunications Standardization Sector, ITU-T, is structured in a similar way to ITU-R but addresses telecommunications standardization other than radio system matters.

The following subclauses identify the Working Parties and Task groups of ITU-R and ITU-T which are of relevance to S-PCN and present the elements of the ITU work that should be taken into account when considering the development of standards for S-PCN.

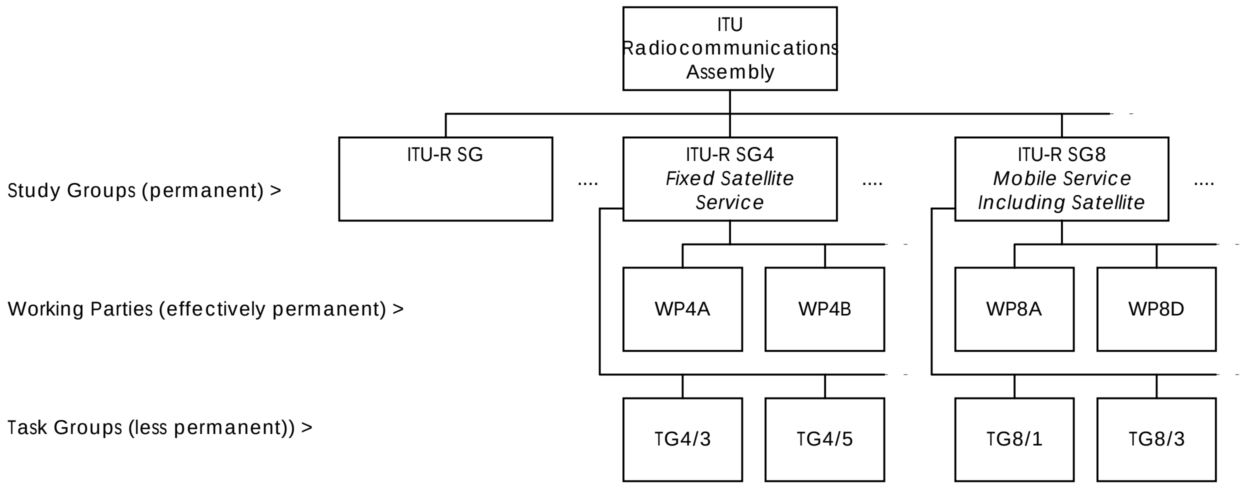


Figure 2: The relationship between the component elements of the ITU Radiocommunications Sector

7.2.1.1 ITU-R WP 8D and TG 2/2 - sharing in MSS service bands for GSO and NGSO networks

WP 8D addresses all mobile satellite services except the amateur satellite service, radiodetermination satellite service and public correspondence (officially: public telephone service) with aircraft. So far WP 8D had only three meetings, the last one in October - November 1993. The work of WP 8D does not have a direct effect on the position of applicants for co-ordination of satellite networks, it provides the basis for work at radio conferences where the administrative procedures and technical criteria are determined or reviewed. Although the expertise in ITU-R for matters related to mobile satellite systems resides within WP 8D, ITU-R has, in order to speedily progress studies in advance of WRC-95, established a task group of Study Group 2, TG 2/2, with a mandate to investigate all inter-service sharing matters in the bands 1 - 3 GHz. Where inputs to the work of TG 2/2 in the area of mobile satellite communications are required, then WP 8D has a role in providing this, and putting liaison statements to TG 2/2.

The work of WP 8D is structured according to 15 study questions. Of these there are 6 that are relevant to S-PCN:

Question 82-2/8	System concepts of the mobile-satellite service;
Question 83-2/8	Efficient use of spectrum and sharing;
Question 84-2/8	Potential types of orbit in mobile-satellite services;
Question 85/8	Availability of circuits in mobile satellite services;
Question 87-2/8	Transmission characteristics for a mobile-satellite communications system;
Question 88/8	Propagation and mobile earth station antenna characteristics for mobile satellite services.

Of all the subjects that are being debated in WP 8D and TG 2/2, there are a few that attract extra attention:

a) Sharing between the MSS and the fixed service. There is a practical problem that emerges because there is a vast number of fixed service links with a primary status on frequencies that are also foreseen for MSS. This problem exists predominantly in the USA, but to a lesser extend also in Europe. WP 8D prepares a working document towards a draft new Recommendation that considers frequency sharing in the 1 - 3 GHz range between MSS systems using geostationary satellites and systems in the fixed service. It is a catalogue and summary of studies in this field. TG 2/2 deals more generally with sharing between different services in the 1 - 3 GHz band, and focuses more on matters related to NGSO MSS systems. Work in TG 2/2 seems to show that sharing between FSS and MSS in the band 1 - 3 GHz will be feasible;

b) WP 8D develops a working document (doc. TEMP 110) towards a draft new Recommendation concerning the need for a co-ordination threshold in MSS allocations (1 - 3 GHz) shared with FSS. The document (applying to GSO as well as NGSO) addresses the question of whether in MSS allocations which are shared with the fixed service, the sharing criteria should be fixed limits or threshold values which trigger co-ordination discussions leading to sharing agreements;

c) The CDMA proponents are establishing recognition in the ITU of the sharing characteristics related to CDMA. As a technique, CDMA is not at all new (it is already in use in a number of mobile satellite networks). For consideration of CDMA systems in sharing problems the ITU is establishing generally accepted sharing characteristics of such systems. In connection with this, WP 8D is developing a preliminary draft Recommendation (doc TEMP 121) containing technical considerations for the co-ordination of MSS systems utilising CDMA and other spread - spectrum techniques in the 1 - 3 GHz band.

Some of the material that WP 8D is preparing in the field of S-PCN is summarised below to indicate its further activities. The working documents of WP 8D are so-called "Temporary Documents". Unlike the name suggests, in ITU-R a TEMP document is not an input document but a document produced by a meeting. It can be forwarded to the next higher body or be maintained as the working document. Examples of these working documents are:

- a draft new Recommendation regarding sharing criteria to permit frequency sharing involving geostationary and low-earth orbit RDSS / MSS satellite systems for 1 - 3 GHz. The draft Recommendation include two annexes concerning computer support. One of the annexes addresses statistical incidence of interference as a basis for a co-ordination method. (doc. Temp 10);

- WP 8D compiles a reference document, summarising the characteristics of current and proposed mobile satellite systems, including those supporting S-PCN. (doc Temp. 43);

- a method for determining power flux-density from NGSO satellites. This concerns the instantaneous power flux-density levels from satellites in the MSS;

- WP 8D is developing a draft new Recommendation related to the interferences from MSS networks operating in the space-to-earth direction into networks operating in the earth-to-space direction in the frequency band 1 613,8 - 1 626,5 MHz;

- different levels of integration of terrestrial and satellite mobile communications are described in doc Temp 85.

7.2.1.2 ITU-R / TG 8/1 - satellite component of FPLMTS / IMT-2000

7.2.1.2.1 Study questions

In 1978, the CCIR adopted a study question 39, of which there exists now a later version (Question 39-3/8) on "Future public land Mobile telecommunication systems". In 1986 Question 77/8 (now 77-1/8) was adopted on "The adaptation of radiocommunication technology to the needs of developing countries". In 1988 question 82/8 (now 82-2/8) was adopted on "system concepts of the mobile satellite services".

7.2.1.2.2 Establishment

TG 8/1 was established in 1986 as Interim Working Party IWP 8/13, to work on the Future Public Land Mobile Telecommunications System (FPLMTS). Originally the satellite component did not receive much attention in TG8/1 but later a subgroup (working group 5) was established to consider specifically the satellite aspects. The three study questions listed above are relevant for the work of TG 8/1 where question 39-3/8 is receiving the most attention, with less importance being given to the other two.

Working group 5 addresses the satellite related aspects in the broader framework of FPLMTS. The work is therefore not only addressing an S-PCN network in isolation but also in relation to terrestrial mobile communications. This reflects on matters such as the definition of services that should be supported but also on the important discussion on integration of the satellite component into a terrestrial network as opposed to interworking between completely self-contained satellite networks and terrestrial networks.

7.2.1.2.3 Recommendations

TG 8/1 is in the process of drafting a number of Recommendations, not all of these Recommendations are in the same state of advancement:

ITU-R Rec. M.687-1:	"Future Public Land mobile Telecommunications Systems (FPLMTS)" [12].
ITU-R Rec. M.816:	"Framework for services supported on FPLMTS" [13].
ITU-R Rec. M.817:	"Network architecture for FPLMTS" [14].
ITU-R Rec. M.818:	"Satellite operation within FPLMTS" [15].
ITU-R Rec. M.819:	"FPLMTS for developing countries" [16] (see also Temp/123 rev. 2).
FPLMTS.RREQ:	"Requirements for the radio interface(s) of FPLMTS".
FPLMTS.RFMK:	"Framework for the radio interface(s) and radio subsystem functionality for FPLMTS".
FPLMTS.SCRT:	"Security principles for FPLMTS" (Temp / 135 rev. 2).
FPLMTS.NMGM:	"Working document towards draft new Recommendation on framework of FPLMTS network management" (Temp 134 rev. 1); see also Temp / 132.
FPLMTS.PRQ:	"Speech and voice band data performance requirements for future public land mobile telecommunications system" (FPLMTS) (Temp / 128 rev. 1).
FPLMTS.SFMK:	"Framework for the satellite component of FPLMTS" (Temp / 157).
FPLMTS.RSPC:	"Radio interface specification for FPLMTS" (Temp / 147).
FPLMTS.RSEL:	"Procedure for selection of radio transmission technologies for FPLMTS" (Temp / 158).
FPLMTS.SECPR:	future new Recommendation "Requirements for security procedures".
FPLMTS.RFRQ:	draft ITU-R Recommendation "Spectrum consideration for implementation of FPLMTS in the bands 1 885 - 2 025 and 2 110 - 2 200 MHz".

Some of these Recommendations (the ones with numbers) have been published. Until the Recommendations are published, they have the generic indication FPLMTS and an extension that reveals the subject. In this way FPLMTS.SAT became ITU-R Recommendation M.818 [15].

TG 8/1 considers itself as the general system architect. Being the architect it recognises the competence of other groups of the ITU.

Concerning sharing problems regarding the radio links of satellites the most relevant entities are:

- WP 8D;
- TG 8/3;
- TG 2/2 (used to be named TG 12/4);
- WP 4A and
- TG 4/5.

ITU-T SG1 is involved in the definition of services and SG11 for network aspects.

The work of TG 8/1 depends on contributions from the work in various regions. The regions that contribute are mainly Europe, the USA and Japan. The contributions from the various regions may be internally co-ordinated, depending on the substance of the regional co-operation.

- in the USA there is regional co-operation in the Joint Technical Committee (JTC), see subclause 6.3.1.2;
- in Europe the regional co-operation is co-ordinated by ETSI in SMG5, see subclause 7.1.3;
- in Japan a FPLMTS co-ordination committee has been recently established.

In general, the work in TG 8/1 will not produce a single standard that includes a detailed description about all of the aspects of the established standard that the whole global community has to adhere to. The precise extent of the work by TG 8/1 is still open. Although there are sub groups in TG 8/1 that have tasks such as the creation of a framework for the selection of the radio access techniques, it is unlikely that a single technique will actually be chosen. In TG 8/1 there are participants from various camps with their own (essentially commercial) interests, and TG 8/1 does not address IPR issues. What seems achievable is that the various techniques are presented alongside each other, because for each of the proponents, it is vital mainly for commercial reasons to have its technology included in the ITU publications.

The expected output of TG 8/1 may be limited to a description of what FPLMTS is, indicating how the various techniques can be incorporated into a global system of co-operating networks. Clearly, TG 8/1 is not the type of body that will produce any mandatory standard like a type approval standard for FPLMTS terminals. The force behind the work of TG 8/1 depends on the implementation on a regional level and supporting regional regulations.

Regarding satellite matters, it seems that TG 8/1 is not going to make a selection for only one single type of orbit configuration for FPLMTS. In the elaboration of aspects that are related to the space component this will then be taken into account and the services that are available to users will depend on both the environment where the user is positioned (urban, rural etc.) and the orbit constellation from which the user is served.

Also TG 8/1 will not make a choice regarding satellite communications to be provided by:

- completely self contained networks; or
- integrated in terrestrial mobile networks with only a separate space component.

In this respect the views have developed as time went on. At an earlier stage, the documents about satellite operation within FPLMTS presented the satellite part of FPLMTS as a completely separate network (this approach was strongly supported by the USA delegation). At present, the documentation also includes the possibility for systems where all the network aspects are basically contained in a PLMN (or fixed network) like GSM and a satellite component is used for extension of the coverage of terrestrial networks to a global scale, as well as for filling gaps in terrestrial coverage.

7.2.1.2.4 Identification of interfaces to be standardized

TG 8/1 has established an ad hoc group (Ad hoc group 1) "Correspondence group on identification of interfaces of FPLMTS interfaces to be standardized". (Temp / 156, Temp / 162, Temp 124) to consider the interfaces that may need standardization. This group is preparing a document which is still in a draft state. It addresses:

- the relative merits of standardization;
- the objectives of interface standardization in FPLMTS;
- concerns regarding interface standardization in FPLMTS.

Starting from the diagram representing the FPLMTS Network functional reference model (refer to figure 2 in ITU-R Recommendation M.817 [14]) conclusions are drawn which are still the subject of frequent and substantive changes in the document.

Of interest is the history of this ETR. At first it contained a number of objectives for standardization of interfaces, many of which came from European participants. These addressed matters like:

- similarity of equipment;
- safety of use and environmental friendliness;
- development of mass market for consumer products;
- minimisation of risk for manufacturers and protection of IPR;
- to create or broaden a market for network elements.

Although some of these objectives may be valid in Europe, they could not be sustained in the global forum of ITU. These objectives are now replaced by:

- terminal roaming;
- personal roaming;
- call delivery to and from other networks;
- equal access to and from FPLMTS components;
- multiple equipment vendors;
- cost reduction.

The interim conclusion is that intra- and inter-network interfaces should be standardized:

- to support personal mobility, including UPT;
- to support transmission independent access features.

7.2.1.2.5 Migration towards FPLMTS

Migration is a method to ease the access to a new technology, in general by enabling the transition from a former technology to be spread out in time by making small steps.

Migration has become a topic for discussion in TG 8/1 since 1993. The subject was first addressed mainly on the occasion of a contribution from the USA (doc. 8-1/350) that addressed FPLMTS inter-system compatibility. TG 8/1 then established an ad hoc group (Ad hoc group 2) "Correspondence group on Migration towards FPLMTS".

In TG 8/1 migration is considered as a possibility to break out of the vicious circle that for FPLMTS to be attractive, there needs to be first a large-scale FPLMTS system coverage achieved, whilst as long as that does not exist FPLMTS remains less attractive for implementation. By migration the advantages of FPLMTS can be achieved earlier if preceding networks could be made compatible with FPLMTS on a number of aspects, such as support for UPT etc.

Secondly, the ad hoc group recognised that migration to FPLMTS from earlier systems may ease FPLMTS introduction by enabling a higher degree of re-use in the FPLMTS network infrastructure of elements from the earlier system. The speed of technological advancement is considered so fast that there is ample time to recover the costs of installing an infrastructure by operating it, before a newer infrastructure, based on a later technology, presents itself.

Depending on the further development of the work on migration in TG 8/1, it may very well be that in the future all the GSM and DCS-1800 networks could become FPLMTS compatible (or IMT 2000 compatible), especially since many of the "advanced" FPLMTS features are already common daily practice in GSM and in DCS-1800.

Increasingly, S-PCNs are perceived as part of the migration path towards FPLMTS.

7.2.1.2.6 FPLMTS and UPT support

UPT is studied in ITU-T by Study Group 2, in ETSI by the technical sub-committee STC NA7. The developments in UPT are closely followed by TG 8/1 as well as by ETSI STC SMG5.

UPT provides personal mobility, in addition to the terminal mobility. This means that in time the user can be registered on different terminals. In the case of S-PCN those terminals themselves are physically mobile.

For mobile communications, especially since GSM, the principles that are pursued by UPT are not new. GSM introduced the separation between the identity of a terminal and the identity of a subscriber. Simply by inserting his SIM card in a different terminal, the subscriber achieves personal mobility in the sense of UPT. The discussion on mobility in fixed networks started only after GSM mobility was devised.

UPT has been described by ETSI technical committee TC NA in:

TCR-TR 007:	Network Aspects (NA); Universal Personal Telecommunication (UPT); UPT vocabulary.
ETR 055:	Network Aspects (NA); Universal Personal Telecommunication (UPT); The service concept.
ETR 065:	Network Aspects (NA); Universal Personal Telecommunication (UPT); Requirements on charging, billing and accounting.

and by ITU-T Study Group 2 in:

ITU-T Rec. I.114:	Vocabulary of terms for universal personal telecommunication.
ITU-T Rec. F.850:	Principles of universal personal telecommunication (UPT).
ITU-T Rec. F.851:	Universal Personal Telecommunications (UPT) - Service description.
ITU-T (draft) Rec.:	Charging and Accounting in UPT.

Discussions on UPT in FPLMTS / UMTS groups led to the common understanding that such networks should be able to support UPT. It should even be possible to register multiple UPT users on a single S-PCN handset.

FPLMTS as well as UMTS foresee the use of a removable user identity device, comparable to the GSM SIM card. It seems reasonable to expect the same from S-PCN proposals.

The relation between UPT numbering and S-PCN support is addressed in subclause 9.2.2.1.4.

Most interesting is the discussion on the type of identity to which a UPT user is associated in the S-PCN network, the S-PCN subscriber identity or the equipment identity. For systems with removable user identity devices it seems that the equipment identity is the best choice because otherwise registrations of UPT users would travel with the S-PCN subscriber to other terminals.

In TG 8/1 some concern has risen since an FPLMTS subscription will provide personal mobility between different FPLMTS terminals and roaming throughout other FPLMTS networks only, whilst UPT provides in addition roaming throughout different types of networks. A UPT subscriber therefore does not need a FPLMTS subscription to roam into an FPLMTS network and hence a UPT subscription offers more mobility than an FPLMTS subscription. However, since the identification and authentication procedures in UPT and in FPLMTS can be very similar, the limitations of roaming by FPLMTS subscribers to only FPLMTS networks might be removed by proper standardization.

7.2.1.3 ITU-R WP4A and TG 4/5 - Sharing between NGSO MSS feeder links and FSS

7.2.1.3.1 Background

Working party 4A is a sub-group of Study Group 4 (SG4) of the Radiocommunications Sector of the ITU. SG4 deals with matters related to the Fixed Satellite Service (FSS) and, since the feeder links of MSS networks usually occupy FSS bands (Refer to RR No. 22 [9]: "... the fixed satellite service may also include feeder links for other space radiocommunication services"), then SG4, initially through WP4A and later through TG 4/5, has a responsibility for studying the sharing problems which will arise in the case of sharing between non-geostationary MSS feeder links and geostationary FSS links and also mutually between pairs of non-geostationary MSS feeder links. SG4 is expected to propose sharing approaches to facilitate the use of the FSS bands by NGSO feeder links, or where sharing is found to be impossible, to propose alternative approaches. (This subclause has been based on information provided to ETSI by the Chairman of ITU-R WP4A.).

7.2.1.3.2 Study questions

When WARC-92 allocated service link spectrum to the MSS and adopted in its Final Acts [8] Resolution No. 46 (Res. 46) "Interim Procedures for the Co-ordination and Notification of Frequency Assignments of Non-Geostationary-Satellite Networks in Certain Space Services and the Other Services to Which the Bands are Allocated", as the interim procedure for co-ordinating its assignment and use, the feeder link sharing issue was not considered in detail although ITU-R was requested to study it urgently. Four relevant questions were adopted by ITU-R (55-2/4, 206-1/4, 205/4 and 219/4):

- Question 55-2/4 - Use of the fixed-satellite service for feeder links in the mobile-satellite service to geostationary satellites;

- Question 205/4 - Frequency sharing between non-geostationary satellite feeder links in the fixed-satellite service used by the mobile-satellite service;

- Question 206-1/4 - Sharing between non-geostationary satellite feeder links in the fixed-satellite service used by the mobile-satellite service and networks of the fixed-satellite service using geostationary satellites; and,

- Question 219/4 - Sharing between non-geostationary satellite feeder links in the fixed satellite service used by the mobile satellite service and links in the fixed service.

SG4 was made the lead study group to deal with these questions. Initially it fell to WP4A to deal with the questions and, by October 1993, four substantial reports had been generated. At that time, however, WP4A did not focus on specific Recommendations. In November 1993, considering that the Conference Preparatory Meeting for WRC-95 (CPM-95) has its deadline for input texts on 5 January 1995, the Radiocommunications Assembly decided to form a new Task Group of SG4 specifically to deal with these matters. The new Task Group 4/5 (TG 4/5) will build on the work done in WP4A and aims to complete its work by November 1994 to meet the CPM-95 input deadline. It is expected to generate draft new Recommendations and / or Report elements establishing sharing criteria, technical and operational criteria and frequency band proposals for MSS feeder links utilising FSS spectrum.

7.2.1.3.3 Work programme for TG 4/5

The work programme of TG 4/5 addresses the study questions set out above, and is summarised in the following subclauses.

7.2.1.3.3.1 Sharing between NGSO feeder links and GSO networks

In respect of question 206-1/4, the following work is being undertaken by TG 4/5:

- describe technical characteristics of FSS allocations between 3 GHz and 31 GHz;

- develop and assess the feasibility of methods to operate NGSO feeder links in FSS bands:
    - co-ordination methods;
    - PFD, EIRP limits;
    - designation of specific FSS band portions for NGSO MSS feeder links;
    - reverse band working of feeder links in FSS bands;
    - other;
- continue statistical studies of interference to develop protection criteria, interference allocations etc.;
- prepare report elements and / or Recommendations;
- develop sharing criteria and interference protection criteria to protect both GSO FSS networks and NGSO MSS feeder links;
- develop technical and operational criteria for the application of RR 2613 to FSS allocations; and,
- identify any frequency band for potential new FSS allocations to be used for NGSO MSS feeder links.

7.2.1.3.3.2 GSO to GSO sharing

Addressing question 55-2/4, the following work items are being carried out:

- develop and assess the feasibility of methods to operate GSO feeder links in FSS bands:
    - co-ordination methods;
    - PFD, EIRP limits;
    - designation of specific FSS band portions for GSO MSS feeder links;
    - reverse band working of feeder links in FSS bands;
    - other.
- develop technical and operational sharing criteria and interference protection criteria to protect both GSO FSS networks and GSO MSS feeder links;
- identify any frequency band for potential new FSS allocations to be used for GSO MSS feeder links.

7.2.1.3.3.3 NGSO to NGSO sharing

In respect of question 205/4:

- develop and assess the feasibility of methods to operate NGSO feeder links in FSS bands including bands being used for NGSO FSS systems:
    - co-ordination methods;
    - PFD, EIRP limits;
    - designation of specific FSS band portions for NGSO MSS feeder links;
    - reverse band working of feeder links in FSS bands;
    - other;
- continue statistical studies of interference to develop protection criteria, interference allocations etc.;
- prepare report elements and / or Recommendations;
- develop technical and operational sharing criteria and interference protection criteria to protect both NGSO FSS networks and NGSO MSS feeder links;
- identify any frequency band for potential new FSS allocations to be used for NGSO MSS feeder links.

7.2.1.3.4 Possible outcome of studies

Whilst it is difficult to prejudge the outcome of the work within TG 4/5 prior to its completion, it is possible to make a reasonable review of the likely possible outcomes, based upon a knowledge of the work of WP4A and activities within TG 4/5 so far.

For the GSO to NGSO sharing case, the possibilities appear to be:

- if NGSO feeder links are implemented in forward band mode, RR 2613 will need to be implemented in order to avoid an unacceptable number of "in-line" interference bursts into the GSO networks, and even more so into the NGSO feeder links themselves. Implementing RR 2613 is likely to be expensive for the MSS operators and will have a potential impact on their services;

- if NGSO feeder links are implemented in reverse band mode, the interference is likely to be tolerable for both NGSO and GSO systems, but co-ordinations in the manner of RR Appendix 28 (i.e. the identification of co-ordination contours based on over-ground interference propagation) will be necessary for the determination of suitable NGSO feeder link sites. The implication of this is that frequency bands used heavily for small-dish services will need to be avoided, otherwise the number of co-ordinations would be impractically high. The FSS Allotment Plan bands are technically ideal for this use, but this may be a "politically" difficult decision because the Allotment Plan bands were set aside specifically to provide "equitable access" for all nations to the spectrum and orbit resource and the perception that some nations were trying to encroach on these bands might be likely to cause dissent. It should be noted that use of the "normal" FSS bands in reverse band mode for MSS feeder links means that feeder link earth stations are unlikely to be able to be located at existing FSS earth station sites if the same frequencies are already in use at those sites. Also, Ka-band is not good for reverse band feeder links because of the severity of rain attenuation at around 30 GHz leading to a requirement for significant downlink power control;

- an alternative solution is to allocate some exclusive spectrum for NGSO feeder links, but this could potentially mean displacing those "normal" FSS networks which might be utilising the band. Because it is at present very lightly used, Ka-band is the most likely band should this solution be adopted. It has yet to be shown, however, that the feeder links for the NGSO networks will be able to mutually share the same band (even if it is free from GSO networks) and potentially there could thus be a significant demand on the Ka-band FSS spectrum to accommodate MSS feeder links;

- there has been some discussion about the practicality of locating MSS feeder links outside of the FSS allocations, but this seems unlikely to find favour with the other users of the spectrum and may not get very far as a proposal.

For the NGSO to NGSO case:

- if (and as already stated, this is not yet proven) the feeder links of several NGSO constellations can share with each other it will certainly be easier for users in the FSS and FS (except, perhaps, for the MSS feeder link operators themselves);

- the analysis of the NGSO to NGSO statistics requires full constellation computer modelling and extensive simulation, which, as yet, seems not to have been developed.

For the GSO to GSO case:

- although there is a question on this subject, it would seem that the sharing situation is really no different from FSS networks in GSO sharing frequencies and is unlikely to be treated any differently.

The outcome of this work should be known when the inputs to CPM-95 are finalised early in 1995. The final results will depend on the decisions taken at WRC-95, planned to take place in late 1995.

7.2.1.4 Relevance of ITU work to ETSI standardization activities

ETSI is not responsible for work in standardizing matters related to spectrum allocations, interference protection, sharing criteria, etc. which are within the responsibility internationally of ITU-R and within Europe of CEPT. Nevertheless, the work of ITU should be kept under review by ETSI during its standardization activities, as the decisions of ITU may impact on several of the areas in which ETSI will undertake standardization work. For example:

- the choice of frequency band for MSS feeder links may impact on standards for spurious emissions, protection of terrestrial radio services, even RF safety;

- the selection of a service-link band sharing method may impact on standards for network control and monitoring, service availability, service coverage, etc.;

- the selection of a feeder-link band sharing method may have implications for the gateway operation with effects on availability, may determine numbers of gateways with an effect on how they may integrate with the terrestrial network, etc.

The work of ITU-R in the development of FPLMTS is perhaps of much more direct relevance to the development of standards for S-PCN by ETSI. These activities are already being taken into account or even being led by ETSI SMG5 in the development of the satellite component of UMTS (see subclause 7.1.3) and the work on the satellite component of UMTS / FPLMTS may also generate useful inputs to the S-PCN activities, especially if S-PCN is to be regarded as part of the migration path to the satellite component of UMTS / FPLMTS.

The ITU activities on UPT are elaborated for mobile communications by TG 8/1. The conclusions of TG 8/1 create guidance for the work of SMG5, which on the other hand provides input to the TG 8/1 elaboration process. SMG5 should maintain an independent position in its appreciation of the results from TG 8/1 and draw its own conclusions regarding what should be reflected in the ETSI documentation on UMTS.

7.2.2 CEPT activities

There are several Working Groups and Project Teams in the CEPT / ERC hierarchy, dealing with the subject of Satellite Personal Communications Services (S-PCS) within the framework of the WRC-95 preparations. All input to the WRC-95 is co-ordinated and discussed within the Conference Preparatory Group (CPG) of the ERC. Firm views are, therefore, not available at the present.

The following subclauses review the current status of relevant activities within ERO and the CEPT / ERC Spectrum Engineering (SE) working group.

7.2.2.1 ERO activities

A specific study on S-PCS has been started by the ERO. The study is on frequency issues related to the introduction of S-PCS in Europe. It is being conducted under a contract from the EC and will study the need for, and use of, frequency spectrum for S-PCS systems which are planned to be introduced later in the decade (The information in this subclause has been provided to ETSI by the ERO S-PCS project leader).

The foreseen introduction of S-PCS is expected to put a great strain on the available quantity of spectrum currently scheduled for use by these systems, and on the conditions for use of this spectrum.

Global agreements on the allocation of spectrum during WARC-92 and the foreseen discussions during WRC-95 and WRC-97 are indicative for the magnitude of the current issues at hand. Domestic licensing of systems in the USA is advancing rapidly and the global implications of the USA domestic use requires early and careful consideration. Furthermore, increasing confidence in the viability of the systems and the addressable market demand requires reflection on the quantity of spectrum which needs to be made available over time, its allocation and its use.

Careful preparation of a European position for the forthcoming WRC-95 conference is not only based on the size of the market in Europe, but also on the spectrum requirements around the globe where European space and telecommunications industries have a clear interest in supplying services and equipment, is a pre-condition to a successful European participation in this new market.

The ERO study incorporates the following tasks:

- to review the quantity of spectrum planned to be made available in Europe and around the globe for S-PCS through geostationary and non-geostationary satellite systems including uplink requirements;
- to review this against latest market studies and other priorities of use for the band;
- to identify and review any foreseen licensing procedures for S-PCS in CEPT member countries in relation to frequency aspects;
- to propose a detailed plan in which spectrum availability, spectrum usage conditions, sharing criteria, interference and other frequency issues are treated on the basis of a longer term strategy, which allows a timely introduction of S-PCS services within the global context;
- to analyse plans of other nations in this area and relate those to the detailed plans as outlined above;
- to propose a strategy in which the combined strengths of CEPT and the EC are called upon to jointly co-operate with other nations at a global level to reach agreement for a solution which is in favour of Europe's position on this matter.

Concerning the execution of this schedule, the ERO has envisaged the following schedule: a project team was formed consisting of ERO and three external experts that will complete the work requirement and produce a draft of the study including a draft European Common Proposal on this matter, which will be submitted to the CPG in time to be dealt with at its meeting in February 1995. The project team started its work in September 1994 and will finish in December 1994. The study should be finalised by ERO and presented to the European Commission in April 1995.

7.2.2.2 SE working group activities

Within the remit of the CEPT Spectrum Engineering (SE) working group is a consideration of the problems related to the sharing of MSS service and feeder link bands with other services utilising the bands. To undertake these studies, CEPT SE has formed two project teams, one to study the L-band service link sharing problems and one to deal with the feeder link problem.

To date, CEPT has not addressed the intra-MSS sharing problems (within both service and feeder links) which were outside of the terms of reference of both CEPT project teams. It is presumed that CEPT is relying on the work of ITU-R in this area. In any case, many CEPT members are playing an active part within the ITU-R groups dealing with intra-network sharing.

It is perhaps worth noting that Europe should be cautious to ensure that the conclusions of the USA NPRM do not become the de facto sharing approach also in Europe (because of possible incompatibility with the European situation) unless this is perceived as being clearly the approach also required for Europe.

7.2.2.2.1 Project Team 17 studying the compatibility between MSS and other radio systems in the 1 610 - 1 626,5 MHz band

CEPT / SE Project Team 17 (PT 17) is studying the compatibility between MSS and other radio systems in the 1 610 - 1 626,5 MHz band (i.e. the main band of interest for S-PCN uplinks and, for some systems, downlinks).

This work has been founded on work already carried out in other organisations, particularly FCC and ITU-R, supplemented by work from within the PT itself.

PT 17 has considered the following issues:

- sharing between MSS and the radio astronomy service;

- sharing between MSS and GLONASS;

- sharing between MSS and radar systems in Sweden;

- sharing between MSS and the Fixed Service.

The current results of this work are presented in the final report of the PT, annexed to [30].

7.2.2.2.2 Project Team 18 studying frequency sharing implications of feeder links for NGSO / MSS networks in FSS bands

SE has also addressed, within its Project Team 18 (PT 18), issues related to sharing between MSS feeder links and FSS systems in spectrum allocated to the FSS.

To some extent the work has duplicated the effort being undertaken within ITU-R SG4 (see subclause 7.2.1.3 above) but nonetheless the PT report presents a useful technical analysis of the problems and possible solutions (within, admittedly, the bounds of the PT 18 terms of reference).

The PT 18 report, executive summary annexed to [30], seems to come down in broad favour of the reverse band working solution to the sharing problem. It should be noted, however, that there are also arguments against this approach, as indicated in subclause 7.2.1.3.4 above.

7.2.3 RACE.SAINT project

The SAINT (SAtellite INTegration) project has been established within the framework of the Mobile and Personal Telecommunications Project Line (PL3) within the RACE 2 Programme and work started in January 1994. (This subclause has been based on information provided to ETSI by the RACE.SAINT co-ordinator.)

7.2.3.1 Objectives

SAINT aims to evaluate and identify the requirements for the integration of satellites into future mobile networks. A key focus is ETSI's UMTS (being developed by STC SMG5), in which satellite integration is expected to be mandatory.

The project will provide a set of Recommendations in services, radio, network and security aspects for the satellite integration in UMTS. The Recommendations are expected to contribute to the work of the appropriate standardization bodies.

7.2.3.2 Approach

The technical approach to be adopted during the SAINT project is as follows:

- initial phase:
    - definition of mobile services to be offered taking into account terrestrial UMTS services and Mobile Broadband Systems (MBS), which is a merging of the UMTS mobile communications concept with transmission capabilities of the B-ISDN broadband network;
    - development of a set of operational and functional requirements to satisfy user needs and network inter-operability constraints;

- subsequently:
    - developing a trade-off between a number of suitable UMTS scenarios, the service requirements and the selection criteria to arrive at the choice of an integrated system configuration.

For the remainder of the project activities, the integrated system will then be divided into two main sections:

- the space communication system, including the satellite constellation, associated control segment, gateways, user segments (terminals), which will be defined in terms of the following:

    - traffic;
    - space segment aspects, dealing with viable space techniques and satellite definition;
    - the air interface, either from the ATDMA project or the CODIT project;
    - impact on terminal technology;
    - Radio Resource Management (RRM).

- the UMTS terrestrial network, based on the MONET approach (specifically functional and architecture assessment, signalling aspects, databases distribution and access related to the satellite integration) regarding:

    - operations and procedures assessment;
    - interworking with other networks.

7.2.3.3 Expected outputs

SAINT outputs are expected to include the following:

- the set of operational, functional and radio channel requirements and limitations for the integration of satellite systems;
- the different integration scenarios and overlapping with the future mobile system UMTS;
- analysis of the different integration scenarios, based on a set of evaluation parameters and objectives;
- analysis of an optimised space communication system including Radio Resource Management (RRM), orbit selection, transparent or on-board processing, satellite architecture;
- definition of the necessary integration and / or interworking protocols and their evaluation;
- investigation on technology aspects for the terminals.

NOTE: In April 1994, the SAINT project produced its first output deliverable which dealt primarily with satellite related impairments and constraints (particularly orbit and constellation implications, propagation effects, and system constraints including terminal aspects, speech compression and channel coding) and also considered some frequency issues and analysed RF biological effects.

Standards proposals are expected to be submitted to ETSI to facilitate the work in standardizing the next generation of European mobile communications systems.

7.2.3.4 Relevance to ETSI standardization activities

The SAINT project seems to be of clear relevance to the work of SMG5 in developing the satellite component of UMTS, and it may also generate some useful inputs to any voluntary standardization programme that might be undertaken for S-PCN.

Some of the SAINT activity is concentrating on an analysis of the satellite component as a dedicated, single system, European specified space segment (i.e. SAINT is developing optimised orbits, satellite architectures, payload options etc.). This activity may not fit in so well with S-PCN, given the fact that currently all "first generation S-PCN" space segment options are proprietary and all quite different from each other. However, RACE seems likely to also lead to an analysis that could facilitate the likely "follow-ons" to these first generation S-PCN systems integrating into UMTS, either to provide an extension to the terrestrial UMTS networks or / and to provide a "satellite only" overlay UMTS network.

The work of SAINT is interesting to the standards development process and is therefore closely followed by both SES5 and SMG5 to ensure that its outputs are taken into account in ETSI work. It may be, however, that in the end, the work of SAINT will prove to be of more relevance to the satellite component of UMTS than to S-PCN. In the case of the approach in which the development of a unique European S-PCN standard is proposed, SAINT could perhaps provide an input to initiate this work.

7.2.4 COST Programme

The EURO-COST programme (EUROpean CO-operation in the field of Scientific and Technical research) is a European research programme including at least three projects which are of direct relevance to S-PCN systems.

7.2.4.1 Objectives

COST 227 on "Integrated Space / Terrestrial Mobile Networks" started in 1991 and are due to be completed by mid 1995. Other projects relevant to S-PCN are COST 231 on "Evolution of land mobile radio (including personal communications)" and COST 244 on "Biomedical effects of EM radiation".

COST projects are divided into specific research Tasks and sub Tasks to obtain co-ordinated results on each subject.

7.2.4.2 Approach

The COST projects are voluntary in nature and many members of the Management Committee can be found in the European research community also through National Administrations and operators. The membership is subject to the acceptance by members of the Management Committee and signing of a Memorandum of Understanding (COST-MoU). Some members joining COST are from countries outside the European Community, such as Hungary, Poland and others.

In COST 227, which is the COST project in which a significant interest in systems for satellite personal communications is shown in the contributions to all Tasks, the activities are as follows:

- Task 1 addresses the Orbit Selection problem;
- Task 2 is focused on Network Architecture;
- Task 3 deals with Radio Aspects.

7.2.4.3 Relation to ETSI standardization activity

As mentioned there are a number of areas of the projects where a direct reference to S-PCN type systems can be found. The result of the projects 231 and 227 could be taken into consideration especially when a standardization activity would involve system technology issues. A standardization by ETSI regarding the technical areas, including Network Aspects and TTE, as considered in this report, could make use of most of 227/231 expected results.

8 Objectives which could be achieved by European standardization

This ETR is the result of a top-down analysis and as such is structured so as to present first the objectives which might be considered as useful or desirable for Europe and then goes on to analyze the actual areas for possible standardization that might assist in achieving these objectives.

In this clause are summarised the various objectives that are identified as potentially relevant to policy makers and others to achieve their desired aims regarding S-PCN in Europe. This ETR does not make any judgement as to whether or not the policy might or should be implemented, but instead considers the technical standards that might be required to ensure that the policy is implemented. This clause considers the areas where technical standards might be required and cross-references to clause 9 where appropriate.

8.1 Unified European standards approach for satellite based networks

This study set out only to consider the possible standardization that might be developed for S-PCN systems. However, other work within ETSI, undertaken in parallel with this study, is reviewing the possible harmonized standards that might be developed for SES equipment (specifically VSAT, TVRO and mobile low bit-rate data terminals).

There is obviously the potential for some overlap between these areas of activity, and indeed it seems quite likely that the conclusions of one study could have a direct bearing on the other. In consequence, it was found to be useful to ensure a liaison between the two ETSI project teams developing the separate studies, to ensure a cross-fertilisation of ideas and to guard against incompatible conclusions.

A conclusion of this liaison is that where the application of the essential requirements is concerned, particularly where the development of harmonized standards, by ETSI through TBRs leading to CTRs, is considered, then a unified approach for satellite based networks could be considered as a key objective. This is particularly important as the distinction between fixed and mobile, VSAT and S-PCN networks is blurred, e.g. a recently proposed multi-satellite network, which appears to be part VSAT, part S-PCN. It is important to ensure that two separate, perhaps incompatible, regimes are not developed for these different classes of systems, leading to an uncertainty of their application in the grey area between the system classes.

With this in mind, the analysis presented in this report, as it applies to the possible development of harmonized standards, has been co-ordinated with the analysis presented by ETSI in ETR 169 [55] for SES equipment.

8.2 Establishment of a common European position on an S-PCN infrastructure

This subclause addresses the European interests in S-PCN, and considers the option of a European initiative for an S-PCN infrastructure.

European interests in S-PCN should be to reinforce:

- involvement in design of S-PCNs by European industries and universities;
- involvement in manufacture by European industries;
- involvement in operation of S-PCN by European based operators and service providers;
- service provided to the European user community.

However, the present situation is characterised by the fact that there is no strong European initiative with respect to S-PCN.

This lack of activity in Europe will make it more difficult to become active in the future as the frequencies to be used by S-PCN are now being assigned to system proponents and as system proponents are now establishing commercial arrangements with various partners all over the world. There will be few frequencies available for late initiatives. It will be more difficult to find capital for later activities.

Furthermore, there is permanent development in the ITU of the criteria to be used for sharing between systems. These developments are focusing on transmission techniques of systems that have been proposed already. This makes it possible for those systems to achieve the best co-ordination results and makes it difficult for later proposals to still find a place in the spectrum.

Trying to keep the options open for European initiatives in the future, as important as it is, does not create heavy European involvement.

For the better European involvement in design, manufacture and operation of S-PCN, it is desirable that there is a strong European initiative, a strong European system proposal.

The perspective on an initiative for S-PCN is determined by "environmental" factors:

a) Europe's land mobile operators are making heavy investments in terrestrial networks. Europe will be very well covered by terrestrial networks (GSM and ERMES), and thus the need for satellite personal communications is limited. Satellite personal communications do not have a high priority in the action plan of mobile telecommunications operators. No individual European operator is going to launch a satellite initiative;

b) each individual mobile operator would be concerned by the satellite communications if that emerges in the area where that operator provides services and most likely the operator would then wish to be in control of - or involved in - what emerges;

c) it is important to preserve the investments in GSM networks. Land mobile operators are not interested to support a development that could make it necessary to write off their present investments at a faster rate.

The fact that Europe has practically standardized on GSM, creates a special situation:

- ETSI TC SMG has recognised that it is possible to connect a satellite component to the A-interface of a GSM network, and established a work item to elaborate a further specification for this as part of its phase 2+ work programme;

- it is possible to connect to a single satellite component not just one GSM network, but for instance all the European GSM networks of operators that so wish;

- via such a shared satellite component, each GSM operator serves his own clients anywhere. Clients remain in their home network and maintain access to the Value Added Services and Supplementary Services that they are used to.

It should therefore be possible for every GSM operator to establish itself as an S-PCN (payload) operator, via a shared investment. At the same moment, the future lifetime of GSM infrastructure is extended well into the era of S-PCN.

A strong European initiative, based on such a migration from its GSM networks, offers a possibility for strong European involvement in design, manufacturing and operation of S-PCN. Such a proceeding would not only build on the success of GSM, but also contribute to an even greater success of the GSM standard.

There are actually two parties for which such proceedings should be of great interest:

a) the manufacturing industry currently involved in GSM. The scenario would create a considerable increase of their business into space communications because there is a growing number of GSM networks all over the world that could all be improved for satellite communications;

b) GSM operators, because a system that is really integrated with GSM can create excellent commercial possibilities to compete with separate satellite communications operators, and because it will preserve the investments in GSM infrastructure in the era of satellite communications.

It should therefore be possible to find investors for such a proposal not only amongst GSM operators, but also amongst the industry. It may be possible to obtain RACE funding for any necessary research.

8.2.1 Relation to standards

If there is support for such an initiative, then ETSI should establish a voluntary standard for an S-PCN, constructed as a shared space component for multiple satellite extended S-PCNs.

8.3 Creation of a competitive environment

The prospect of a competitive environment in the provision of S-PCN services requires a consideration of some technical areas and an analysis of the structure of the different level of competition in S-PCN providing technical facilities and services offered to the user. In this subclause the subjects competing are identified and it is considered how the creation of a competitive environment may be achieved, based on technical as well as other related means. This analysis leads on to a consideration of the technical standards which could be used to help create this environment.

The existence of an S-PCN market has been identified, at different international levels and the "strategic" importance of such communications systems in:

> "providing mobile telecommunications services, as well as the related regulatory structure under which they are provided" and "not only in terms of new service introduction, but also in terms of industrial participation and benefits, and geo-political relations" [29].

The S-PCN competition in establishing a global mobile satellite system is to be considered, at present, in light of the WARC-92 resolutions and regulations concerning international satellite service provision. WARC-92 has been a turning point for system proponents since it resulted in a frequency band assignment well suited for S-PCN service, whilst is now being co-ordinated (see subclause 6.2.1). The consequences on the start of operations of some S-PCNs system proposals of an advanced phase of co-ordination procedures may result in an advantage with respect to other systems to be co-ordinated with a growing number of GSO and NGSO systems in the same bands (see subclause 6.2.1).

It is a principle of telecommunications regulations that telecommunications services should be provided competitively. This principle has its roots in Europe in the Treaty establishing the Community and is traceable also in the Council Resolution [17] on the introduction of satellite personal communications in the Community:

> "the Community's ... satellite communications policy in particular, (underlines) the need for competitive provision of services, in line with the rules on competition laid down in the Treaty ...".

As a general perspective, the S-PCN service, by its nature, may not offer the best opportunities for the creation of a competitive environment because of:

- the intensive investment needed for S-PCN ground and satellite segment;
- scarce band resource available world-wide, to be shared by a number of systems;
- service market likely not to support many global S-PCN systems in terms user base.

It is technically possible on one hand to conceive the S-PCN as a stand-alone network offering world-wide ubiquitous service, by the capability to tailor the service provision to any geographical region which would make it economically profitable. On the other hand S-PCN offers possible network and system integration scenarios that may enlarge the potential user base having benefits from the system.

The potential effect, at an international level, of the decisions taken inside the FCC have not been taken into account, so far, in the general discussion on the European role in S-PCN technology and yet result in de facto global standards outside those resulting from the work made to establish the role of the satellite in FPLMTS by ITU. These matters have been reviewed in subclause 6.3.1.2 of this ETR.

It is in this context and considering the requirement of:

> "equitable and standard conditions of access for all countries"

expressed in the Final Acts of the WARC-92, [8] to such services that the setting of a competitive environment has to be evaluated. The Community has made this proposition a part of its interests :

> "policies which determine access to the available spectrum should take into account of the desirability of equitable access, rather than on a basis of first come first served" [29]).

8.3.1 Competing entities

It can be recognised that the capability to provide the voice service via hand-held terminals to wide regions without having necessarily in place "infrastructures" (in the sense of today's mobile telephony) in those regions will cause the initial stage of a development process where five entities are here identified:

- space segment (providing S-PCN coverage) and possibly network provider;
- space segment access provider;
- service provider;
- TTE manufacturer;
- user.

Depending on the system network design, the competition may be bound to one or more of the above mentioned entities. One example is described in the following.

The situation in Europe may be similar to that encountered in today's mobile GSO systems where few gateway earth stations provide the service to the region. The number of space segment access providers in Europe will be limited, while there may be a number of service providers offering the service to customers in different countries. Depending on the agreements between service providers and space segment access providers world-wide it may be possible for the customer to be given service in different regions.

In this context competition is therefore not only related to entities offering the service over an S-PCN system to the customer, but also to different S-PCN systems offering facilities to service providers (e.g. operators) across several countries.

The main field of competition where regulation and standardization may apply is the competitive offer of S-PCN services to the customer. Such a situation is similar to that foreseen in PCNs operations where the cost of the infrastructure may be shared amongst different network operators and roaming will be allowed between different operators with overlapping coverage within the same country (e.g. inter-operator roaming capability in DCS-1800).

In ETR 093 [1]it was anticipated that the S-PCN provision of truly global roaming would be one of the main advantages from a user perspective unique to S-PCN. How the roaming will actually be implemented, and how the S-PCNs will interwork with existing mobile networks and the fixed networks are essential issues related to the user advantages. There is also the possibility of one or more global networks offering world-wide mobile communications services without the need for roaming.

The mobile operators offering an S-PCN service may provide it as a mobile regional / global "wide range" PCS, opposed to the "short range" regional PCS, in competition with other "wide range" and fixed long-distance operators at an estimated user cost per call in a range much lower that present mobile satellites facilities, anticipated not to be far from the present cellular tariffs [94].

Consideration must also be given to the regulation of how the routing of the call happens (with the objective of optimising and protecting existing investments, e.g. PLMNs), how the location of the calling party (often referred to as "A party") and called party (referred to as "B party") affect the billing of the call, how the call may by-pass the network of the national carrier, if allowed. The possibility of by-pass of the national carriers is also a concern outside Europe, as evidenced in subclause 6.3.4 (report of AUSTEL [4]).

8.3.2 Trans-border service provision

Trans-border service provision is a key element of the competition. Depending on the architecture of the system the S-PCN traffic may be handled by a large number of distributed gateways, possibly embedded in the already existing PLMNs, or by a smaller number of regional gateways serving larger international areas. ETR 093 [1] identifies in subclause 5.2.6.2. the Network Co-ordination as an original problem, of importance especially in developed countries where there are a number of mobile networks already in operation. The problem can be divided in what has been identified as "first and second order assignment" (ETR 093 [1] subclause 5.2.6.1). If the call processing will have available information to be associated with a coarse but sufficiently precise location of the originating (and terminating party, if S-PCN), so that trans-border calls will be identified, trans-border service regulations could be applied. Therefore trans-border service provision and operation and geographical extension of service arise as areas for technical consideration.

Some examples of possible, basic, options are represented in figure 6 (in some designs, the mobile terminal service link may be established through more than one satellite simultaneously).

If the S-PCN is based on gateway interconnection via PSTN, trans-border operation may still occur whenever either a mobile terminal link (circuit) or an inter-satellite link (circuit) is established crossing an International Switching Centre (ISC) border (see figure 6(b) and 6(d)). This applies in principle to both mobile originated and mobile terminated calls.

Because of the foreseen limited capacity of S-PCN over Europe (the number of channels available over the European region for some systems can be found in ETR 093 [1]), the location of service gateways for the European region will be determined by factors which may lead to the sharing of gateway infrastructures among service providers, thus leading to systematic trans-border service provision.

The industrial aspect of competition can be found in the user segment of the network, or Mobile Station (MS), and in the control part. The space segment, although carrying new concepts such as a foreseen "line" production of small platforms (mainly due to the lifetime of a single satellite, compared with the number of operational satellites necessary to support the system's operations) is more difficult to address as a segment where competition seems unlikely, apart from possible competitive tendering.

8.3.3 Relationship between entities in a PLMN

The general relationship model between entities in a PLMN environment, as set out in [27] is shown in figure 3.

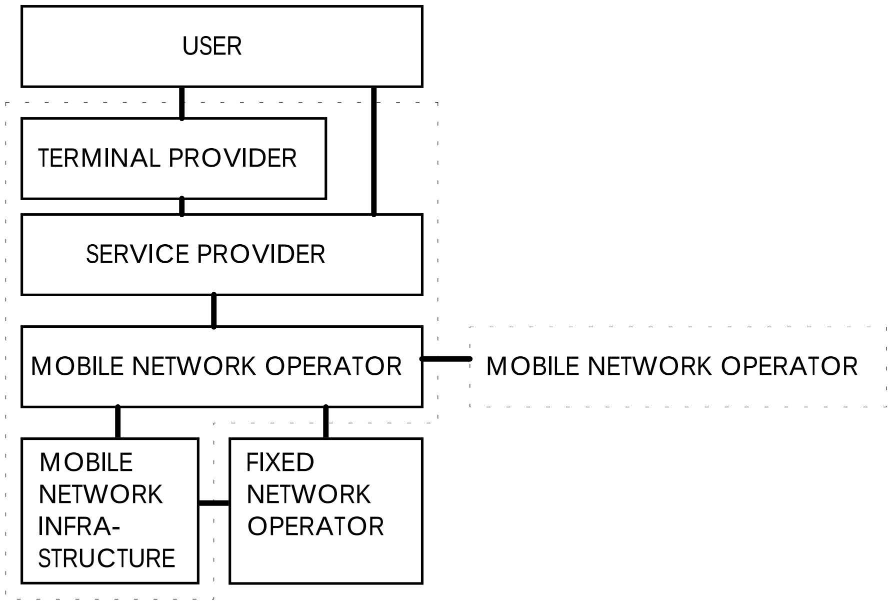


Figure 3: General PLMN relationship model, as set out in the Mobile Green Paper

The links represent a relationship of commercial nature which may require physical interconnection of networks or data transfer facilities (see [27]).

The service providers may either offer value added services on top of those offered by the mobile network operator or / and buy and re-sell network capacity (mainly air-time) to users.

Some organisations may include part if not all of the mobile functions, an example of a mobile service and network organisation grouping all mobile functions is shown above.

8.3.4 Relationship between entities in an S-PCN

Taking as a starting point the general PLMN relationship model of figure 3, ETSI has modified the model to address the entities involved in S-PCN, and this is shown in figure 4. The commercial roles of, and relationships between, these entities are also analysed in subclause 8.6.2.2.3.

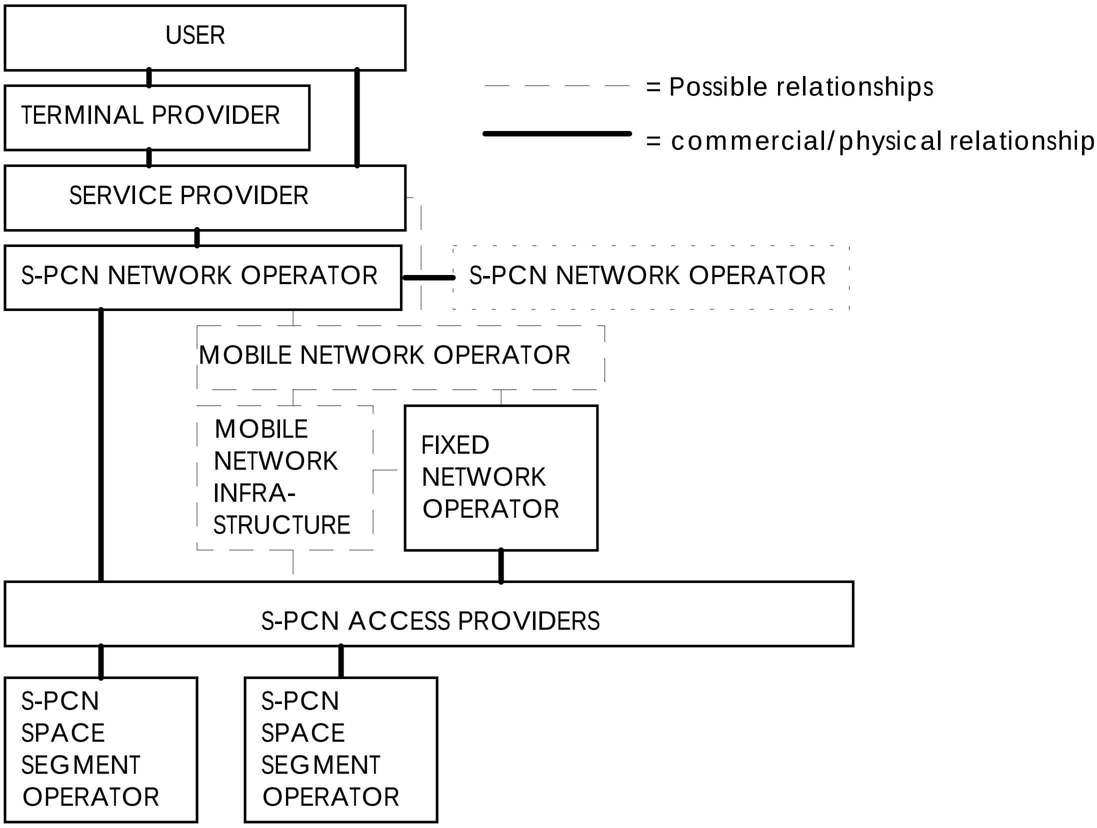


Figure 4: General S-PCN relationship model

The general model is more complex (in terms of links) and layered:

- the S-PCN space segment operator operates and maintains the space segment, including ranging, spare satellite launch and management, system operating parameters such as positioning accuracy, in-orbit phasing (if needed) etc.;

- the S-PCN access provider operates the satellite access infrastructure facilities and earth station(s), to provide access to S-PCN systems (possibly operating with different access schemes and requiring different satellite diversity and tracking facilities to handover inter- and intra-satellite (see ETR 093 [1] subclause 5.2.5.3 and subclause 9.2.4 of this ETR). The S-PCN access is shown as horizontally shared by several S-PCN operators taking into account what is said in subclause 9.2.2.1.

- the S-PCN network operator provides the S-PCN service at national or international level either directly or through service providers which may act in the same way as in today's mobile cellular systems;

- if a service provider exists then it is only visible to the S-PCN network operator with which it has a direct relationship (e.g. buying service air-time) but not to other operators to which the S-PCN mobile network has a roaming agreement. (However, the role of a service provider could be much more extended, as considered in subclause 8.6.2.2.3).

The figure 4 model includes the situation of possible incompatibility of S-PCN systems, represented by several different S-PCN space segments.

The possible consequences on competition issues of network interworking and integration aspects include means to enable already-existing mobile operators to extend their networks by providing a "satellite extension", optimising the cost effective (and timely) provision of mobile service to large areas anticipating terrestrial coverage (see subclause 8.7).

The model introduced can be used to analyze the implications when the integration between S-PCN and PLMN is considered. Integration at a network level (meaning also dual-mode S-PCN / PCN terminals) can be represented as shown in figure 5.

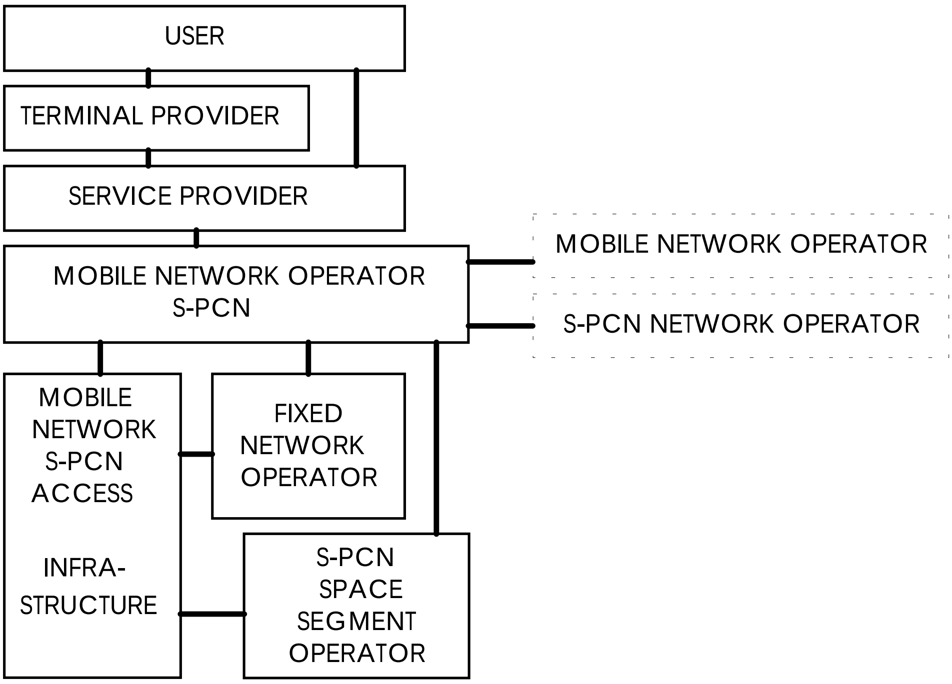


Figure 5: Integrated S-PCN relationship model

The re-use of network functions reduces the number of interfaces (and links) and allows a direct relationship between the mobile operator offering S-PCN extension and other S-PCN operators. The relationship with the S-PCN space segment operator becomes very similar to that with the fixed network operator to the extent that the relevant Open Network Provision (ONP) principles (transparency, non-discrimination and equality of access) and implications could be considered here, especially if the satellite coverage capacity is regarded as a limited resource.

If the connection to access the S-PCN system, providing effectively the possibility to extend the mobile service area, is considered as being in the context of a general mobile-to-mobile interconnection ([27], annex D.6), using the terminology of ONP, this case may be included among those examined in future extension of ONP Directives.

At the service provider / network operator interface ONP principles apply unchanged with respect to the case of terrestrial mobile as well as at the user / mobile network operator interface. In this latter case the ONP application means ([27], annex D.6):

- clear accounting rules allocating cost between network operator and service provider;
- equality of access to the mobile network for all service providers;
- non-discrimination in interconnection conditions for all service providers;
- transparency of interconnection requirements;
- mobile network operator offering facilities to support pan-European service provision.

The latter point in S-PCN could be translated into trans-border service provision, as discussed further on.

Competitive environment elements relevant to the operators arise mainly from the national and potential trans-European service provided through S-PCN. Other service regions may be addressed by European operators but emphasis is here put on the arising European position in trans-European services. Satellite mobile services are among those considered in the proposal for the mutual recognition of services in Europe. If the mutual recognition principle will be adopted there will be a single service licensing process in any country that will be recognised mutually by a Directive in the rest of the European Union.

The operator would be allowed to provide the satellite network or communications service "without delay" in the territory of each national administration (Article 4, COM(93) 652 final [28]). The possible services include mobile voice telephony as provided by "personal satellite communications services via geostationary and non-geostationary satellite systems including low earth orbiting systems" (see annex II to the Council Directive COM(93)/482 4 Jan 1994).

A service provider aiming at offering a mobile voice service will have the choice to use different infrastructures and make arrangements with several local operators. The S-PCN nature offers the opportunity to offer a wide area voice service by simply one agreement with an S-PCN "backbone" network operator, the actual infrastructure operated could be consisting of gateway station(s) in which case the air time and some network facilities are provided by the S-PCN network operator, or no infrastructure, where the space system access and network management facilities could rely upon infrastructure provided by another operator. This would ultimately encourage competition in service provision. Licensing to provide S-PCN services may consequently become a single step procedure for trans-European S-PCN service providers.

The mutual recognition of licensing may include provisions to implement the numbering, space segment access, site and frequency co-ordination (COM(93) final) in conformity with the European regulations and under the control of a monitoring procedure. The monitoring is under the responsibility of national regulatory authorities but the Community may also take part to it.

The user relations with the terminal and service provider remains the same in all relationship models presented in this subclause. The user related competition issues are associated with the terminal and to the type of services and tariffs structure, aspects of the S-PCN service are presented in subclause 9.2.5 of the ETR. The technical areas to be considered for the set-up of a competitive environment in the user aspects are those that enable the competitive offer of terminal equipment by manufacturers and or of subscription packages by service providers, enabling the user to have a choice on the terminal equipment and subscription features according to the needs. The areas of TTE and TTE radio interface will be addressed later on in this ETR.

As a consequence of the foregoing, there are a number of inter-related technical areas expected to be important for the set-up of a competitive environment:

- trans-border service provision;
- geographical extension of service;
- interworking aspects;
- integration aspects;
- TTE;
- terminal radio interface;
- radio regulatory procedures for NGSO systems (the first system to achieve successful co-ordination may obtain a competitive edge if subsequent system face an increased co-ordination hurdle).

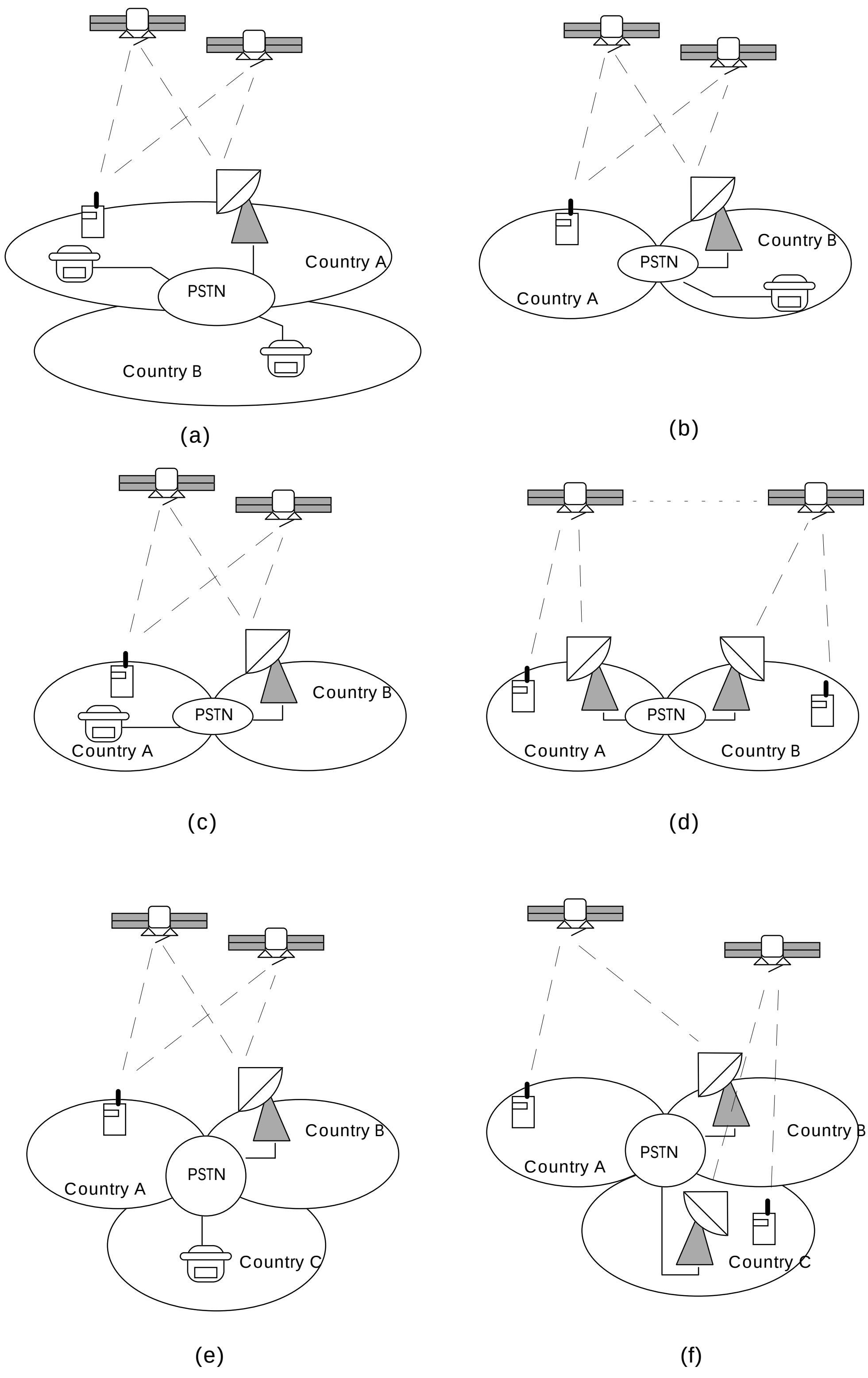


Figure 6: National and trans-border operation of S-PCN

8.4 European initiatives for S-PCN

This subclause addresses the possible objective of European initiatives on S-PCN summarising the conditions under which such initiatives could arise and the foreseeable main technical areas where standards would be required to offer technical support. Other technical areas would be included in those introduced here, but their type depend on the kind of initiative (short / long term, proportions, institutions involved and their relationship with ETSI etc.).

The recognition of the "strategic importance" of the S-PCN infrastructure and service and of the "opportunities this may offer for European industry, service providers and users" [17] has a possible direct consequence in terms of development of the European initiative towards direct participation to the technical specification of an S-PCN system. In the Council Resolution on the introduction of satellite personal communications services is noted that "the advantages of satellite personal communications may be extended to a wide range of potential users" (including countries with less developed telecommunications infrastructure) and that interested telecommunications administrations include all the CEPT members.

Council Resolution [17] also presents (in points 4 and 5 of the Resolution) the preliminary actions for possible European initiatives, they consist of examination of the standardization, radio frequency and licensing issues by ETSI, ERC and ECTRA respectively and discussions on strategic matters related to S-PCN within Europe.

The role of technical standards in this process in order to support European initiatives for S-PCN may be a primary one. All technical areas identified in this report which do not result from the essential requirements fall within this objective.

Further short-term European actions on S-PCN may take into account the general common interests in telecommunications within Europe arising from consultations and based on the following technical issues:

- the new mobile S-PCN services and applications and their consequences (e.g. mobile service extension) for peripheral regions in the Union and third countries;

- the stage of development of proposed S-PCN systems (see ETR 093 [1] for system descriptions) and the foreseeable technical and organisation structure evolution;

- the opportunities offered by timely technical standardization to avoid de facto standard situations in line with the principles laid down in the Mobile Green Paper [27];

- the provisions for implementation of S-PCN based trans-European networks;

- a number of cost / benefit trade-off analyses on the combined (PCN) terrestrial / S-PCN coverage to provide service to dual- / multi-mode handsets or extend the service to other regions (via single-mode handsets).

Developments could be triggered by a final assessment and conclusions of the broad significance of S-PCN for Europe (reference is made in the above mentioned Resolution [17] to the ability for European operators, service providers, industry and users to participate in an S-PCN global and open market). This in turn would have a considerable impact on the standardization requirements.

The range of options is broad, ranging from the general "envelope standards" for the essential requirements under the TTE Directive [19] to the development of an S-PCN system "out of" GSM, based on some integration criteria and aiming at protecting the effort and investments already in place, to the definition of an original new S-PCN system adopting the same or different approaches, and possibly organisation, already applied for the GSM system (see also subclause 8.2).

The implications of European initiatives on standards development are included in some main technical areas:

- essential requirements under the TTE [19] and SES Directives [20] (conformance tests);
- S-PCN Mobile Station (MS) radio interface;
- S-PCN MS SIM card operation (and interface);
- S-PCN Earth Station (ES) operations and maintenance;
- S-PCN ES to PLMN / PSTN interface;
- trans-border service provision;
- service aspects;
- network aspects: numbering and integration aspects;
- type approval and acceptance testing;
- security matters and "legal tapping" requirements;
- control and monitoring of S-PCN;
- user interface;
- TTE.

There are already some co-ordinated European actions covering some aspects or touching some areas. A conformance test standard for S-PCN mobile earth stations will be published by ETSI, developed by ETSI / SES5 (see subclause 7.1.1) and aspect related to S-PCN are also considered in ETSI / SMG5 in the satellite component of UMTS (see subclause 7.1.2). The CEPT Spectrum Engineering (SE) working group is developing two reports (on L-band and feeder-link sharing issues) [30].The European RACE.SAINT (SAtellite INTegration) project is described in subclause 7.2.3 and the COST 227/231 research projects are covered in subclause 7.2.4.

The time frame for standardization is one of the key element to the usefulness of the standards developed for European initiatives, especially in an area where there are already a number of activities in place setting a de facto time frame for some issues. The time frame for S-PCN will be introduced and discussed in clause 12 taking into account the constraints imposed by other international activities and initiatives.

There are some of the ITU filings and proposed systems originated from Europe that should be also considered in a European initiative. System are described in ETR 093 [1]:

- QUASIGEO voice / data system (using a LOOPUS orbit system), also filed to ITU QUASIGEO;
- DIAMOND voice / data system (using HEO orbits);
- TAOS data system (using circular LEO orbits), IFRB notification.

Recently two filings have been made by the Administration of The Netherlands to ITU for networks operating in the bands 12, 13, 15 and 18 in table 2a in application of resolution 46 of WARC-92, they are the PETALRING30C-S and the PETALRING 60E-S.

8.5 Regulatory

This subclause addresses the objectives that could be identified as potentially relevant to regulators and identifies the role of technical standardization in supporting these objectives. This ETR provides a set of options to assist the regulators in defining what might be done with standards to support the achievement of the regulatory objectives that might be required.

Radio regulatory matters are extensively discussed in subclause 6.2.

8.5.1 Frequency issues

An important aspect of the regulatory objectives are those related to the frequency issues. Whilst it is recognised that the selection of appropriate frequency allocations to be used for S-PCN in Europe is not the responsibility of ETSI, there are a number of objectives that can be identified in the frequency area as being of interest to the frequency planners and regulators and this subclause will address the possible technical standards that might be of use to achieve the implementation of these objectives.

Broadly, these objectives link into technical standards which will be implemented to satisfy the essential requirement for the effective use of the RF spectrum and satellite orbit (see subclause 9.1.6).

8.5.1.1 Common European position on frequency allocations for S-PCN

S-PCNs are, by their very nature, likely to be global systems. In consequence, the adoption of different frequency allocations by different countries may not be a viable proposition, if the S-PCN systems are to be operated in an effective manner. The process of determining the frequency assignments for the USA are already in hand as part of the NPRM process (see subclause 6.3.1.2). If the USA allocation process is concluded as a solely USA procedure then this will possibly impose a frequency allocation regime on the rest of the world, which may not be regarded as a desirable process or may encounter some regional practical problems.

Europe needs to consider what frequency bands might be allocated to S-PCN systems and how this spectrum will be divided between systems of different type (e.g. TDMA vs. CDMA), also if bi-directional working of the 1 613,8 - 1 626,5 MHz band will be permitted in Europe. With regard to these observations, it is perhaps worth noting that the allocation of particular services to particular bands in the ITU Radio Regulations does not make it mandatory for Administrations to permit such a use and a review and decision making process may well be needed. This process might require something akin to the USA NPRM, although the analysis and decision could well be undertaken in the frame of CEPT, e.g. by the ERC.

ETSI has requested ERC to study the frequency bands required for S-PCN and come to a view. In the opinion of ETSI, this decision is needed urgently and the band allocations should be adopted on a Europe-wide basis as "harmonized frequencies", in a manner similar to that for GSM. ETSI also believes that additionally the Commission has provided ERC with a mandate to study the frequency requirements for S-PCN with the aim of ensuring harmonized frequencies for Europe. In the event that possible harmonized bands are identified, these could be reserved for S-PCN through the application of an EC Directive, as has been done for GSM, DECT, ERMES, etc. (see subclause 9.1.2.5.1).

Once these bands have been identified and harmonized, ETSI could then go on to develop a technical standard to ensure that S-PCN equipment makes correct use of the harmonized frequencies for S-PCN and does not operate S-PCN outside of this spectrum (see subclause 9.1.1.6). The specific matter of bi-directional use of a frequency band by an S-PCN terminal (i.e. for both transmit and receive purposes) could potentially be an area in which some standardization would be useful, particularly to ensure that terminals can operate in a co-ordinated way without causing interference to each other, or to other radio systems, and can do so in a way that makes an effective use of the spectrum resource.

Taking into account the essential requirements for the effective use of spectrum and effective use of the orbital resource there is the problem whether CDMA or TDMA based schemes provide sufficient efficiency when used in conjunction with some orbital configurations. The consequences or the efficiency requirements may include requirements such as:

- thresholds for parameters describing the "efficient use of the spectrum and orbital resource" to be set for Europe harmonized frequencies;

- sharing of the common S-PCN harmonized service band among different systems (adopting CDMA or TDMA based schemes);

- protection requirements of other systems (e.g. GSO) from interference.

8.5.1.2 Protection of other satellite networks

It is possible that one European objective in the frequency area is to ensure that the operation of S-PCN systems ensures the protection of other satellite systems. This consideration will fall into two main areas:

- firstly there is the protection of other systems sharing the service link bands; and
- secondly there is the protection of systems sharing the feeder link bands.

The problems, and their potential solutions, are quite different. But ETSI might be able to develop technical standards, or more probably adopt technical standards developed outside of ETSI (e.g. in CEPT, ITU-R), that will facilitate such inter-system protection.

Some aspects of this objective will clearly be covered by essential requirements (see subclause 9.1.2.5.6), but it should be considered whether some voluntary standardization in addition to that provided for by the essential requirements might be a useful objective to ensure that the inter-system interference environment is well controlled within the European region.

8.5.1.3 Effective use of the spectrum / orbit

This can be regarded as an objective, both within the terms of the TTE and SES Directives [19], [20] and, perhaps beyond them as part of general regulatory policy. This is an area where technical standards will be the most effective way of implementing any objectives that might be adopted for Europe.

The standards in this area may well depend upon how "strong" the European frequency regulators want to make the rules that they develop. But also could be a matter for mutual agreement amongst the system proponents, operators and administrations with a view to adopting some mutually acceptable, voluntary standardization that would maximise the capacity available from a relatively limited spectrum resource.

Subclause 9.1.2.5 has identified a wide range of possible technical standards approaches that would, if implemented, go a long way towards ensuring an effective use of the spectrum and orbit resource. Certainly a full implementation of all or most of the areas itemised in the referenced subclause would lead to a very strong regime, whereas a weak implementation would result if only a few of the items were addressed.

The objective of making effective use of the orbit (specifically) is considered by ETSI to be of importance in Europe as it is on a global level, since this provision was added to the TTE Directive [19] essential requirements by the SES Directive [20]. However, it is not clear to ETSI how standards meeting this essential requirement might be implemented (see subclause 9.1.2.5).

8.5.2 Objectives in licensing

The instrument of licensing is a means by governmental institutions to control a specific phenomenon. When something is subject to licensing, then it (possession, use, transport etc.) is illegal unless a licence has been obtained that justifies it.

Individual elements of S-PCN may be subject to a licence requirement. In the framework of S-PCN, licences may be required for:

- providing a public infrastructure / public utility function like a telecommunication service;
- for construction of telecommunication infrastructure;
- for establishment of a database containing subscriber related information;
- the use of radio spectrum;
- possession of radio equipment;
- for encryption.

To identify the required licences, this subclause will first elaborate on the players concept, then it addresses the objectives in licensing and it concludes with an overview of the licences that are required for the various parties.

8.5.2.1 Players concept

When addressing the licences that are required, it is necessary to identify the players in the S-PCN business, and then to consider which entity will need a licence and for which purpose.

S-PCNs may be operated by different categories of "operators". The operators that are considered relevant in the players concept are:

- the space segment operator;
- the S-PCN network operators;
- the access provider;
- the commercial operator of a terrestrial network;
- the service providers;
- the subscriber;
- the user.

It is recognised that a single entity may carry out different roles. It could well be that the space segment operator will also take care of the S-PCN network operator function whilst the S-PCN network operator may decide to carry out also the role of an access provider, but for the consideration in this report the various roles are considered separately because then the different roles identify the single entity in different capacities.

An important issue to address is whether a player is determined by the hardware he owns / operates or by the functionalities that he groups together.

The players and the activities that each of them may carry out are summarised in table 3.

The following subclauses address each of the identified players separately.

8.5.2.1.1 Satellite component

The satellite component of the network will be composed of a space segment and ground segment elements. The satellite component and its segments are illustrated in figure 7.

The space segment include the satellites, the Telemetry Command and Ranging (TCR) stations and the network control stations.

The ground segment includes the gateway earth stations. The gateway earth station may be provided by a separate S-PCN access provider (see also subclause 8.4.4).

There may be a single owner for the entire satellite component (space segment and ground segment) or ground segments may be owned by separate access providers.

The operator of the ground segment can be the space segment operator, it can be the separate access provider or it can be a terrestrial operator, depending on the type of contracts / agreements that the space component operator is prepared to enter into.

A single entity may need licences in parallel for different capacities in which it operates.

It is possible that an S-PCN consists of not more than only a satellite component. It is also possible that an S-PCN comprises a satellite component and a terrestrial component. In the case that an S-PCN is created as a (shared) extension to multiple PLMNs, then each PLMN re-uses its functionality to perform the functions of a terrestrial component in the S-PCN.

Table 3: The players concept and activities of players

Space Segment Operator	Access Provider	S-PCN Operator	Terrestrial Network Operator	Service Provider	Retailer	Subscriber	User	NOTE: X signifies the case of S-PCN co-operatorship
								Entity to make space segment available
								Entity to provide / operate ground segment
			X	X				Entity to operate S-PCN
								Entity to operate terrestrial network
								Entity to establish subscriptions
								Entity to provide terminals
								Entity to have a subscription
								Entity to use the S-PCN services

The owner of a space segment needs to have his usage of frequencies organised in accordance with the regulations of the ITU. This applies to the service links between satellites and user equipment as well as to the feeder links. Processes of "advanced publication" or "co-ordination" are carried out via a national governmental administration and are therefore subject to co-operation from that administration. Although there may not be a licence issued as part of this procedure, it shows the characteristics of a licensing procedure in which an application is filed and the applicant depends on acceptance by an authority. For a European initiative, the proponent is free to seek co-operation from any of the European administrations.

The system of co-ordination of frequencies by the ITU depends on respect for the ITU procedures by system implementors and national administrations. There is no international police force to undertake corrective action if frequencies are occupied without appropriate co-ordination and unfortunately that sometimes happens.

The operator of the ground segment may need a licence for transmitting on the frequencies of a feeder link from the Land Earth Station(s) (LES), carrying user traffic. This **licence** is required only from those national administrations in countries where a LES is going to be installed. In Europe the number of **licence**s that is required for this purpose can be anything between zero and the number of telecom-operators or other companies that want direct access to the satellite component, see also subclause 9.2.4. As with the service links, the conditions that enable issuing of a feeder link **licence** are established via the earlier ITU co-ordination procedure (if any).

The operator of the space segment needs a licence for the use of frequencies for a link for Telemetry, Command and Ranging (TCR) between the earth and a (or multiple) satellite(s). Via this link, the satellite configuration can be managed as well as the telecommunication facilities. This **licence** is required only from the national administrations of countries in which an LES is going to be installed for TCR. The number of LESs for TCR is low, there may be one per continent or less until only one for the whole configuration. Such an LES for TCR may be co-sited with an LES for user traffic, in fact it may be integrated to a great extend with such an LES. If it is integrated and uses the same frequencies, it may be covered by the same **licence**, depending on the licensing conditions. As with the service links, the conditions that enable issuing of a feeder link **licence** are established via the earlier ITU co-ordination procedure (if any).

The question as to who needs a **licence** for the provision of a telecommunication service could not be solved. Permission to provide this is separate from permission for the use of any radio frequencies.

In the USA (at least) a **licence** is required before construction of the satellite system. Actually an individual licence is required per satellite. ETSI is not aware of any moves to introduce such a regime in Europe.

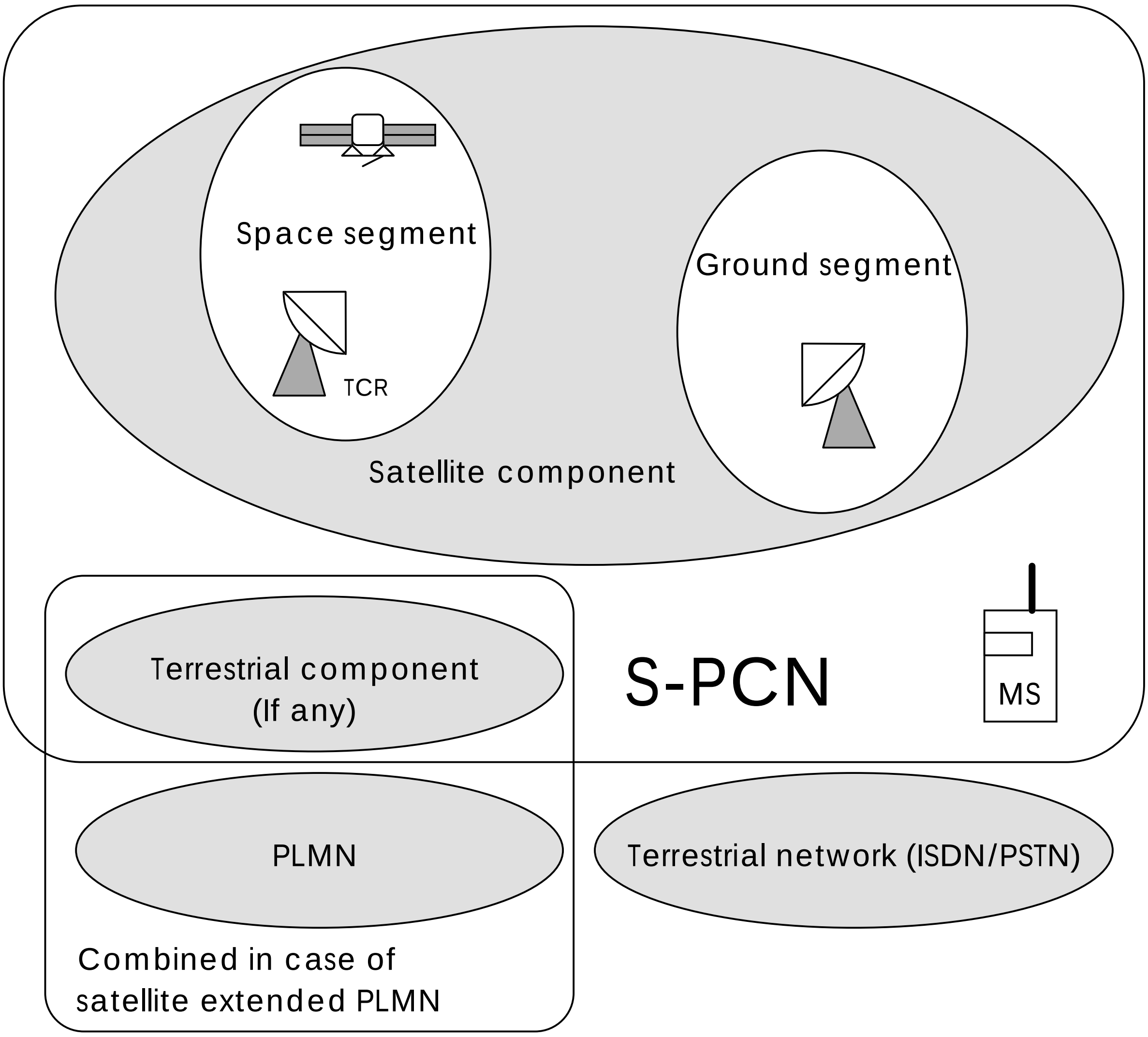


Figure 7: Components of an S-PCN

8.5.2.1.2 S-PCN network operator

The S-PCN network operator is the entity that commercially operates the telecommunication facilities that are on board the satellites. The S-PCN network operator may be the same entity as the satellite component owner, but is here considered in a different capacity. The payload may be operated by one single S-PCN network operator or multiple S-PCN network operators may operate the same telecommunication payload in co-operation. In this ETR, regarding S-PCN, such operators are referred to as co-operators.

In the case that the S-PCN network operator does not posses hardware that transmits radio waves from the territory of a state, then the S-PCN network operator does not need a licence.

In the case where multiple operators operate a common satellite component, a special case may occur if an LES is the property of an individual S-PCN network operator. In such a case that S-PCN network operator assumes in parallel the role of access provider and needs a licence to transmit radio signals from the LES.

8.5.2.1.3 Access provider

The access provider is a specialised entity that provides and operates the ground segment. It provides the transmission functionality for uplink and downlink for one or more S-PCN operators or co-operators.

8.5.2.1.4 Operator of a terrestrial network

In the framework of this study, the operator of a terrestrial network is the entity that provides a physical network for fixed or for mobile communications and that commercially exploits its network by establishing subscriptions, billing for the use of it and in general terms controlling the commercial conditions on which access to the network is granted to users / subscribers and roamers.

The operator of a terrestrial network does, in general, not need any special licence for its involvement in S-PCN (see also subclause 8.7).

In a special case where the operator of a terrestrial network is one of the multiple operators that operate a common satellite component. The operator of such a terrestrial network then takes on the role of a S-PCN network operator, see subclause 8.5.2.1.2.

8.5.2.1.5 Service provider

The service provider is the entity that provides to users (its subscribers) access to network services on the basis of commercial agreements with one or more network operators in who's networks the users may then roam.

Basically, the service provider is identical to the commercial operator function of a (terrestrial) network operator without having a network of its own. Its subscribers are permanently roaming. The concept of the service provider has been developed mainly in UPT.

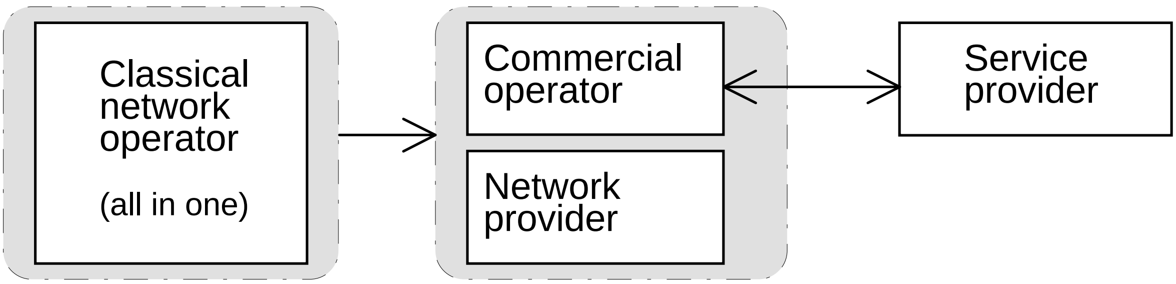


Figure 8: Different aspects of a network operator and relation to the service provider

This split-up corresponds to the internal separation of responsibilities that is seen inside many operators. A service provider directly manages its own subscriber database. Towards subscribers there is no basic difference between the commercial operator's aspect and a service provider.

The service provider without physical elements that produce radiation of radio signals does not need a licence. The service provider does not qualify for any licence. In a special case a service provider could qualify as a payload operator. If this is established, using an LES owned by the service provider, then a licence is required for operation of that LES.

8.5.2.1.6 Subscriber

The subscriber is the entity that has entered into a commercial relation with a service provider or directly with the operator of a terrestrial network or with a payload operator for the purpose of obtaining user access rights to telecommunication facilities.

The subscriber may be a legal entity or a natural person. A legal entity may obtain multiple subscriptions for multiple users.

The subscriber as such does not need a licence. The same person may need to be covered by a licence in the capacity of a user.

8.5.2.1.7 User

The user is the person that is actually operating the S-PCN / MES. This may be the same person as the subscriber, but that is not necessarily the case.

- for the presence as well as for the use of an S-PCN / MES a licence is required by most of the national authorities;

- the user needs licences for the use of frequencies in the service link between satellites and user equipment.

For equipment conforming to a European harmonized standard, the use of frequencies as well as the presence of radio transmitting / receiving equipment is normally solved by class licences.

Equipment conforming to a non-European harmonized standard remains to be discussed with every individual administration.

8.5.2.1.8 Summary of involved licences

The licences that are required by various entities are summarised in table 4.

Table 4: Summary of licences for various entities

Entities	Required licences, in relation to S-PCN
Space segment operator	No licence
Ground segment operator	For feeder link transmissions
S-PCN network operator	Licence unless also access provider
Access provider	For feeder link transmissions
Terrestrial network operator, S-PCN co-operator	No licence, unless owner / operator of ground segment
Service provider	No licence
Subscriber	No licence
User	Class licence or individual radio licence

8.5.2.1.9 Relation to standardization

The player's concept introduces separate categories of operators. Practical implementation of S-PCN can be eased if in standardization of interfaces between S-PCN network elements these coincide with the separation between operators.

8.5.2.2 Identification of objectives in licensing

Licences are issued by national telecommunication authorities. Licences are applied for on a national basis. Final decisions about issuing any of the licences addressed above all remain with the same body. Each of these bodies (in the European Union about 15) independently takes its own decisions, based on its own circumstances and responsibilities.

The objectives in licensing are first of all those of the entity that issues them, i.e. the national authorities. These objectives are primarily determined by the tasks that have been given to that entity at the moment of its establishment, eventually amended later on. In this respect it is relevant to recognise that the objectives of a single entity that is at the same time "national authority" and "monopoly operator", are different from those of an entity that is only the national telecommunications authority and has no direct involvement in operations or business.

Secondly, in licensing the national administrations are expected to enforce the agreements that they have established in international fora. Most relevant for S-PCN are the Radio Regulations (RR) of the ITU [9].

It is recognised that an administration can have objectives for not licensing just as well as in licensing. However, these objectives can not be related to technical standardization.

There also exist international fora that consider government use of frequencies. Although the details about the agreements that are achieved here are not available to the public, they have a very strong co-ordinating effect between individual administrations and they will have an important impact on licensing decisions of national administrations if a conflict of frequency use occurs.

8.5.2.2.1 Objectives in licensing for providing a telecommunications service

Apart from licensing for the use of frequencies, a licence is separately required for the provision of a telecommunication service.

National administrations, when issuing such licences, will include conditions that serve objectives related to:

a) safety / security of the nation and of the public;
b) special circumstances where the state wants to increase its level of protection;
c) disasters;
d) criminality;
e) implementation / availability.

The points a) and b) are sensitive areas that will not be commented here in detail. **The impact on the standard to be adopted may be (since this is a national decision) that it should permit that part of the network or the whole network can be reserved for government use only, or priority or exclusive access is given to categories of users**. The administration of the territory where the S-PCN network management facilities are located will be able to enforce such a restriction. The administrations of countries that are served via an S-PCN but without significant infrastructure in its territory would need to rely on the co-operation of a different administration. Therefore administrations (except those where the system is based / managed) will have control only as long as administrations behave co-operatively.

An administration can not be confident about its capabilities to exercise control, even if it requires the availability of network control facilities inside its territory. An S-PCN can not depend on only one single control facility.

Point c) is not likely to have an impact on the standard.

Point d) will normally result in the requirement that it should be possible for judicial authorities, to listen into or trace the communications of suspected persons. The standard to be adopted may require to support legal tapping. The same point d) is also served by the requirement of access to position reporting. Some of the S-PCN systems that are proposed have position reporting (see ETR 093 [1]). This position reporting may be required for one or more functions of the satellite system itself. National authorities may wish to connect to this facility by requiring access for judicial authorities to position reporting or to a record of reported positions in time of a single handheld. The standard to be adopted may need to support access to position reporting (records).

8.5.2.2.2 Objectives in licensing for the use of service link frequencies

When licensing for the use of frequencies for the service link, an administration may or will have a number of specific objectives. Explicit objectives are included in the licence as conditions under which a licence is issued. This is the only means that an administration has to enforce its objectives, as long as it is prepared to issue a licence. The only sanction an administration has is (the threat) to withdraw the licence. Once a licence is withdrawn, an administration can take practical action inside its own territory, as detailed by national legislation.

In the case of S-PCN some of this may become impractical. A licence for use of frequencies in the service link is obtained by a company that (in many cases) is established in a territory where the jurisdiction of the country that issues the licence does not apply (an administration may therefore negotiate conditions to establish a hold on the system proponent before issuing a licence).

Secondly, the use of frequencies for the service link by the S-PCN handheld needs to be covered by a licence. European legislation has two regimes:

- the TTE Directive [19], which gives the right to circulate, bring into the market and use type approved equipment; and

- the SES Directive [20], which gives the right to circulate and to place on the market type approved equipment, but does not give the right to use. Use remains the subject of a separate licence.

The regime to apply for S-PCN is yet to be decided.

National administrations give licences based on national legislation. However, national legislation will be harmonized so that administrations will issue licences in legislation based on European regimes in fields where these are established.

The applicability of the TTE Directive and / or of the SES Directive is subject to interpretation, see subclause 9.1.1.5.

If application of the SES Directive is foreseen, then licensing to cover the use of handhelds within their own territory remains to the discretion of national administrations without any obligation to allow it. Therefore the decisions may be different from country to country.

If application of the TTE Directive is foreseen then the right to use the S-PCN / MES will be the same in every country.

The most practical way to establish the right for use of the S-PCN / MES is probably by a sort of class licence. Such a class licence can be issued in parallel when the licence to the system proponent is issued.

It is technically possible that an operator may provide service in a country for which it does not have a licence. Under such circumstances the only effective means for the administration of the served country to stop such service is via the administration of the country where the operator is based.

A number of neutral objectives in licensing for the use of service link frequencies can be identified:

- adherence to the frequency plan of the ITU as well as to regional and national frequency plans. This impacts predominantly on the frequency bands;

- avoidance of interference, not only between terrestrial and satellite systems as in the essential requirements, but also between existing and planned satellite systems;

- optimisation of use of the radio frequencies, in optimising the spectral efficiency. The impact of this is hard to predict since spectral efficiency is appreciated by various administrations in different ways. It is determined mainly by the radio access techniques;

- possibilities to maintain manageability of the use of frequencies. From an administrator's perspective it is useful having the possibility to re-arrange the use of frequencies to following later developments in telecommunications;

- instruments to counter unlawful use of frequencies. The use of the facilities for illegal purposes will normally be excluded in the licensing conditions, detection of it may require the facilities of tapping and positioning. It could be argued if unlawful use should not be outside the scope of a licence, the unlawful user might not worry about a licence;

- instruments to enforce special conditions under which the use is authorised;

- possibilities to restrict the use of frequency sub-bands under certain conditions (e.g. avoiding transmitting on specific frequencies within a specified geographical area). An administration may have to accommodate more than one system, as a consequence, a standard should offer flexibility in the use of frequencies;

- optimisation of society benefits of the use of radio frequencies. This is a very general objective. This has no direct relation to standardization. However, the existence of a solid standard contributes to optimisation.

8.5.2.2.3 Objectives in licensing for use of frequencies for infrastructure

Licences for the use of frequencies for infrastructure are required for:

- the use of frequencies for the LES feeder links; and

- the use of frequencies for the TCR link when not combined with feeder links.

On itself, for the establishment of infrastructure no licence is required. A licence is required for the use of frequencies. However it is necessary to protect reception by an infrastructure earth station via a ITU co-ordination procedure, and this requires co-operation of a national administration. The only way open to a national administration to secure the receiver's operating characteristics is via licensing. Therefore, even a receive-only infrastructure earth station will in practice be licensed for objectives of the infrastructure owner.

The installation of an LES may be to connect a gateway to a PSTN or it may be to connect a TCR station.

If it is for connection to the PSTN (to handle also the traffic to and from surrounding countries) then its presence may increase the revenues of the nation's international telecom operator(s).

From the LES there will be at least an interface to the PSTN, for this interface the CCITT Recommendations should apply.

The installation of a TCR / network management station within its territory does not really provide a national administration a better possibility to enforce special measures regarding functioning of a global network. Law enforcement personnel can not operate a network management facility, and uncoordinated action may be in conflict with the actions of a network management centre elsewhere. An administration needs to rely on co-operation with the operator. No further objectives in licensing are identified in association with this enforcement.

Furthermore, there are objectives like adherence to frequency plans, avoidance of interference, optimisation of frequency use and manageability of the use of frequencies, similar to subclause 8.5.2.2.2.

8.5.2.2.4 Reciprocal licensing regimes Europe and world-wide

Reciprocity in licensing is a procedure in which an administration will accept to license a legal or natural person of a different state only if (and for as long as) its own subjects can obtain a licence in that other country. This reciprocity technique is well known from how administrations determine which citizens need to have a visa for entry into the country.

Reciprocity in licensing regimes therefore serves as a means to administrations to prevent companies within their own territory from being subjected to unequal commercial and legal conditions compared to companies from other countries.

8.5.3 Trans-border service provision (Europe and outside)

Trans-border operation is here referred to as the possible provision of communications services from an operator using a system independent from the national satellite or terrestrial carriers, independent from how practical this may result to the user of such S-PCN services (especially in terms of tariffing). The issue of national carriers' rights and the regulatory framework for the provision of S-PCN voice and data services have consequences in some technical areas intended as possible tools to support the enforcement of licensing. The provision of mobile communications service within the territory of an Administration and trans-border, across the territory of several Administrations, are two aspects of S-PCN that find their distinction on regulatory rather than technical grounds. Trans-border service provision (previously introduced related to competition) as an object of technical standardization may nevertheless have some important outcomes when applied to the European situation and geography.

The only trans-border mobile service is today provided through the INMARSAT international organisation, by its signatories licensed to provide maritime, aeronautical or land mobile service in each country. The Administration issues the licence within the country, the service may be provided through any available Coast Earth Station (CES), by manually selecting procedure. The choice may based on tariffing depending on the destination.

S-PCN trans-border operation range (see figure 6) may not be comparable with present systems, (approximately 17 000 km) specially if low earth orbit constellation are used (LEO is here used in the sense on the definition given in ETR 093 [1]). For ISL LEO systems the trans-border operation range, even if in theory larger that the geostationary, may be practically limited by delay introduced by the processing in each ISL hop and by the complexity of the call route. Another difference with today's systems, deriving from the said possible shorter range and the way network resources are used in S-PCN, is the meaning that the range of a call itself may have in S-PCN, e.g. for charging purposes (in today's mobile satellite systems the charging is independent from the distance, because of the use of a regional centralised satellite resource).

The geographical information associated to the call may be derived by positioning information provided by S-PCN or other (external) positioning system. It has been already observed (subclause 8.4) that if the call processing will have available information to be associated with a sufficiently precise location of the originating (and terminating party, if S-PCN), trans-border can be identified. The principles applied to identify "trans-border" may be several. Rather than taking into account actual national borders it could be useful to consider trans-border calls as those exceeding a certain range.

The geographical information may also be useful for purposes other than regulatory, namely market or other operation and maintenance purposes, to implement:

- flexible charging due to the use of a more "local" resource (mobile-to-mobile, fixed-to-mobile);
- shut down communications for crisis or emergency situations (in defined areas);
- provide technical means to enforce service unavailability in the territory of Administration not licensing the service (blocking of communications from or to the Administration domain);
- legal tapping of communications and access to user data for legal purposes (subclause 9.2.3.4).

8.6 Commercial

Commercial objectives are outside the scope of standardization activities of ETSI. Nevertheless they may be relevant to other bodies that can influence the standards to be developed. In this ETR, commonly valid commercial objectives are identified so that they can be referred to in the clause where the results of standardization of different aspects of S-PCN are being discussed.

In general, commercial objectives focus on existence of, and access to, a market. In the case of S-PCN this is relevant on different levels, and to different types of markets. In addition it may be relevant to consider the impact of standardization on the place where industrial or other economic activity may emerge.

The establishment of S-PCN creates new business opportunities and markets to be accessed. This subclause summarises how access to the S-PCN business could be modelled. The expectations are based on developments in ITU on the position of the satellite component in FPLMTS as well as developments in service provision.

The different markets and access to them are addressed separately below.

8.6.1 Market for space segment operators

The investment that is required to establish a satellite telecommunications network amounts to several thousands of millions ECUs. The parties that could be interested in owning such a facility are:

a) a global or regional mobile telecommunications operator; and

b) operators of (land) mobile cellular systems that wish to create extended coverage.

Entities of type a) are potential stand-alone S-PCN network owners / operators.

Entities of type b) are the PLMN operators. Not every PLMN operator is going to establish its own satellite network since the required investment is generally more than the value of a total PLMN. The prospect of a hundred or more satellite systems to support S-PCNs seems neither very attractive nor technically viable. With many PLMN operators the use of a common resource that is loaded with traffic to a degree that makes it commercially attractive is more interesting than establishing many systems to be loaded with traffic below a commercially attractive degree of occupation.

The different types of space segment operators a) or b) have different types of clients. Type a) deals directly with terrestrial operators and service providers, Type b) only with terrestrial operators (who could well be its owners).

It seems unlikely that more than a small number will achieve co-ordination on a global scale and achieve implementation. It is generally expected by participants to meetings where S-PCN matters are discussed, that (eventually after a shake-out) there is commercial "space" for only a limited number of space segment operators in the order of three or four.

8.6.2 Markets for S-PCN business

In operations of S-PCN, there are different types of operators involved and they should be addressed separately. This is closely related to the "players concept", see subclause 8.6.2.1. The subject of markets for S-PCN business is considered in terms of access to the markets for various types of entities.

8.6.2.1 Different types of S-PCN networks and operators

This subclause addresses the different types of S-PCN networks that may exist, to be able to distinguish between their operators in later subclauses. In this subclause the S-PCN will include at least the satellite component.

There are two types of S-PCNs foreseen (FPLMTS.SFMK, doc 94/41 by TG 8/1). An S-PCN network can be:

- a completely independent, self-contained network; or
- a space-extended terrestrial network.

A completely independent, self-contained S-PCN is a network that finds its base in operation of a satellite network only. All the network functions, up to including the subscriber administration and billing facilities, are part of the satellite network. In principle, such a network could do without interconnection to a terrestrial network by making only calls between its own subscribers. In practice, such a network has an interconnection with terrestrial networks for passing calls from and towards terrestrial networks. This type of network may well establish interconnection or roaming with a PLMN.

A space-extended terrestrial network is a network that finds its base in operation of a terrestrial network that has an extension into space. The space component is a common resource that provides the space extension to multiple terrestrial networks. The space component does not contain a duplicate of all the network functionalities that are already contained in the terrestrial network. The special aspect about this extension is that the client remains in the terrestrial operator's network, even if he is served via the satellite extension.

These two types of S-PCNs are described in the TG 8/1 document "Framework for the satellite component of FPLMTS". The modelling according to these two types is adopted as a basis for the considerations in this ETR.

8.6.2.2 Access to the S-PCN for commercial operators

There are three types of commercial operators that wish to obtain access to the S-PCN business. these are:

- the owner of a self-contained S-PCN;
- the owner of a terrestrial cellular network;
- the service provider.

How access is gained by operators in these categories is considered separately in the following subclauses and is illustrated in figure 9.

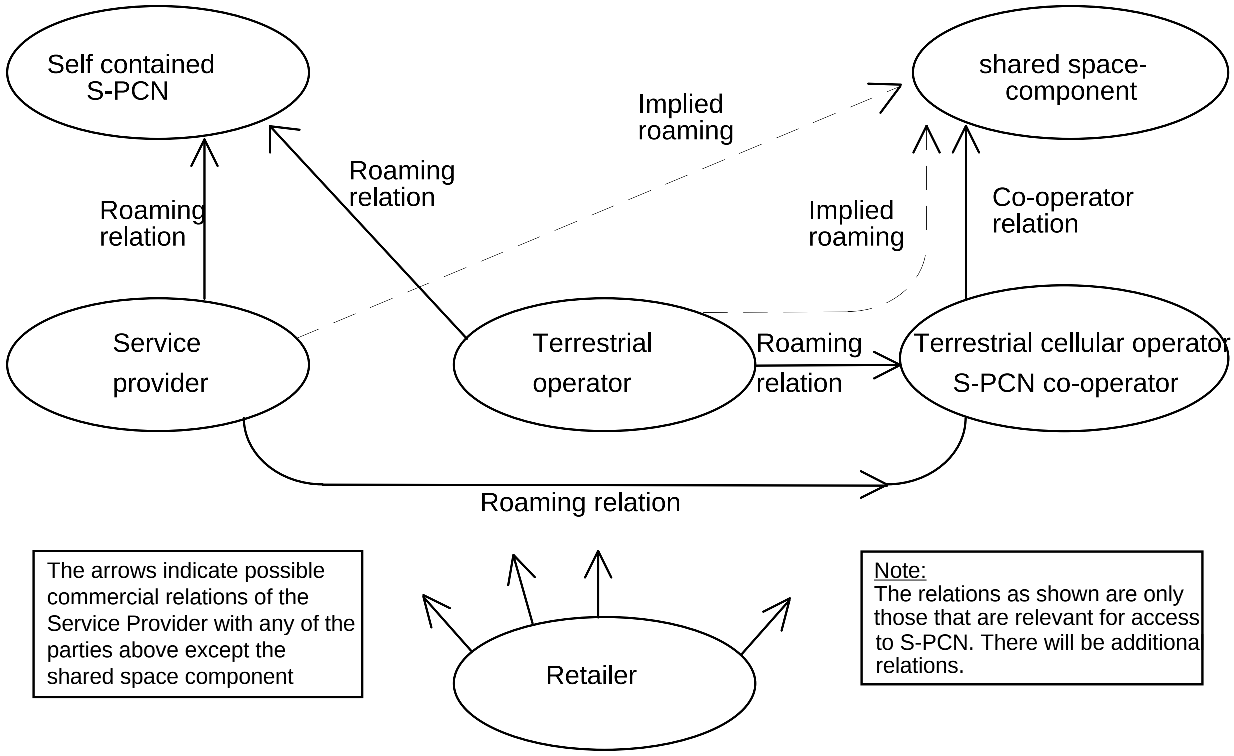


Figure 9: Overview of relations to gain access to S-PCN

8.6.2.2.1 Owner of a self-contained S-PCN

The owner of a self-contained S-PCN is not in any uncertainty about possibilities to enter into operation. His only dependency is on (inter)connection to terrestrial networks.

8.6.2.2.2 Owner / operator of a terrestrial network, cellular or fixed

To access the S-PCN business, so that its clients can make use of S-PCN, the owner / operator of a terrestrial network, cellular or fixed, needs a roaming agreement.

The operator of the terrestrial cellular network could as an alternative opt for a possibility to become a S-PCN co-operator. The operator of a terrestrial fixed network could gain access to S-PCN via roaming based on UPT.

There is a considerable difference in business implications between these two options.

In both cases, if the S-PCN network uses the same technology as the terrestrial mobile network, than the clients do not need a different terminal. If the S-PCN network uses a different technology, then clients need a second terminal or a dual (or multi) mode terminal.

8.6.2.2.2.1 Business access by becoming a S-PCN co-operator

By becoming a S-PCN co-operator, the clients of a terrestrial operator can make use of an S-PCN network. The terrestrial operator adds a space component (a shared resource) to his terrestrial network.

The process of becoming a S-PCN co-operator will depend on acceptance by the space component owner in a commercial decision. Acceptance will depend of financial stability / reliability of the applicant and the absence of a conflict of commercial interests with the space component owner.

8.6.2.2.2.2 Business access via a roaming agreement

Via a roaming agreement with an S-PCN-only network operator or a roaming agreement with an S-PCN co-operator, clients of a terrestrial operator can make use of an S-PCN network.

The establishment of a roaming agreement will depend on acceptance by the S-PCN (co-)operator in a commercial decision process. Acceptance will depend of financial stability / reliability of the applicant and the absence of a conflict of commercial interests with the S-PCN (co-)operator. It may well be that a terrestrial operator that fails to establish a position as co-operator of a shared space component, can establish a roaming agreement with a third party that did manage to qualify as a co-operator. As the third party's network includes the shared space component, clients of the terrestrial operator gain access to the satellite by this agreement, see figure 9.

The main commercial difference between an operator that relies on roaming and an operator that is a S-PCN (co-)operator is that:

- the S-PCN (co-)operator:

    - remains in full control of all the commercial possibilities when his clients are served via the satellite;
    - does not receive nor pay call detail records from other operators because the client remains in his home network;
    - the clients maintain access to all the Value Added and Supplementary Services that they are used to in their home network;
    - does receive a bill for allocation of transmission capacity from a shared resource;
    - the home network remains fully in control of the communication possibilities of the client;

- whereas the operator that relies on roaming:

    - the client is lost to an other network when he / she is served via the satellite;
    - is left with responsibility to account for the call detail records;
    - the client does not have access to the services of his / her home network.

8.6.2.2.3 Service provider

The expression "service provider" is used for commercial operating entities varying from "simple" air-time resellers to operators with a network which can be considered as being collapsed to one with no physical coverage.

A service provider in the full sense would have those network functionalities available that enable him to be an S-PCN co-operator (clients database / HLR, mobility management, billing and accounting facilities and signalling connections to other networks). The users of the services of a service provider are permanently roaming.

To access the S-PCN business, so that his clients can make use of S-PCN, the service provider of terrestrial services, cellular or fixed, needs a roaming agreement either:

- directly with a self-contained S-PCN operator; or

- with a satellite extended terrestrial operator (S-PCN co-operator).

A roaming agreement with a terrestrial operator that has implied roaming via a roaming agreement with a S-PCN co-operator does not provide access to the S-PCN business, as roaming is not transferable.

Alternatively a service provider could become an S-PCN co-operator since he does have sufficient network functionalities to complement the shared satellite component. However, this would mean the actual step from a service provider to management of an actual telecommunication network and this may make the service provider subject to a different licensing regime.

8.6.2.3 Access to the S-PCN business for retailers

Retailers are the entities that actually sell the commercial telecommunications packages as devised by operators or service providers to the public The retailer is comparable to the "terminal provider" of subclause 8.3.4. The retailer will ask his client about his actual communication need and then offer a choice of those packages that will meet the need of the client, possibly from different operators and / or service providers. The retailer will then establish the subscriptions and offer the hardware and eventually the installation of hardware.

Retailers do not re-package the telecommunications service offerings of their sources and are not involved in the billing process for the communications of their clients. For retailers, the business of S-PCN consists of selling terminal equipment and of selling subscriptions on behalf of an operator / service provider.

For a retailer to be able to offer S-PCN to his clients, he needs to establish a direct or an indirect relation with an actual S-PCN operator or service provider. Therefore, the retailer has the following options which will result for him in substantially different offerings for his clients:

a) relation with a terrestrial operator, annex S-PCN co-operator;

   This results in the offering of a package where service to the customer is handled by terrestrial means where terrestrial coverage is provided, and where service will take place via the satellite when the client is outside terrestrial coverage. In principle, a call in progress can be handed over to the satellite without interruption when the mobile travels outside terrestrial coverage, because there is no roaming involved.

b) relation with terrestrial operator that has a roaming agreement with a self-contained S-PCN operator;

   This results in the offering of a package where service to the customer is handled by terrestrial means where terrestrial coverage is provided, and where service will take place via the satellite when the client is outside terrestrial coverage. There is no handover of a call in progress (unless inter-network handover of a call in progress will be devised in the future). Service via the satellite involves roaming in this case and the terrestrial operator (and his client) is subjected to the commercial conditions imposed on individual calls by the S-PCN operator.

c) relation with a terrestrial operator that has a roaming agreement with a terrestrial operator that is an S-PCN co-operator;

   This results in the offering of a package where service to the customer is handled by terrestrial means where terrestrial coverage is provided, and where service will take place via roaming to the satellite extended terrestrial operator when the client is outside terrestrial coverage. This is very similar to the case b). It is a demonstration of the fact that a terrestrial operator can quite simply provide satellite access by establishing a roaming agreement with an S-PCN co-operator of which there will be (potentially) many.

d) relation with a service provider that has a roaming agreement with a self-contained S-PCN operator;

   This results in a service offering that depends greatly on the other services that the service provider uses in his packaging. One should expect that such a service provider also has a roaming agreement with a terrestrial operator so that the majority of the traffic can be handled at terrestrial tariffs. Handover of calls in progress between terrestrial-and-satellite networks or between terrestrial networks is not expected.

e) relation with a service provider that has a roaming agreement with a terrestrial operator that is S-PCN co-operator;

   This results in the offering of a package where service to the customer is handled by terrestrial means where terrestrial coverage is provided, and where service will take place via roaming to the satellite extended terrestrial operator when the client is outside terrestrial coverage. This is very similar to the case a).

f) relation with an S-PCN operator;

This results in the offering of a satellite communication-only package. Wherever the customer is, his service is handled by the satellite operator, within the constraints of the satellite communications possibilities. However, S-PCN operators may develop roaming agreements for their customers with terrestrial operators, and if that is included in the package then there exists a situation that approaches the case b). The major difference being that the client does not have a home network for handling of his terrestrial communications, but instead for handling of his space communications.

8.6.2.3.1 Evaluation by the client

Clients buy what is the best commercial offering in their case. What the best commercial offering will be in the specific case will be strongly determined by:

- the extension of coverage by terrestrial networks in the area where the client would use its phone most of the time;

- the fact that in urban centres and indoor terrestrial communications may be able to provide a better quality of service than some of the satellite proposals.

In Europe, where the terrestrial coverage is generally good, those that want access to S-PCN will in general be best served with a combination package of terrestrial / S-PCN services, in such a way that his communications are handled via terrestrial means where these are available and via satellite where only that is available. The satellite systems have difficulties in providing service in high rise areas and inside buildings, where terrestrial systems are better equipped.

In regions where there is no good terrestrial coverage, a combination package is less important to the user. Coverage is not so often nation-wide as in Europe so that many individual networks would have to be involved in the package and, unless the user happens to remain normally in the terrestrial coverage by one or more terrestrial networks of the same standard, he / she would probably opt for a separate satellite telephone.

NOTE: Special circumstances of a client will also reflect in the choice of a customer. For instance in Europe a phone call to the USA may be cheaper via S-PCN than via a terrestrial network. An S-PCN operator may have the possibilities to create "special circumstances" for their prospects to promote their business, e.g. low tariff mobile-to-mobile calls.

8.6.2.4 Competition in the market between operators

Competition in the market between S-PCN operators is not subject to Directive 90/388/EEC [87] on competition in the markets for telecommunications services, as satellite services are excluded in its Article 1 bis.

There is however a draft Commission directive, SEC (93) 1891 final [88], which proposes to modify the aforementioned directive and makes the modified version explicitly apply to satellite services and by implication to S-PCN. Therefore, EU Member States "shall withdraw all exclusive rights for the supply of telecommunications services other than voice telephony" also with respect to satellite services, if the modifying directive is adopted.

Although the number of S-PCN system owners will be limited, the number of commercial operators can be considerable and multiple operators may be competing with each other in the same country, eventually on the same infrastructure.

Stand-alone S-PCNs operators compete with offers on the level of service providers / terrestrial operators. Shared S-PCN satellite component operators compete with offers on the level of retailers.

It is interesting to note that in both cases of:

- operators that use a single shared space component, or in the case of
- roaming through multiple service providers on a single stand-alone S-PCN,

although the competition (by operators and / or service providers) may be against each other, it does not work out against the commonly used system whilst it is always to the detriment of a competing S-PCN system.

The S-PCN / MES (the user terminals) of all the subscribers of all the S-PCN co-operators using a single system have a compatible radio interface towards the satellite as a single standard applies here. This enhances competition between operators concerning subscribers that already have a terminal as it need not be replaced when subscribers move between such S-PCN co-operators. The terminal may be constructed for dual-mode operation (satellite and terrestrial), in which case the movability of subscribers may be reduced regarding moves between operators that apply different standards for terrestrial mobile communication but will always be possible for the satellite part.

8.6.3 Market of infrastructure elements

This subclause addresses the impact of standardization on the market for infra structure elements.

S-PCN infrastructure elements are satellites, Land Earth Stations (LESs) and Gateway MSCs. Depending on the size and architecture of the network, it may contain further switching nodes (that can be located on earth or in space).

In Europe, procurement of infrastructure elements for the fixed and mobile public telecommunications networks normally takes place via an open tendering procedure.

8.6.3.1 Existence of a market for infrastructure (elements)

The market for infrastructure elements for telecommunications networks is regulated by the Council Directive 90/531/EEC (the Procurement Directive) [89].

The applicability of the Procurement Directive is restricted as detailed in Article 2, clause 2d, that mentions "the provision or operation of public telecommunications networks or the provision of one or more public telecommunications services". This clearly restricts application to "public" networks or services. In this respect there may be an impact resulting from the discussion in subclause 9.1.1.

In Annex X of the Directive a number of entities are explicitly listed as public authorities or public undertakings that are affected by the Directive. It is not yet clear from reading the Directive, whether an S-PCN operator will be subject to it, except if it is one of the entities listed in Annex X which contains all the classical national fixed network operators (and others).

The field of applicability of the Procurement Directive is not restricted to procurement for infrastructure that is established inside the European Union (except in some special cases). Therefore, for a contracting entity inside the EEA, procurement of satellites Land Earth Stations and Gateway MSCs may be affected by it, if the investment that it requires exceeds ECU 600 000 (Article 12).

For a contracting entity outside the EEA the Procurement Directive may be applied only as far as it concerns LES and gateway MSCs that are to be established inside the EEA.

It is generally expected that the market will be created by only a rather limited number of S-PCN initiatives, the number of initiatives may be in the order of three for the whole world. In the EEA, per satellite component, the market that is affected by the Procurement Directive may substantially exist of:

- LESs, in number between 1 and 12. The maximum number is not the same for every system proponent. There are systems that require so much space between LESs that they can not be installed in every neighbouring country. In addition, the amount of traffic to and from some countries may make it unattractive to place an LES there, so some countries may be served via an LES in a different state;
- Gateway MSCs;

- satellites, only for European initiatives. The number of these is not known.

8.6.3.1.1 Relation to standards

The relation to standards follows from Article 13 of the Procurement Directive, of which the first three paragraphs state:

1) "contracting parties shall include the technical specifications in the general documents or the contract documents relating to each contract";

2) "the technical specifications shall be defined by reference to European specifications where these exist";

3) "in the absence of European specifications, the technical specifications should as far as possible be defined by reference to other standards having currency within the Community".

However contracting entities may derogate from paragraph 2 according to the paragraphs 6d and 6e if:

6d) "the relevant European specification is inappropriate for the particular application or does not take account of technical developments which have come about since its adoption. Contracting entities which have recourse to this derogation shall inform the appropriate standardising organisation, or any other body empowered to review the European specification, of the reasons why they consider the European specification to be inappropriate and shall request its revision";

6e) "the project is of a genuinely innovative nature for which use of European specifications would not be appropriate".

Regarding the precise system characteristics, it seems quite possible for an entity that invites to tender to apply paragraph 6d) or 6e) of Article 13. There is not a European system specification, and if there were, it does not exclude other systems. It will also be debatable to consider an S-PCN as a project of a genuinely innovative nature.

A European system specification, e.g. UMTS or a GSM extension, may in the future support public procurement.

8.6.3.2 Access to the infrastructure (elements) market for the industry

Under the present conditions, access to the market of system elements depends on the ability of the manufacturer to:

a) establish its position in direct contact with the system proponent, alone or as a consortium; or

b) to establish a position as part of a consortium that makes a bid in reply to a Request For Tender (RFT).

However, for the near future, there is very little hope for application of the competition rules and therefore option a seems to offer the best chances.

8.6.4 Market of Telecommunications Terminal Equipment (TTE)

8.6.4.1 Directive on competition in the markets on TTE

The market of Telecommunications Terminal Equipment (TTE) is regulated by the TTE Competition Directive 88/301/EEC [10]. According to the whereas clauses, this Directive was mainly created to open up the market of terminal equipment which was exclusively controlled by national telecommunications monopolies in a number of Member States in 1988.

Commission Directives 94/46/EEC [88], amending TTE Competition Directive 88/301/EEC [10], and 90/388/EEC (on competition in the markets for telecommunications services in particular with regard to satellite communications) [87] , have recently been adopted.

Article 1 of the amended TTE Competition Directive defines terminal equipment in such a way that also a S-PCN handset is subject to it.

The amended version includes two definitions in Article 1 that make this very explicit:

- firstly by stating that "terminal equipment also means satellite earth station equipment";

- secondly by defining satellite earth station equipment as "equipment which is capable of being used either for transmission ("transmit") or for transmission and reception ("transmit / receive"), or for reception only ("receive-only") of radiocommunication signals by means of satellite or other space-based systems", without any reference to direct or indirect connection to the public telecommunications network.

Article 3 of this amended TTE Competition Directive states that Member States may refuse to allow satellite earth station equipment to be brought into service if the equipment does not meet the requirements of a CTR or if in the absence of CTRs, the equipment does not meet the essential requirements of the SES Directive [20]. In the original version the Directive refers to an independent body to decide on this, and it does not address any CTR.

Article 5 of the TTE Competition Directive states that the Member States shall formalise and publish the specifications and type approval procedures for terminal equipment, and Article 6 states that these specifications shall be drawn up by an independent body.

For a TTE connected to a public network, the TTE Competition Directive requires the publication of technical specifications of the interface at the NTP. It states (whereas 14) that:

> "to enable users to have access to the terminal equipment of their choice, it is necessary to know and make transparent the characteristics of the termination points of the network to which the terminal equipment is to be connected. Member States must therefore ensure that the characteristics are published and that users have access to termination points";

and (Article 4)

> "Member States shall ensure that users have access to new public network termination points and that the physical characteristics of these points are published not later than 31 December 1988".
>
> NOTE: Obviously the principle of the Directive applies to new networks after the deadline, as well as to networks existing before the deadline.

Also Article 1 defines Terminal Equipment as:

> "equipment directly or indirectly connected to the termination of a public telecommunications network...to send, process or receive information".

Taking into account the TTE Competition Directive, for a Terminal Equipment connected to the NTP of a public network, the full specification of the interface must be made available through publication.

It is understood that a mobile terminal designed for a specific S-PCN may not be able to operate with other S-PCNs.

These technical specifications may be contained in a CTR or have a different form. The way of the publication of the specifications of the mobile air interface and the possible IPR implications need further consideration. In any circumstances, for the publication of those specifications, the following considerations should be taken into account:

- the S-PCN will be world-wide networks;

- if the specifications are transformed into standards in various countries and regions of the world, by ETSI in Europe, by the T1 in USA, the RCR in Japan etc., then any modification of the specification will have to be reproduced in each standard. Some difficulties will arise quite soon: the updating process could be long and / or some modifications could be blocked in some countries or regions, leading to a possible divergence between the latest versions of each region.

8.6.4.2 Access to the terminal market by the industry

Access to the S-PCN terminal market by the industry may be open or restricted. These cases are addressed below.

The TTE Competition Directive establishes an open market for terminals, in the sense of a market where multiple manufacturers have the possibility to provide terminals for an S-PCN system, through the full public, unconditional and non-discriminatory availability of technical specifications and the availability of type approval.

Access to the terminal market for the industry depends on the decisions of the CEC on the application of the TTE Competition Directive, otherwise on the attitude of the specific S-PCN proponents and on the nature of the mobile interface specifications:

- European harmonized standard (a public standard drafted or adopted by ETSI);

- published specification (brought in the public domain by publishing of the full specifications, not adopted by ETSI);

- non-public specification (a specification either not published or partially published).

In cases where the mobile interface specification is not adopted by a public standards body, there is no guarantee of equal opportunity of access for the industry to the terminal market. The market for terminals for a specific S-PCN may even be under the control of a single manufacturer.

If the system designer is also a manufacturer of terminals, in developing system specifications he will be in a privileged position and will have the possibility to develop terminals exploiting all the system functionalities and including provisions for future new features, in anticipation of the provision of the enhanced specification to other manufacturers.

Even if the mobile interface specification is proprietary it is possible to create access to the market for the industry if the specification can be made publicly available. Examples of such an arrangement are NMT (where the standard can be obtained from national type approval authorities) and TACS.

Such a procedure of publication of a proprietary specification, including the specification changes, can be also carried out through a public standards body.

Even if the market for S-PCN TTE were eventually opened and sufficient information regarding the mobile interface were published to enable other manufacturers to design, test and produce terminals, then the industry would still suffer from a drawback due to time gap needed to develop features to match network developments. In addition manufacturers may have licence-fee obligations towards the owner of the proprietary specification.

In cases where the mobile interface specification is managed by a public standards body like ETSI, or a world-wide organisation with similar characteristics, then there is equal opportunity of access for the industries to the terminal market, provided that the IPR issues are resolved before the adoption of the standards and that a facility for conformance testing is available.

8.6.4.3 Effect of open standards on the terminal market

The Directives currently regulating the market for terminal equipment are described elsewhere in this ETR. In particular the TTE Competition Directive 88/301/EEC [10] and the TTE Directive 91/263/EEC [19], supplemented by the SES Directive 93/97/EEC [20] address the introduction of competition in the supply of terminal equipment and satellite earth station equipment, through the development of a pan-European approvals system. These Directives were prepared for the situation of terminal equipment intended for connection to monopoly public networks. In practice, the pan-European approvals system is developing much more slowly than hoped because of long delays in the production of suitable TBRs, due to the complexity of requirements that include complex protocols and the time taken for the procedures associated with formal standards.

The whole concept of the TTE Directive 91/263/EEC [19] and the SES Directive 93/97/EEC [20] is based on the distinction between public and private networks. This distinction is already facing difficulties in the area of data communications where competition already exists, and will be even more difficult to discern after the liberalisation of infrastructure and voice services from 1998. This will coincide with the introduction of S-PCN.

In view of these issues, discussions are already beginning about a revision of these regulations.

In the area of fixed networks, there has been a need for formal published standards and a fairly comprehensive approvals system that confers a right of connection because the monopoly network providers were previously also the monopoly providers of terminal equipment. Consequently it was necessary to ensure that sufficient information was given to new entrants to terminal market so that they are not at a disadvantage compared to the network operator's own terminal business. Because the network was a monopoly, terminal manufacturers who suffered anti-competitive practice from one network operator could not redirect their efforts to supplying terminals for a different network.

Furthermore it was necessary to use standards to create harmonization between the networks in different countries so that there would be a pan-European market for terminals, and Europe would enjoy the benefits of a market size comparable to those in other regions.

In the case of GSM, there is competition between networks, and because the networks were new, the network operators did not have an established position in the supply of terminals. However standards have played a very important role in:

- ensuring roaming between different networks, not only in the same country but also in different countries;

- increasing competition between operators by allowing customers to change their subscription from one network to another without having to buy new terminals.

The use of formal standards was possible because the development of GSM was co-ordinated at a European level.

The situation of S-PCN is quite different for the following reasons:

- S-PCNs will be in competition with each other;

- S-PCNs will use different technologies, and so the transfer of handsets from one network to another may not be possible;

- the developments are being led from outside Europe and are not under European control;

- S-PCNs will generally provide global coverage and so roaming is not an issue;

- S-PCN operators in general will not rely on a single source for the manufacture of terminals.

Formal standards, developed by ETSI or other standards bodies, are not necessary to ensure competition in the supply of S-PCN terminals.

S-PCN operators will not benefit from restricting access to the specifications of handsets to work with their networks. They would benefit only if they could increase the profit margin per terminal or the number of terminals sold. If access to specifications is restricted, prices for handsets will tend to rise but because there are alternative networks this will result in a reduction both in sales of terminals and traffic on the network. Thus there will be a strong incentive to allow access to handset interface specifications. S-PCN operators will wish to have an open competitive market in handsets, and the prices in this market will influence the market expectations for all S-PCNs.

Because there will be different specifications for the different S-PCN systems, there is little point in requiring their publication through a formal standards body such as ETSI because such a procedure would:

- delay the finalization and hinder the maintenance of the specifications;

- involve complex arguments over intellectual property;

- achieve nothing that would not be achieved through normal commercial relationships between the network operators and the terminal manufacturers.

The conclusion is that the requirements for competition in the terminal market can be adequately met provided that the specification is made available to manufacturers under fair and reasonable commercial terms. Existing general competition laws will then be sufficient.

As discussed later, there will be a need for approval standards addressing requirements concerning EMC, the effective use of the radio spectrum, orbital resources, avoidance of interference and additional essential functionalities. These standards should be developed through ETSI.

8.7 User-oriented objectives

User-oriented objectives relate primarily to issues of the man-machine interface, its useability and operability, and are normally regarded as Human Factors matters. Objectives in this area will relate to aspects such as:

- how the user will operate the S-PCN handset to place and receive calls and utilise additional facilities through supplementary services;

- how information will be presented from the terminal to the user to facilitate its useability;

- how user co-operation possibly required by S-PCN might be ensured;

- how people with special needs might access the system etc.

Objectives in this area will arise out of a desire to ensure that the telecommunications networks established under S-PCN will be in conformance with the same kinds of user requirements applying to other telecommunications networks. Thus, the basic requirement is likely to be that the user interfaces from S-PCN are not substantially different from those established for other fixed and mobile networks.

For S-PCN, the user access to the satellite based service may not in principle be simple and so the user should be facilitated to enable the operation of S-PCN in a manner similar to the operation of any mobile telecommunications system.

In consequence, the S-PCN user objectives are unlikely to lead to standards that are substantially different in nature to those already developed, e.g. within ETSI and ITU-T.

Subclause 9.2.5 identifies a range of possible standardization that might be applicable to S-PCN with regard to user aspects, addressing the areas of:

- user requirements in UPT;
- user control procedures;
- user co-operation in S-PCN telecommunication sessions;
- supplementary service access and control;
- terminal design and controls;
- tones, messages and announcements;
- numbering and addressing;
- system and user response times;
- service quality and availability;
- people with special needs.

Further objectives of possible relevance to users are addressed in other parts of this ETR, in areas such as incontestable billing (subclause 9.2.2), security (subclause 9.2.3) and encryption (subclause 9.2.2).

8.8 Impact of S-PCN in Europe

This subclause is not so much an objective per se, rather it is an analysis of the possible outcomes resulting from the implementation of S-PCN in Europe. Thus the options selected to achieve specific objectives might lead to particular effects and impacts within Europe being observed and an attempt is made here, at the end of the clause related to the objectives, to review some of these possibilities.

8.8.1 Telecommunications industry

The European telecommunications industry would expect to be a major beneficiary of any developments in S-PCN that are specifically aimed at Europe. However, the impact on the telecommunications industry depends very much on how "European" the S-PCN implemented for Europe actually turns out to be. If USA systems, with proprietary standards and limited participation of European companies in their development and implementation, become the de facto implementation then the scope for a beneficial impact on the European telecommunications industry might be small. It should be considered, however:

- most (if not all) of the "big LEO" proposals incorporate to some degree or another a European partner or partners and the proposal of one (INMARSAT) is in any case from an inter-governmental organisation in which European members play a significant role;

- several of the proponents have European subsidiary companies or European partners with which they maintain a close and well established business relationship;

- several of the proponents have indicated their intent to undertake a proportion of their procurement activities from European companies and European companies are well placed to respond to this procurement activity, particularly in view of experience gained in GSM development;

- at least one proponent has indicated that their air interface specification will be made available to all "qualified manufacturers" and that licences for the terminal unit IPR will also be made available on "fair and reasonable terms" to "qualified manufacturers" (although the definition of a "qualified manufacturer" is not stated); and

- that even in the event of a primarily USA driven S-PCN implementation in Europe there may be significant opportunities for European companies to play a part, but these opportunities are likely to be on the basis of commercially arrived at arrangements between specific European and USA companies and not through the opportunity for all European firms to participate in the market.

The position might look very different, however, for the European telecommunications industry if a means is found to exploit the experience of the European telecommunications industry in the development and implementation of GSM by developing a European project to specify a satellite integration with GSM.

In this case, it could be considered that the significant expertise and effort that has gone into establishing GSM as an almost world-wide standard for digital cellular mobile networks could and should be readily translated into the satellite area. Whilst it is probably too late to do anything in advance of the implementation of the USA driven, "first generation" S-PCN systems, there could exist for Europe a real possibility to develop a "second generation" standard for a European system.

It is noted that in the development of GSM the inclusion of a satellite component was never considered, at least not in the years 1986 and onwards, although a work item on the interworking of GSM with satellite systems has recently been added to the GSM Phase 2+ work programme (see subclause 7.1.2). Had this been part of the initial GSM development programme than this would have predated most, if not all, of the currently proposed S-PCN programmes, European space telecommunication industry would have been at the forefront, as well, perhaps, as European space technology.

In this context it is worthwhile analysing whether the development of a firm European standard, in the spirit of GSM, and its subsequent implementation is still achievable.

The initial reaction might be that it is already too late since there are several programmes now underway. Nevertheless there is the analogy of GSM which has shown that although different systems exist such as NMT, TACS and C-Netz, it is possible to make a successful programme for a new system. The key factor in the success of the GSM programme was the establishment of an MoU in which operators took on a public commitment to implement the new standard.

This approach could indicate a possible way forward for a successful European initiative. Developing a European initiative will only have a chance if there is a public commitment behind it from relevant parties to implement it, and it could be considered that there are two possibilities for an MoU which could support it:

- a new and separate MoU could be considered, perhaps from all the European telecommunications operators; or

- it could be envisaged that an extension to the MoU on GSM (or some other commitment of that existing community) could find a way to implement a system according to a specific standard.

In either case, however, it seems probable that one of the most significant problems would be to find the necessary investors for the project.

A separate item which would need to be solved is the specific standard to be adopted for such an MoU. To build on the success of GSM, ETSI concludes that a revision of the priority and scope of the existing ETSI TC-SMG work item on mobile satellite interworking (see subclause 7.1.2) should be considered in order to ensure that:

- the existing and established European activity regarding GSM may be developed to support integration with mobile satellite systems; and

- a migration path from GSM to S-PCNs may be established so that investments made so far are protected.

It is critical that such a work item is developed in a co-ordinated way with other possible standardization activities carried on by ETSI, such as UMTS.

Whether such an approach would find favour as a desired objective in Europe is less easy to establish. The views of the interested communities presented in clause 11 of this ETR may give some indications in this regard, where less than half of the replies to the ETSI questionnaire seemed to find favour with this kind of approach (although it must be noted that as the number of replies was so small it is hard to draw any statistically significant relationships from them). Subclause 8.2 addresses the possible objective of a European S-PCN approach in more detail. In any case a synergy between terrestrial network communications engineers and satellite communications engineers and, to less extent, between the telecommunication specialism and the space technology specialism seems to be essential. In the past, the parties seem to have been working somewhat in isolation.

8.8.2 Space industry

The opportunities for the European space industry may not depend to such a significant extent upon the outcome of the European S-PCN implementation. Whichever system or systems are eventually implemented there will be a requirement for a major procurement of satellite hardware possibly requiring advanced technology solutions to solve the difficult problems (both in terms of bus and payload) generated by the complex nature of the S-PCN networks.

Consider, as examples a 70 satellite constellation or even an 850 satellite constellation, both of which are consistent with current proposals. If a baseline 5 year satellite lifetime is assumed then the entire constellation would need to be replaced every five years. This implies, from the start of service and for ever thereafter, an average of just over one new satellite manufactured and launched per month for the 70 satellite constellation and an average of just over 14 new satellites manufactured and launched per month for the 850 satellite constellation - without any allowances being made for sparing to cover launch or in-orbit failures. During the constellation set-up phase the launch intensity is likely to be greater, and in any case multiple satellite launches will be utilised, leading to an increased manufacture and launch demand and an eventual "bunching" in the replacement strategy also. So the 850 satellite constellation, and to a lesser extent perhaps, the 70 satellite constellation, imply a "line production" of satellites and a constant demand on launch facilities. It is not clear at present whether the satellite manufacturing capacity within the USA alone could support this line production without requiring support from outside the USA.

In any case, because of the presently relatively limited opportunities existing world-wide for satellite procurement, most, if not all, manufacturers have established associations and groupings to create a mutual benefit from their pooled knowledge and experience, leading generally to multinational bids for satellite procurements. Again, it is not clear if the satellite procurements for S-PCN will be made through competitive international tender, but it could be a sensible policy objective, in the interests of fair trade, for the Commission to try and ensure that, wherever possible, this is the case. In practice, though, this possibility might not be regarded as very realistic, particularly because many of the S-PCN consortia already contain, or are even being led by, spacecraft manufacturers who will probably expect to undertake the majority, if not all, of the construction required, and this may lead to restrictions in opportunities for European manufacturers.

It could be expected, therefore, that although the European space industry might be well placed to achieve an involvement in the satellite procurements arising out of S-PCN implementation (whether the implemented systems are USA-driven or European based) provided that the procurement is undertaken in an open and competitive manner, or at least in a way that will ensure the possibility of some European participation. This might not be achieved if the procurement is not open and competitive.

The Commission could therefore consider, and bring into their discussions with interested parties in the USA, the possibility of making the open and competitive procurement of satellite hardware, or at least the possibility of European participation in the procurement process, a requirement for the licensing and operation of S-PCN networks within Europe.

8.8.3 Transport programmes

The ubiquitous availability of S-PCN based communications throughout Europe may offer some benefits to the transport industry and the technical programmes of the Commission and others to develop the transport and its related support infrastructures in Europe.

However, this comment should be modified by a consideration that the generally ubiquitous (in Europe) availability of the terrestrial mobile communications infrastructure may offer similar, if not identical, benefits and therefore the additional benefit gained through the introduction of S-PCNs might not be so great.

Even so, it is useful to consider if there are any particular ways in which it might be envisaged that S-PCN could be of benefit in this area, to see if there could usefully be the development and application of standardization that might assist the transport sector.

There are a number of technical programmes aimed towards transport, such as the EC DRIVE programme and its follow-ons and within these, the benefits of enhanced communications technologies are being considered under a number of specific projects (which are summarised in the 1993 Annual Technical Report on Transport Telematics [96]), such as:

- PROMISE - Prometheus CED 10 mobile and portable information systems in Europe (V2101);

- SOCRATES 2 kernel project (V2013);

- QUARTET - Quadrilateral advanced research on telematics for environment and transport (V2018);
- ATT-ALERT - Advanced transport telematics - Advice and problem location for European road traffic (V2028).

These programmes are generally based on a requirement for mobile data communications from small terminals, and in general foresee the use of satellite communications. These programmes are an area in which it is possible to identify that the application and use of S-PCN might be beneficial.

It could be useful for the Commission to inject into these programmes some inputs related to the opportunities that might be presented by S-PCN and to encourage the S-PCN proponents to make inputs to this work.

9 Technical areas considered for standardization

In this clause is presented a detailed analysis of possible technical standards, grouped by area, which have arisen out of the consideration of the objectives in clause 8.

9.1 Essential requirements under the TTE and SES Directives

ETR 093 [1] has already reviewed (in subclauses 8.1.1 and 8.1.2) the background to the TTE Directive 91/263/EEC [19] and its extension to satellite earth stations [20] under the SES Directive 93/97/EEC (and also the Low Voltage Directive [23] and EMC Directive [24]). These Directives establish the so called essential requirements which must be met by all TTE and SES equipment, and the application of which are intended to lead to a regime of free circulation, placing on the market and use of TTE and to a regime of free circulation and placing on the market of SES equipment throughout Europe. The SES Directive, unlike the TTE Directive, does not imply the free use of transmitting satellite earth station equipment in conformity with the Directive, as this would normally be subjected to national licensing.

The essential requirements of the Directives are not "options", but the manner in which each essential requirement is to be specified and conformance demonstrated is not stated in the Directives and it is necessary to consider in more detail how they might be applied to S-PCN.

In the following two subclauses the issue of standardization under the essential requirements is addressed. Firstly a general review is made in order to determine the standardization regime likely to apply to S-PCN and secondly each of the essential requirements is addressed in turn to consider how it might be implemented in standards for S-PCN that could be produced by ETSI.

In this subclause it is assumed that voluntary standards (ETSs) will be developed to satisfy the essential requirements for S-PCN and no specific assumption is made as to whether these technical standards will then go on to become embodied in TBRs as part of the process of developing European harmonized standards for S-PCN. The subclause does analyse, however, what elements might be incorporated in any TBR that might be subsequently developed for S-PCN, as it is to be expected that ETSs would form the basis for any TBR that is eventually developed. These elements are analysed in subclause 9.1.2 and cover principally the areas of EMC, protection of the public network, effective use of the spectrum, interworking of terminals with the public network and, in justified cases, end-to-end interworking of terminals through the network.

9.1.1 General consideration of the application of the essential requirements and harmonized standards to S-PCN

9.1.1.1 Summary of the essential requirements

For the convenience of the reader, and because they will be referred to extensively throughout the following subclauses, the essential requirements established by the TTE Directive and the SES Directive are reproduced here. The numbering of the essential requirements is taken from the Directives.

Under the TTE Directive, the essential requirements are as follows:

Article 4(a) user safety insofar as this requirement is not covered by (the Low Voltage Directive);

Article 4(b) safety of employees of public telecommunications networks operators, in so far as this requirement is not covered by (the Low Voltage Directive);

Article 4(c) electromagnetic compatibility requirements in so far as they are specific to TTE;

Article 4(d) protection of the public telecommunications network from harm;

Article 4(e) effective use of the radio frequency spectrum, where appropriate;

Article 4(f) interworking of TTE with public telecommunications network equipment for the purposes of establishing, modifying, charging for, holding and clearing real or virtual connections;

Article 4(g) interworking of TTE via the public telecommunications network, in justified cases.

The SES Directive applies, comments on, or modifies the essential requirements specifically for SES equipment, applying the essential requirements to SES equipment, even when this equipment is not TTE in the context of the TTE Directive.

Article 4.1 states that SES equipment shall satisfy the same essential requirements as those in Article 4 of the TTE Directive (i.e. those listed above);

Article 4.2 states that the essential requirement 4(a) shall, for the purposes of the SES Directive, imply the safety of persons in the same way as in the Low Voltage Directive;

Article 4.3 states that, for SES equipment, the essential requirement 4(e) on effective use of the spectrum shall include the effective use of orbital resources and the avoidance of harmful interference between space-based and terrestrial communications systems and other technical systems;

Article 4.4 states that EMC requirements that are specific to satellite earth station equipment shall be subject to essential requirements in Article 4(c);

Article 4.5 applies essential requirement 4(f) on interworking of the SES equipment with the PTN;

Article 4.6 applies essential requirement 4(g) on interworking of SES equipment via the PTN in justified cases;

Article 4.7 states that, notwithstanding 4.1, 4.5 and 4.6, SES equipment which is not intended for connection to the public telecommunications network shall not be required to satisfy the essential requirements 4(b), 4(d), 4(f) and 4(g).

9.1.1.2 Principles regarding the application of essential requirements

The following set of working principles have been used in subclauses 9.1.1.3 and 9.1.1.4 to consider the implementation of essential requirements for S-PCN:

a) TTE must be subjected to the regime of essential requirements under the TTE Directive; SES equipment is also subjected to essential requirements under the SES Directive;

b) following a mandate from the Commission, such essential requirements will be embodied in Harmonized Standards such as TBRs, leading to the development of CTRs;

c) under the present regime, TBRs and CTRs only apply to TTE and SES equipment;

d) public network infrastructure is not the subject of TBRs and CTRs except for non-"purpose built" SES equipment "intended for use as part of the public telecommunications network". The specification of the inter-network interface is generally a matter for private agreement between network operators, usually under the control of the National Regulatory Authority (NRA). In order to ensure competition, the ONP Directive applies to the interconnection between public networks. Existing technical standards should preferably be used;

e) the definition, for a particular system, of what is TTE and what is public network infrastructure is not a matter for ETSI. ETSI will develop the standards for TBRs that will be required by the Commission and ACTE;

f) essential requirements for EMC and effective use of the RF spectrum, 4(c) and 4(e), will apply to all elements of the TTE or SES equipment;

g) essential requirements for protection of the public network and interworking of TTE or SES equipment with the public network, 4(d) and 4(f), will only apply at the Network Terminating Point (NTP). These essential requirements do not require the standardization of any other interface. There may also be a need for harmonized standards for the interworking of TTE or SES equipment in justified cases via the public network (essential requirement 4(g)). The standards could apply at the user (man-machine) interface as well as at the NTP. The application of the essential requirements 4(f) and / or 4(g) in a TBR implies that the protocols are published;

h) there is no direct requirement on interfaces between elements of TTE. Such interfaces would need to operate correctly during the conformance testing to the requirements at the NTP.

9.1.1.3 Discussion on the application of the principles to S-PCN

The next step in this analysis is to review how these principles can be applied to S-PCN. The most fundamental aspect is to determine what parts, if any, of the S-PCN system are to be regarded as "public network infrastructure" and what parts are to be regarded as TTE or SES equipment. The NTP will be defined as the boundary between these two elements and the positioning of this boundary will have a significant impact on the development of standards and regulations, and under principle g) above on what aspects of the system specifications need to be public.

Principle f) above applies to any S-PCN connected or not connected to the public network infrastructure.

The S-PCN topology (with regard to the interconnection to the public network infrastructure) could be considered, as a starting point in this analysis, as falling broadly within one of the two types shown in figures 10 and 11.

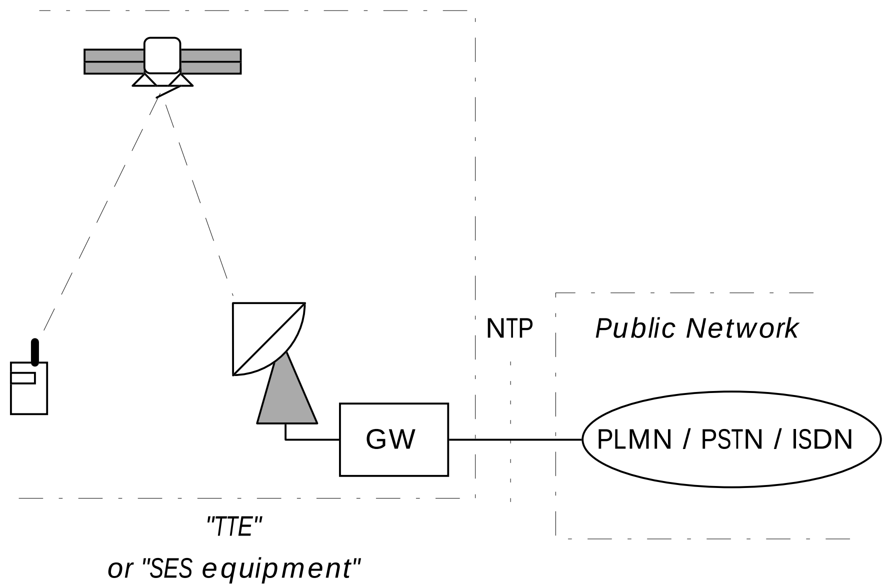


Figure 10: Case 1 - NTP at the interface between the gateway and the terrestrial public network

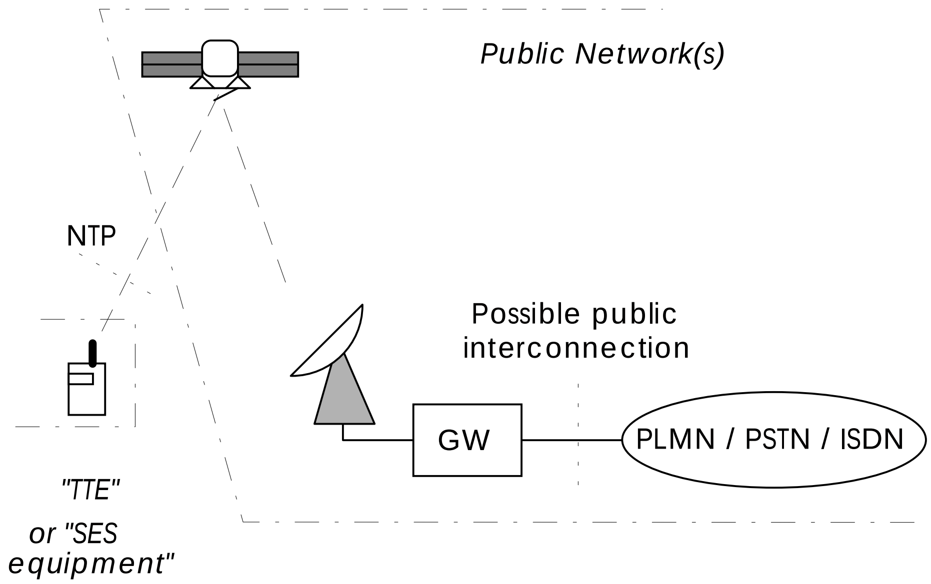


Figure 11: Case 2 - NTP at the air interface between the S-PCN handset and the satellite

The following subclauses consider how the principles set out in subclause 9.1.1.2 above might relate to both of these cases and, for each, what standards might be required.

9.1.1.4 Observations on standards and regulations

Based upon the principles set out in subclause 9.1.1.2 and the discussion in subclause 9.1.1.3 the following observations are made regarding the application of standards and regulations to S-PCN.

9.1.1.4.1 "Case 1" S-PCNs

For the "Case 1" S-PCNs, i.e. where the NTP is deemed to be at the interface between the gateway switch and the terrestrial network:

- the main elements of the S-PCN may effectively be an assembly of SES equipment or TTE, but some elements of the S-PCN may fall outside of both definitions. The S-PCN handset would be SES equipment, but not TTE to which the TTE Directive applies, as the entire S-PCN could be regarded as TTE. The gateway earth station would be SES equipment and might effectively be regarded as TTE;

- interfaces are defined at the boundary between the gateway (GW) and the public telecommunications network (PTN);

- under principle f) above, essential requirements 4(c) and 4(e) will apply to all the elements of the network that are satellite earth station or TTE, not just the handsets;

- under principle g) above, essential requirements 4(d) and 4(f) will only apply at the NTP i.e. where the GW interfaces to the PTN;

- under principle g) above, there is no direct essential requirement on, nor standardization of, the handset, the handset air interface, the GW air interface or interworking between the handset and the GW switch.

9.1.1.4.2 "Case 2" S-PCNs

For the "Case 2" S-PCNs, i.e. where the NTP is deemed to be at the air interface between the S-PCN handset and the satellite:

- the handset is both SES equipment and TTE;

- the satellite, the GW and the GW switch are "public network infrastructure";

- under principle f) above, essential requirements 4(c) and 4(e) will apply to the handsets and may also apply to the gateway earth station (if it is not a "purpose built" element of the public telecommunications network);

- under principle g) above, essential requirements 4(d) and 4(f) will only apply at the NTP, which is the handset air interface and its specification has to be made available through publication;

- under principle d) above, there is no requirement for standardization of any aspect of the S-PCN outside of the TTE;

- under principle d) above, the GW / PTN interface could be the subject of a non-mandatory standard, if considered useful and if required by the parties. ONP may apply here in the future;

- TBRs and CTRs may apply to the S-PCN handsets and may also apply to the gateway earth station (if it is not a "purpose built" element of the public terrestrial network);

- the "Case 2" approach seems most applicable to the satellite component of UMTS.

9.1.1.5 Consideration on the standardization for S-PCN

An S-PCN is made of elements and interfaces as shown in figure 12.

Mobile Earth Station	⇐|⇒	**Satellite**	⇐|⇒	**Gateway**	⇐|⇒	**Public Network**
	Mobile air interface		Gateway air interface		Gateway terrestrial interface	
	|⇐		**Public S-PCN**		⇒|	or:
|⇐			**Private S-PCN**		⇒|	

Figure 12: S-PCN elements and interfaces

The S-PCN elements and interfaces are:

a) the interface between the S-PCN Gateway and the public network:

- For a private S-PCN:

  the interface could be a user interface as for PABXs. In that case this interface is at the NTP of the public network to which the TTE Directive applies, and for which no new standards are required. This case is similar to most of the VSAT network interconnections with public networks. However, as explained in subclause 9.1.1.5.1 of this ETR, the use of this type of interface leads to various operational limitations such as numbering, charging etc. For those reasons the interface should preferably be of the type of those between two public networks;

- For a public S-PCN:

  the interface is an interface between public networks, the characteristics of which are defined by the two network operators and usually under the control of the National Regulatory Authority (NRA). The provision of such interface is covered by the ONP Directive. Such an interface has already been defined for the interconnection of GSM networks to ISDNs (ETS 300 303) and is agreed by ETSI members. The suitability of this type of interface should be checked and the desirable interfaces should be defined in a later phase.

b) the radio aspects of the gateway are covered by the SES Directive. Nevertheless, due to the small number of such earth stations over Europe, there are two possibilities:

- TBRs:

  covering the essential requirements 4c and 4e for the EMC and for the efficient use of the spectrum and of the orbital resources;

- No TBRs:

  but, in each concerned country, the need for a licence delivered by the national regulatory authority. In order to ease the implementation of earth stations built to the same specification in other countries, mutual recognition of those licences should be encouraged;

c) the interface between the gateway and the satellite is an internal interface of the network and does not need standardization;

d) the satellite is part of the infrastructure of the S-PCN and does not need standardization;

e) the radio aspects of the mobile earth station (MES) are covered by the SES Directive, so TBRs covering the essential requirements 4c and 4e for the EMC and for the efficient use of the spectrum and of the orbital resources are necessary;

   The conformance of an MES to a CTR under the SES Directive allows the MES to be placed on the market but normally its use is only permitted by a licence given by the National Regulatory Authority (NRA). In order to enjoy the benefits of S-PCN, free use of the terminal equipment as defined by the TTE Directive will be an important issue. The right to use terminal equipment, in a manner similar to that of the TTE Directive, can be applied if the limits of unwanted emissions are defined taking into account the protection of the other radio services and the effective use of the spectrum and orbital resources. The licensing regime by each National Regulatory Authority (NRA) is not convenient for a mobile terminal which may be carried by travellers crossing borders over Europe and may be difficult to apply in practice;

f) the protocols on the air interface of the mobile earth station:

- **If the S-PCN is regarded as a private network:**

  This interface is internal to the network and no standard is needed;

- **If the S-PCN is regarded as a public network:**

  The requirements 4f and / or 4g of the SES or TTE Directives may be applied to that interface. The European Commission and the ACTE decide which of the essential requirements 4f and 4g have to be applied:

  - if the essential requirements 4f and / or 4g are applied then the protocols must be published. According to the TTE Directive, and apart from the restriction on use under the SES Directive for radio aspects, in such a case, the terminal may be connected to the public network and used in any Member State;

  - if the essential requirements 4f and / or 4g are not applied at European level then according to the subsidiarity principle, each national regulatory authority may decide to apply them or not.

  The method of the publication of the specifications of the MES air interface and the possible IPR implications need further consideration. For the publication of those specifications, the following considerations should be taken into account:

  - the S-PCN will be world-wide networks;

  - if the specifications are transformed into standards in various countries and regions of the world, by ETSI in Europe, by the T1 in USA, the RCR in Japan etc., then any modification of the specification will have to be reproduced in each standard. Some difficulties will rise quite soon: the updating process could be long, some modifications could be blocked in some countries or regions, leading to a possible divergence between the latest versions of each region.

However, it will certainly be necessary to protect the mobile satellite systems from unauthorised access by any type of mobile terminal conforming to the CTR only on radio aspects and put on the market. The protection could be obtained either by the inclusion of the protocols of the mobile air interface in the TBRs or, for each type of mobile terminal, by the existence of an agreement of the concerned mobile satellite system operator as a condition for the licence.

It is understood that a mobile terminal designed for a specific S-PCN may not be able to operate with other S-PCNs.

If it is decided at a European level that Articles 4d, 4f and 4g apply then the approval procedure needs further consideration taking into account the status of the handset interface protocol.

Table 5 summarises the various possibilities for the standardization of elements and interfaces of an S-PCN.

9.1.1.5.1 Implications of the gateway terrestrial interface being a user access NTP

If the terrestrial gateway interface is of a user access NTP type, there are some inconsistencies in the application of standards to networks:

- an NTP is understood to be a point to which terminal equipment is connected (implicitly defined in Article 1 of the TTE Directive) to the public telecommunications network. If the connection between networks is across what is in fact a user access interface (e.g. Q.931, DSS 1 subject to TBR 4) then it will not necessarily support all the functions required by the S-PCN. This is the type of interface to which a user terminal or a Private Automatic Branch Exchange (PABX) is normally connected and in this case the S-PCN gateway switch acts on the same level as the PABX and should also be subject to TBR 4 (the severe limitations that follow from connecting networks via an NTP are addressed in later clauses);

- a single S-PCN network is likely to be connected terrestrially in more than one place and consequently would be connected to a multiple number of NTPs;

- in some cases the S-PCN is envisaged to connect "through its gateways on the international side of the International Switching Centre (ISC)"; see ETR 093 [1]. The ISC does not support user access.

It is therefore hard to understand how the NTP can be at the interface between the MSC and the (terrestrial network) ISC in this case;

- for GSM or UMTS, the interconnection with the terrestrial public Network is not an NTP; only the air interface of the mobile is an NTP. An S-PCN which is also a satellite component of one of these networks should be treated in a similar manner.

An S-PCN interconnection through a Network Termination Point (NTP) supporting only user access offers only limited capabilities. A number of network functionalities are protected from events on a user access interface. If the interface of the S-PCN is towards an ISDN, then Q.931 will apply. This offers the capabilities of DSS 1. Whatever is connected to it should be type approved according to the TTE Directive. A suitable network test standard should be like TBR 4 "attachment requirements for terminal equipment to connect to an ISDN using ISDN primary rate access", which is now in an advanced state of drafting. This standard applies to terminal equipment and equipment like PABXs using bit rates up to 2 Mbit/s on the interface.

Table 5: Possibilities for the standardization of elements and interfaces of an S-PCN

S-PCN Element / interface	**Private S-PCN**	**Public S-PCN**
Public Network to Gateway Interface	- NTP with a user interface as for PABX; The TTE Directive applies; No new standard needed; Operational limitations anticipated **OR** - network to network interface (preferred)	Network to network interface; the ONP-D applies; existing standards should apply
Gateway radio aspect	The SES Directive applies; either TBR for 4c and 4e (EMC, spectrum & orbits) or due to the small number of earth stations, no TBRs but local agreements with the NRAs	
Gateway - Satellite interface	Internal interface of the S-PCN No standard needed	
Satellite	Infrastructure element of the S-PCN No standard needed	
Satellite - Mobile interface	Internal to the S-PCN No standard needed	The SES Directive or TTE Directive may be applied - If decided by the EC and ACTE: TBRs for 4f and **/** or 4g with publication of the specification world-wide - Else - If decided by the NRA: requirements for 4f and **/** or 4g
Mobile radio aspect	The SES Directive applies TBR for 4c and 4e (EMC, spectrum & orbits)	

If the interface of the S-PCN is towards an analogue PSTN then NET 4 could be considered. However, this is a standard that summarises the different standards in the various countries and is practically not adequate as a harmonized standard.

There may be serious drawbacks from using a user access type of interface (an NTP) as an inter-network interface. The concept of requiring the use of an NTP for these purposes although technically possible (if limiting), seems in practice very unlikely to be practically applicable by S-PCN proponents who would have the possibilities of their networks restricted by these requirements. Because a user access type of interface would be based on Q.931 (for a digital network) and DSS 1 would apply, a number of things that are normally exchanged between networks would be restricted:

- there would be restrictions in the numbering. All the S-PCN numbers are actually becoming numbers on the local exchange of the fixed network;
- charging restrictions. One would remain subjected to charging from the public network as applied to a local extension. A local termination should also not be allowed to send charging pulses to the fixed network although the interface might support it for reasons of symmetry;
- echo control information about where the echo should be cancelled or suppressed cannot be conveyed via this interface;
- call history (supervision statistics). This is also related to echo cancelling;
- tones and announcements. Networks exchange information about which tones and announcements should be generated to users; on the Q.931 the tones and announcements themselves need to be presented;
- address complete timer. The PSTN would need a reaction on a call presented to the terminal **/** PABX type of interface to the S-PCN within a few seconds. However the S-PCN needs the time to interrogate registers and eventually to page the terminal and establish at least a signalling connection before it can signal back that ringing takes place. Alternatively the S-PCN might accept the call, give a message to the caller to wait and start searching for the subscriber. In that case the caller would be charged also if the call is not delivered;
- UPT support may be problematical. Seen from a PSTN, the S-PCN on a Q.931 interface is connected to a user extension line. Basically, all the S-PCN subscribers would have a number on the local PSTN switch. If the PSTN supports UPT, then by implication the PSTN supports UPT for the S-PCN. On the Q.931 interface UPT registrations would be initiated in the direction from the extension towards the local PSTN switch. For UPT support by the S-PCN itself, it should be possible to initiate a UPT registration from the PSTN to the S-PCN and it seems odd that the PSTN would do that to one of its extensions. Also at call set-up time, an extension line is not supposed to provide further information to the PSTN on routing of the call.

As a basis, from the above considerations the constraints deriving from the NTP being at the terrestrial network interface are not attractive.

Furthermore although the connection of S-PCNs to local exchanges in the PSTN through user access interfaces may be considered, it appears that this is not going to be the only basis for operation of S-PCNs. It is also unlikely to be the basis best suited to the objectives of the system proponents or the needs of the users. However, this type of local access for the S-PCN could be envisaged as an additional interconnection.

9.1.1.5.2 Implications of the gateway terrestrial interface being an NTP with access to network protocols

As a rule, for protection of networks, network protocols are never accessible from a user access type of interface. The current interworking and access standards applying at NTPs support this by terminating the network signalling connections (e.g. SS#7) internally and providing only a user access protocol (e.g. LAP-D) to the extension, see figure 13. This clear separation between the network signalling and the user signalling is necessary to prevent improper use of the system access, resulting in technical and **/** or economic damage to the operator as occurred in the era of in-band signalling in analogue networks. In practical terms, unauthorised parties could make fraudulent calls, establish subscriptions or take over control of the network as well as interfere in networks that are connected to the network to which they gained unauthorised access at network protocols.

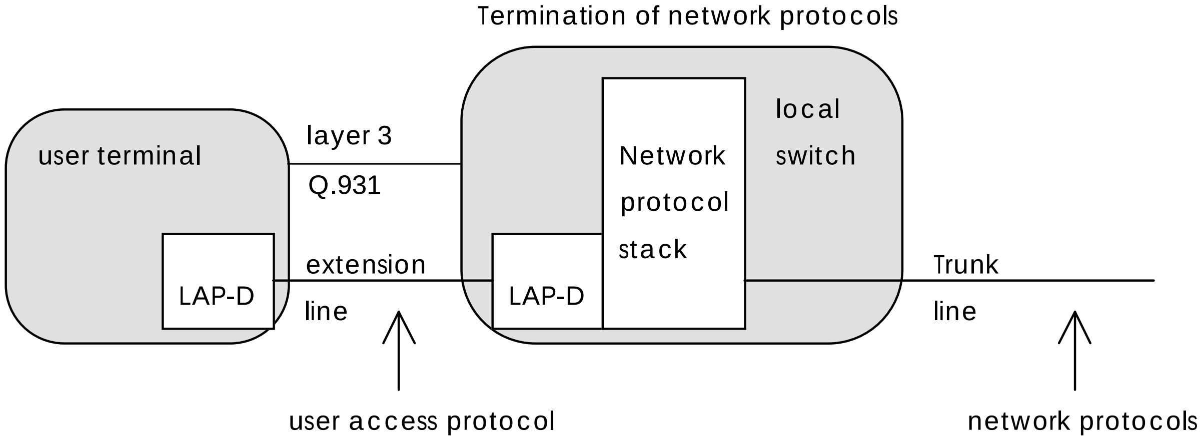


Figure 13: Separation between internal network protocols and extension line protocols

In cases where networks are interconnected, there is no exposure to unauthorised access as long as also the connected-to network allows only user access protocols on its extension lines.

If the network termination point supports network protocols, then other means to protect are necessary.

The interface between the S-PCN and the public network should not be confined to only a user access type of interface, but support the functionalities that are normally supported between networks. Therefore protection of the public networks, by excluding the access to the network protocols via the user radio interface, becomes the responsibility of the S-PCN proponents.

The S-PCN should be designed so that users and others may not obtain access to inter-network protocols, thus preventing problems of fraud and interference with operation of the network and of interconnected networks from re-occurring. Fixed network operators, before connecting an S-PCN, may wish to assess the protection issues related to the implementation of the specific S-PCN.

9.1.1.6 Summary regarding the application of harmonized standards under the Directives

To conclude the above analysis, table 6 summarises approaches and consequences presented above.

In addition to the cases 1 and 2 shown in table 6, a proposal for the regulation of S-PCN is discussed under subclause 9.1.1.8.

Table 6: Analysis of the consequences of the selection of an approach to standardization

	"Case 1" NTP at the interface of the fixed public network	"Case 2" NTP at the air interface between the MES and the satellite
Status of the S-PCN	Probably private	Probably public
Mobile radio aspects	TBR covering EMC and effective use of spectrum and orbit (including functionalities to protect other users from interference)	TBR covering EMC and effective use of spectrum and orbit (including functionalities to protect other users from interference)
Protocol over satellite service link	Does not have to be published or harmonized	TBR covering access and terminal protocols to be published and harmonized
Status of the S-PCN MES	SES equipment	SES equipment and TTE
Status of the S-PCN gateway earth station (radio aspects)	SES equipment;	SES equipment, except if "purpose built" and part of a public network
Status of the Gateway interface to the terrestrial network	TTE to be type approved for connection to the terrestrial public network ;	Part of the public network; does not have to be type approved for connection to the terrestrial public network
Type of interface between the S-PCN and the fixed public network	Limited to user access type of interface (e.g. Q.931, TBR 4)	Unrestricted in type of interface; normally SS #7 (comparable to ETS 300 303) to be expected; ONP may be applicable
Consequences of the interface between the S-PCN and the fixed public network	Designed to support user access implemented at the NTP and does not support well a network interconnection and will impose restrictions on the S-PCN	Interface is a full inter-network interface
Support for UPT by the S-PCN	Cannot be assumed	Yes
Conflict with commercial IPR	None	Potential conflict because of publication and / or standardization of protocols that may be proprietary

9.1.1.7 Objectives for regulatory regimes for S-PCN

The regulatory regime for S-PCN should satisfy the following objectives:

a) the mutual recognition of type approval not only throughout Europe but also in other parts of the world;

b) exemption from individual licensing for handsets and mobile terminals not only throughout Europe but also in other parts of the world, so that approved handsets and terminals can be used anywhere without additional administrative procedures;

c) approval arrangements that will not impede the development of terminals and the resolution of technical problems;

d) fair and equitable arrangements for access to spectrum and markets by competing S-PCN providers;

e) fair and equitable arrangements for access to markets by competing terminal manufacturers;

f) transparent and non-discriminatory arrangements for service providers to sell S-PCN services to users;

g) adequate protection of other radio systems.

Neither case 1 nor case 2, if strictly applied, appear to be suitable to provide a regulatory framework meeting all these objectives.

9.1.1.8 Proposal for regulation of S-PCN

The approvals regime in Europe is expected to change within the next few years because:

- the distinction between public and private networks that forms the basis for the essential requirements will be difficult to discern following the introduction of competition in both voice services and infrastructure from 1998;

- the long process for the development of complex standards for type approval required by the current regulations, for the protocols of digital systems, if maintained will hinder the development of new services, products and markets.

These changes will coincide with the introduction of S-PCN. It is therefore inappropriate to regard the current Directives as given. We therefore consider what approval arrangements would best achieve the overall objectives of promoting a European market whilst safeguarding the essential requirements.

9.1.1.8.1 Gateway earth stations and their connections to other networks

There is no benefit in attempting to subject gateway earth stations and their connections to other networks to a European approvals regime for the following reasons:

- gateway earth stations will all be purpose built;

- there will be only a few gateway earth stations located in Europe, and therefore a pan-European approval will be of little value;

- the preparation of standards for a formal type approval regime will lead to delays in the bringing into service of the earth stations and involve unnecessary effort;

- control of the performance and specification of the earth stations will not provide control of the overall S-PCN system because it can be operated from earth stations outside Europe;

- special arrangements or features may be needed at the interface between the gateway earth stations and the terrestrial networks;

- it will be more efficient to leave any approvals requirements to the countries concerned. If the gateways are procured and operated by responsible organisations it will be possible to treat the connection to the terrestrial networks as an interconnection between peer networks.

The conclusion is therefore that only voluntary standards and no type approvals should apply at a European level to gateway earth stations.

9.1.1.8.2 Handsets

A pan-European type approval for handsets is essential for a healthy and competitive handset market. However, it is also essential that the approval should provide a right of use without additional licensing procedures being applied. This would go beyond what is provided by the current SES Directive.

In order to protect the user and the environment and to ensure effective use of the radio spectrum, there is a need for approval requirements under Articles 4a (user safety), 4c (EMC) and 4e (effective use of the radio spectrum etc.) of the TTE Directive as supplemented by the SES Directive.

Considering that the handset is connected to the PTN through the S-PCN, then the application of Articles 4d and 4f does not need the publication of the handset interface protocols provided that the handset protocols are terminated within the S-PCN.

User safety issues are covered by existing standards. The European standards needed for S-PCN handset approvals will concern EMC, the effective use of the radio spectrum, orbital resources, avoidance of interference and certain additional essential functionalities.

The preparation of these standards will need to be co-ordinated with activities in other parts of the world in order to ensure that as far as possible there is a harmonized approach to S-PCN throughout the world. Because handsets will be carried into and out of Europe, it is highly desirable that the approval procedures within Europe should be aligned with those in other countries, particularly North America and that if possible a global approvals system should be developed.

The correct operation of the handset protocols will be of concern for the S-PCN operators. They may wish to implement testing facilities or a marking regime. In view of the competition between operators and the incentives that the operators will have to see terminals being used to generate traffic, no objection to either scheme is seen.

This approach to approvals is realistic in that it recognises the reality that there will be little practical control of handsets being carried into Europe and used anywhere within Europe since the S-PCN service will provide coverage of the whole of Europe. It is recommended that this approach to approvals is taken into account for the establishment of a regulatory regime for S-PCN.

As a consequence, for S-PCN an approach is needed between the two cases as summarised in subclause 9.1.1.6.

9.1.2 Specific consideration of essential requirements as applying to S-PCN

Although it is presumed that the most pressing requirement will be for the development of standards for the S-PCN handsets, this subclause of the ETR addresses the standards that could be required for both the handset and the gateway, under both of the topology interpretations, as discussed above.

9.1.2.1 User safety

Although user safety is an essential requirement, under the TTE Directive and SES Directive, this should only be considered in as much as this requirement is not covered by the Low Voltage Directive. Moreover, compliance with the requirement is presumed in respect of TTE and SES equipment which are in conformity with national standards that implement relevant harmonized standards.

User safety is an essential requirement equally applicable to the handset and to the gateway and is not affected by the interpretation of network topology.

It should be noted that standards in this area are excluded from inclusion in TBRs and CTRs according to the Handbook on CTRs [21], although cross-references may be made, where appropriate, to relevant standards if they already exist. On this basis it would not be expected that ETSI should undertake any new standardization work in this area, nor that detailed requirements relating to safety matters would be incorporated into standards developed by ETSI.

Matters related to user safety fall under the responsibility of CEN / CENELEC and are not within the general terms of reference of ETSI. Thus, although technical standards are clearly required in this area in order to ensure conformity of S-PCN TTE and SES equipment with the essential requirement on user safety, it is not expected that ETSI would be required to undertake work in this area.

Within ETSI the responsibility for co-ordination between CEN / CENELEC and ETSI falls within the terms of reference of ETSI STC RES9 and moves are already underway to establish the necessary liaisons between ETSI and CEN / CENELEC to ensure that the necessary user safety standards either already exist or will be developed.

The Commission could have a useful role in ensuring that the necessary liaisons between the different standards bodies are dealt with in an effective manner, leading to the development of the standards in a timely manner.

9.1.2.1.1 General and electrical safety

An informal liaison with CENELEC was established to determine if there are appropriate standards relating to safety for S-PCN handsets that could be cross referenced in this ETR, and in any ETSs subsequently developed.

The view of CENELEC is that EN 60950 [44], less clause 6, would be the appropriate safety standard for S-PCN handsets. Clause 6 is excluded as it is applicable to equipment connected to a telecommunications network.

For the standards applicable to S-PCN gateway earth stations it would be appropriate to extract relevant references from other ETSI earth station standards, such as those developed for VSAT.

This standard, or (as a result of anything identified through the liaison with STC RES9) some more appropriate standards could usefully be cross referenced in any ETS developed by ETSI for S-PCN.

9.1.2.1.2 RF radiological safety

RF radiological safety standards are also the responsibility of CENELEC and work is beginning in co-operation with ETSI.

RF safety is a serious concern, especially given that the transmit power of hand-held S-PCN handsets (particularly if operating to a geostationary or highly inclined elliptical orbit) may be quite high (EIRP values of up to 10 dBW have been quoted by system proponents in ETR 093 [1]).

It is noted that in general the S-PCN system proponents state that they will meet the required safety standards, but there appears to be little or no consensus amongst them regarding what is a safe "standard". Moreover, there are a number of different standards adopted by different national standards bodies world-wide. There has been much controversy recently (mainly in the USA) about the potential detrimental effects to health of hand-held cellular telephone equipment and it is clear that a well analysed and publicly trusted standard is of great importance.

The rapid development by CENELEC and ETSI of a standard suitable for application in the frequency bands and for the technology and transmission methods proposed for S-PCN would be of great use in facilitating the rapid bringing onto the market of S-PCN handsets.

In any case, once again there should be no requirement for ETSI to develop any standardization specifically for S-PCN and, in the absence of any other standards to reference, there should probably be no need to include any subclauses related to RF safety in ETSs developed by ETSI for S-PCN.

9.1.2.2 Protection of employees of PTOs

The comments under subclause 9.1.2.1 are equally applicable in this subclause, as matters related to the protection of employees of PTOs, also being safety matters, fall within the remit of CEN / CENELEC.

Safety of employees is an essential requirement equally applicable to the handset and to the gateway and is not affected by the interpretation of network topology.

Either the standards referenced in subclause 9.1.2.1 will be applicable in this subclause, other existing standards will be more appropriate or new standards will need to be developed. In any case, any ETSs developed by ETSI could usefully contain a cross reference to the appropriate CENELEC standards, where these exist.

It should be noted that requirements related to safety of employees are also excluded from inclusion in TBRs and CTRs according to the Handbook on CTRs [21].

9.1.2.3 Electro-Magnetic Compatibility (EMC)

The TTE Directive and the SES Directive make EMC an essential requirement for requirements that are specific to the equipment (non-equipment specific EMC requirements are established under the EMC Directive). However, the standardization of unwanted emissions from SES equipment falls within the regimes either of the essential requirement on EMC, Article 4c, or of the essential requirement on the effective use of the RF spectrum, Article 4e.

Standards to meet the essential requirements on EMC will be needed both for the handset and the gateway earth station and will not be affected by the network topology.

STC RES9 has the lead responsibility within ETSI for the development of standards for Electromagnetic Compatibility of radio equipment. RES9 is developing a general product-family standard on EMC for radio equipment which is intended to apply to all radio equipment for which a product-specific standard does not exist. A product family standard applies to all equipment in a specific product class, such as radio equipment, where there are factors specific to a particular type of equipment, perhaps an S-PCN handset, that mean that the product-family standard is not sufficient, then a product-specific standard may be developed for that particular equipment.

Once adopted, this general standard may be acceptable for application to S-PCN handsets, but a specific review could perhaps be required within RES9, probably in co-operation with SES5, to determine the need or otherwise of product specific EMC standards for S-PCN handsets. Product-specific EMC standards would seem to apply where the satellite earth station operates in frequencies outside the range specified in product-family standards and also may be needed to take account of unwanted radiation through the antenna, possibly with gain. There are also likely to be product-specific EMC requirements relating to the immunity of the equipment in the presence of an external electromagnetic field. The product-specific elements would relate to immunity at frequencies outside those specified in the more general standards.

With regard to the gateway earth station, depending on the frequency of operation, the specifications contained in other ETSI earth station standards (e.g. VSAT) could be directly applicable, or at least could be regarded as a starting point for the development of such a specification.

ETSI STC SES5 have already initiated liaison statements to STC RES9 to determine the availability of appropriate EMC standards and this should ensure that the essential requirement on EMC is taken into account.

9.1.2.4 Protection of the public network from harm

As has already been referenced in ETR 093 [1], this essential requirement deals with potential harm caused by improper characteristics of the equipment when used in its normal environment (rather than that caused by deliberate misuse). This essential requirement applies across a user access interface (the NTP) and the standardization required will be very dependant on the network topology.

The implication of the approach proposed in subclause 9.1.1.8 is that for S-PCN handsets there should be no requirements imposed in this area and thus no specifications to meet essential requirements need to be developed.

For the gateways, the assumption means that this essential requirement applies across the interconnect point between the gateway and the terrestrial fixed public network. It might be possible to rely on existing access standards (for example the ETSI TBR 4, ISDN access [71], which is in an advanced state of drafting) to define this essential requirement but because of the high probability that the access to the public network from the S-PCN gateway will be across a non-standard interface (or at least across an interface that is not normally available for public network access - i.e. this is most likely to be effectively an inter-network interface) this may not be the case. In this situation there may be the need to develop an additional access standardization for the gateway to public network interface.

The implication of the gateway to terrestrial interface point being a user access type is that this will impose some constraints on the S-PCN operation (refer to subclause 9.1.1.5). It is also worthwhile questioning whether or not this is really an interface that ought to be or needs to be standardized. It might be argued that the S-PCN operators and fixed network operators would really want the flexibility to define their own interconnect possibilities. The interpretation on network topology presented earlier might then seem strange in that it makes the requirement to standardize where perhaps none really needs to exist.

9.1.2.5 Effective use of the RF spectrum (and orbit)

As has already been referenced in the ETR 093 [1], for TTE using radio frequencies the essential requirements in this area are intended to safeguard the effective use of the RF spectrum. The SES Directive adds "the effective use of orbital resources and the avoidance of harmful interference between space based and terrestrial communications systems" to this essential requirement.

This essential requirement will apply both to S-PCN handsets and to gateway earth stations and is independent of the network topology.

The Directives are not explicit regarding the precise composition of the elements that should be considered to ensure that a terminal meets this essential requirement but the Handbook on CTRs indicates that CTRs should, where appropriate, cover both intentional and spurious performance and suggests, as examples: utilisation of correct harmonized frequencies, out of band transmission, inactive occupation of radio channels, modulation modes and oscillator stability.

It is also considered important by ETSI to require that the RF spectrum is used effectively by ensuring that a minimum set of terminal and network control functions are supported dealing with, for example, ensuring that handsets do not transmit unless they receive their network, suppressing of transmissions during fault conditions, the ability of the network to remotely switch off or bar a terminal or terminals and - particularly important in the context of dual-mode handset use - ensuring that intentional transmissions do not occur outside of the "intended" European band or bands for S-PCN or other European mobile networks.

The ETR 093 [1] identified a number of possible approaches by which specifications to satisfy this essential requirement might be developed for S-PCN handsets, but indicated that these were preliminary suggestions and required further work. In this ETR, these possibilities have been developed further and, in addition, new concepts have been added. These are set out in the subclauses that follow.

Because the Directives do not state explicitly how the essential requirement is to be ensured, it is possible to envisage a wide range of possible standards, some rather weak in ensuring the essential requirement is met, others much stronger. A "check list" of possible standards to ensure effective use of the spectrum and orbit might include such items as:

- antenna and coverage issues:
  - earth station antenna radiation patterns;
  - satellite and earth station beam pointing accuracy;
  - satellite beam dimensions and shape;
  - maintenance of spatial isolation as a proportion of time;
  - transmission by the satellite in inappropriate coverage areas;
  - polarisation isolation of earth station and satellite antennas;

- orbit and constellation issues:
  - use of satellites with constant or substantial angles between wanted and unwanted satellites;
  - use of orbits where diffraction, obstruction and other propagation effects are minimised;
  - use of inter-satellite links to avoid redundant earth-space links;

- modulation, coding and multiple access issues:
  - spectral efficiency of the signal, e.g. information bits/s/Hz;
  - effective utilisation of a frequency band as a proportion of time;
  - use of signals with FEC (or other methods) to minimise required C/N and C/I;
  - pre-processing of data;
  - use of separate framing structures for voice, circuit mode data and packet mode data within a common superframe;
  - protection ratio reduction;
  - CDMA networks and power control;

- RF and frequency issues:
  - transmission of unwanted carriers, spurious, harmonics etc. by satellite and earth station;
  - frequency error in the transmission or translation of signals and / or use of AFC;
  - reverse band working;
  - frequency management;
  - transmission in correct frequency slot;
  - transmission in correct time slot;

  - receiver sensitivity;
  - adjacent channel immunity;
  - inter-modulation immunity;
  - co-channel rejection;
  - spurious responses immunity;
  - inter transmitter inter-modulation;

- control and monitoring issues:
  - prevention of incorrect transmissions in a failure mode;
  - prevention of transmissions when the intended S-PCN network is not present or not available;
  - prevention of transmissions from an integrated non S-PCN MS when its "own" network is not present;
  - transmitter power control;

- system issues:
  - use of common pilots, timing and synchronisation signals;
  - ONP / OSI and the use of link layer, network layer and router addresses;
  - receiver blocking.

Note that some of these items are more appropriate for standards relating to the handset and some to standards for gateway earth stations. Moreover, this ETR does not propose possible standards for all of these items. However, those for which a technical standard might reasonably easily be implemented have been explored in order to present a list of what might be achievable, should the desire exist within ETSI to undertake this level of standardization.

By selecting from this list, the relevant ETSI committees will be able to develop a standards framework to support this essential requirement that is as "weak" or as "strong" as required.

This essential requirement will apply both to the S-PCN handset and to the gateway earth station. However, the specific set of standards that might be developed is likely to be different for each of these due primarily to the significant difference in antenna gain between the handset and gateway earth station, and also to the different frequency band utilisation.

9.1.2.5.1 Utilisation of the correct harmonized frequencies

If S-PCN systems are to be truly global in their operation and use then it is clear that the frequency bands used by such systems must be co-ordinated between countries. Within Europe the possibility exists for the "harmonization" of frequency bands for certain services to ensure that this common approach, particularly the right of free distribution, movement and use, may apply. Several bands have already been harmonized for a number of different systems (e.g. for GSM under Directive 87/372/EEC [76], for ERMES under Directive 90/544/EEC [77] and for DECT under Directive 91/287/EEC [78]).

The analysis of the use of particular frequency bands for particular services (within the limits of the Radio Regulations Article 8 frequency allocations) is primarily a responsibility of the European Radiocommunications Committee (ERC) of the CEPT and is not a direct responsibility of ETSI, as recognised in the EC Council Resolution on Europe-wide co-operation on frequencies [79], although this Resolution does specifically recognise "the close link between standards development and allocation of frequency spectrum". Nevertheless, given that the harmonization of frequency bands is likely to be implemented in Europe for S-PCN (the ERO has already begun a Commission sponsored study in this area, see subclause 7.2.2.1), ETSI could then have a responsibility to define a specification to meet the essential requirement in this area.

ETSI could develop a specification to meet the essential requirement by ensuring that the handset utilises the correct designated harmonized frequency band. It might be particularly important to consider that dual-mode satellite / terrestrial handsets from outside of Europe (e.g. a D-AMPS / S-PCN handset) might have the possibility to transmit in terrestrial mobile bands for which operation is not licensed in Europe (the possibility might also arise, for example, that the European harmonized band for S-PCN is a subset of the generic band used globally). It will then be important to be able to ensure that the handset is disabled from transmitting on the incorrect frequencies when in Europe and only utilises the correct European harmonized S-PCN bands. Also consider that some S-PCN-only equipment might be capable of transmitting in bands, licensed for S-PCN outside of Europe, and for which no licensed use is permitted within Europe. Again the demonstration of operation only within the correct bands might be the subject of a possible standardization in Europe.

It could also be considered to apply a similar standard to the gateway earth station, but this does not seem so appropriate. In any case, the gateway earth stations are likely to be subject to a much more formal process of licensing, including frequency co-ordination under the Radio Regulations, and thus the use of frequencies will be much better controlled.

9.1.2.5.2 Handset local oscillator frequency stability

On an issue related to the previous subclause, it could be considered to implement a standard on the handset local oscillator frequency stability or on the observed effects of frequency stability.

Because of the drive to achieve a high level of sales and user penetration of the S-PCN systems, there is likely to be a corresponding trend towards the development of equipment at the minimum cost. One implication of this trend could be to compromise on the frequency stability of the local oscillator, especially under varying conditions of battery voltage and ambient temperature, and this could have an impact on the number of channels that could be supported in a specific frequency band and also on the EMC ("just out of band" unwanted emission) performance.

On this basis, a standard on the minimum frequency stability could help to ensure that the quality of the equipment does not fall to a level where inefficient spectrum use results.

Alternatively a different method could be applied that leaves freedom to the manufacturers of TTEs to find the optimum combination of the bandwidth that is occupied with the stability of the local oscillator. In that approach, the power that an S-PCN / MES produces in both the adjacent channels (whilst being modulated), is measured under defined conditions of varying power supply voltage and ambient temperature. A narrower signal can then have a bigger variation in frequency. Note that a specific system may impose a more stringent frequency stability.

However, a standard on frequency stability and adjacent channel power would need to be based on an agreed channel separation, which might make it unsuitable for application as an "envelope" type standard for general application.

9.1.2.5.3 In-band spurious emissions

It is considered that in-band spurious emission limits could be developed both for the handset and the gateway earth station, but are likely to be more important for the handsets, due to the anticipated proliferation and mobility of these.

In order to ensure effective spectrum use, ETSI needs to develop standards to limit the level of in-band spurious emissions in all directions (i.e. both on-axis and off-axis in the case of an antenna with gain, such as the gateway earth station).

As already explained in the ETR 093 [1], work to develop spurious emission standards for radio TTE is being undertaken in a number of groups including ITU-R, CEPT and ETSI (see ETR 077 [25]).

The standards to be developed here should be considered from two views:

- what the S-PCN equipment will be capable of achieving regarding the minimum level of spurious emissions and what a practical level might be to set for the emission mask to ensure that equipment can be built to meet the requirement at reasonable cost;

- what is necessary to protect other users of the spectrum. Primarily this is a matter of intra-MSS sharing, but is also a problem of sharing with other radio systems utilising the band. The emission mask defined for DCS-1800 could be a good starting point for the development of this specification when applying to S-PCN handsets, given the proximity of the frequency bands in question.

For the gateway earth station, the specification on spurious emissions could be taken from existing ETSI earth station standards in the event that the frequency bands are similar, or these could be used as a starting point for the development of new standards if this is more applicable.

9.1.2.5.4 Emissions when the carrier is suppressed

It is common practice in radio system specifications to include a standard on carrier suppression level, and it could be useful for ETSI to consider standardization relating to the level of carrier suppression when an S-PCN handset is switched-on but not transmitting. A standard in this area is perhaps of more significance to a satellite system, as it is to be expected that there will eventually be a large user population of S-PCN handsets and the presence of any significant level of residual EIRP when the carrier is suppressed could lead to an interference problem leading to a restriction on the efficient use of the spectrum. It is expected that a significant proportion of the population of S-PCN handsets that are switched-on will be in the non-transmitting state at any given time. Any residual power radiated by these handsets will be received by the satellite for all handsets in its coverage and the aggregate effect of these residual powers could possibly be large when compared to the level of the carrier power.

The level at which this carrier suppression should be set will, of course, require some detailed analysis, and will generally depend on the configuration of the S-PCN system. Nevertheless, it should be possible, through a general analysis of typical S-PCN parameters (e.g. using as a base, those parameters identified in ETR 093 [1]) to set a level that will offer some degree of protection without being over constraining on S-PCN system design. A consideration of other ETSI standards for L-band MES equipment could give some indications of the possibilities here.

This standardization is perhaps not so relevant for the gateway earth station, however, it should be considered that a gateway earth station, particularly one in a NGSO based network, may need to suppress its transmissions when it points in certain directions (e.g. towards the horizon to protect fixed service receivers, or towards the GSO to protect GSO satellite receivers) as shown in the figure 14, and that this may also require a specification of the suppression level required.

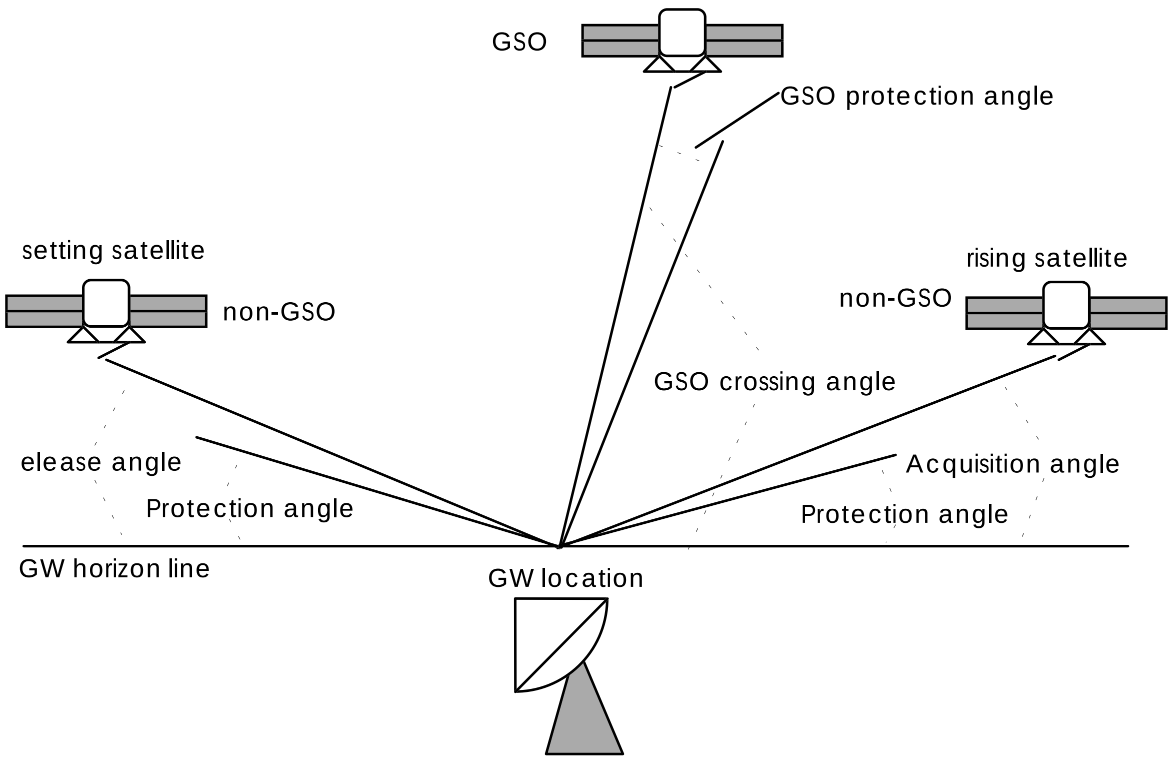


Figure 14: Protection of other systems when the carrier is suppressed in the GW

Figure 14 shows the general situation of a multi-satellite system with tracking gateway earth station, possibly crossing the GSO visible arc (depending on the location of the GW and the orbit system). For each GW location horizon line, before the satellite acquisition point at a certain acquisition angle and after the release point, at a certain release angle, the carrier may be suppressed to minimise direct interference and protect other systems. The protection angle may be defined by decreasing the acquisition and release angle by a decided fixed angle value.

The carrier may also be suppressed (either in service or non-service operation) when crossing the GSO arch visible from the GW location to protect the GSO orbit, in general the GSO arc and the rising-setting satellites are not in the same plane and the GSO arc crossing may not happen at the same position in the arc. The protection angle, symmetric around the GSO crossing point, may be of a decided fixed value.

9.1.2.5.5 Avoidance of interference with other radio systems

The following subclauses address the possible essential requirements that might arise out of the need to avoid causing interference to other radio systems, both terrestrial and space based.

9.1.2.5.5.1 Terrestrial systems

Again through the SES Directive, the avoidance of interference with terrestrial systems is added, for SES equipment, as part of the essential requirement relating to effective use of the RF spectrum and must be considered in a way similar to that discussed for the effective use of the orbital resource in the previous subclause.

As before, it is not clear at this stage how the requirement will be interpreted in applying the SES Directive and further work will need to be undertaken in this area, particularly to define the types of standard that might be considered to demonstrate compliance with the requirement.

Much work regarding the avoidance of interference between satellite and terrestrial systems is being undertaken within other bodies such as ITU-R and CEPT. On this basis it will probably not be necessary for ETSI to consider the development of any new standardization, rather to refer to and apply suitable and relevant standards being developed within these other bodies. It is also noted that a number of the other standards proposed to demonstrate effective spectrum use will also have the effect of reducing interference to terrestrial (and indeed space based) systems.

9.1.2.5.5.2 Space systems including radioastronomy

Interference to space systems should generally be controlled by the other standards on effective use of the spectrum. However, the Radioastronomy Service (RAS) is a special case and needs particular attention. In the main service bands of interest to S-PCN systems, the RAS has a primary frequency allocation at 1 610,6 - 1 613,8 MHz and a secondary allocation at 2 670 - 2 690 MHz and these are generally protected through the application of RR footnotes (e.g. RR 733E: "harmful interference shall not be caused to stations of the radio astronomy service by stations of the ... mobile satellite service") [9].

It can be considered that the resolution of potential interference problems is a matter of effective spectrum use, and in consequence this can be regarded as an essential requirement, to be subject to standardization.

Because of the extreme sensitivity of the RAS to interference from other systems, it is generally the case that protection of the RAS from transmissions in the same bands from mobile earth stations will require the establishment of a "protection area" around the RAS site, within which the frequencies used by the RAS have to be avoided. This avoidance could be continuous, or implemented in such a way that the avoidance is only necessary when RAS observations are being made and the service needs to be protected.

A number of different technical approaches could be envisaged to provide this functionality:

- S-PCN service uplinks never to use the RAS bands. But this is over cautious and wasteful of spectrum, which is limited for S-PCN;

- RAS sites to transmit a fixed EIRP beacon when observations are taking place; S-PCN handsets to avoid transmission in RAS bands if the beacon is received above a certain signal strength. Whilst this might work in practice, it could be technically difficult to implement, would require a specific functionality to be built into all S-PCN handsets and might cause difficulties when the channel assignment is made to the S-PCN handset by the gateway (as is likely to be the case);

- S-PCN system operators to provide a means (without it being necessary to define in a standard how this means should be implemented). As part of licensing conditions (presumably) S-PCN operators will be informed as to which geographical locations shall be protected and shall provide a means whereby the S-PCN handset is not allocated a channel within the RAS band by the gateway, or is sent an "RAS band disable" indicator or signal so that transmissions within the RAS band are suppressed, whenever the position of the handset falls within the protection zone.

The last approach seems to be the most feasible technically, but still raises some difficulties, particularly regarding how the function should be tested within a conformance test procedure. If the "technical means" referred to is provided by a function of the gateway which might not allocate channels within the RAS bands when the position of the S-PCN handset is determined to be within the protection zone then this is a function of the network and not the handset. On this basis it is worth questioning how a test house can ensure the provision of the functionality when testing handsets. It seems unreasonable, however, to insist on the provision of this "technical means" within the handset, just so that it can be tested, when the "technical means" may be equally well or better provided by the network. Even in the case where the means is provided within the handset, it is difficult to envisage how this can be tested, but both approaches might be testable through the provision of a system simulator or special test equipment by the manufacturer to the test house. However, because the S-PCN systems would be likely to all operate to a different specification, the simulator or test equipment would need to be specific to each S-PCN.

Note that the above approaches relate only to the case where the interference is originating from the S-PCN handset (i.e. an earth-to-space path).

9.1.2.5.6 Control and monitoring functions

In standards for mobile earth stations (non-S-PCN) already developed by ETSI (e.g. for Land Mobile Earth Stations: ETS 300 254 [73] and ETS 300 282 [74]), ETSI has felt it to be important to include specifications for a number of network control functions and terminal control and monitoring functions primarily for the purpose of ensuring a level of control over the equipment that will ensure that the other users of the spectrum will be protected.

The provision of a minimum set of network control functions to be supported by the S-PCN handset could thus be regarded as necessary to support the effective use of the spectrum, which may be harmed through uncontrolled or rogue transmissions originating from handsets.

The following subclauses indicate some of the possibilities which may be considered in this area and identifies any special considerations or problems that should be borne in mind when developing this kind of specification.

9.1.2.5.6.1 Terminal control and monitoring functions

Standards in this area would require that the terminal provides an internal function that monitors certain internal processes, functions or subsystems and will ensure that transmissions are not possible in the event that an error condition is observed.

The provision of these functionalities within the S-PCN handset will ensure that the handset is able to display a degree of autonomous control over its operation with the objective of reducing the risk that through fault or unexpected conditions unwanted transmissions occur which might then cause interference to other users of the radio spectrum.

These standards would not be relevant for gateway earth stations.

a) No transmit before receive

To promote an efficient use of the spectrum, it can be considered to implement a standard for all S-PCN handsets to ensure that they cannot transmit if they do not receive a valid indication (transmit enable, broadcast channel, etc.) from their own network, or at least a network operating to their own standard.

A standard in this area will serve two purposes: firstly it will reduce interference by removing the possibility for transmissions when the handset cannot receive the satellite transmission; secondly it should provide some degree of assurance that under certain fault conditions (e.g. frequency reference shift, receiver failure, etc.) the handset will be disabled from transmitting, removing the possibility of blocking or interfering with other users through incorrect transmitting.

b) Processor or software monitoring

For similar reasons to those explained in the previous subclause, the monitoring of the operation of the internal processors involved in traffic handling and control and monitoring functions can be considered for standardization.

A requirement in this area would ensure that in the event of a processor failure the transmitter would be expected to shut down automatically within a given time. It could also be considered to develop a standard requiring the monitoring of critical elements of the terminal software, perhaps through the use of a checksum. In the event that the software is corrupted (which may result in the operation of the terminal in an unexpected way) transmissions would shut down.

Problems that need to be taken into account in establishing this kind of requirement are:

- how the specification should be defined (what should be regarded as a fault or failure); and

- how conformance with the specification can be tested. Specifically, how a test house can ensure a consistent test process for all handsets; if the test procedure requires the manufacturer to provide a specially modified handset to enable the test to be carried out; if so, if there is any sense in this being part of type approval.

c) Battery power level monitor

As the battery powering the terminal discharges, its external voltage will drop and, if the terminal is poorly designed it is conceivable that, when the voltage drops below a certain threshold, the operation of the terminal may become unpredictable, perhaps transmitting when not intended, increasing the levels of unwanted emissions, etc.

In order to protect other users of the RF spectrum, it could be considered to establish a requirement that manufacturers should design their terminals so that there is a declared battery voltage below which the handset will shut down its operation and above which the operation will be "normal" (i.e. a channel can be established and maintained and no unexpected transmissions will occur).

Demonstration of conformance with a standard of this kind could probably be tested without the need for a specially modified test handset but a network simulator (to simulate call establishment) and means to control the handset voltage would probably be required.

d) Transmit frequency subsystem monitoring

A standard requiring the monitoring of the transmit frequency sub-system could be considered so that, in the event of a fault or failure in this subsystem, the handset will automatically suppress transmissions within a given time.

It may be difficult to define a test method and a set of test requirements that can equally be applied to all S-PCNs. It may also be difficult to force the handset to demonstrate the fault mode without requiring a specially modified handset for testing purposes.

A different approach to this standardization might be simply to require that all S-PCN handsets utilise a single frequency reference for both the transmit and receive sub-systems. A failure or fault in this reference would almost certainly mean that the receiver fails and as a consequence of the "no transmit without receive" requirement, transmissions would automatically be disabled. Even in this case, it may be difficult to develop a test method which was not dependent on the provision of a specially modified terminal.

e) Power on / reset state

To protect other users of the spectrum a requirement could be established to ensure that the handset enters a controlled and non-transmitting state following a power-on. This would ensure that no unwanted or intended transmissions occurred before the terminal has established itself into its controlled power-on state. A standard in this area is unlikely to impose any undue restrictions on terminal designers, as it is to be expected that this mode of operation would be ensured by usual good design practice.

9.1.2.5.6.2 Network control functions

A further degree of protection can be provided to other users of the RF spectrum by the provision of a requirement for the provision of a minimum set of control functions that must be supported by the network. As has been mentioned earlier this is an approach that has already been adopted by ETSI for other standards developed for certain classes of mobile satellite earth station.

Standards in this area would require that S-PCNs support functions that permit the network to remotely switch off or bar a user, such that a regulator can, for example, ensure the remote disabling of an MS reported or identified as being defective on the radio part, or require that all MSs, or MSs in a specified region, can be disabled for regulatory reasons.

Whilst in principle this functionality is similar to that established for other mobile networks the consideration of possible standards in this area raises several issues that should be resolved before standards are adopted:

- if the switch-off / barring should be on the IMSI, the equipment identity or both. If the objective is to ensure protection of other spectrum users then the answer would seem to be that the equipment identity is the relevant consideration, as it is the equipment that could be operating in an erroneous manner, not the user subscription. However, the regulators may also perceive some advantages in being able to switch-off / bar also on the IMSI, but this consideration appears to be outside the scope of the essential requirement on effective use of the spectrum;

- if there should be a regulatory requirement for remote switch-off / barring when this is not supported in an analogous way in the GSM environment. The justification for applying this requirement to a satellite based network and not to one terrestrially based might be that for satellite networks this control function is more important to prevent interference and disruption to other users which is more likely in a satellite network than in a terrestrial network, because the satellite can see potentially many more mobiles than can a terrestrial base station.

9.1.2.5.7 Treatment of multi-mode handsets

Already mentioned in the previous subclause is the matter of how dual-mode handsets are treated. The possibility will certainly exist that a dual-mode or multi-mode S-PCN / other mobile system(s) handset will have the possibility to transmit in a non-S-PCN band that is not permitted for such use in Europe. Such transmissions are clearly intentional, and so it would not seem sensible to treat them either under the regime of EMC nor as part of the spurious or unwanted emission requirements. On this basis, it is suggested to consider such transmissions under the requirement of effective use of the RF spectrum, as these transmissions would have the possibility to cause interference to other legitimate spectrum users. The avoidance of interference is a valid consideration of the essential requirement on effective use of the spectrum, as is made clear by the TTE Directive and SES Directive.

In order to type approve such multi-mode handsets it could be considered to include a requirement in the standard that specifies that the handset should not radiate in any band which is not authorised for use in Europe. This, however, would be difficult to implement practically, as the standard would need to contain a list of the bands within which it is permitted that the multi-mode handset can radiate (which must be maintained accurately) and the testing might then become complicated as it will be necessary to check in many bands. In addition, it is possible that the multi-mode handset might transmit in an "authorised" European band, but in a manner not compatible with the correct European system. It is therefore considered that the following approaches might be adopted for dealing with dual-mode handsets in conformance test standards:

- where the integrated system(s) are themselves subject to an existing harmonized European type approval standard (e.g. GSM), and have been so approved, then there should be no special requirements arising out of the multi-mode operation and the S-PCN part should be type approved as a single-mode S-PCN;

- where this is not the case, it should be a requirement of the type approval of the S-PCN component of the handset that the non S-PCN component is incapable of transmitting without first receiving a valid indication from a network functioning to its own standard.

These two requirements, together, should ensure that all multi-mode handsets remain under an appropriate European regulatory framework and that there is no danger of RF interference arising from the use of a multi-mode containing a non-European network component.

It needs to be further considered, however, that an objective in establishing a European type approval regime is likely to be to facilitate its becoming part of a world-wide scheme of mutual recognition of S-PCN type approvals (see subclause 9.2.7.2) and it should be ensured that the European type approval should be compatible with this world-wide approach. On this basis, the first of the two approaches is unlikely to be sufficient, as the world-wide approach must ensure that the integrated MS part of the multi-mode handset can never transmit when it is outside of the coverage of a network functioning to its own standard. The only way that this can be assured is by the implementation of the second approach. This would mean that a multi-mode S-PCN handset which integrated a MS from a system which, although type approved to a harmonized European standard still allowed "transmit before receive" could not be type approved under a European regime that was part of a world-wide scheme, as the "transmit before receive" capabilities are likely to be unacceptable to other (non-European) Administrations.

In consequence, it should be considered that a requirement on the integrated MS component of an S-PCN multi-mode should be that it operates on the basis of "receive before transmit".

It should also be noted that the integration of S-PCN and other mobile system(s) into a single multi-mode handset is likely to have an impact on the type approval for the "other" system component as well as for the S-PCN component. As an example, the integration of a GSM mobile station with an S-PCN / MES may require a revision of the GSM type approval standards in order that the existence of the S-CPN part does not lead to the GSM part failing type approval.

9.1.2.5.8 Effective use of orbital resources

As a result of the SES Directive, the effective use of orbital resources is now a part of the essential requirement on effective use of the spectrum, when it is applied to SES equipment.

This requirement may be viewed in two ways. Firstly it can be argued that no specific action needs to be taken to implement the requirement, as a consideration of effective spectrum use will, for SES equipment, automatically increase the effectiveness of use of the orbit (i.e. orbit use may be regarded as a factor controlled entirely by the radio interference environment). A second view would be to say that effective use of orbital resources must also be considered separately from spectrum use, particularly when the use of NGSOs is considered, and issues such as efficiency of coverage, numbers of satellites in a constellation, geometrical isolation of one constellation from another, etc. might all be measures of effective orbit use.

However, if this parameter is to be embodied in a standard as an essential requirement then it must be a measurable parameter of the SES equipment (i.e. the gateway earth station or the handset) and cannot rely on the knowledge of any parameter external to the equipment, such as the constellation.

In this case, it is very difficult to envisage how any standards to demonstrate effective use of the orbit could be written that did not rely either on a parameter external to the terminal being tested (e.g. a network function, or even the constellation parameters) or was simply a reiteration of a standard relating to spectrum use such as sidelobe performance or antenna tracking accuracy.

It is not proposed to develop any specific standard for S-PCN related to the use of orbital resources. Reliance will be placed upon the effective use of the spectrum requirements to also promote effective use of the orbit.

9.1.2.6 Interworking of TTE with PTNE for purposes of establishing, modifying, charging for, holding and clearing real or virtual connections

The approach proposed in subclause 9.1.1.8 leads to the conclusion that this essential requirement applies across the interface between the gateway MSC and the terrestrial network.

For this interpretation, as already discussed earlier, an existing access standard such as NET 4 or the developed draft TBR 4 would probably be appropriate, as they already specify the user access requirements to the terrestrial fixed networks. An S-PCN access standard could utilise these existing standards directly or could at least use them as a starting point for the development of something more specific to S-PCN.

In the likely event that the interface across the NTP is not through a user access type of interface, then the existing access standards seem unlikely to be appropriate, as they are specified for access to a user interface. Other standards exist, relating to the interconnection between networks, and these may be appropriate for application in this case, although further analysis would be required, in specific cases, to ensure that the essential requirements were satisfied. If existing standards are found not to be suitable for application, then the development of new standards to meet this essential requirement is likely to be a sizeable task.

9.1.2.7 Interworking of TTE via PTNE, in justified cases

If a telecommunications service is defined as a "justified case" by the Commission (following procedures given in the TTE Directive) then the end-to-end inter-operability of TTE via the public networks becomes an essential requirement. In this case, the requirements cover only those characteristics which are essential for the correct operation of the service concerned.

The approach proposed in subclause 9.1.1.8 would imply that this requirement not be applied to the S-PCN handset, but instead to the interface between the gateway and the terrestrial fixed network. This would not seem to make good sense, since the concept of defining end-to-end requirements on the interworking of gateways does not seem to be credible.

However, ETSI is not aware of any proposal to define S-PCN supported services as a "justified case" (although it does need to be clarified, possibly within NTRAC and ETSI or the Commission may wish to consider initiating this discussion), if the S-PCN voice service would fall within the already identified justified case of voice telephony and on this basis it would seem unlikely that any standardization by ETSI will be required in this area.

However, if standardization is required, it would seem sensible to consider basing this upon an existing ETSI "terminal" TBR, although consideration to developing a new standard specifically for S-PCN might also be appropriate. In the event that an existing ETSI standard is considered then the GSM "terminal" TBR [57] might be a good place to start this consideration.

9.1.3 Summary of possible standards related to the essential requirements

The foregoing subclause has explored a number of technical areas where standards may be considered for S-PCN. Tables 7 and 8 summarise the possible standards that might be considered, in order to assist the decision makers in easily identifying the options. Note that a very detailed list of possible standards in this area has been identified in subclause 9.1.2.5, but as explained in that subclause, not all of them were identified as useful for more detailed elaboration in this ETR. Tables 7 and 8 only include references to the items that have been elaborated, and reference should be made to subclause 9.1.2.5 for the full list.

9.2 Voluntary standards

The previous subclause has addressed essential requirements. This subclause discusses options for possible voluntary standards which might be considered in a range of areas.

9.2.1 Service aspects

This subclause addresses the objectives that are obtained by standardization of the services that are to be supported, as well aspects that are related to the geographical area over which service is available.

Service area will be considered as defined in the ETR 093 [1].

Services which could be supported by S-PCN may be grouped under the general headings of:

- mobile voice service;
- mobile real-time data service;
- mobile store and forward data service;
- paging / messaging;
- paging with acknowledgement;
- position reporting (and related service such as emergency position reporting);
- two-way video to the S-PCN terminal to provide video-telephone, video-conference, video-surveillance and monitoring, teleaction services.

9.2.1.1 Support of telecommunication services

This subclause addresses aspects that are related to the support of telecommunication services, but also to the support of supplementary services (especially relevant for the user to be able to manage his telecommunication needs) as well as network operator determined services.

The mobile voice telephony service and data service (including facsimile) are the telecommunications services used in ETR 093 [1] (and consistently in this ETR) to make a fundamental distinction between two classes of S-PCN, according to the capability to provide the service.

In ETR 093 [1] the mobile telephony service has been defined as the capability to deliver and process a voice call (real-time two-way bearer connection) within a defined region (coverage service area), with a certain service availability and a certain overall service quality. The minimum requirement for this service is the recognition of the speaker.

The voice service is expected to be digital, provided by spectrum efficient digital coding schemes running at rates equal or lower to those of today's digital mobile systems and matched to the mobile satellite channel impairments.

To achieve better call establishment performances the system may include means to improve link margins on paging messages with respect to traffic channels.

Table 7: Summary of possible standards for S-PCN handsets related to the essential requirements

Possible Standard	Ref. Subclause
S-PCN specific EMC standards - essential requirement 4(c)	
Out of band emission limits defining an envelope	9.1.2.3
Immunity requirements	9.1.2.3
Effective use of the RF spectrum and orbit - essential requirement 4(e):	
Use of correct harmonized frequencies - ensuring that the handset operates within a harmonized band (if one should be implemented)	9.1.2.5.1
Local oscillator frequency stability	9.1.2.5.2
In-band spurious emission limits defining an envelope mask	9.1.2.5.3
Carrier suppression when the handset is switched on but not transmitting, to limit interference within a network (idle mode suppression)	9.1.2.5.4
Avoidance of interference to terrestrial systems	9.1.2.5.5.1
Avoidance of interference to space systems especially Radioastronomy	9.1.2.5.5.2
Terminal control and monitoring functions	
Mobile station cannot transmit unless it receives a valid network broadcast signal	9.1.2.5.6.1.1
Processor or software monitoring	9.1.2.5.6.1.2
Battery power level monitor	9.1.2.5.6.1.3
Transmit frequency subsystem monitor	9.1.2.5.6.1.4
Power on reset state	9.1.2.5.6.1.5
Network control functions to ensure remote switch off and barring of mobile stations (for regulatory or other purposes)	9.1.2.5.6.2

Table 8: Summary of possible standards for S-PCN gateways related to the essential requirements

Possible Standard	Ref. Subclause
S-PCN specific EMC standards - essential requirement 4(c):	
Out of band emission limits defining an envelope	9.1.2.3
Immunity requirements	9.1.2.3
Protection of the public network from harm - essential requirement 4(d): either based on existing Access standards (e.g. ETSI TBRs) or new Access standard developed for S-PCN	9.1.2.4
Effective use of the RF spectrum and orbit - essential requirement 4(e):	9.1.2.5.1
Use of correct harmonized frequencies - ensuring that the GW operates within a harmonized band (if one should be implemented)	9.1.2.5.2
In-band spurious emission limits defining an envelope mask	9.1.2.5.3
Carrier suppression for interference avoidance	9.1.2.5.4
Avoidance of interference to terrestrial systems	9.1.2.5.5.1
Avoidance of interference to space systems especially Radioastronomy	9.1.2.5.5.2
Interworking of Terminal Equipment (TE) with Public Telecommunications Network Equipment (PTNE) - essential requirement 4(f): either based on existing Access standards (e.g. ETSI TBRs) or new Access standard developed for S-PCN	9.1.2.6
Interworking of TE via PTN, in justified cases - essential requirement 4(g): either based on existing Access standards (e.g. ETSI TBRs) or new Access standard developed for S-PCN	9.1.2.7

Access to the service may be subject to some conditions due to the S-PCN mobile link features (link margin in certain conditions) requiring the user to use some indications provided by the S-PCN MS. The user related issues are introduced and discussed in subclause 9.2.5.

The user terminal indications may include directions to achieve:

- better position (within the location where the call is being established);
- better orientation of the terminal;
- efficient use of the terminal battery, if battery operated (not only when voice service is active, related to the dynamic coverage conditions).

If the S-PCN mobile voice telephony is within the scope of the essential requirements (Article 4g - justified case) then there are a number of possible standards on "end-to-end" voice performance (see also GSM TBR 9 [57] on telephony) that are introduced in subclause 9.1.2.7.

If such standards are not adopted as relevant to essential requirements, they could be considered to form the elements for voluntary standards.

9.2.1.2 Geographical extension of service

This subclause addresses aspects that are related to the geographical area over which the service is supported by the S-PCN system. In general there is no firm relation between the orbit used by a system and the geographical service area provided, for example a LEO system may be designed to provide regional coverage (some LEO systems are intended to provide a regional coverage) while a HEO system may provide global coverage. Orbit and system design features (such as beam steering) may be used to achieve the wanted system service area.

Approaches here identified are:

- extension of the coverage area of a terrestrial system;
- independent coverage of a region, multiple regions or the whole Earth;
- virtual private global networks based on S-PCN.

9.2.1.3 Service availability and quality

This subclause addresses the aspects that are related to the types of service that may be available, and the conditions thereunder. Depending on the environment in which the user finds himself, only a reduced / limited set of services may be available.

A standard on service availability could establish requirements for an acceptable level of services to be provided. In general the service availability has to be considered against the geographical extension of the service. In particular the service availability is a result of the combination of the availability of several components depending on the S-PCN.

A standard on service quality would be generally based on some assumptions on service availability, setting limits to acceptable services balancing the quality with the ubiquitous availability of the channel. Service quality could be defined for every service provided, taking into account already existing standards for other mobile services. Where the quality is an "end-to-end" parameter, Recommendations on how to measure service quality could be developed leaving the issue of applying the measure to specific S-PCN services open for further work.

The resulting standards include:

- mobile voice telephony service quality;
- mobile real-time data service quality;
- mobile store and forward data service quality;
- paging service quality;
- paging with acknowledgement service quality;
- mobile video service quality (two way);
- position reporting (including emergency position reporting) service quality;
- strict service availability;
- percentage of time service available at desired quality.

If the system requires the terminal to dynamically adjust the transmitted power to cope with small link margins to bring the service quality to a decided level, there is the possibility of exceeding RF protection levels. The terminal may have the requirement to give priority to RF protection levels and shut down transmission when the RF protection levels are exceeded, possibly giving some form of indication to the user.

Information on system fault tolerance and survivability, which is related to service availability and quality, is presented in annex D.

9.2.1.4 Summary of possible standards for service aspects

The foregoing subclause has explored a number of technical areas where standards may be considered for S-PCN. Table 9 summarises the possible standards that might be considered, in order to assist the decision makers in easily identifying the options.

Table 9: Possible standards related to service aspects

Possible Standard (Service aspects)	Reference Subclause
S-PCN mobile voice telephony specification (Support of telecommunications services)	9.2.1.1
Geographical extension of service	9.2.1.2
Service availability and quality (general)	9.2.1.3
Mobile voice telephony service quality	9.2.1.3
Mobile real time service quality	9.2.1.3
Mobile store and forward data service quality	9.2.1.3
Paging service quality	9.2.1.3
Paging with acknowledgement service quality	9.2.1.3
Two way video service quality (UMTS)	9.2.1.3
Control of RF protection limits as related to service quality	9.2.1.3

9.2.2 Network aspects

Network design for S-PCN, although a challenging matter, has not been considered in detail in the public domain while most of the attention has been devoted to radio aspects and satellite design issues. The filings to the FCC and the discussion carried on so far also reflect a greater attention to radio aspects, related to frequency band sharing and compatibility with existing systems.

The network aspect is introduced here in general terms and will be discussed in the following subclauses with the purpose of analysing the potential and advantages of a standardization in this area. The objectives of standardization include network interfaces, aspects of network management, control and monitoring, subscriber databases, security (against fraud, incontestable billing) and privacy (encryption, user location).

Legal tapping is also an issue that was identified as a matter of priority in the framework of this ETR. It will be regarded as the possibility by competent authorities to legally access user data transported by the network and other information relevant to trace S-PCN mobile communications. The network architecture is required of being capable to cope with the mobility management possibly world-wide and depends on the architecture of the space segment. As pointed out in ETR 093 [1] subclause 5.2.2.2, there are mainly the following options:

- transparent payload;
- On Board Processing (OBP) capability;
- Inter-Satellite Links (ISLs) within the constellation or inter-constellation with other data relay satellites to carry traffic and signalling.

The system capacity in terms of offered circuit density may not be compared with that of current and planned digital cellular systems, but here it is recognised that the switching difficulties posed by S-PCN move from those related to real-time processing of high density circuit systems to those related to the geographical extension of the coverage (and therefore of a consistent switching structure). In a LEO system the minimum number of GW Earth stations to provide global coverage may be large (in the range of 100 to 300) therefore the network resource assignment and co-ordination becomes an important networking issue either performed in the GW or "on board".

In particular the criteria and algorithms employed to perform the association relationship between NGSO satellites and mobile terminals, named 1st and 2nd order assignment in ETR 093 [1] subclause 5.6.2.1, will be here considered against system capacity management (see ETR 093 [1], subclause 5.2.6.1.1).

The possibility of having some of all or the network functions performed on board brings the problem of identifying the essential differences, from the network model point of view, between S-PCN including OBP or not. A generic OBP capability does not necessarily imply ISL traffic handling routing. In this ETR the OBP role in the network model is to provide traffic / signalling switching functions to the S-PCN.

The functions of the OBP payload of a satellite based S-PCN may also include all the mobility management functions or these may be distributed between the OBP payload and the gateways. The following clauses will relate this distribution to the possible integration achievable with existing PLMNs.

The possible structure of a world-wide S-PCN based on a terrestrial mobile system (e.g. divided into four regions), figure 15 may be considered. Note that this, and other figures in this subclause, are presented as examples and are not intended to reflect architectures that might actually exist.

The S-PCN numbering assumed in the model makes use of an S-PCN country code, following the structure CC + NDC + SN:

CC: S-PCN Country Code (a single CC, assigned by ITU);

NDC: National Destination Code, may be used to identify HLR regions or operators;

SN: Subscriber Number, used to address the subscriber within the operator network or within the region.

Each region has a PSTN gateway also providing VLR / HLR functions to other mobile services switching centres in the S-PCN GWs. The GW - ISCs are connected by a signalling / traffic network structure that may be a full connectivity mesh or layered.

As an example of mobile terminated call set-up procedure the following shown in figure 16 may be considered for the structure shown in figure 15 (i.e. the MS is a home subscriber of region 1, HLR1, registered as visitor in region 4, VLR4).

The simplified example given above does not regard the space segment as an entity involved in the network procedures, therefore is not representative of a system where the satellite (or satellites) handling the call have an On Board Processing (OBP) capability. The satellite may add a further switching layer and perform some call set-up and intra-satellite handover functions so that the call set-up scenario introduced may change into that shown in figure 17. In this figure is represented the call set-up for a fixed-to-mobile call, the location and authentication information is stored in a GW node interrogated via the satellite network, the call route is then set-up between the two ending points (the mobile and the PSTN GW) without passing through any further GW.

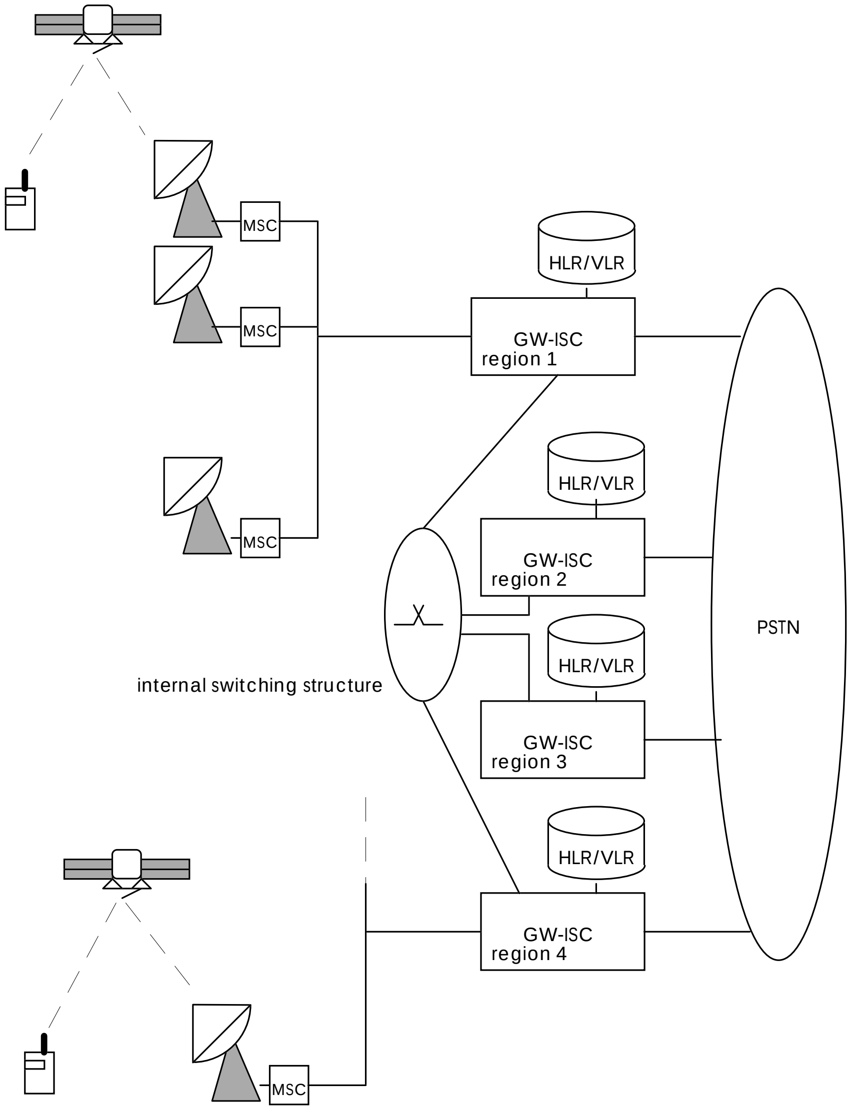


Figure 15: Example of a world-wide S-PCN structure

These systems will be addressed in such issues as call routing in the following subclauses.

The structure of the satellite mobile network may result in a multi-layer Location Register (LR) structure due to the possible large extension of the coverage (the gateways may also perform switching functions to maintain the circuit through multiple satellites or beams).

A comparative evaluation of different network architectures, independent on a particular system, has to be done with respect to an expected grade of service. The traffic of the Mobile Satellite Services (MSS) has not been estimated within the FPLMTS and elsewhere much of the attention has been devoted to the market sizing. Some traffic estimation for both S-PCN voice and non-voice service will be of importance to assess possible interworking and integration scenarios. The problem of estimation of traffic will be considered in the following subclauses.

For both S-PCN mobile originated and terminated calls, the PSTN route may be compatible with a GSO satellite link, depending on the delay introduced by the S-PCN hop. Some typical values may be found in ETR 093 [1], table 44. This will be discussed in the following interworking subclause.

Virtual Private mobile Networks (VPNs) are value added applications to obtain a private mobile network on a non dedicated infrastructure. Some applications are developing today in this area and the "wireless office" concept has been given consideration for some time. VPNs supported by the S-PCN infrastructure may be considered as a new service, potentially capable of obtaining a large coverage and availability. The network related issues are here analysed with respect to interworking and advantages of integration with other mobile systems, assuming a world-wide S-PCN system offering support to VPNs.

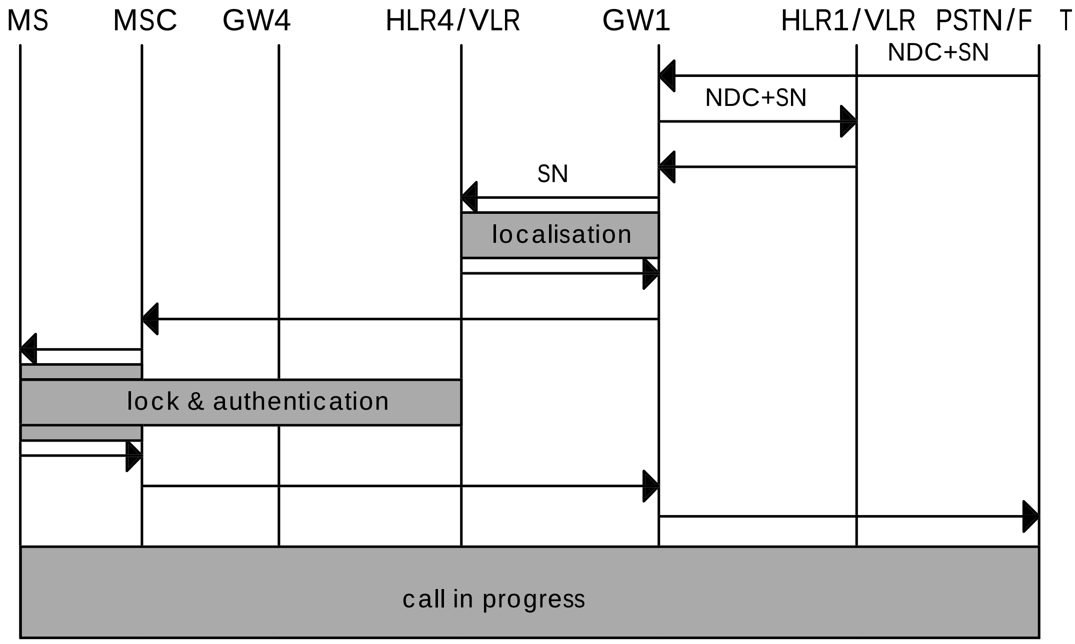


Figure 16: Simplified example of generic S-PCN mobile terminated call set-up procedure, without ISLs, MS = S-PCN mobile station, FT = fixed terminal (PSTN)

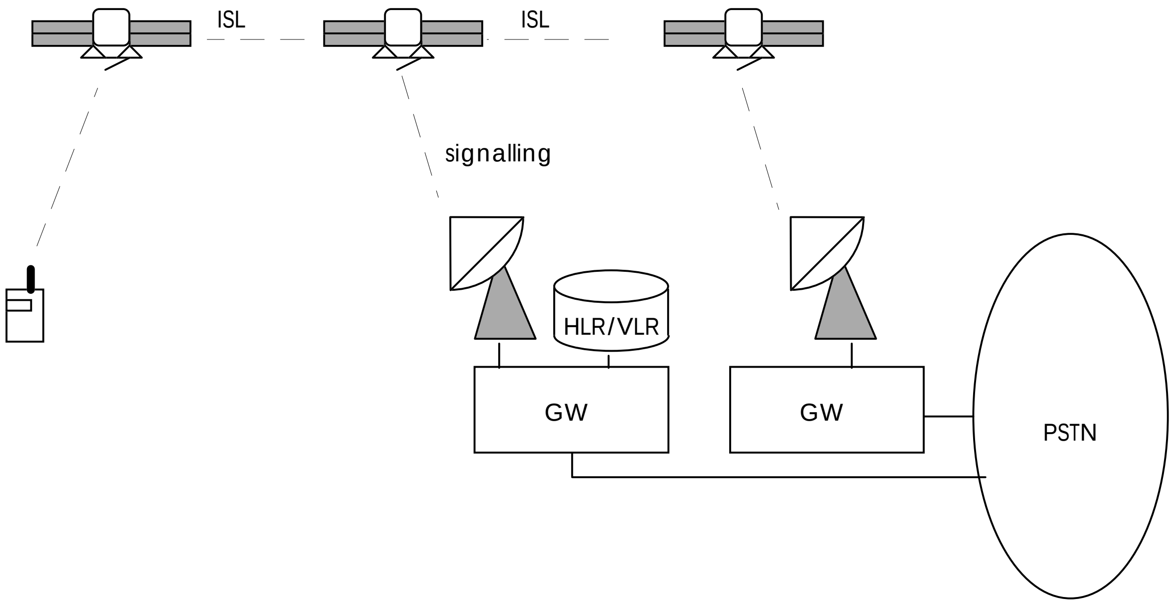


Figure 17: Example OBP call set-up scenario

9.2.2.1 Interworking aspects

This subclause addresses the objectives that may be met by standardization of interworking aspects. Subjects are interworking with the fixed PSTN / ISDN, the PSPDN and (depending on network integration) mobile networks. Specific systems are addressed in the following subclause while here the different interworking scenarios and consequences are described.

The main objective of interworking is twofold:

- extend the access to a service;
- optimise infrastructure usage.

The nature of S-PCN opens some new options to interworking interfaces, according to the architecture adopted.

For an ISL based S-PCN the PSTN and PSPDN are in principle the only access interfaces to be considered.

For a ground switching based S-PCN, there different interfaces according to the level of integration with other mobile systems. As an example of this case consider the architecture shown in figure 18 where the S-PCN is used to extend the coverage of a terrestrial mobile system, offering the service to S-PCN handsets (either S-PCN-only or dual-mode).

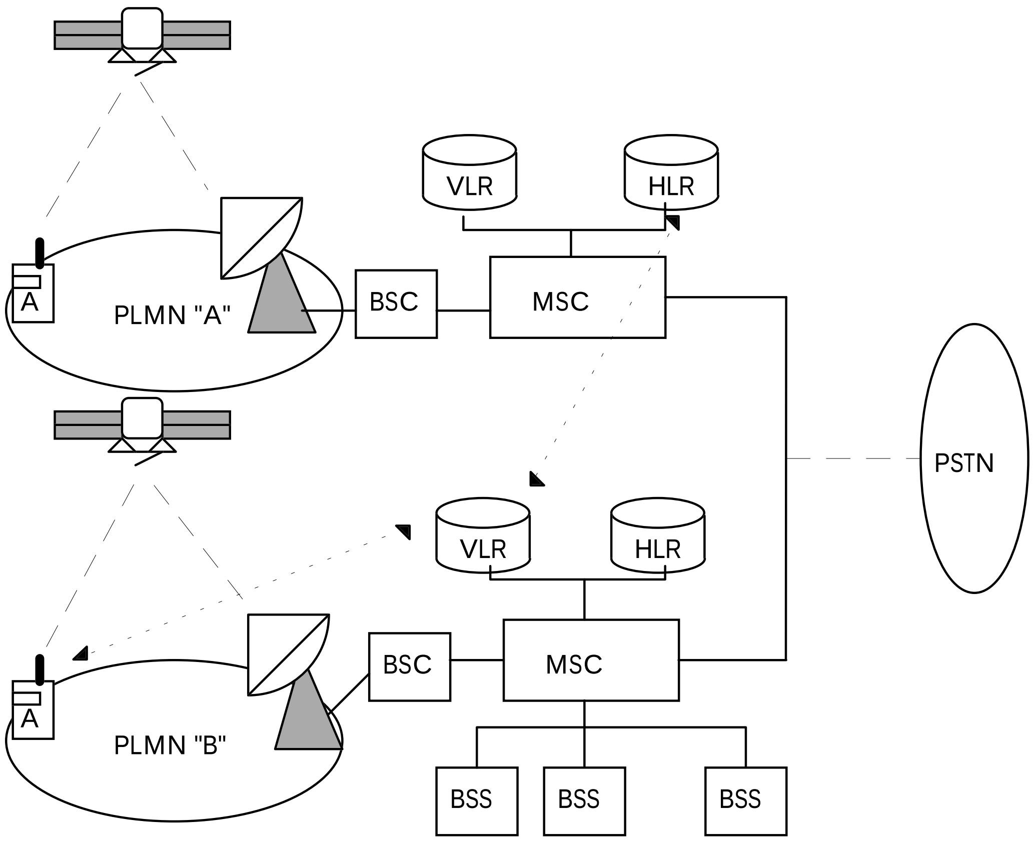


Figure 18: Example S-PCN terrestrial network extension architecture

The possibility to obtain service in a different PLMN is subject to a roaming agreement between the two PLMNs satellite networks and to the exchange of information on the relevant signalling interface. In this example the interworking with PSTN is a function already performed by the PLMN.

The interworking with PSTN is one of the essential issues for S-PCN because is expected to be provided by any public system (PSTN interworking is foreseen in all the system proposals of ETR 093 [1]).

The interworking functions would have the objective of providing the necessary information to support the interconnection of PSTN with a general S-PCN system, describing the general requirements and the services capabilities. A set of interworking specifications will necessarily have to be defined if a certain degree of interworking with PSTN is foreseen, a policy decision stating the need for a standard in interworking would then cause the possible adoption of some (if not all) elements of the interworking specifications in the standard.

The interworking function location and their specification is a field which could be of basic importance for the introduction of the service as public. A similar approach to that already developed by the ITU-T for terrestrial, land mobile and aeronautical systems (Recommendations in the series Q.1100 to Q.1152, Interworking with Satellite Mobile Systems) are considered.

The main parts of an interworking standard would be (according to the usual ITU structure):

- part 1: General requirements for interworking and terminology;
- part 2: Description of services available (service capabilities);
- part 3: Mapping of services;
- part 4: Description of interfaces (interworking scenarios) and requirements (considering Recommendations, e.g. ITU-T Q.41 and Q.14, Nature of Circuit Indication (NCI));
- part 5: Procedures for interworking.

Some of the elements are already part of the essential requirements (as discussed in the relevant subclause) or they may be developed as voluntary standards; some elements would be based on an existing system interworking specification and on existing ITU Recommendations; others may be included as (part of) additional elements developed independently.

As an example it is possible to consider the routing of an inter-PLMN S-PCN call. According to the delay introduced by the S-PCN mobile link, in an international call route there may be the need to adopt Q.14 or "means to control the number of satellite links in an international telephone connection", based on Recommendation Q.41 (avoid connections with one way propagation time in excess of 400 ms) as shown in figure 19.

The nature of the Incoming Circuit (IC) is first considered, then the NCI is tested (NCI may be unknown), either the DA or the RA may be necessary. Then the selection of the outgoing circuit may lead to priority to terrestrial, only terrestrial or any circuit.

It should be also taken into consideration that the delay introduced by an S-PCN link contains two contributions:

- the delay introduced by the slant range path of signals (often referred to as the "altitude path delay") depending on the orbital configuration and service elevation angles;
- the delay introduced by processing, depending on the voice coding algorithm employed and the amount of processing performed on board and at gateways.

The second contribution, often not considered, may be more important than the first one. It is possible that the amount of processing required by the access and coding technique and OBP switching functions makes the first contribution almost negligible (e.g. in a multi-satellite LEO constellation).

The applicability of Q.41 it is not limited to those cases where the orbital configuration of the system employees LEO orbits but other considerations are necessary.

A standard on how the S-PCN delay has to be taken into account in the application of Q.41 is important to preserve the quality of voice telephony and other end-to-end delay-sensitive services over S-PCN and PSTN connections.

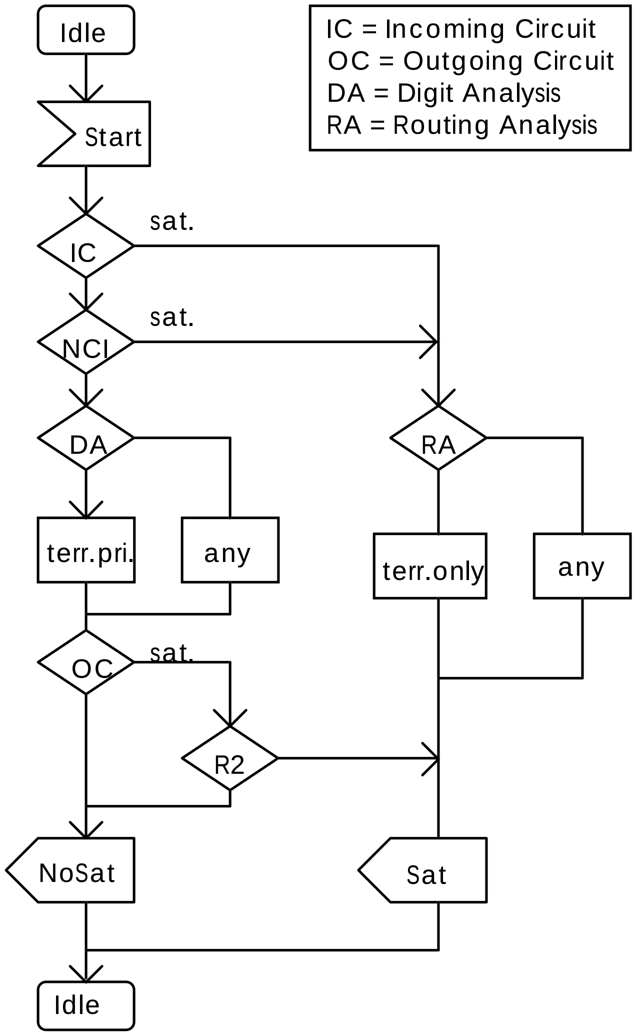


Figure 19: Control of number of satellite links - Q.41

9.2.2.1.1 Inter-operability with PSTN

This area has been recognised as one to be addressed as a matter of priority. The interface involved is provided by the gateways of the S-PCN system. Depending on the system architecture and co-ordination the number an location of such gateways may vary, but for the purpose of inter-operability each gateway should meet a common set of requirements. Where the gateway earth station is integrated with an existing terrestrial mobile facility the considerations made here are not applicable.

The only specifications in the public domain describing the telephone service interworking interface between a mobile satellite system and PSTN arise from the ITU-T Q.1100 - Q.1152 series of Recommendations on "Interworking with mobile satellite systems" on the INMARSAT systems A, B and Aeronautical. These systems show also some features resulting in networking issues similar to those expected for S-PCN (international service, global service access, global coverage, dedicated numbering scheme, dedicated country code). Therefore these interworking specifications are taken as a reference in this ETR and the system prototype for the interworking procedures is the set of INMARSAT systems A, B and the Aeronautical. In referring to the INMARSAT ITU Recommendations some applications of the Recommendations to S-PCN is presented The approach taken in these Recommendations and the need for possible further work is analysed.

The prototype systems are described in terms of service capabilities and configuration, some detail on the internal procedures is also given. The basic interworking scenario is as shown in figure 20.

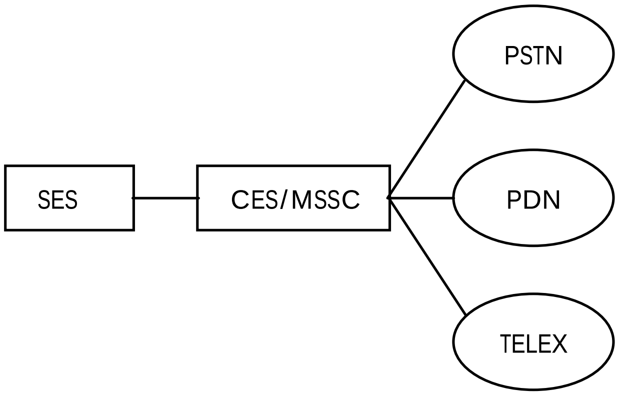


Figure 20: Basic interworking scenario in Q series Recommendations

The requirements for inter-operability are(generally) the following:

- traffic circuits (MSSC - networks):

  Transcoding to 64 kbit/s at the gateways, the speed of the mobile speech channel may be 64, 16 and 9,6 kbit/s, according to I.211;

- signalling circuits:

  Relationship between signals in the PSTN network and messages in the mobile satellite network, cases of interest are the SSN7 (TUP, ISUP), the R2 system;

- signalling circuits:

  Logic procedures for incoming (mobile originated calls) and outgoing (mobile terminated calls). Cases of interest are the SSN7 (TUP, ISUP), the R2 system;

- signalling circuits:

  Between MSSC over the PSTN SCCP may be used.

A similar set of requirements may be included in the S-PCN interworking specification.

The logic procedures, based on the definition of correspondence between signals, give the description of the actual interworking. Such procedures are essential to establish the interworking and unique to the S-PCN system.

Calling procedures in INMARSAT systems are different for satellite mobile originated or terminated.

The mobile originated call involves an mobile switching centre (MSSC in the INMARSAT terminology) which should provide to the fixed network the following (if supported by the signalling system):

- continuity indicator;
- echo suppresser indicator;
- satellite indicator.

The following should be returned to the S-PCN handset:

- called party answer;
- indicator of the cause of the failure of an unsuccessful attempt;
- clearing signal.

Fixed originated calls need:

- deletion of country code (e.g. 87S for INMARSAT);
- interworking procedures to generate the appropriate messages towards the PSTN and the mobile terminal.

The handling of supplementary services is another area to be considered for possible standards development. New services may be introduced with the implementation of S-PCN (e.g. position reporting and related services e.g. Route Guidance Service), other than the ISDN supplementary services. Prefixes and access codes are already allocated for the INMARSAT system, shown in table 10, but many of them are considered for further study. Spare access codes are available to support new services. If S-PCN networks are allocated country codes as in INMARSAT a similar standard set of access codes may be expected.

Table10: Supplementary services access codes in INMARSAT

Category of service	Digit 1	Digit 2	Available codes or prefixes
Operator	1	0, 6, 8, 9	4
Automatic facilities	2	6 - 9	2
Assistance	3	0	1
Ship reporting	4	0, 4 - 9	7
Information retrieval	5	0, 7 - 9	4
Not defined	7	0 - 9	10
Not defined	8	0 - 9	10

9.2.2.1.2 Inter-operability with other PCNs

This area has been recognised as a matter of priority. The inter-operability is not a single relation but is used here to encompass the levels of integration identified in ETR 093 [1] (subclause 5.2.5) as well as possible compatibility or commonality relations with other PCNs. It has been already singled out in ETR 093 [1] that in an integration scenario, the S-PCN would be a component of the general PCN.

The general reasons why inter-operability with other PCNs is attractive is the better level of service experienced by the user and the possible use of already existing infrastructures, TTE subsystems and services. The "double choice" offered by the two systems may provide backup in situations including:

- coverage complement;
- congestion in either of the systems;
- temporary unavailability of certain services in either of the systems (e.g. network authentication, messaging etc.);
- poor quality.

Inter-operability with a generic PCN will be considered here as a stand-alone technical area, while an application will be addressed in the section on GSM / DCS-1800. Capacity needed to support S-PCN operation, common services, routing, roaming and mobility management, numbering and billing are considered.

S-PCN as a widely available personal communication service may require the supporting PCN to have adequate resource capacity. Due to the wide coverage area of S-PCN, the subscriber base loading the PCN may be significant in terms of requirements for signalling and databases. For example an S-PCN covering a region comparable in size to the European region could support a significant subscriber base if compared to that of a single PCN operator, especially if the dual-mode terminal case is considered. In absolute terms, therefore, considering only the service in identical service area, the traffic carried by S-PCN is expected to be a small percentage of that carried by the aggregate PCNs. In relative terms, when considering the world-wide operation of S-PCN, there may be considered weighting factors such as the overflow capacity provided by S-PCN to dual-mode terminal traffic, the ubiquitous availability of service in areas uneconomic for PCN (see also subclause 9.2.1.3), the operation as land, maritime or aeronautical mobile communications system.

A common set of teleservices and supplementary services throughout all PCNs supporting S-PCN would be needed for consistency when anticipating PCN and making the mobile service ubiquitous. A common set of bearer services would permit the use of common data terminals connected to S-PCN as well as S-PCN handsets. Mobile real time data applications are of interest in S-PCN, giving access to facilities from remote regions, especially in combination with position reporting (ETR 093 [1], subclause 4.3.7). A European standard in this respect would open the development of software applications and terminals to industry, possibly achieving the goals of:

- making available data services from an early stage of the introduction of S-PCNs;

- allow the portability of such services to PCNs.

Routing of calls in an interworking scenario progresses in two stages:

- choice of the system to which traffic is offered ("call set-up routing", ETR 093 [1], subclause 8.4.4.2.1.2);

- routing to the destination from the chosen system.

The possible competitive relation between S-PCN and other mobile terrestrial systems has been a subject of debate when S-PCN proposals have been introduced and now more attention is devoted to the possible mutual benefits of these systems. It can be recognised that in this area the two systems benefit most from each other. This synergy arises from the sharing of infrastructure costs between the two networks if the routing algorithm is tailored to select the system optimising the use of available capacity.

Considering a terminal able to access both S-PCN and PCN, call set-up routing may be under user control, if both systems are reported as available, or automatic following a defined algorithm of registration into a network. The automatic registration of the terminal could, as an example, follow a priority (1 = high priority, 4 = low priority) choice list arranged to make use of terrestrial facilities first:

1) home terrestrial (home PCN);

2) roaming terrestrial (PCN);

3) home satellite network (S-PCN extension of home PCN);

4) roaming satellite network (S-PCN as a separate PLMN):

    4.1) satellite global system (S-PCN);
    4.2) satellite extension (S-PCN extension of another PCN).

A number of options are foreseen here for the call set-up. Call set-up could force a registration into another network if certain conditions are met (system unavailable, access barred, system busy or congestion conditions encountered). Also, depending on the kind of terminal used (S-PCN only, dual-mode or multi-mode), and on the service requested (data or voice) the call attempt could be given different priority when assigning satellite traffic channels.

It is of considerable strategic importance to establish an accepted standard in system selection in an interworking context because of the co-ordination of interests of both PCN and S-PCN operators, also considering those cases where terrestrial operators will be able to offer an S-PCN extension to their networks. Roaming agreements in such an interworking context could benefit from the technical set-up arising from a standard as the number of agreements between operators will be large, because of the S-PCN coverage. In the case of choice 4.1, the S-PCN channel capacity would be shared among the largest possible terminal population, achieving high efficiency. In the case of choice 4.2, there would be possibly the situation encouraging a competitive tariffing (for example because of the possible optimisation of terrestrial tails for mobile originated calls).

In the case of choice 4.2 the roaming agreement to support S-PCN operation could be just an extension of an already existing agreement for the terrestrial part (choice 2). The technical support of this extension may regard the definition of new parameters involved in the exchange of billing data such as:

- operator satellite airtime;
- user identity;

- S-PCN user airtime and positioning services utilisation;
- call related information (e.g. ITU-T D.93: date and start time, number called and area code, CC of destination, duration, supplementary services).

This situation is the same described in figure 18 (subclause 9.2.2.1).

In the case of choice 3 it seems unlikely that a roaming is taking place and if it may be better regarded as location registration within the same coverage in a cell that may be considered overlapping (logically contiguous) to all the cells in the network, although this may be dependent on the specific architecture of the network.

Routing is also related to mobility management procedures. In the interworking context the handover procedures to be considered are those involving cellular PCN and S-PCN. The handover support in either direction implies a common set of mobility management functions, meaning integration at a "system" level. The complexity of the systems and the implications in the design are issues making "system" integration a theoretical reference rather than a practically achievable target by the S-PCN current proposals. The study on the implications in the network design, and the achievable advantages are a major preliminary task to be undertaken for future, second generation S-PCN systems. In this respect what has been stated in the clause 7 should be considered (especially the subclause 7.2.3, RACE.SAINT project).

Routing to the destination, based on the relevant ITU Recommendations (Q.14, Q.41), brings the problem of a possible different meaning of the "satellite indication" in signalling. The purpose of the "satellite indication" is to indicate a condition of a circuit, the delay introduced in a link by the satellite routing. The nominal value of the delay is considered that of a transparent geostationary satellite hop (uplink and downlink). When considering S-PCN links, the satellite hop delay is a system dependent parameter, depending also on the constellation configuration of the system, the use of "satellite indication" on that link has to be evaluated. It is possible that the Gateway Earth Stations distribution will make possible the use of GSO trunks to certain destinations. Figure 21 summarises the situation (annex A to Recommendation ITU Q.13, on the effect of satellite communication).

All circuit groups represented are international. The use of national satellite circuits for international originated (and terminated) traffic should be avoided (annex A to Recommendation Q.13). Direct satellite circuit groups are to be used only for traffic originated at either end, not for transit traffic. When the information about the existence of the satellite link is not available by means of signalling, there is the need for special agreements between administration or operators involved.

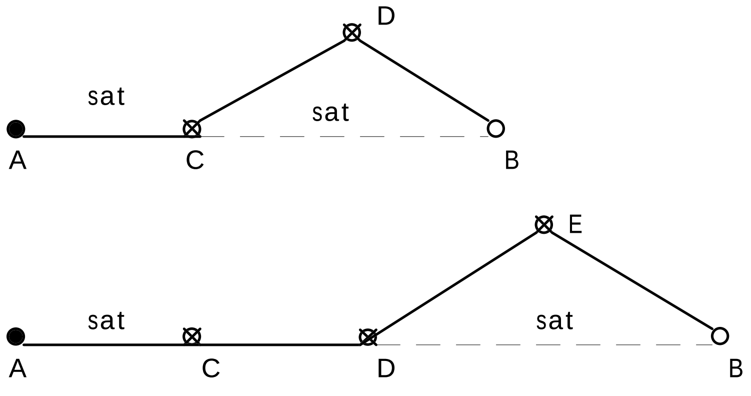


Figure 21: Recommendation ITU Q.13 on the effect of satellite communication

A standard on the technical requirements for routing of traffic to preserve the quality of connection with respect to delay introduced would be a part of the actions towards quality of the S-PCN system.

Billing and charging definition is outside the scope of ETSI. Some principles relevant to the specific S-PCN aspects may however be outlined, following the approach taken in UMTS. The following issues are identified: charging principles, types of charging parameters, supplementary services for charging, charge optimisation with respect to route, charging options for service providers, credit control and flexible accounting requirements.

The international Recommendation on charging and accounting (ITU-T D.90 - D.93) apply to the maritime mobile and international land mobile telephone service provided through a cellular system. In the latter case a number of scenarios are foreseen for the application of charging and accounting principles to different routing cases. Where the route involves (at least) two PLMNs, the Recommendation provides charging principles as well as inter-PLMN settlement. The basic situation is shown in figure 22. The two administrations (or operators) A and B are represented by the set of PLMN (Home / Visitor-PLMN, HPLMN / VPLMN), the National Network (NN) and an international transit point connected to International Switching Centres (ISCs).

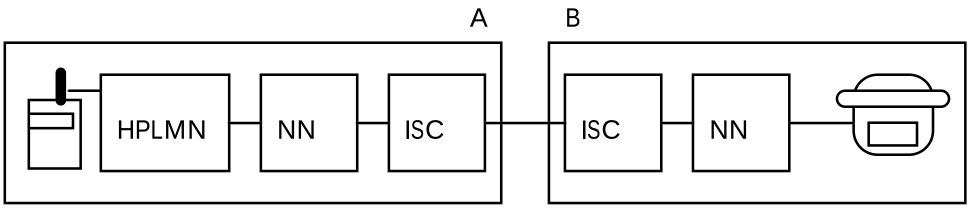


Figure 22: Model for international billing

If the mobile is located in HPLMN the call from fixed-to-mobile and vice-versa is included in the relevant outgoing traffic account. No inter-PLMN settlement applies.

When the network supports the roaming, the mobile station is able to use the resources of another network and the billing of the mobile station is made in general according to the data provided by the visited PLMN (VPLMN).

In S-PCN the situation above may become as shown in figure 23.

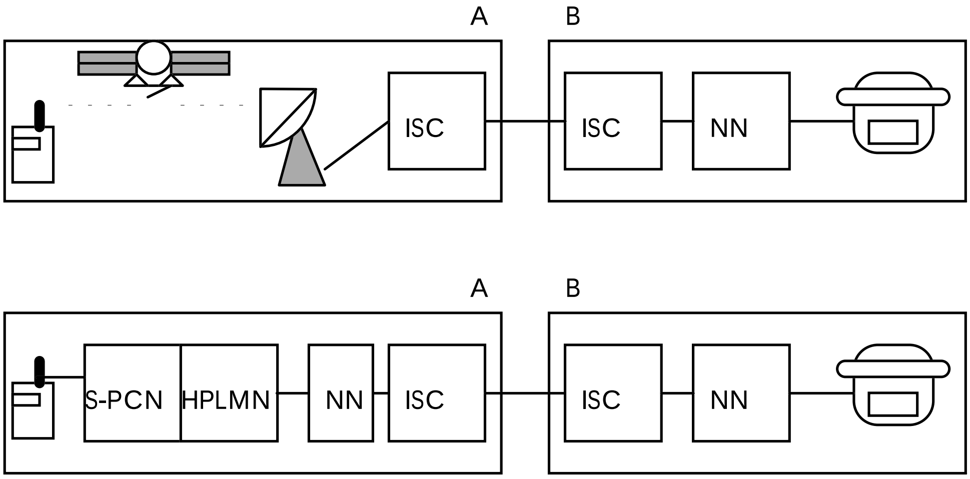


Figure 23: S-PCN and billing

If the S-PCN is intended to be addressed as a separate logical country (meaning that the S-PCN has a single or a set of CCs assigned) the ISC functions would be part of the gateways. If S-PCN is an extension provided by an existing HPLMN there is virtually no difference from billing cases from a basic situation. A different and new situation would arise from having both the above mentioned possibilities (on a first / second choice list). As an example the situation of a S-PCN mobile station (mobile station A) roaming into the S-PCN (country C) from an extension of the HPLMN (country A) is shown in figure 24.

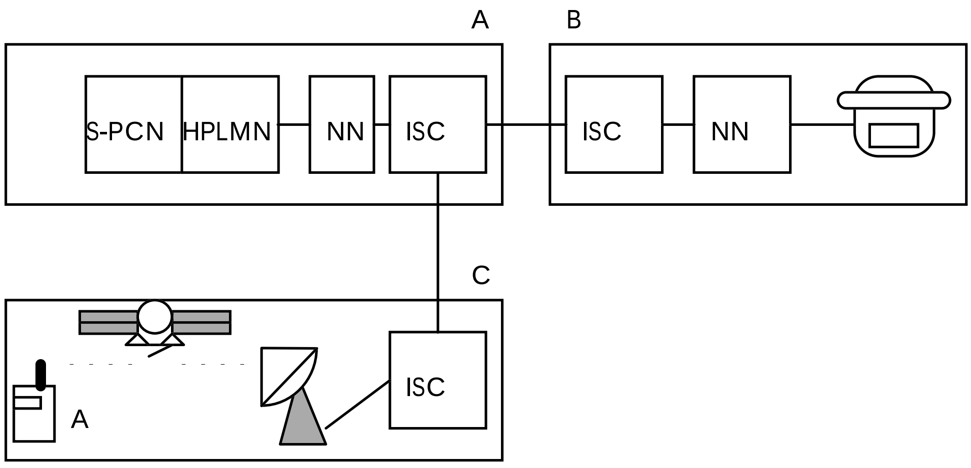


Figure 24: S-PCN Roaming with three countries involved

The situation that could be regarded as the one involving the most complex inter-PLMN settlement is as follows, two mobile stations (mobile stations A and B) roaming in an S-PCN extension (VPLMN of country C) and the S-PCN only (country C) respectively (see figure 25).

The above situation shown in figure 25 is also useful to show that the possible satellite extension to already existing mobile networks offers in principle an inter-S-PCN / PLMN roaming capability between any two mobile terrestrial systems. This is independent from the dual-mode or multi-mode capability of terminals, single-mode S-PCN handsets may roam using satellite extensions. For the A mobile terminal originated call:

- charging:
    - A would be billed by HPLMN A on the basis of data provided by S-PCN C;
- inter-network settlement:
    - S-PCN C is reimbursed by HPLMN A for A terminal roaming into C;
    - HPLMN B may raise a charge to terminal B for the forwarding of the call;
    - HPLMN B may raise a roaming charge to terminal B based on data provided by VPLMN D;
- accounting of traffic:
    - traffic from C to B is accounted in C outgoing traffic;
    - traffic from B to D is accounted in B outgoing traffic.

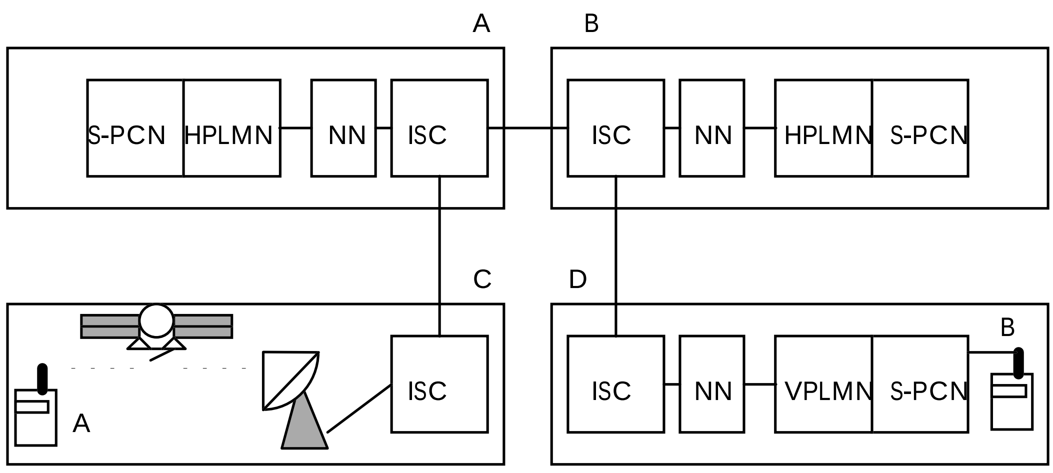


Figure 25: S-PCN roaming with four countries involved

Because of the nature (international, in general) of service links established in S-PCN operation, as shown in figure 3 (subclause 8.3), international charging principles would have to be applied. Most of fixed terminated and originated calls would be international. Mobile-to-mobile calls may be treated differently if the S-PCN operates as an autonomous S-PCN / PLMN. The role of the trans-border operation still has to be considered in this case, both when the mobile-to-mobile call involves a single or double hop to the satellite. On a bilateral agreement basis, numbering schemes could be used not involving a new country code for a particular S-PCN system, but in order to get a wide access to the network the number of separate agreements to be arranged (and possibly updated) is considerable.

A set of Recommendations or principles on billing and charging would be consistently related to standards in routing. Assuming that S-PCN would have possibly a global coverage and that consequently there would be always an available service to the terminal (provided either by roaming agreements or just by a global system) the Recommendations on billing and charging would clarify and complete the cases arising.

Numbering will be considered in some detail in the following subclause together with identification.

9.2.2.1.3 Numbering and identification

The requirements of the S-PCN numbering and identification plan will be considered here. Numbering and identification are defined in subclause 3.1. Available ITU-T Recommendations have been developed so far for land mobile stations and maritime mobile satellite stations with reference to the INMARSAT systems. These are examined here to clarify a possible problem in their application and how the standards may be used.

It should be noted that all of these schemes have differing limitations where S-PCN systems are concerned.

ITU Recommendations E.210 and E.212 - 215 describe the identification plan and numbering plan for "land mobile stations and maritime mobile satellite stations (INMARSAT)", operated with and without a SIM-type of card. The design considerations that form the basis of the Recommendations include the direct relationship between a "Country", the possible existence of a number of PLMNs in one "Country" (Mobile Country Code, MCC and Mobile Network Code, MNC) and the identification plan making possible the identification of the Country and the home PLMN. The fact that "roaming" enables the services to be provided by a PLMN which is different from that to which the Mobile Customer subscribes.

The PLMN services, according to E.212 may not allow trans-border operation using the same MCC.

Within the scope of ITU Recommendation E.212, the structure of the International Mobile Station Identity, uniquely identifying the station internationally, is as shown in figure 26.

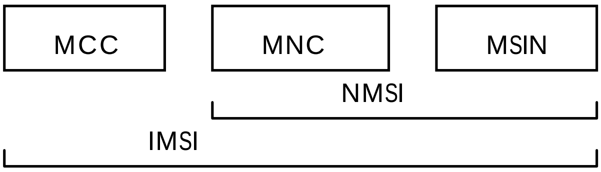


Figure 26: Structure of the IMSI

MCC, Mobile Country Code, is assigned by ITU-T and consists of 3 digits (0, 1, 8, and 9 may not be used as first digit).

International Mobile Station Identity (IMSI) should not to exceed 15 digits.

National Mobile Station Identity (NMSI) is assigned by each National Administration.

Mobile Network Code (MNC) is assigned by each National Administration and should be such that never more than 6 IMSI digits should be analysed in a foreign PLMN (this will be increased to 7 digits through Recommendation E.162).

The coverage provided by S-PCN may include several "country" entities and therefore there are three new options, not foreseen in the mentioned ITU Recommendations:

- the possible (intentional, by design) trans-border operation;
- one S-PCN / PLMN containing a number of "countries", possibly all;
- several S-PCN / PLMNs each containing a number of countries and possibly co-existing in the same geographical area.

The requirements of S-PCN identification plan depend on the relationship (possible integration) of S-PCN with other mobile networks and on the existence of such a concept as roaming, within and between S-PCNs.

A range of different options is still open and standardization in this area may reflect the structure of S-PCN operation. As an example it is possible to consider the case where the S-PCN is a stand alone PLMN, covering a number (if not all) countries, connected to the PSTN by means of gateways operated by service providers. In this case the MCC part has the same meaning, the MNC may be given the meaning of the service provider by which the MS is being served, the MSIN may be the identity of the subscription by which the MS is operated as a part of the S-PCN PLMN. MCC may still be assigned by ITU, but the question about the assignment of MNC and MSIN is open.

E. 210 recommends that the station identity is as shown in figure 27.

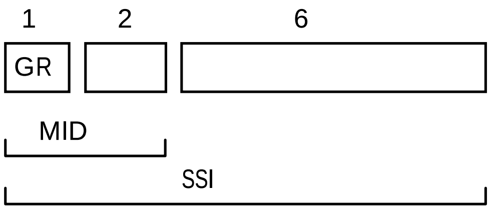


Figure 27: Station Identity structure as in Recommendation ITU-T E.210

Geographical Region (GR) identifies one out of 6 regions where the nationality of the ship station belongs, one digit is used.

Maritime Identification Digits (MID) conforming to the Radio Regulations, assigned to a country when necessary, this is a three digit number of which the first digit is a geographic identifier.

Ship Station Identity (SSI) unique, 9 digit, depending on the number of digits available on PSTN, the trailing part of SSI may include as many 0 digits as necessary to keep SSI a 9 digit number.

The INMARSAT mobile numbering plan specified in Recommendation E.215 allows to identify the MS uniquely from the INMARSAT mobile number. The INMARSAT mobile number is the part of the INMARSAT mobile international number following the country code the format is as shown in figure 28.

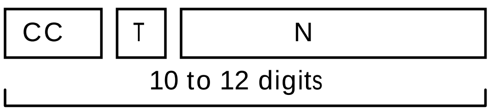


Figure 28: Mobile numbering structure as in Recommendation ITU-T E.215 (INMARSAT)

Country Code (CC) is 871, 872, 873 or 874 depending on the INMARSAT region addressed (Atlantic East, Pacific, Indian and Atlantic West). The numbering sequence requires the calling party to know the satellite coverage area in which the mobile terminal is located. This may not well be used for S-PCN, the user would have a number independent of the location within the whole network.

T may be either a single digit or a combination of 2 digits used to identify INMARSAT systems and applications for routing and charging purposes. Future T digits are allocated by ITU in consultation with competent Study Groups. At present some values are reserved for future use (they are 2, 6, 76, 8 and 9).

N is the group of digits following the digit T. The structure and length depends on the system (systems A, B, C or aeronautical) and on the application. This group of digits does not need to be analysed, in principle, at international switching level (with one exception for the case where T = 9).

The SSI is derived from the INMARSAT mobile number by mapping T and the following digits into the MID + XXX sequence, where XXX represents the first three digits following MID.

Automatic mobile originated calls make use of international selection procedures, including a standardized prefix identifying automatic international calls. For example, an international mobile originated telephone call to a fixed subscriber will be placed using the following numbering sequence:

$$00 \quad I_1 I_2 I_3 \quad N_1 \quad N_n$$

where I represents the CC and N the national number.

The routing of the call will depend upon the LES preferred identity used, the choice of the LES is not an automatic function and is done by the calling party (mobile customer). The choice may be made on the basis of different tariffing applied to the end destinations by different LESs for mobile originated outgoing calls.

Whilst it is recognised that E.215 is limited to INMARSAT applications, if a similar plan was used for S-PCN the choice of the gateway may be a part of the roaming procedure. In this case the mobile originated call would follow the same selection described above. If the selection of the gateway is automatic, following a set of rules (e.g. roaming is not permitted when the PLMN of the MS is reachable, see subclause 9.2.2.1.2 on the selection of the system) then the numbering and selection procedure may be reconsidered for S-PCN use.

As a part of the roaming procedure the roaming number allocation requirements should also be considered (according to ITU-T E. 213). The roaming number allocation needs a signalling link to the origin PLMN to perform an update. The Mobile Global Title (MGT) used to address the PLMN by SCCP is derived from IMSI. The structure of MGT with respect to IMSI is described in Recommendation E. 214.

The identity of the mobile station may not be from an international organisation such as INMARSAT. The practical problem of administration and assignment of IMSI and its standardization leads to the general problem of the possible trans-border operation of a system, on a possible large scale, and therefore to the regulatory framework of S-PCN.

Where the international Recommendations have to be reconsidered for possible change, or a new one should be adopted, the standards development process will have to fit to the time frame of the relevant body, such as ITU-T. If S-PCN is going to adopt the already existing Recommendations (with possible minor modifications) then some consequences on how the network will be arranged are to be foreseen as well as consequences on the way service is provided.

Further studies of this aspects should be conducted in conjunction with ETSI STC NA2 before any decisions on possible implementations scenarios are made.

Numbering issues of a pan-European nature are now co-ordinated within the European Numbering Forum (ENF). This body is comprised of representatives from relevant organisations which are represented at a European level. It gives due regard to the policies of harmonization of numbering issues which are currently being promoted by the European Commission. The ENF is chaired by a representative of ECTRA and the European Telecommunications Office (ETO) provides secretariat support.

Under the Council Resolution 92/C318/02 on "Promotion of Euro-wide co-operation on numbering of telecommunications services" [40], the ENF will consider the following tasks [27]:

- research to support long term development of numbering plans;
- co-ordination of development of national numbering plans in the CEPT;
- development of common approach for future management and allocation of numbers nationally and internationally;
- development of a common European position with respect to ITU activities and development of links between numbering and standards in co-operation with ETSI.

The development of a common allocation of numbers at European international level by means of the European Numbering Space (ENS) is the object of a Council Resolution [41].

The ENS is a clear candidate to support European-wide personal mobile services such as those supported by S-PCN (see also annex to [41]).

Allocation of numbers within ENS would allow the introduction of the following pan-European services:

- Europe-wide subscriber telephony numbers (for pan-European services);
- flexible-routing service (routing according to country of origin, time of day etc.) to accommodate service such as Europe-wide customer assistance according to the country of origin and time;
- Europe-wide green / free-phone call service (making use of flexible routing);
- Europe-wide "kiosk" billing service (allowing flexible call charges for calls to service providers, within a maximum set by national regulatory authorities);
- Europe-wide shared cost call service (e.g. to implement split billing);
- Europe-wide mobile services.

It should be acknowledged that additional benefits would be achieved if some of the services were realised as a subset of global numbering solutions (e.g. free-phone).

The ENS would cater for portable numbers allowing independence on location, terminal equipment, network provider and service.

Already implemented general numbering requirements for both European mobile and fixed network are (see subclause 9.2.5 on user aspects):

- common European emergency call number (112), in parallel with already existing national numbers;
- common European international access code (00), already covered by ITU-T.

This means that previously allocated services on these two codes should be released and re-assigned by those Member States already making use of them for other purposes.

The standards on numbering may be based on the establishment of ENS and Europe-wide mobile services. Identification brings, as pointed out, the problem of administration and assignment of identities that do not fall within the existing ITU Recommendations, involving their possible modification to take into account the needs of S-PCN systems.

9.2.2.1.4 UPT support

UPT essential aim is to provide transparent called party mobility within several networks and across networks making access to a user-independent from location, type of terminal, type of network and network operator. The UPT number provides access to a database where translation to network numbers is done. Once the number is translated the call is routed accordingly. The fundamental reference for UPT numbering is ITU-T Recommendation E.168 [86]. Here the main implication of UPT support for S-PCN will be addressed.

The UPT number provides a user number valid across different networks and operators, including S-PCN. The structure conforms with ITU-T Recommendation E.164 [66], and is shown in figure 29.

CC = Country Code, NDC = National Destination Code, SS = Subscriber Number

Figure 29: ISDN basis for UPT number structure

The length of CC + NDC + SN is variable, it does not exceed 15 digits after time T (defined in Recommendation E.165). UPT number structure is based on ISDN number structure and provides indication of UPT to the network or calling party. The three fields may contain such an indication with different consequences when considering the applicability to S-PCN.

The ITU-T UPT Recommendation provides three schemes to implement UPT:

- home related scheme;
- country based scheme;
- country code based scheme.

In the home related scheme the significance to the number as UPT is given in the home network. The number is interpreted as composed of a CC and national number:

CC Country Code;
NDC + SN National number.

This scheme is applicable to S-PCN when integrated with another mobile network providing a satellite extension, but it is of difficult application to a regional / global system (having assigned its own country code) because the UPT service interpretation may differ within each S-PCN.

This is not considered to be a good option for the provision of S-PCN supported UPT as no future evolution path exists without a change of number (see ETR 144 [97]).

In the country based scheme the NDC is structured to allocate UPT indicator and service provider indication. The number is interpreted as follows:

CC country code;
NDC UPT indicator and service provider identification;
SN subscriber number.

In this scheme the structure of NDC is decided by the national administration. The scheme is applicable to S-PCN both in the integrated and not integrated case as the NDC analysis may be done according to a decided structure.

The country code based scheme the CC identifies the number as UPT. This requires the allocation of spare CCs to UPT service. The number is interpreted as follows:

CC UPT indicator;
NDC global network identification or country identification (ITU-T Recommendation E.164 CC [66]);
SN subscriber number.

If NDC is chosen to identify a country via the use of ITU country codes, then the management of SNs is within the control of each administration. Otherwise, if NDC does not identify any country code, the management of numbers needs international co-ordination. This scheme is applicable to S-PCN both in the integrated and not integrated cases. In the latter the S-PCN would benefit from an administration of numbers not different from that of other systems. The responsibility of numbering administration for different schemes is shown in table 11.

A prefix may also be used to identify UPT numbers, in addition to the above solutions. Assignment of prefixes is for decision by each national administration but UPT may benefit from an harmonization more than other services. The use and advantages of an international UPT prefix identifying UPT numbers internationally, not developed in the current ITU Recommendations, is identified as a work study item.

Table 11: Number administration for UPT (ITU-T Recommendation E.168 [66])

Scheme	CC	NDC	SN
Home related	ITU	national	national
Country based	ITU	national	national
Country Code based	ITU	ITU	ITU / national

When the structure of UPT numbering is considered against the S-PCN deployment, the advantages of direct identification of Service Provider (SP) or of international UPT numbers are considerable.

A standard on S-PCN numbering including provisions for the support of UPT numbering would ensure that S-PCN is included into UPT services from an early stage. The international nature of S-PCN and its service organisation via service providers naturally fits in the UPT framework.

In addition, due account should be taken of the standardization work on FPLMTS and UMTS with particular regard to the S-PCN numbering. Current views within the standardization sector favour the provision of numbering capacity from within national numbering plans (ITU-T Recommendation E.164 [66]). These aspects are currently being progressed in ITU-T and ETSI STC NA2. Alignment with this work is required at an early stage of the possible standardization process for S-PCN. The development of numbering and addressing requirements for S-PCN is foreseen as a key activity, as outlined in clause 12 and shown in figure 44.

9.2.2.2 Integration aspects

This subclause will address the objectives that may be satisfied by standardization of aspects of network integration. Early candidates for integration are the PLMNs (and, based on UPT, the PSTNs).

Considering the European efforts towards GSM and DCS-1800, and the international interest caused by the growing number of non-European GSM implementations, most of the focus here will be devoted to GSM. Other European projects such as RACE.SAINT are already looking into systems designed to have a satellite component as well as a terrestrial component with possibly a complete integration (system level, see ETR 093 [1]). These advanced systems, providing a platform for services requiring high speed data (2 Mbit/s or more) are outside the scope of this ETR and consequently will not be considered.

In this scenario terminals would be "dual-mode" combining S-PCN terminal with mobile terminals for voice telephony or paging services (e.g. taking advantage of the battery autonomy of the paging terminal side), such as S-PCN / GSM, S-PCN / DECT terminals or S-PCN / ERMES terminals. One of the assumptions supporting the integration scenario is the enhanced service provided by combining two (or more) systems, each having a quite a different position in a rank of mobility, coverage area, capacity and circuit costs.

Network infrastructures already developed may offer an attractive solution to the problem of fast and cost-effective implementation of S-PCN, providing a "long range" reach set of services for dual-mode mobile terminals, in contrast with the "short range" provided by the ground coverage. Alternatively the S-PCN may be a systematic solution to the cost effective deployment of the terrestrial coverage, providing capacity in less populated regions (where the capacity needed is also less). In the latter case all terminals would be dual-mode.

In the dual-mode terminal design the use of close frequency bands for the S-PCN and the terrestrial (PCN) part is one of the most important issues because of the impact on the RF part (including the antenna design). The latest progress in design of other digital mobile terminal subsystems makes the possibility of a duplicated baseband subsystem within one single portable terminal not an unrealistic one.

Finally, the case of an S-PCN-only terminal may be considered as a special case of dual-mode where the PCN part is never active, still capable of making use of network functions.

9.2.2.2.1 Integration with GSM / DCS-1800

GSM and DCS-1800 are two closely related systems (a brief description of GSM can be found in ETR 093 [1]). The main difference is the frequency band allocated to the service and some enhanced network functions specified in DCS-1800. At the moment DCS is considered a platform for implementation of PCN. Both standards are a complete network functional and service description, defining a set of interfaces between network entities based on the same network architecture (as shown in figure 30). S-PCN / GSMDCS integration offer different opportunities for standardization according to the integration, the "network level" integration will be here introduced as a model for standards proposed.

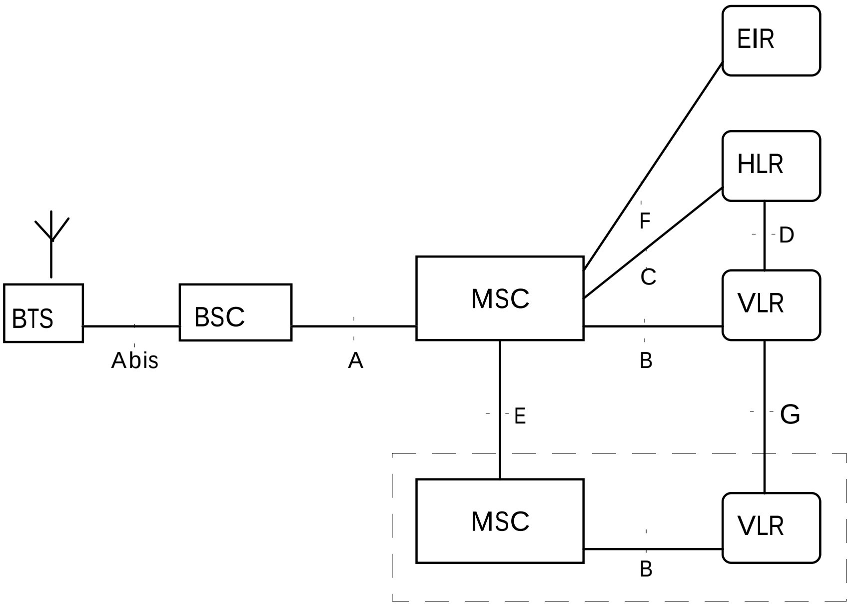


Figure 30: GSM / DCS network architecture (from ETR 093 [1])

Integration at a network level is independent of the radio interface, allowing optimisation of the S-PCN radio access (protocol and modulation). Going deeper into the GSM DCS architecture, the first interface encountered is the A (and A bis, whose main purpose is to provide remote location of the BTS), a candidate to provide satellite coverage interface functions. Most of the studies on this subject have identified the A-interface as a solution to the integration problem, providing sufficient signalling capabilities to support a satellite extension.

In the following subclauses the integration at A-interface level will be considered. This is one of the possible solutions, presented to point out related possible standards, for a comprehensive treatment of the network integration subject a dedicated study is needed.

9.2.2.2.1.1 Network architecture

The GSM (DCS) / S-PCN reference chain is shown in figure 31.

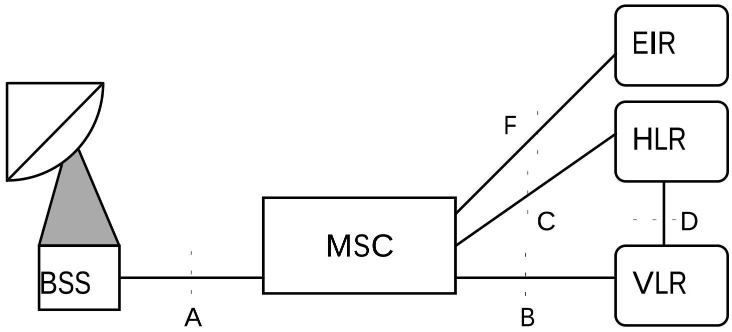


Figure 31: S-PCN BSS

Some GSM BSS functions, typical of the S-PCN environment, would also be performed. These include the tracking and control functions necessary to establish and maintain service radio channels. Unlike in GSM there will not be the need for consideration of an inter-BSS handover event (or an inter-MSC handover event) because the speed of the MS will always be negligible if compared to that of the S-PCN coverage. It is possible to recognise that a mobile station initiated handover event would have a very low probability, since any practical MS conceivable speed would be well below one tenth of the coverage speed (e.g. for a constellation at 1 000 km a MS operated at a speed of 100 km/h and e.g. on an aircraft up to 2 000 km/h would have a speed ratio to the coverage speed respectively of 0,004 and 0,09). If an handover event occurs in this scenario it may be regarded mainly as a "non random" or synchronous event, possibly included in the control functions of the gateway or of the satellites, associated to the service radio channels. This possibility to regard the MS as almost always stationary or as having a "long term" mobility is a remarkable difference of S-PCN with respect to terrestrial mobile systems, and has important consequences in terms of requirements for the mobility management and Radio Resource Management (RRM) functions.

The GSM Mobile Subscriber ISDN number (MSISDN) is used for S-PCN. Possibly split billing may be provided when using the S-PCN links, because of the different cost arising from available capacity.

In table 12 (see ITU-T Recommendation Q.1003, annex A), a list of subscriber data stored in both HLR and VLR is shown in the left column, the data influenced by an S-PCN extension are identified in the right column (other data are assumed not to change in value or meaning).

Whenever the S-PCN MS selects the satellite extension the S-PCN Location Area (LA) is shown in the LAI value. The LAI consists of three parts: Mobile Country Code (MCC), Mobile Network Code (MNC) (Recommendation E.212) and Location Area Code (LAC) identifying the Location Area (LA) within the PLMN. The S-PCN LAC may be unique to each PLMN supporting S-PCN access, there is no Recommendation on the encoding of LAC and the consequent overall length of LAI.

Standards to be considered for network architecture are mainly those regarding data reflecting the S-PCN extension or specification of functional requirements for the extension:

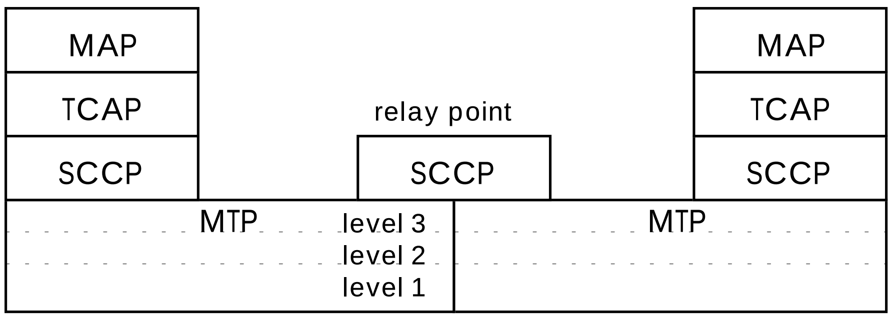
- S-PCN class-mark (possible class-mark update when the MS registers in the S-PCN extension);
- mode of operation (card or not card operated);
- access privilege to S-PCN extension;
- specification on the use of LAI in an integrated GSM / S-PCN network;
- S-PCN supplementary service type;
- mobility management functional requirements for S-PCN extension;
- Radio Resource Management (RRM) functional requirements for S-PCN extension.

The reference protocol stack for GSM / S-PCN chain is shown in figure 32.

The MTP is shown as three sub-layers, they provide: signalling data link functions (level 1), signalling link functions (level 2), signalling network functions (level 3). The MTP sub-layers correspond to the OSI physical layer, data link layer and lower network layer.

Table 12: Location register data in S-PCN / GSM

PLMN HLR stored data	**S-PCN**
IMSI (International Mobile Station Identity)	
MSISDN (MS number)	
MS category (class-mark) and mode (SIM)	S-PCN MS class-mark and mode
Preference (for access to the GSM PLMN)	Preference (access to the S-PCN)
Authentication key, security parameters (*)	
VLR address (*)	
Location Area Identification (*)	S-PCN LAI in the PLMN
Supplementary Service type	S-PCN SS type
Mobile station status	
Subscriber data	
PLMN VLR stored data	**S-PCN**
IMSI	
MSISDN	
MSRN (*)	
TMSI (*)	
MS category (class-mark) and mode (SIM)	
Authentication key, security parameters (*)	
Location Area Identification (*)	S-PCN LAI in the GSM PLMN(*)
MSC address (*)	
IMSI detached flag (*)	
Handover number (*)	not applicable
NOTE: (*)= temporary stored data	



MAP: Mobile Application Part

TCAP: Transaction Capabilities Application Part

SCCP: Signalling Connection Control Part

MTP: Message Transfer Part

Figure 32: MAP protocol stack

The SCCP corresponds to the upper OSI network layer, providing addressing for connectionless or virtual signalling connections between any two nodes in the signalling network, four classes of service are provided.

The TCAP corresponds to the lower OSI application level (level 7), providing support to dialogues between applications such as the MAP. TCAP includes common Application Service Elements (ASE) facilities, e.g. for remote operations, but the application specific elements are specified in the MAP, as shown in figure 33.

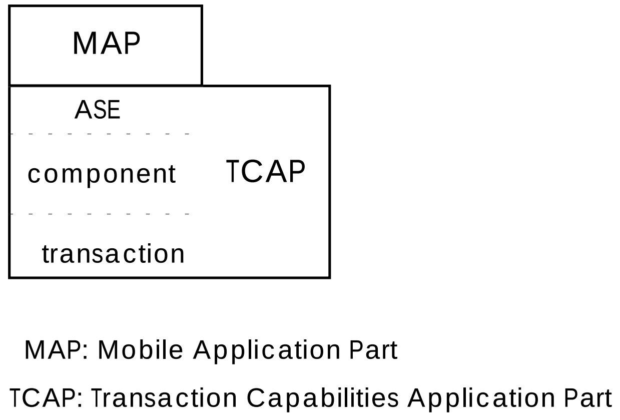


Figure 33: Application layer structure

TCAP is sub-layered into Application Service Elements (ASE), that can be used by any application, Component sub-layer, providing requests to perform remote operations and replies containing their outcome and Transaction sub-layer, providing services to direct the transactions with other applications.

MAP can be described as a set of ASE exchanged across the structure to perform mobile network procedures.

A possible S-PCN BSS model, called from now on Base Earth Station (BES), protocol stack is shown in figure 34 (general). The term BSS will be used in the rest of this ETR in the GSM context.

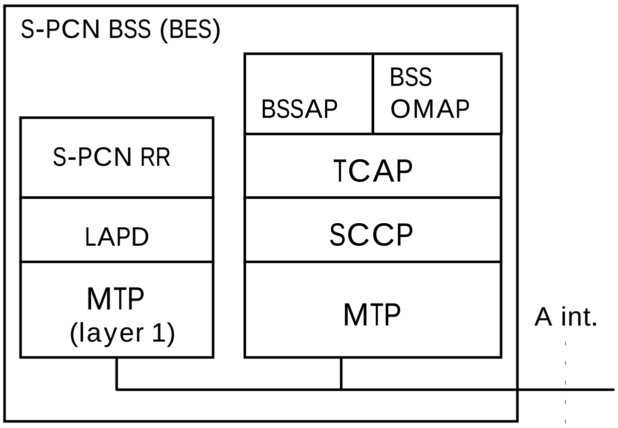


Figure 34: BES general protocol stack

The S-PCN Radio Resource Management (RRM) layer performs all the radio resources functions associated with the satellite coverage (inter satellite handover, intra-satellite handover) and first and second order assignment (see ETR 093 [1], subclause 5.2.6.1). S-PCN handovers may be treated as internal (intra-cell) GSM handovers, a BSS function according to GSM 08.02. The GSM call re-establishment procedure may be considered to re-route the call via the BES when the circuit is dropped on the terrestrial BSS, depending on how the S-PCN LA is configured in the coverage. The MAP procedures are transparent to the BES, signalling on the A-interface includes commands to assign radio channels to mobile stations and security related functions (authentication and ciphering).

The functional split between MSC, VLR, HLR and BES is shown in table 13, based on GSM 08.08.

Table 13: Functional split at A-interface
(F = function performed, indication = function returns indication of its activity *= option)

Function	BES	MSC, HLR, VLR
Terrestrial Channel Management		
channel allocation		F
blocking indication	F	
local blocking (MSC side)		(F)
Radio Channel Management		
idle channel observation	F	
power control	F	
traffic channel allocation (choice)	F	
link supervision	F	
frequency hopping	F	
traffic channel release	F	F
control channel allocation	F	
control channel release	F	
broadcast channel management	F	
Radio Resource (RR) Indication		
channel status report	F	
Channel coding / decoding (depending on call type)	F	F
Transcoding / rate adaptation	F	
Interworking function (data calls)		F
Measurements		
reports from MS	F	
uplink	F	
traffic		F
Handover		
internal (optional) (within the S-PCN coverage)	F	indication
internal inter-cell handover	F	indication
external (between Terrestrial and S-PCN)	(F)	(F)
Mobility Management		
authentication		F
location updating		F
paging		F
discontinuous receive (DRX) paging scheduling	F	
Call Control		F
User Data Encryption	F	(key) (*)
Signalling Element Encryption	F	(key) (*)

From the functional split it can be seen that the Radio Channel Management and Handover functions may result in an indication to the MSC but are carried out by the BSS. The traffic channel assignment command and measurement are commands originated on the MSC side, containing a number of parameters that may be used by the BES to allocate an S-PCN traffic channel.

In GSM specifications the assignment command issued by the MSC is used by the BSS to start the radio channel assignment procedure. After completion the BSS returns an assignment complete message to the MSC or, in case of failure, an assignment failure message. The causes of an assignment failure may be several, including cell congestion and terrestrial resource unavailability. The information elements of the assignment command include:

- channel type (speech, either full-rate or half-rate / data / signalling);
- circuit identity code (PCM multiplex and time slot);
- DTX flag (DTX allowed / not allowed);
- interference band to be used (level of acceptable interference, among a set of 32);
- class-mark information (mobile station class-mark type information).

Measurements are reported to the MSC by the resource indication message. The MSC starts the operation by sending a resource request message to the BSS. This may request resource indication replies periodically, according to OMC dependent conditions, or once.

The information elements of the measurements available in the resource indication message include:

- cell identification;
- total resource accessible (total number of accessible full-rate and half-rate channels).

The support of handover to and from the GSM satellite extension has different complexity implications depending on the direction of the handover. The GSM call re-establishment procedure may also be considered to re-establish a call coming from the satellite extension. The problem is complex and only some main network configuration issues are here presented to be possibly further developed for a set of "system" specifications on the integration.

Figure 35 shows the general handover situation of a call from the origin MSC (MSC-A, terrestrial in the example) to the target MSC (MSC-B, satellite extension in the example). Subsequent handovers are possible either back to the originating MSC or to a subsequent different MSC.

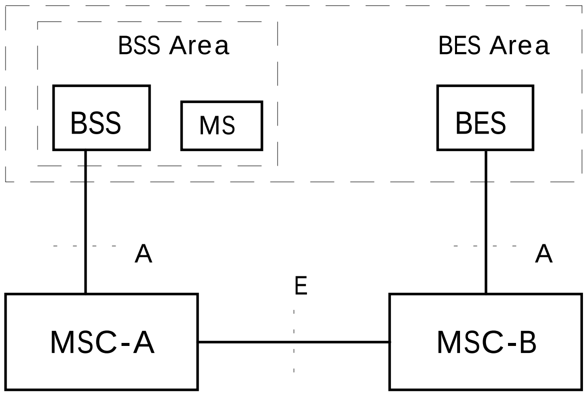


Figure 35: Handover involving S-PCN

It can be observed that:

a) handover from BSS to BES requires that the BES cell should be in the list of "adjacent" cells for all the cells configured in the GSM network, even if belonging to another MSC area;

b) handover from BES to any BSS requires that the BES should contain in the list of "adjacent" cells all the cells of all the base station areas in the network. It is then necessary to set-up a procedure for the identification of the GSM cell (and BSS) where the MS is located. This "cell hunting" procedure could be implemented differently according to the satellite system specifications. Then and there would be the establishment of the inter-MSC handover. The target MSC can be any MSC of the PLMN;

c) for a call established in the satellite extension of a visited PLMN (as introduced in subclause 8.7), the handover to the home PLMN may not be supported;

d) using the GSM call-re-establishment procedure for a call coming from the BES requires that the BES MSC is logically adjacent to every MSC in the network.

The use of the A-interface to provide S-PCN access and network extension is here identified as a useful technical areas as an option for standard.

In the following subclauses, some procedures will be considered with reference to the model chain shown in figure 31.

9.2.2.2.1.2 Roaming and location updating

Assuming that S-PCN would be implemented in multi-operator conditions, the roaming function would allow roaming of users among operators. The main difference with GSM roaming is that S-PCN roaming is poorly related to geographical location and coverage infrastructure. When the mobile station is able to be in reach of the S-PCN BSS, roaming may occur. The choice of operator would be possibly based on tariffing, according to the destination. Two, or more operators may share the S-PCN access. In this respect the situation of S-PCN is more similar to DCS than to GSM.

Location Updating procedure would be activated when the dual-mode terminal enters, intentionally or automatically, the S-PCN location area (logically one within the PLMN, even if possibly divided internally for other purposes), a default location area consisting in one cell adjacent to any other. Location updating may occur at switch-on time or when "crossing" location area borders. In this latter case the border may be identified by different propagation conditions, for example where terrestrial coverage is not present.

The GSM MSISDN number is reused for S-PCN. Under this assumption S-PCN-only terminals would need SIM (issued by any operator having roaming agreement with those supporting S-PCN access).

For a true global S-PCN, roaming will not necessarily take place, just location updating.

9.2.2.2.1.3 Authentication and ciphering

The authentication of access (and handover) and encryption of information on the radio interface are controlled by a procedure involving data stored temporary in the VLR, and generated by the Authentication Centre (AUC). Because of the possible down-link monitoring over a large area the ciphering becomes more important than in cellular systems (where the monitoring station needs to be at a distance from the monitored link comparable with the cell size).

In the model assumed both authentication algorithm and encryption parameters are based on the GSM SIM, according to the GSM standard on SIM (see ETS 300 608 [91]).

The issues to be considered for standardization on authentication and ciphering include:

- specification of S-PCN encryption algorithm different from the GSM implementation;
- use of the GSM SIM security features in the S-PCN MS (authentication and cipher key generation procedure and algorithm).

9.2.2.2.1.4 Services

The voice telephony service and low speed data are the main services provided by S-PCN networks. Voice would need transcoding at BSS (as in GSM) depending on the voice coding adopted by the S-PCN system, while a common set of data services would have to be defined to support data communications with S-PCN handsets. The common set is derived from those specified in GSM / DCS, they are grouped in table 14.

Table 14: GSM Teleservices and bearer services (T / NT = Transparent / Not Transparent)

Teleservices	
Telephony	
Emergency Calls	
Short Message Mobile Terminated Point-to-Point	
Short Message Mobile Originated Point-to-Point	
Short Message Cell Broadcast	
Alternate speech and Facsimile Group 3	
Automatic Facsimile Group 3	
Bearer Services	
Data Circuit Duplex Asynchronous	300 - 9 600 bit/s (T / NT)
Data Circuit Duple Synchronous	1 200 - 9 600 bit/s (T / NT)
PAD Access Circuit Asynchronous	300 - 9 600 bit/s (T / NT)
Data Packet Duplex Synchronous	2 400 - 9 600 bit/s (T / NT)
Alternate Speech / Data (T / NT)	
Speech followed by Data (T / NT)	

9.2.2.2.1.5 Numbering

Assuming that the SIM roaming is possible in the integrated GSM / S-PCN environment, the numbering and identification of mobile stations follows GSM recommendations with no necessary modification. An operator not having a direct S-PCN access facility could still assign S-PCN numbers, offering S-PCN access through agreement with other operators, as said above.

9.2.2.2.2 Integrated network management

Since only GSM has been considered for network integration, the integration of network management functions will be addressed with reference to GSM. The supervision and management functions of the model GSM / S-PCN network are an extension to those of GSM, including the features unique to the satellite access and service band management.

These functions may be located at S-PCN BSS and make also use of the centralised TT&C facility of S-PCN backbone. Figure 36 shows the network management architecture of GSM.

Operation and maintenance aspects could be based on Telecommunication Management Network (TMN), defined by the ITU-T in Recommendation M.30.

Operations of the OMC are defined as all those actions of a technical and / or administrative nature that may be needed due to changes in external conditions (demands for services, etc.).

Following the same line, maintenance is understood as all those technical and / or administrative actions (including supervisory actions) intended to maintain the system operating correctly or restore normal operation after a breakdown in one of its parts, in the shortest possible time (GSM 01.02).

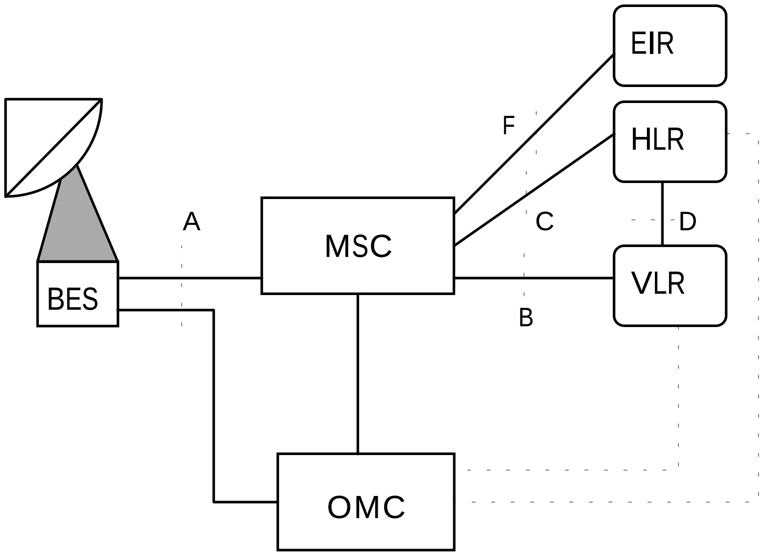


Figure 36: Network management network

The following network management functions are identified in GSM and could be considered for standards:

- functions related to administrative or commercial management of the PLMN:
  - subscribers;
  - terminals;
  - billing;
  - accounting;
  - statistics;

- security management;

- operations and performance management;

- system change control;

- maintenance.

In ETS 300 612-1/2 [45 and 46], ETS 300 613 [48], ETS 300 614 [49], ETS 300 615 [50], ETS 300 616 [51], ETS 300 617 [52], all aspects of the GSM operations and maintenance subsystem are described.

Supervision functions at the S-PCN BES could include:

- BSS fault isolation and recovery;
- space segment fault detection;
- spectrum monitoring;
- mobile station emission monitoring;
- traffic monitoring.

Management functions at the S-PCN BES could include:

- control of transmission (possible shut down) from mobile terminals, when the station causes interference or the control functions are not working;

- means to perform frequency sharing and co-ordination (traffic channels assigned according to rules such as forcing to occupy one or more compact portions of the available band);

- configuration of channels in the S-PCN band;

- control of configurable radio link parameters;

- BES fault recovery and report.

9.2.2.2.3 Analogue European systems

There are a number of analogue systems operating in Europe according to different standards on different frequency bands, providing a significant nation-wide coverage. They include: RC 2000, NMT 450, C Netz, RTMS, TACS, ETACS and NMT 900.

The identification of the interface providing a set of integrated functions in these networks has no general solutions. It would imply a detailed analysis of each system architecture. This system dependent design (and possibly implementation dependent) may be justified by the extension of the existing network.

The re-use of network resources may be limited and the sharing of S-PCN access from a common GW by several networks would imply the design of special interworking functions allowing roaming between incompatible standards.

9.2.2.2.4 Non-European systems

The situation at an international level is not different in quality from that inside Europe. Most of the non-European systems are analogue, they have different architecture and radio interface standard. The same considerations made above may hold. Dominant technologies are AMPS (Advanced Mobile Phone Service) and USDC (USA), N-MATS and J-TACS (Japan), NMT 450 (Nordic Mobile Telephone, also NMT 900).

When considering the international mobile systems heterogeneous situation, the question arises weather it is possible to identify areas for standards on S-PCN making the integration easier.

One area to be considered is the interworking function supporting roaming between two networks offering S-PCN access. If roaming in the satellite extension is supported by a standard, two mobile terrestrial systems, not based on a compatible radio interface, each of them providing a satellite extension may still provide a common service. This scenario has been discussed in subclause 9.2.2.1.2 (represented in figure 25) and requires the definition of an signalling interface able to support roaming by interworking with different signalling systems, as shown in figure 37. The interface here is deeper in the system compared with the GSM A interface. ITU-T has developed sets of Recommendations on interworking, in particular Recommendations Q.601 to Q.699 on "Interworking of Signalling Systems" provide a set of interworking specifications for ITU-T signalling systems. ITU-T Recommendations Q.1000 to Q.1032 on interworking between PLMN and ISDN / PSTN provide specification of procedures by which PLMNs may be interconnected at international level using SSN 7. In particular Recommendation Q.1051 specifying the Mobile Application Part provides functions to support international roaming.

9.2.2.3 Summary of possible standards for network aspects

The foregoing subclause has explored a number of technical areas where standards may be considered for S-PCN. Table 15 summarises the possible standards that might be considered, in order to assist the decision makers in easily identifying the options.

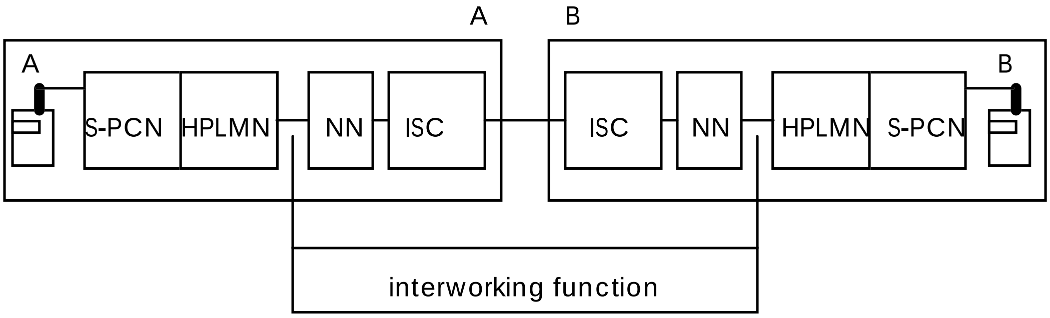


Figure 37: Interworking for S-PCN roaming

Table 15: Possible standards related to networking aspects

Possible Standard	Reference Subclause
Interworking with PSTN	
General requirements for interworking and terminology	9.2.2.1.1
Description of services available	9.2.2.1.1
Mapping of services	9.2.2.1.1
Description of interworking scenarios (ITU-T Q.41 / Q.14)	9.2.2.1.1
Procedures for interworking	9.2.2.1.1
Requirements for the application of Q.14 and Q.41 to preserve the Quality of connection over S-PCN and PSTN	9.2.2.1.1 9.2.2.1.1
Allocation of standard set of access codes for supplementary services	9.2.2.1.1
Inter-operability with PCNs	
Specification of a common set of bearer services	9.2.2.1.2
Specification of common set of supplementary services	9.2.2.1.2
System selection algorithm (call set-up routing)	9.2.2.1.2
Specification of a common set of system parameters involved in the Exchange of billing data	9.2.2.1.2 9.2.2.1.2
Routing of traffic to preserve the quality of connection	9.2.2.1.2
Principles on billing and charging (related to routing)	9.2.2.1.2
Numbering and identification	
Rules to assign IMSI to S-PCN MS (SIM)	9.2.2.1.3
European Numbering Space for S-PCN use	9.2.2.1.3
Common European numbering requirements for mobile, including S-PCN (e.g. emergency, internationals access codes)	9.2.2.1.3
UPT numbering for S-PCN	9.2.2.1.4

(continued)

Table 15: Possible standards related to networking aspects (concluded)

Possible Standard	Reference Subclause
Integration Aspects (integration with GSM / DCS-1800)	
Use of the GSM / DCS A interface to provide S-PCN access (BES, general aspects)	9.2.2.2.1
Speech transcoding	9.2.2.2.1.1
Split billing due to S-PCN access (see also confidentiality)	9.2.2.2.1.1
S-PCN class-mark	9.2.2.2.1.1
S-PCN mode of operation (card or not card operated)	9.2.2.2.1.1
Access privilege to S-PCN extension	9.2.2.2.1.2
Specification on the use of LAI in an integrated GSM / S-PCN network	9.2.2.2.1.2
S-PCN supplementary service type	9.2.2.2.1.4
Mobility management functional requirements for S-PCN extension	9.2.2.2.1.4
Radio Resource Management (RRM) functional requirements for S-PCN extension	9.2.2.2.1.4
S-PCN call re-establishment procedure	9.2.2.2.1.1
Authentication and ciphering procedure on S-PCN access	9.2.2.2.1.3
Specification of S-PCN encryption algorithm different from the GSM implementation	9.2.2.2.1.3
Use of the GSM SIM security features in the S-PCN MS Services supported by S-PCN access	9.2.2.2.1.3
General Network Management Requirements for S-PCN access (BES)	9.2.2.2.1.1
Remote S-PCN MS shut down	9.2.2.2.1.1
Means to perform frequency sharing and co-ordination art BES	9.2.2.2.1.1
Network Management and Supervision	
BSS fault isolation and recovery,	9.2.2.2.2
Space segment fault detection,	9.2.2.2.2
Spectrum monitoring,	9.2.2.2.2
Mobile station emission monitoring	9.2.2.2.2
Traffic monitoring	9.2.2.2.2
Control of transmission (possible shut down) from mobile terminals	9.2.2.2.2
Means to perform frequency band sharing and co-ordination	9.2.2.2.2
Configuration of channels in the S-PCN service band	9.2.2.2.2
Control of configurable radio link parameters	9.2.2.2.2
BES fault recovery and report	9.2.2.2.2
Integration Aspects (integration with other mobile systems)	
inter-working function	9.2.2.2.4

9.2.3 Security aspects

Security in today's communications systems has been influenced by the adoption of digital techniques. The digital information is processed and encrypted with a large number of techniques to obtain secure communications. On one hand this has benefits in flexibility and processing. On the other end the handling of information in digital form may make it easier to systematically trace events and record information related to calls, including the call content itself (voice / data). This awareness has been the basis for measures in several Member States in the European Union [27]. The security of systems and data handled in mobile systems may also be considered under the general issue of security of information systems, addressed in the Council Decision [93], where also some aspects of mobile communications are taken into account.

The security aspect in mobile communications is especially important in public access systems and it touches upon technical as well as regulatory matters [37], not only because of the use of a radio interface, but also because of the subscriber data stored in by the network (location, call related data, user profile, etc.). The security matters are twofold, in this subclause they are intended as related to access and user data or to the system availability (fault tolerance and survivability) to maintain acceptable level of service. In this subclause the security of S-PCN is discussed with respect to the need, the possible system specific features and the critical aspects of secure mobile communications. S-PCN may offer survivability features which are not offered by other mobile systems. They will be introduced and discussed in this subclause. S-PCN regulation on security matters may be included in regulation on mobile telecommunications systems.

There is not yet common legislation in all countries regulating this area. A proposal for a "Council Directive concerning the protection of personal data and privacy in the context of public digital telecommunications networks, in particular the Integrated Services Digital Network (ISDN) and public digital mobile networks" is currently under discussion [35], [36]. The International Conference on Data Protection Commissioners and the Organisation for Economic Co-operation and Development (OECD) is also active in the area.

A comprehensive Council Directive [96] on data protection and protection of data and privacy in ISDN and digital mobile networks, if adopted, will, among other:

- limit the period of storage of sensitive billing data allowing the identification of the subscriber;

- limit call forwarding to a third party number only with the consent of the third party;

- provide the right not to receive unsolicited calls;

- allow rejection of call on a per-call or per-line basis when Calling Line Identification is requested by the caller. A number of areas are here regarded as security related. They are authentication, confidentiality of user profile data and location, air interface and, for different purposes, legal tapping [27].

Some important requirements for S-PCN security may be derived for consistency with other mobile communications systems, considering the kind of service S-PCN aims to provide. A simple example may be obtained from the assumption that the S-PCN equipment would be card operated. Security aspects are also important when considering dual-mode or multi-mode terminals where the security and privacy functions are candidates for being used in common.

The actual scenarios of possible implementation of security functions depends on the S-PCN network configuration, especially on the capability to perform some OBP functions. Therefore a general and PCN oriented picture is chosen and no assumptions will be made in the following subclause on the network configuration. A card operated S-PCN MS is assumed.

9.2.3.1 Authentication

The purpose of authentication is generally twofold: to ensure that the user logging onto the system is an authorised subscriber or has subscriber's authorisation and to ensure that the subscription is valid and cleared to receive the service request from the network.

The data about the subscription may be stored in a removable device (e.g. card) that could request user authentication. Other functions / data to be considered for removable device are:

- IMSI;
- temporary IMSI (if foreseen);
- user authentication related data;
- timers for network operation (e.g. periodic location updating timers);
- authentication algorithm;
- ciphering key generation algorithm (the ciphering algorithm may be a function of the S-PCN / MES);
- storage memory for calling numbers and messaging.

The specification of the interface between the removable device and the S-PCN MS may also be considered for standardization. This would ensure inter-operability between the removable device and an S-PCN MS irrespective of the terminal manufacturer and the S-PCN operator issuing the subscription to which the removable device is attached. The authentication procedures may not be required for some special services such as emergency calls, enquiries or operator assistance service. These services are included among those whose numbering is going to be harmonized in Europe (see subclauses 9.2.5.7 and 9.2.2.1.3). The harmonized emergency call number (112) in Europe is the only requirement for S-PCN emergency calls at the moment (Council Decision 91/396/EEC [38] on the introduction of a single European emergency call number.

Authentication procedure data are in control of the "home" operator and are passed between operators for a roaming mobile station. This signalling data transfer has to meet security requirements as well. In S-PCN there could be gateways controlling large regions with a significant roaming percentage therefore special care should be given to the security requirements and techniques of the data transfer, trading off these requirements with the quick availability of authentication data (considering that in many cases the S-PCN handset could be the only communications means available).

The functions, physical dimensions and use of the removable device (when foreseen) may be similar to those of the present systems (e.g. GSM).

A standard on authentication may be a part of an action towards integration with terrestrial mobile systems. The authentication requirements may be also addressed to ensure:

- an authentication effective as that provided by GSM;
- possible integration with that provided by GSM;
- security of transfer and storage of authentication data across the S-PCN;
- availability of authentication data across the S-PCN.

The authentication signalling procedure could be addressed by a standard but the authentication algorithm itself may not be addressed because of different requirements according to the S-PCN system design.

9.2.3.2 User data and location confidentiality

The profile of the user and personal details, the supplementary service parameters (such as call divert numbers, times of diversion etc.) and the mobile station location information are also confidential information in mobile public networks. In S-PCN there is the potential for a user location information far more accurate than that provided by the terrestrial cellular mobile networks because of the satellite positioning functions that may be associated to the MS operation. The location information in S-PCN may be reported to the network by the mobile station upon completion of a positioning procedure as a part of the user localisation procedure. Therefore the confidentiality of user location information in S-PCN is of critical importance.

The more accurate is the position information the more restricted should be the access to the data because of privacy issues. The position data may be useful to provide a range of services to the subscriber such as those related to guidance. The access to the position information may be authorised by a legitimating procedure (e.g. using a code under permission of the subscriber for services such as driving assistance or recovery and rescue services).

There are other indications of the subscriber location that are not as accurate as those considered above but no less critical to location confidentiality and should be considered. In those cases when the called party is not reached by the network, the reply to the calling party may not give any awareness to the calling party of the called party location or roaming into another network (e.g. if a voice announcement is used, this should not differ by that used in the subscriber home network).

In those cases when the called party is reached and a communication is established via S-PCN there may be no indication to the calling party of the called party location or visiting network. In this respect split billing may be considered an opportunity.

A standard considering the area of user data and confidentiality of location and movements would ensure an approach to personal communications consistent with that adopted in systems like GSM and ERMES, where particular attention is devoted to the provisions to achieve flexible and secure services. In this respect it is important to consider that in GSM one of the main reasons to adopt split billing has been the decision of preventing the caller knowing that the called is outside the subscription domain, therefore already a system has been implemented in Europe recognising that billing the called party is a way to enhance privacy [27].

9.2.3.3 Air interface

Over the air interface the need for protection of communications privacy is more evident, but also there is identity and service information to be protected on the same interface.

In general the same considerations about the present status of regulations in subclause 9.2.3 apply.

A standard considering the aspects and requirements for adequate protection level of communications privacy would ensure that one of the basic principles of PCS is met by S-PCN. Additional areas where the air interface is concerned are presented in the following subclause on legal tapping.

9.2.3.4 Legal tapping

Legal tapping is considered as a matter of priority in the framework of this ETR. Legal tapping is regarded as the legal access to user data transported by the S-PCN network and other information relevant to trace S-PCN mobile communications (e.g. location and subscription information).

The issue of legally access mobile network communications and user information and arises from the concern of both:

- identify fraud access to the system (by an unauthorised user);
- capability to trace mobile communications and subscription related data;
- capability to monitor traffic of a specific subscriber.

In some sense the legal issue looks at the security and privacy issues from an opposite side, and with opposite purposes. A mobile network offering a very high level of security and privacy to the user is also a protected system for communications likely to be used if a party is determined to hinder the possibility of legal tapping of his communications. This issue is often neglected or considered as a special case not falling within those of more general interest. Nevertheless it brings important consequences.

The developments of today's mobile systems are moving (e.g. GSM) towards provisions for authentication of access and the protection of traffic over the air interface. Consequently these provisions make legal tapping impossible over the air interface. It is still possible at a centralised, but still "local" level (e.g. MSC area and register level).

When considering the features of S-PCN the concern about the potential practical difficulty of legal tapping are well met, especially because of the small and simple to operate satellite terminal foreseen in many cases not to substantially differ in size from a cellular terminal. The possible independence of service provision from the infrastructure in a country, the cellular configuration of the coverage and the possible multi-satellite path of a call make the legal tapping for S-PCN difficult to implement by the same means used for terrestrial mobile. Assuming that the security and privacy provisions in S-PCN will be at least of the same kind of those provided by GSM (i.e. authentication, public key) and considering the wide coverage involved, the tapping over the air interface without network support would not be a viable solution. A possible way to screen a call over the air interface could be, for example to have the encryption disabled for a particular subscriber number. However, this would give way to third parties to tap the call content, considering the coverage of the satellite network.

The problems of legal tapping in cellular communications may be taken to the extreme in S-PCN communications. In S-PCN where a subscription may not be associated with a Country or not fall within the control of an Administration and the switch may be located virtually anywhere in the network, the problem arises of which subscriber communications an Administration has the right to tap and by which process and technical means.

The network support for legal tapping could include:

- relatively accurate positioning information of the terminal (for example when mobile network functions are activated);

- availability of the identity of the terminal and of the subscription (removable device);

- availability of supplementary services parameters;

- means to tap a call in progress irrespective of the gateway through which the call may be routed to PSTN / PLMN or handled for mobile-to-mobile call, including roaming stations.

Considering that the S-PCN may be operated by several operators offering service over the same territory, there may be the need to address the mobiles involved in legal tapping not by equipment identity but by an IMSI. The equipment identity may be used to remotely stop transmission of faulty equipment when this is justified under the terminal essential requirements, while the capability to control the communication itself for legal purposes involves the control of IMSI, equipment identity and the supplementary service parameters by a clearing house.

IMSI is relevant to legal tapping because of possible ways to avoid detection or tapping of communications by using multiple roaming subscriptions in each call, in a certain organised way.

A standard on legal tapping issues would ensure that the S-PCN system could not be used to provide a better way to avoid legal tapping than terrestrial mobile means. The standard could have a scope including the points above mentioned, with particular emphasis on the availability of called and calling party details and call screening.

9.2.3.5 System fault tolerance and survivability

Information on this subject, which is another aspect of security aspects, is presented as annex D.

9.2.3.6 Summary of possible standards for security aspects

The foregoing subclause has explored a number of technical areas where standards may be considered for S-PCN. Table 16 summarises the possible standards that might be considered, in order to assist the decision makers in easily identifying the options.

Table 16: Possible standards related to security aspects

Possible standard	Reference Subclause
Functions / data of the S-PCN MS removable device:	
IMSI	9.2.3.1
Temporary IMSI	9.2.3.1
User authentication related data	9.2.3.1
Timers for network operation	9.2.3.1
Authentication algorithm	9.2.3.1
Ciphering key generation algorithm	9.2.3.1
Storage memory for calling numbers and messaging	9.2.3.1
Specification of the S-PCN MS to removable device interface	9.2.3.1
Security aspects	
Authentication procedure compatible with GSM	9.2.3.1
Security of transfer and storage of authentication data across the S-PCN	9.2.3.1
Availability of authentication data across the S-PCN	9.2.3.1
User data and Location Confidentiality	
Access to accurate position information by a legitimisation code	9.2.3.2
Split billing	9.2.3.2
Requirements for protection over the S-PCN radio interface	9.2.3.3
Requirements to allow Legal Tapping of Communications, provisions for:	
positioning information	9.2.3.4
identity of the terminal and subscription	9.2.3.4
supplementary service parameters	9.2.3.4

9.2.4 Gateway aspects

For the purpose of this subclause, the term gateway includes all ground stations providing network access to the satellites (in contrast with user access - via the S-PCN mobile station) and involved in the call processing and mobility management of the S-PCN, excluding the stations for Telemetry, Telecommand, Control and Monitoring (TTC&M). The antenna aperture requirements, satellite tracking scheme, diversity and a number of other features functions performed by gateways varies accordingly to the S-PCN design. In ETR 093 [1] clause on S-PCN proposals (clause 7) the gateways are described in terms of:

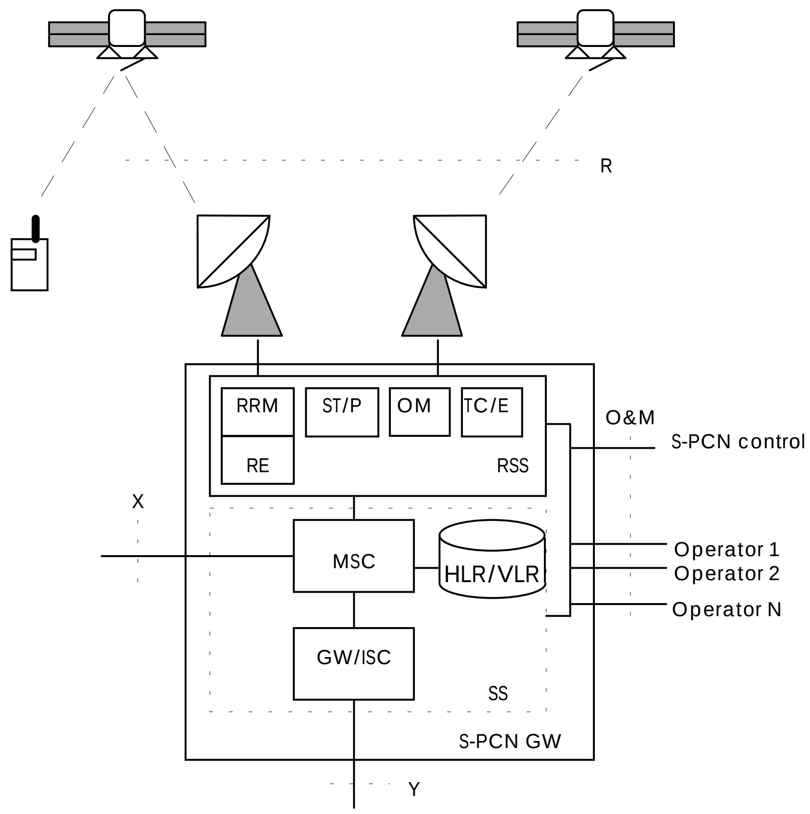
- traffic / network co-ordination;
- functionality;
- number and deployment;
- geographical distribution.

The description referred to above shows that the design is still in progress, but results in some common issues of S-PCN gateways such as their geographical distribution and interfaces. The analysis of gateway aspects, being in some cases the only S-PCN ground infrastructure, has important consequences on standardization issues and presents a range of options. Aspects are first introduced, the analysis is focused on:

a) networking:
   - network interconnection (interface to other networks);
   - network access;
   - resource assignment;
   - satellite resource sharing and co-ordination;
   - network resource sharing and co-ordination;

b) operation:
   - allocation of calls to GWs (GW coverage area definition);
   - operations and maintenance;
   - GW access and sharing among operators;
   - operator issues;
   - protection of other satellite networks.

The S-PCN gateway model, external interfaces and main subsystems are shown in figure 38.



RSS = Radio Station System, SS = Switching System, RE = Radio Equipment

RRM = Radio Resource Management subsystem

ST/P = Satellite Tracking and Positioning Information subsystem

OM = Operation and Maintenance subsystem, TC/E = Transcoding/Encryption

MSC = Mobile services Switching Centre

HLR/VLR = Home Location Register/Visitor Location Register

GW/ISC = Gateway International Switching Centre

X = inter gateway interface, Y = inter-network and international switching interface

O&M = Operations and Maintenance interface, R = Radio Interface

Figure 38: Gateway interfaces and subsystems

Integration with other mobile networks is here not considered a main issue but some reference to the relevant clauses of the report will be made. As shown in figure 38, in general there are four external interfaces in the model. They are the radio feeder link interface (interface R), intra-network interface (X interface), the interface to other mobile or fixed networks (Y interface) and the operations and maintenance interface (O&M interface). The GW is modelled as divided into two parts (many systems would be redundant): the radio station subsystem (RSS) and the Switching and control system (SS). The RSS provides, among others the Radio Equipment (RE, Radio Resource Management (RRM) functions, Satellite Tracking and positioning information (ST/P) functions (implemented differently accordingly to the diversity scheme adopted), Operation and Maintenance (OM) functions and Transcoding / Encryption (TC / E) functions. The SS provides switching, control and inter-network interface functions, Location Register functions (both HLR and VLR are foreseen here) and interface functions to other networks. Both the RSS and SS provide an interface to the O&M centre.

In the case of integration (subclause 9.2.2.2.1 and model shown in figure 31) the RSS correspond to the BES.

O&M functions may be performed regionally and the GW may have some O&M functions, if the S-PCN GW is shared among operators they may perform each O&M functions and the O&M interface will have to support several operators, system O&M functions would also be supported by this interface.

In the following subclauses the networking and operation issues presented are considered.

9.2.4.1 Networking

Networking issues include: network interconnection, network access, resource assignment, satellite resource sharing and co-ordination, network resource sharing and co-ordination.

Interconnection with other networks (Y interface) has been already introduced in subclauses 9.2.2.1.1 and 9.2.2.1.2 in the case of PSTN and PCN. Figure 39 shows the different interfaces that may be required by the S-PCN design and supported by the Y interface.

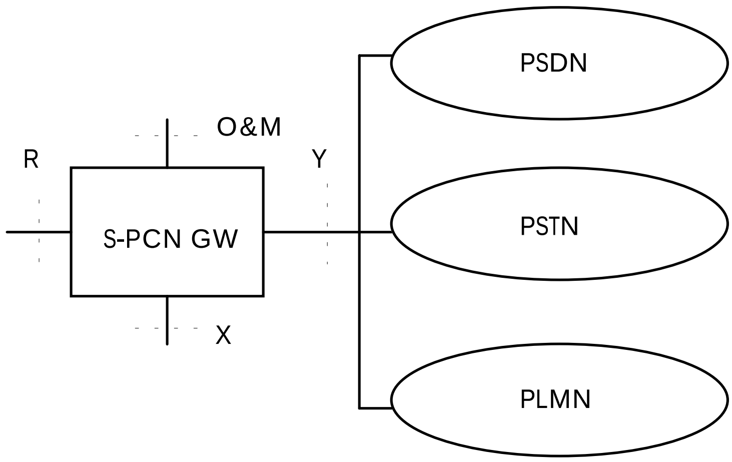


Figure 39: S-PCN gateway networking interfaces

The X interface supports the inter-network functions / access to the S-PCN and may be implemented at a national or international level. National level should be specified according to different ITU Recommendations. Possible interworking functions between S-PCN and other signalling systems are supposed to be performed by the S-PCN GW at this interface.

Network access can be defined for all services excluding RDSS, where the service is supposed to be provided without any activation of dedicated network functions. S-PCN MS network access for other services (subclause 9.2.1) involves the association of satellite resources and S-PCN network resources to the mobile. To highlight the difference they have been already referred to as 1st and 2nd order assignment (ETR 093 [1]). Depending on the OBP and ISL capabilities of the S-PCN the 1st and 2nd order assignment procedures can be considered as belonging to subsequent stages of the call set-up or as two phases of the same stage (resource assignment). During other network procedures such as forced handover (handover forced for network management purposes, not including ordinary mobility driven handovers) the 1st and 2nd order assignment are logically separated.

As an example consider the two following cases:

a) ISL OBP S-PCN:

Call set-up:

- 1st order assignment may be performed by the satellite, assigning signalling and traffic channels to the S-PCN MS, routing through ISL with the co-operation of network co-ordination entities;

- 2nd order assignment would be following a pre-determined scheme, according to the routing tables in the network.

Handover intra-satellite (if foreseen):

- 1st order assignment may be performed by the satellite as a part of the OBP radio control function, following a pre-determined schemes (see ETR 093 [1]);

- 2nd order assignment may not need modification.

Handover inter-satellite:

- 2nd order assignment may be performed by the S-PCN GW;
- 1st order assignment may be performed by an S-PCN GW.

b) S-PCN with no OBP (and no ISL):

Call set-up:

- 1st order assignment and 2nd order assignment would be performed by the S-PCN GW and transparent to the S-PCN MS.

Handover intra-satellite (if foreseen):

- 1st order assignment controlled by the S-PCN GW;
- 2nd order assignment would not need modification.

Handover inter-satellite (if foreseen):

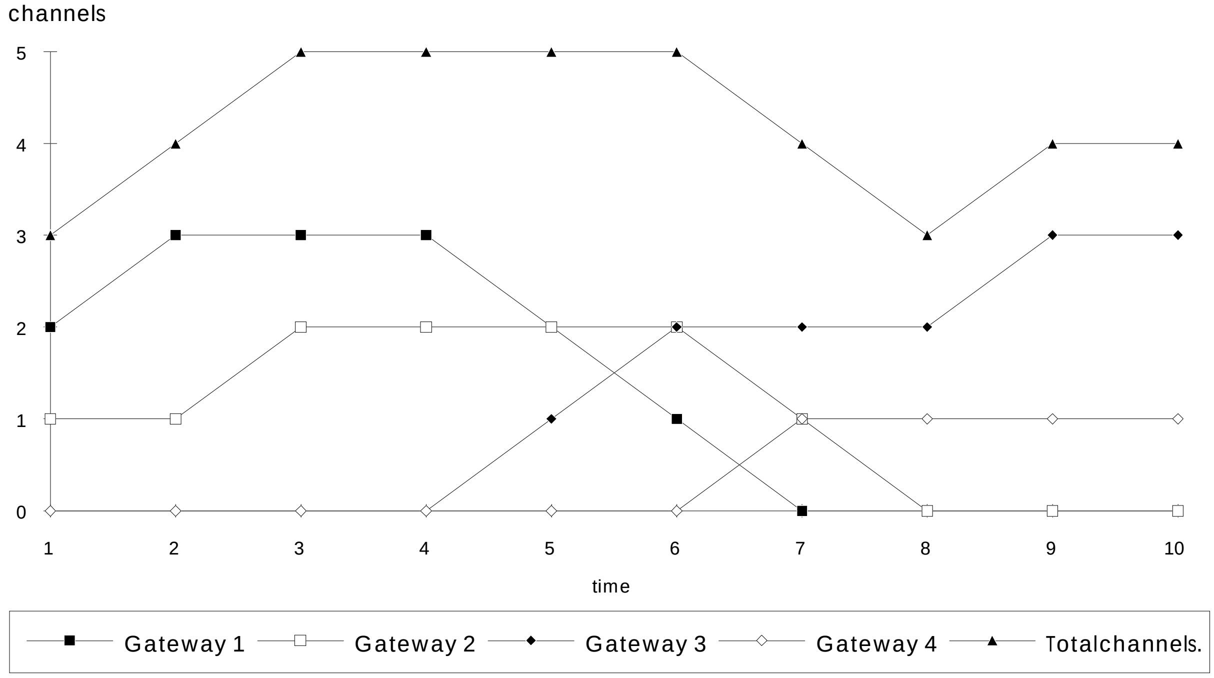
- 1st order and 2nd order assignment would be performed by the S-PCN GW.

Resource assignment in the feeder link is an internal network function and will not be considered here.

On the service link side, resource assignment includes several procedures to meet requirements for (see also subclause 9.2.3.5):

- frequency sharing and co-ordination to occupy certain portions of the service band (to ease frequency sharing with other systems in regions to be protected e.g. Radio Astronomy, including limiting of power spectral density levels;
- means to exclude countries from service, where service is not licensed or authorised;
- implementation of the S-PCN frequency plan (reuse of frequencies in the coverage);
- handover (intra-satellite and inter-satellite) due to mobility of the constellation, including satellite resource sharing with other gateways;
- type of call set-up (Early Assignment (EA), Off Air Call Set-Up (OACSU));
- idle service frequencies monitoring.

Satellite resource sharing and co-ordination is foreseen here as one of the most demanding functions in S-PCN. In this respect a general model is again considered here to identify issues rather than attempting to describe a possible system design. It is an essential function to achieve optimisation in the use of the limited satellite resources through the network trading off the dynamic coverage requirements against the flexibility and modularity in gateway deployment. In a constellation, in principle, each S-PCN GW has at least two antenna systems to continuously track at least one satellite for service and a second one to ensure a set of service channels for changeover (diversity requirements are not addressed here. Also in a network using ISL the multiple satellite tracking may not be needed). Also (see ETR 093 [1], clause 7) each satellite may correspond to several (say N) S-PCN GW. Service channels are continuously seized and released on each satellite by each gateway. The problem may be seen in general as a dynamic 2nd order assignment, on a service request basis. Figure 40 represents a possible sharing condition.



Evolution of channel occupancy of one satellite (5 service channels) shared among 4 S-PCN GWs

Figure 40: Satellite service channel sharing

The larger is the number of GWs sharing a single satellite pool of service channels the better is the efficiency. Again there are two extreme solutions that depend on the features of the satellite (OBP, ISL):

- a satellite may be occupied by one GW at a time;

- a satellite may be occupied by a number of GWs limited only by the complexity of the payload and the S-PCN GWs.

The satellite resource sharing poses the problem of the definition of the GW coverage, this is included in the operation issues.

Network resource sharing and co-ordination can be described in analogy to the satellite sharing.

Common network resources as those providing a common layer of nominal features to all co-existing regional or global networks or operators supported by the S-PCN. The quality and availability of services depends on the implementation of the common resources including:

- TTC&M (including software update to the satellite);
- positioning information reference monitoring and correction;
- space segment fault isolation and recovery;
- OBP and ISL routing tables maintenance, when applicable;
- spectrum monitoring (service, feeder and ISL link);
- GW configuration (routing tables consistency);
- GW co-ordination;
- GW fault isolation and recovery;
- S-PCN MS fault isolation and recovery (identification of defective handsets);
- system operation data collection and analysis;
- billing (consistency, data collection).

These issues should be considered for a full system specifications standard of the GW sharing and co-ordination functions.

9.2.4.2 Operation

Operation issues include configuration of allocation of MSs to GWs and GW coverage area definition, configuration of allocation of calls to GWs, Operations and Maintenance (O&M), GW access and sharing among operators, operator issues, protection of other satellite networks.

Allocation of MSs to GWs is related to the definition of GW coverage area. While 1st order assignment defines how an MS is allocated a GW (registration and subsequent verification of the MS state), the identification of the GW is the result of a network procedure arising from the capability of S-PCN to provide service to Geographical Areas (GA) via several GWs. This procedure is critical because of the implications on all technical and regulatory aspects of the S-PCN operation. In this respect the allocation of calls to GW is a critical issue for ISL-operated networks.

For mobile-fixed call set-up, if the S-PCN does not include ISL traffic routing the allocation of MS to GW occurs at the S-PCN MS station end. If ISL is used (either orbit dependent or independent, see ETR 093 [1], subclause 5.2.5.3.3) the allocation of call to GW occurs at the fixed side, involving a possible optimisation of the terrestrial tail and procedures to recover from temporary unavailability of gateways (for maintenance or congestion reasons).

For mobile-to-mobile call set-up, allocation of call to GW does not raise different points from those mentioned above . It is possible to envisage cases where the GW, although involved in the call processing (e.g. call set-up) does not carry traffic, as shown in figure 17.

The S-PCN coverage mainly presents a structure that makes possible the selection of a GW based on radio coverage features (such as a cellular "cell selection" procedure), as shown in figure 41. The analogy in terrestrial cellular PLMNs is found in a common radio access and switching structure shared among operators.

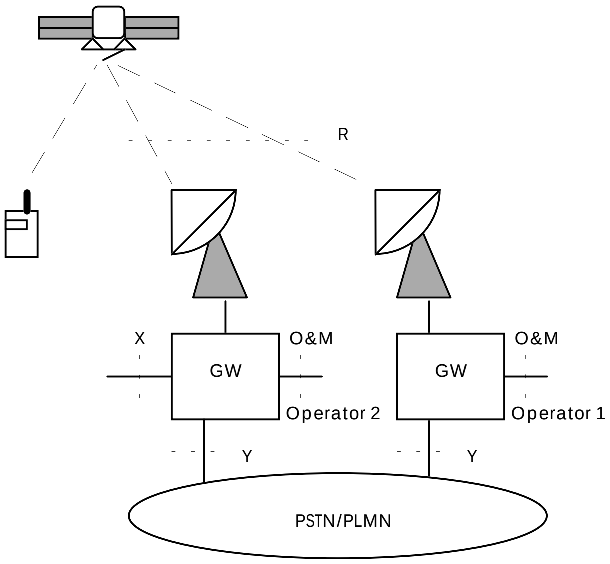


Figure 41: Analogy between S-PCN and PLMN

If the system provides means to define a GA associated to a GW, the allocation of MSs to GW may be automatic. When the GA is served by more than one gateway or operator the selection of the operator, once the S-PCN system is selected (an example of selection criteria is given in subclause 9.2.2.1.2) may be subject to different rules, influenced by licensing terms and regulations.

The GW service area concept is of great importance to solve several issues related to the provision and licensing of service licences. It is important to distinguish between the GW coverage and the GW service area.

For a S-PCN using transparent payloads the GW coverage area is the result of the constellation and satellite design, arising from the number of tracked satellites providing service channels to the GW. The shape of the coverage area depends also on parameters including the latitude of the GW. The GW service area may be restricted to a portion of the coverage area because of areas to be protected and other licensing and regulatory issues.

For S-PCN using ISL and OBP the GW coverage area is potentially the whole S-PCN (possibly Global Coverage - GC, see ETR 093 [1]). The GW service area may be restricted only network design and for infrastructure optimisation purposes (to avoid ineffective use of the available capacity, e.g. by redundant routing) due to the extension of the access network. Such restrictions are much less related to the GW location and size (in terms of number of service circuits provided) and to the user location and type of terminal. Figure 42 shows the model assumed for the ISL S-PCN user-to-operator network model.

Here it is proposed to identify the S-PCN GW coverage area as the geographical distribution of service channels provided through a single GW.

Licensing could be based on a GA service licence or on other principles. A standard on the GW "service area" features supporting different kind of licensing regimes, including those that could be adopted in the European "co-ordinated approach" (Directive on the introduction of S-PCN service in the Community) would ease the process of service licensing by different National Administration within the Union and ensure the effective use of the limited S-PCN resource (spectrum and orbit). The GW features to be taken into account should include:

- GW location constraints (taking into account the system constellation);
- GW interfaces constraints;
- GW service and coverage area (geographical distribution of service channels);
- assignment algorithm when it is necessary to ensure compliance with national or regional carriers' rights;
- GW management of service channels to achieve effective use of the spectrum resources (possibly under the essential requirements, Article 4e;
- interface to the Operator (O&M).

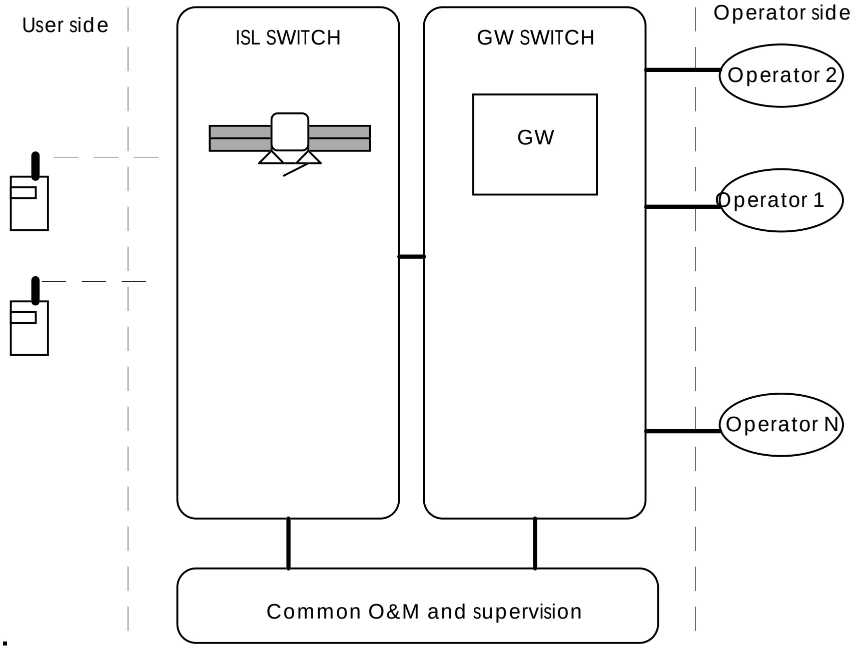


Figure 42: ISL S-PCN user to operator network model

GW access and sharing among operators functions provide a common support for operator use of the network facilities. These functions include all operator service tailoring and supervision functions, allowing sharing of the GW or exclusive use of the GW infrastructure.

Protection of other satellite networks includes provisions to characterise the type and amount of interference potentially caused to another satellite system by S-PCN. This standard would ease the implementation of frequency sharing and co-ordination with other networks, either S-PCN or not. An example of a possible protection specification could be the shut down of emission when crossing the GSO arc during operation (and carrier suppressed state) as introduced in subclause 9.1.2.5.4.

9.2.4.3 Summary of possible standards for gateway aspects

The foregoing subclause has explored a number of technical areas where standards may be considered for S-PCN. Table 17 summarises the possible standards that might be considered, and is intended to assist the decision makers in easily identifying the options.

9.2.5 User aspects

Possible standards and guidelines related to user aspects of Satellite Personal Communications Networks (S-PCN) arise primarily with respect to the man-machine interface to the system, its terminals and services presented to the user. Within ETSI, responsibility for standardization in this field rests with the Technical Committee for Human Factors (TC-HF) and in particular with STC-HF1 (Telecommunications Services) and STC-HF2 (People with Special Needs). Outside of ETSI responsibility for international standardization in this field rests with the ITU-T and in particular Study Group 1, Special Working Group on Human Factors (SG1 SWG-HF). One of the principle objectives of standardization with respect to the man-machine interface of any system is to establish minimum levels of usability, which is defined as "the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in a particular environment" (see ETR 116 [33]). This is tempered with due regard to both the manufacturers' and service providers legitimate concerns for establishing product and service differentiation.

Table 17: Possible standards related to gateway aspects

Possible standard	Reference Subclause
Gateway aspects	
Gateway networking	9.2.4.1
network interconnection	9.2.4.1
network access	9.2.4.1
resource assignment	9.2.4.1
satellite resource sharing and co-ordination	9.2.4.1
network resource sharing and co-ordination: Specification of:	
TTC&M	9.2.4.1
the positioning information reference monitoring and correction	9.2.4.1
space segment fault isolation and recovery	9.2.4.1
OBP and ISL routing tables maintenance	9.2.4.1
spectrum monitoring	9.2.4.1
GW configuration	9.2.4.1
GW co-ordination	9.2.4.1
GW fault isolation and recovery	9.2.4.1
S-PCN MS fault isolation and recovery by the GW	9.2.4.1
System operation data collection and analysis	9.2.4.1
Billing (consistency, data collection)	9.2.4.1
Gateway operation	
allocation of MSs to GWs and GW coverage area definition	9.2.4.2
(geographical distribution of service channels)allocation of calls to	9.2.4.2
GWs	9.2.4.2
GW interfaces constraints	9.2.4.2
Algorithm when it is necessary to ensure compliance with national or	9.2.4.2
regional carriers rights	9.2.4.2
GW management of service channels to achieve effective use of the spectrum	
resources	9.2.4.2
Operations and Maintenance	9.2.4.2
Interface to the Operator (O&M)	9.2.4.2
GW access and sharing among operators	9.2.4.2
operator issues	9.2.4.2
protection of other satellite networks	9.2.4.2

It seems unlikely that there will be many areas within the S-PCNs that will require any user-related standardization that is specific to S-PCN. Instead, the already established body of work in this area, and the ongoing work programmes in, for example TC-HF, should be considered for application to S-PCN, and new standardization activities only undertaken where a clear S-PCN specific need is identified. Nevertheless, in order that adequate consideration of the required standardization may be made at this stage, this section briefly reviews the following areas of interest, and identifies where standardization and / or guidance might be useful, where possible cross-referencing these areas to the body of work and standards that have already been developed (e.g. within TC-HF), and applying them to S-PCN:

- user requirements in UPT;
- user control procedures;
- user co-operation in S-PCN telecommunication sessions;
- supplementary service access and control;
- terminal design and controls;
- tones, messages and announcements;
- numbering and addressing;
- Personal numbers / addresses;
- Special numbers / addresses;
- system and user response times;
- service quality and availability;
- people with special needs (subclause 9.2.5.10).

9.2.5.1 Users requirements in UPT

The implementation of satellite personal communication network services is moving towards the satellite component of the Universal Mobile Telecommunications Service (UMTS) and as such will be another part of the overall world telecommunication service, which will continue to enable people to have telecommunication sessions with other people and services. From the users' perspective the technology which enables these telecommunication sessions is of secondary importance, the users primary goal is to communicate. Consequently there is a considerable overlap between the user requirements for one system and those for another. TC-HF is currently working on the user requirements for Universal Personal Telecommunications (UPT) in collaboration with STC-NA7 [60]. Many of these requirements will be very similar to the overall user requirements for UMTS and as such will be equally applicable to S-PCN.

Consideration should be given to the user requirements identified for UPT to determine their applicability to S-PCN and to ensure a consistent approach within the contributory parts of a UPT / UMTS service.

9.2.5.2 User control procedures

User control procedures are the means by which the user can access and control S-PCN telecommunication sessions. As a minimum they will enable the user to initiate or receive an S-PCN call. ETSI TC-HF has already developed a set of general rules for guidance on the development of user control procedures (and also a set of generic user control procedures including call set-up, incoming call, call in progress, payment, identification and call termination) in the context of ISDN terminal and service design [62]. It could be useful to consider adopting these rules and procedures for S-PCN to ensure that the systems developed do not appear to the user to be radically different in their basic operation than other telecommunication systems.

Two fundamental principles embedded in the generic rules and control procedures are worth quoting as examples:

a) the concept that at all stages the user should be presented with prompts and feedback for all necessary control actions.

   This principle requires that every user control procedure should demonstrate the sequence "Indicate - Control - Indicate", and that consequently full consideration is needed of these user indications within the specification of the S-PCN signalling. Within the generic procedures, no distinction is made about the format (tone, voice message, displayed text etc.) or source (terminal, service provider, network, etc.) of the user indications, nor about the integration of feedback and prompting information into a single indication.

b) the concept of flexibility

   If several control actions are necessary before a control command is completed, then the principle requires that the order in which these actions are made should, if possible, be immaterial. For example to initiate a call within a multimedia S-PCN service, it may be necessary to define the teleservice, define the address and define a "start" (off-hook / send). Flexibility in the resulting user control procedure would require that any of the six possible sequences should result in a correct call set-up.

9.2.5.3 User co-operation in S-PCN telecommunication sessions

ETR 093 [1] has identified that, for certain implementations of S-PCN, co-operation from the user will be required to ensure, for example, adequate link margin, and hence link quality and availability. This co-operation will be required to enable the user to place the S-PCN handset into a position where the available down-link field strength (from satellite to handset) is adequate to maintain the service, where the up-link path blockage (from handset to satellite) is not excessive, or where the S-PCN antenna is aligned so as to maximise the gain available in the direction of the satellite. These strategies serve two purposes: firstly, to ensure that the down-link communications channel can be supported within the link power budget available and secondly, where up-link power control is utilised, to allow the minimum radiated power from the handset commensurate with supporting the required link quality (this power control could have RF safety, spectrum efficiency and EMC implications, see subclause 9.1.2).

The method by which user co-operation is obtained will require a feedback mechanism, and it could be considered that both visual and auditory indications could be required to ensure that communications links can be maintained during normal call establishment and call in progress conditions.

The requirement for standards to be developed to cover this situation should be considered at two levels:

a) that if an implementation requires user co-operation then there should be clear indication / instruction to the user of how to optimise the handset / satellite radio signal paths, and when it will be required. A standard would define the requirement for such an indication / instruction and the circumstances under which it should be presented, but no specification would be made of how or in what form these indications / instructions should be presented.

b) that if an implementation requires user co-operation then there should be common minimum indications / instructions to the user on how to optimise the handset / satellite radio signal paths and when it will be required, such that the user knows how to co-operate optimally irrespective of the handset / S-PCN currently in use. A standard would define, in addition to the items indicated in the previous paragraph, a minimum set of indications / instructions that would be applied to all S-PCNs which required user co-operation.

In principle TC-HF prefers the second level of provision as it ensures that the user / system has a minimum level of usability. This need not preclude any service provider or manufacturer from offering an alternative indication / instruction if this provides a better level of usability.

9.2.5.4 Supplementary service access and control

Where the S-PCN supports the provision of supplementary services (such as call forwarding, call waiting, etc.), irrespective of the source or provider offering these services, it can be argued that the means by which these services are accessed and controlled should be harmonized across different telecommunications systems. TC-HF is in the process of developing an ETS on a minimum man-machine interface for public network based telecommunication services [61]. The standard defines the command language ('*' and '#' based code scheme) and the necessary indications that can be used to access and control supplementary services. It would be useful to consider supporting the proposed ETS within the S-PCN.

NOTE: A set of supplementary service access codes for use in mobile satellite networks have also been considered by the ITU (see subclause 9.2.2.1.1) but as they are for application in the INMARSAT maritime mobile satellite network and are not based on a '*' and '#' code, they may not be so appropriate for consideration in S-PCN.

The existing networks (PSTN, ISDN, GSM, ERMES etc.) each currently provide their own supplementary services. However with the increasing mobility of users and the overlapping competition of networks there is significant potential for user confusion between different networks offering apparently similar but substantially different supplementary services. For example both ISDN and GSM offer a Conference Service (in GSM this is called Multi-Party Service) but they are defined and hence controlled by the user in different ways. Within ISDN the user has to book the Conference Service first and then set-up each call and add it to the Conference, whereas in GSM the user adds calls together one after another and the Conference Service is invoked automatically. Therefore if the S-PCN service is considering offering supplementary services in its own right, careful consideration should be given to the definition of these services, to ensure maximum consistency with existing services commensurate with maximising the service usability.

9.2.5.5 Terminal design and controls

Terminal design and controls are typically seen to be outside the area for standardization, however there are some recommendations which are worth considering as principles for application within S-PCN terminals:

a) the overall design of any S-PCN handset should, if it incorporates an earpiece and microphone, attempt to comply with ITU-T Recommendation P.35 [69], to ensure their correct relative positioning;

b) the layout of any numeric data entry keypad, together with any assignment of alphabetic characters to the keypad, should comply with ITU-T Recommendation E.161 [65];

c) the access to the relevant international access code for the connected S-PCN system should be via the use of the '+' key defined for GSM (see ETS 300 511 on the GSM mobile station MMI [59];

d) the labelling of controls with symbols should where relevant make use of internationally agreed symbols, see ITU-T Recommendation E.121 [63], ETS 300 375 [58] and ETR 116 [33];

e) the physical orientation of any telephone card based token or Subscriber Identification Module (SIM) used to set-up a terminal should be identifiable by the use of a tactile identifier which complies with ITU-T Recommendation E.136 [64]. Consideration should also be given to the use of other tactile identifiers e.g. on any numeric or alphanumeric keys used within a terminal design, to support the use of the terminal by people with visual impairments.

9.2.5.6 Tones, messages and announcements

ETSI TC-HF is attempting to rationalise the proliferation of different telephone service tones used within telecommunication networks. This is being addressed by two deliverables:

- ETR 187 [34] describes the characteristics of telephone service tones when locally generated in terminals;

In order to present users with a common interface across different S-PCN systems, consideration should be given to adopting one or both of the proposed standards as appropriate for S-PCN.

ITU-T has, in Recommendation E.183 " [67], defined guidelines for the design and presentation of voice messages and announcements for use in supporting the telephone service. Consideration should be given to recommending these guidelines as appropriate for the design of voice messages and announcements to be used within the S-PCN system.

For a global system such as S-PCN it could become difficult for users if the system messages, prompts and announcements are made in a language with which they are not familiar. The UPT user requirements [60] state that users should be able to receive indications in their preferred language and consideration should be given as to whether this requirement should be adopted for S-PCN. Two technical solutions are offered:

a) the S-PCN Subscriber Identification Module (SIM) could contain an indication of the users preferred language, and all system (network and terminal) announcements would then be made in that language.

   NOTE: This would probably require the definition of a minimum set of acceptable languages in order to ensure system compatibility. If the language presentation is in written form then it may be necessary to consider the transliteration of languages that use special character sets, such as Greek or Cyrillic, or that use pictograms, such as Chinese or Japanese;

b) A minimum set of system announcements could be defined and stored in the user's SIM in their preferred language. Then, if the user experiences an announcement in an unfamiliar language, a function supported within the terminal could display (audibly or visually) the nearest translation, mapped from the minimum set.

Consideration should be given to whether a preferred language will be supported and which of the two solutions (or another solution) should be adopted and if appropriate to developing a minimum set of announcements.

9.2.5.7 Numbering and addressing

This subclause introduces some early considerations of the issue of personal numbering and addressing, and also mentions special numbers that may need to be supported by S-PCN.

9.2.5.7.1 Personal numbers / addresses

As the world telecommunications user base grows, the number space required will also increase and the length of numbers consequently will become larger. User's memory and keying errors are high enough in the 10-16 digit strings and the problem will increase as the size increases. This may only partially be alleviated by imposing an extended logical structure to the overall number as recommended in ITU-T Recommendation E.331 [68].

The provision of technical facilities within terminals, such as dialling from an address book stored in terminal or SIM card memory, will help, but is not a complete solution. In the long term, it may be necessary to consider the adoption of a numbering / addressing scheme more akin to that used for conventional and electronic mail systems, where the addressing is alphanumeric and is based on real user, system and / or geographic names, rather than numeric codes e.g.:

j.smith@serviceprovider.country.network.spcn

might be a way of representing a user address.

If this approach is to be developed, then careful consideration of the implications across the whole telecommunications system (S-PCN, UMTS etc.) will obviously be necessary and a strategy for migration and temporary co-existence of the two systems developed.

This is a very new concept, and ETSI are not aware of any specific work being undertaken internationally at present to address the issue.

9.2.5.7.2 Special access codes / prefixes

The S-PCN system should facilitate the continued use of regionally agreed access codes and internationally agreed prefixes e.g. 00. Currently the only access code that is identified as a requirement in Europe is the emergency number (112) which is established under Council Decision 91/396/EEC [38].

9.2.5.8 System-response and user-response times

Operational time-outs and response times of the S-PCN system can significantly affect the performance with the system as experienced by the user. Three situations are worth quoting:

a) system responses that are too fast may be missed by some users, particularly the leading part of a voice announcement or transient visual prompts / reminders if the terminal being used follows a typical mobile terminal design (with visual display and controls positioned between the earpiece and microphone). It takes time for users to change position from using the keypad to listening at the earpiece, and some users have disabilities that make it hard for them to manipulate objects easily and rapidly;

b) system time-outs that are too short can prevent some users from completing quite simple operations, e.g. in fixed networks telephone numbers that have to be cross checked can sometimes require re-keying by ordinary users because the network has been too quick to drop the line (inter-digit time-out);

c) users will not wait for an overly extended period to get a response from the system. Frequently if nothing occurs within the user's relevant timeframe the user assumes the control action was ignored or missed and will try again, or will stop the operation and start again (e.g. hang-up and dial again!). The end result can be a network which is being used for little or no revenue.

TC-HF has provided guidelines on system-response and user-response times within the context of ISDN systems ETR 116 [33]. Consideration should be given to the appropriateness of these guidelines to S-PCN systems, and to the inclusion of minimum system response times and time-outs within the proposed S-PCN standards / guidelines (taking into account the S-PCN specific features).

9.2.5.9 Service quality and availability

Service quality and availability are obvious concerns to the users, but are such basic provisions of the S-PCN systems that they are dealt with in this ETR in the clause relating to service issues (see subclause 9.2.1).

Three user related concerns regarding service quality and availability can be addressed in this subclause:

a) the first concern is the difficult area of "telepresence". The basic PSTN network offers a service which has been described as a "shared auditory space". Some of the attributes that contribute to that feeling of a shared "telepresence" are caused by the basic provision of a simultaneous real-time bi-directional path between the two terminals. The S-PCN system could consider how best to maximise the feelings of "telepresence" across all teleservices which offer an audio or audio-visual path;

b) the second concern is the interference factor that is introduced into natural dialogue by delays in the auditory path, and by direction switching triggered by the vocal segregates (oh! ah-ha! huh? etc.) in existing PSTN technology using satellite links. The potential for S-PCN to suffer from this effect may need to be assessed and, if necessary, taken into account in appropriate standards;

c) the third concern is related to who is in control of a telecommunications session. For example within Videotelephony there is the opportunity to give the user control over some choices with respect to the quality of the transmitted picture and sound. Users could perhaps chose how they bias the use of the ISDN channels available to maximise audio or visual quality. However, currently it is the transmitting user who is in control of their transmitted signal, but it is the receiving user who receives the benefit or otherwise of control changes. Consequently the question arises should the receiving party be able to directly control the quality of the audio-visual signals transmitted to it, and if so what are the signalling and user interface requirements. This also causes concerns for billing, because if it is the receiving party who has requested the quality up-grade (or down-grade) then presumably it is the receiving party who should pay (or be credited) for that benefit. The question might also be relevant for S-PCN providers if they also intend to support such a facility within their networks.

9.2.5.10 People with special needs

People with special needs (the young, the elderly and the physically and mentally disabled) form a very significant proportion of the population. To give some feel for the scope of this population (which may be perceived also as a market) there are today for example, within Europe, 80 000 000 people who are hard of hearing, 25 000 000 who are dyslexic and 11 500 000 who have reduced co-ordination. By the year 2020 it is estimated that 25% of the population will be over the age of 60 (information from COST 219 [82]). Therefore manufacturers and service providers should take every opportunity to ensure S-PCN systems do not inadvertently preclude themselves from these markets. For example:

- by making sure that the indications / instructions necessary to enable the user to co-operate and optimise the handset / satellite radio signal paths (see subclause 9.2.5.3) are also available to or operable by "special needs" users;
- by ensuring time-outs and response times are adequate to prevent forced errors by "special needs" users;
- by making the interfaces and user procedures less reliant on a user's memory (point and select is easier than remember and type);
- by enabling undo and backtrack facilities within user procedures to help people recover gracefully from their errors.

There is also the opportunity for S-PCN to consider the provision of services which are specifically for one or more of the groups of people with special needs, for example by enabling provision for a text-telephony or text-message service. These aspects should be considered with respect of the implications for the proposed S-PCN standardization programme.

Finally it is worth mentioning that significant concern and publicity arose with respect to the levels of electromagnetic radiation emanating from a transmitting GSM terminal. There can be a serious immunity deficiency of unscreened hearing aids or other electronic aids being used within a significant envelope from the transmitting terminal. Every effort should be taken to ensure that the S-PCN system does not cause similar problems to the lifestyle of others, users and non-users, particularly to those already disadvantaged.

9.2.5.11 Summary of standards related to user aspects

The foregoing subclause has explored a number of technical areas where standards may be considered for S-PCN. Table 18 summarises the possible standards that might be considered and is intended to assist decision makers in easily identifying the options.

Table 18: Possible standards related to user aspects

Possible standard	Reference Subclause
Standardized user interface (keypad, display, etc.)	9.2.5.5
Minimum user control procedures for call set-up, etc.	9.2.5.2
User indications and responses necessary to ensure user co-operation in ensuring operation (e.g. position and orientation) of the handset to achieve a usable link	9.2.5.3
Procedures for supplementary services access	9.2.5.4
Harmonization of tones:	
Tones generated in the S-PCN Mobile Station	9.2.5.6
Tones generated by the network	9.2.5.6
National language support for system messages and announcements - messages in the user's selected language even when roaming internationally	9.2.5.6
System and user response times	9.2.5.8
Access to S-PCN for people with special needs (e.g. disabled, elderly, etc.)	9.2.5.10

9.2.6 Terminal equipment aspects

This subclause addresses technical areas considered for standardization of terminal equipment that do not qualify as essential requirements.

This subclause will first address standardization of the radio interface that applies to S-PCN / MES and then consider aspects of terminal integration.

Terminal equipment may be further affected by aspects that are addressed in subclause 9.2.5.

9.2.6.1 Radio interface

Under the SES Directive, only:

- EMC; and
- efficient use of frequency spectrum including effective use of orbital resources and avoidance of harmful interference between space-based and terrestrial communications systems and other technical systems are considered as the minimum set of essential requirements.

Under application of the TTE Directive, the aspects:

- user safety;
- safety of employees of PTNOs;
- EMC;
- protection of PTN;
- interworking of TE with PTN;
- interworking of TE via PTN in justified cases provide additional essential requirements.

There is considerable uncertainty left as to what is included in the essential requirements since it is not clear whether an S-PCN is considered as a public telecommunication network or as a non-public telecommunication network. An S-PCN may be integrated with a PLMN on a network level, in which case the public aspect is recognised at least for a part of the system. In practice, both aspects (public and non-public) may appear combined in a single network, in which case both Directives should apply. It has become quite common nowadays to provide a virtual private network on a public land mobile infrastructure. The establishment of an S-PCN for non-public-only service seems unrealistic for the near future (except for "governmental use").

Standardization of the essential requirements regarding the radio interface is addressed in subclause 9.1.1. Specifications beyond this can only be voluntary standards but may nevertheless become part of a European harmonized standard.

If application of the essential requirements as in the TTE Directive is not implemented, then these requirements can become part of the voluntary standard.

Standards on the aspects of:

- protection of S-PCN;
- interworking of TE with S-PCN;
- interworking of TE via S-PCN in justified cases;

will be related to specific protocols that are used on the interface between the S-PCN / MES and the satellite.

Specifications on these aspects will reflect in specifications for the protocols on layers 1, 2 and 3 as selected for the transmission of user data as well as for signalling. Examples of this are protocols related to call management and to mobility management including identity management and confidentiality functions.

Furthermore specifications on the interworking of services will reflect in the transcoding of the user information as selected for the S-PCN. This impacts on speech coding / decoding (for the telephony teleservice) and rate adaptation for the data / bearer services.

9.2.6.2 Terminal integration

Terminals for an S-PCN and a terrestrial platforms may be integrated into a single unit. Especially as in European perspective the S-PCN is to complement coverage by terrestrial networks, it is adequate to integrate S-PCN terminals with a PLMN terminal of an existing standard like GSM, NMT, TACS etc. For users of systems not type approved in Europe, there is no terrestrial service in Europe and so for S-PCN proponents from outside Europe it may be interesting to integrate with (D)AMPS or PDC etc.

Integration of S-PCN terminals has been often considered as a solution for a general problem of S-PCN, expected limited quality of service within buildings or in a built-up area. In this respect, the terminal that is integrated with the S-PCN performs the same function of "gap filler". Ideally both systems should complement each other when it comes to service areas.

In one S-PCN it is possible to use terminals that are integrated with terminals constructed according to different types of PLMN standards, so in one S-PCN there may be a terminal integrated with a GSM handset and with a PDC handset. These two terminals can then interwork via the S-PCN, as an alternative to the possibility that they also have via the PLMNs and the international fixed networks.

Apart from terminal integration there is also integration on system level, the combination of which will create additional aspects.

9.2.6.2.1 Terminal integration with GSM

Terminal integration with GSM, as with any type of PLMN station will be most useful if the amount of hardware and software that is used in common can be maximised. Shared use of the microphone, speaker, power supply, audio circuitry and user interface is an attractive perspective. Other possibilities depend on commonalties in specific aspects.

It may be possible to re-use radio circuitry if the combination of the radio access protocols and powers permits it. The same applies to re-using the actual antenna subsystem. These two aspects depend very much on the combination of the frequency bands that are used by both the systems and considering the table in subclause 6.2.1 it may eventually result in even better possibilities for integration of GSM in its 1 800 MHz implementation than in its 900 MHz implementation.

Other parts of the GSM communication systems that could be a candidate for integration are the Subscriber Identity Module (SIM), the encryption technique, the mobility management, call management and signalling protocols.

Optimum benefit can be achieved if the S-PCN system can be designed to create the maximum result from terminal integration. The item in the ETSI / GSM work programme on extension of the GSM standard for satellite communication is an excellent opportunity to achieve a system that is thoroughly integrated, considering integration of terminals as well as of networks. The concept of satellite extended GSM PLMNs and integrated terminals offers possibilities to re-use practically all the software and hardware, even the SIM.

9.2.6.2.2 Terminal integration with DECT

Specific considerations on integration with DECT follow from the general considerations on terminal integration and service by geographically complementary systems.

Terminal integration of S-PCN with DECT is useful in areas where S-PCN coverage and DECT coverage complement each other. However, the DECT standard is not a network standard but a standard for a radio interface. This radio interface can be connected to a PABX or it may in the future be possible to combine the DECT radio interface with the GSM network functionalities.

With an S-PCN / DECT integrated terminal, the DECT interface can be used at home, on a PABX and in areas where DECT is available for public access based on its Public Access Protocol (PAP). The integrated terminal makes it possible to switch to S-PCN where none of this is available. This provides the possibility for a ubiquitous private network. Various sites of a company can be served with wireless DECT PABXs, these can be connected to an S-PCN to create a VPN with global coverage (a similar connection, possibly cheaper to use, could also be made from DECT PABXs to PLMNs).

Regarding engineering of the terminal, shared use of the microphone, speaker, audio circuitry and user interface is evident, as when integrating with GSM.

There may be possibilities for the DECT part to re-use the S-PCN power supply and RF circuitry, as the power level used by DECT will be smaller than those of S-PCN (unless the use of very low power on the service up-link is proven). Basically it means that the combined terminal will need to be dimensioned for S-PCN, with DECT in a "piggy-back".

Regarding frequencies, DECT is in the same position as GSM in its 1 800 MHz implementation for reuse of circuitry and antenna.

9.2.6.2.3 Multi-mode terminal integration

Multi-mode terminal integration goes at least one step further than dual-mode integration. In this case the S-PCN terminal is physically integrated with terminals according to at least two other standards.

Integration of S-PCN with two or more other terminals such as with GSM, with DCS-1800, with DECT, with (D)AMPS, with PDC, with ERMES or NMT etc. is conceivable, but a market for each of the specific combinations would need to be identified.

In general, using a multi-mode terminal requires subscriptions in different networks. Alternatively, roaming can be established between networks according to a different platform.

There is a specific combination where three different interfaces can be used on the same subscription without roaming. ETSI has developed a specification for interworking between DECT and GSM, allowing terminals with a DECT radio interface to be used in GSM networks. This can be the same network that also provides standard GSM coverage. In addition this can be the same network that is also a satellite extended GSM-PLMN. Such terminals can be used:

- at home on a radio-extension of the PSTN;
- at the office on a DECT wireless PABX, this may also be a VPN in a GSM PLMN equipped with DECT radio interfaces;
- outside the office or residence on the coverage that is provided by the aforementioned GSM PLMN on its standard radio interface (or its DECT radio interface); and
- outside such coverage by the S-PCN extension of the same GSM PLMN.

This combination of radio interfaces, integrated into a single terminal, all based on work by ETSI, offers not only a basis for many commercial possibilities but also excellent opportunities for re-use of hardware and software.

9.2.6.2.3.1 Relation to standards

The possibilities to make use of three different radio interfaces without the need to roam, as presented above, can be achieved by actively pursuing the GSM Phase 2+ work item of ETSI-SMG on satellite communication.

9.2.7 Type approval and acceptance testing

Type approval is introduced as a consequence of the regulatory regime that is applied to the S-PCN equipment. For an in-depth consideration on the applicable regulatory regimes, see subclause 9.1.1.

9.2.7.1 Type approval for S-PCN handsets

The handset is at least subject to the following essential requirements (refer to subclause 9.1.1 for a detailed analysis of the application of essential requirements):

4a) user safety insofar as this requirement is not covered by the Low Voltage Directive [23];

The main issue of this aspect is a reference to the Low Voltage Directive. Apparently this will not require the development of standards by ETSI.

4c) electromagnetic compatibility requirements that are specific to SES equipment.
The EMC Directive applies to SES equipment. The EMC Directive is rather broad. This subclause should cover further requirements that are specific to SES equipment.

4e) effective use of the radio spectrum including effective use of orbital resources and the avoidance of harmful interference between space-based and terrestrial communications systems and other technical systems.

This is to assure effective use of radio frequencies. It will contain requirements on the radio frequency parameters regarding the expected use of particular bands. The CTR should cover all performance parameters needed for proper radio licensing of the terminal. The CTR shall cover intentional and spurious performances. The effective use of the orbital resources leads in practice to a judgement on the frequency / orbit efficiency of the S-PCN for which the handset is made. This question should be solved long before a specimen handset is offered type approval testing because it should guide investment decisions.

Note that there are no essential requirements related to protocols on the user radio interface, and so there may be implications for protection of the fixed network (see subclause 9.2.7.1). The cases 1 and 2 present situations where the fixed network can be protected, either through standardization of a user access protocol at the radio interface or at the interface between networks respectively. Protocols on the radio interface are proprietary. Therefore, the degree of access via the radio interface to network protocols of the fixed network becomes unspecified.

As a minimum, these essential requirements should be detailed, and test methods should be defined as far as possible. There is a problem in that the exact characteristics of the S-PCN for which terminals will have to be type approved are not yet known. Especially in the establishment of test specifications it is of great help when these characteristics are known, because it simplifies the translation from a test objective to a practical implementation. Where system characteristics are unknown, test objectives have to remain generic and test descriptions have to leave open details of implementation.

Practical implementation of the tests will require the availability of a device that simulates the S-PCN towards the S-PCN / MES. Especially since S-PCN / MESs seem unlikely to be allowed to transmit without or before receiving a signal from an S-PCN of its own type, an equipment under test could not be made to transmit without such a device and tests of spurious emissions could not be performed. This device needs to be constructed after the specific system characteristics of the S-PCN, its design may necessitate the co-operation of the system proponent. With the specification of this test device, the practical tests can be specified much more exactly.

The whole subject of test specifications is less problematic if an S-PCN is designed according to a standard that is managed by ETSI. The practical problems would not be less, but the possibilities to contribute to a solution are much more clear for all interested parties.

An S-PCN may however be designed to a proprietary specification:

- although such a specification is not harmonized for Europe, it could be published (e.g. NMT). In that case it is necessary to establish a point where various manufacturers can obtain conformance testing of their user equipment;

- such a specification may also be not published. In this case it is not possible to create access for different manufacturers via type approval.

9.2.7.2 Type approval strategies for dual-mode handsets

Handsets for S-PCN will in general be dual-mode, so that the user can take the benefit from the combined terrestrial coverage and space coverage. This will occur especially in areas where there exists considerable terrestrial coverage as is the case in Europe for GSM.

The fact that a handset is both a MS (in terrestrial mobile network terms) and an MES (in S-PCN terms) is likely to create problems in the steps that should lead to type approval for any of the two. For proceedings that are recognisable and accessible to all interested parties, it is necessary that a common approach be explicitly adopted and communicated.

There needs to be a separate possibility to apply for conformance testing / certification / type approval of a multi-mode terminal. This procedure should require that a multi-mode handset subsequently passes the type approval for each of the types of terminals that are built together in the mode in which the handset operates in only that mode. In addition the handset needs to pass additional test specifications that should be developed to deal especially with the fact that multiple applications are active in parallel in the same equipment and the adverse effect that this may have on operation.

The different cases that should be tested are summarised below for the dual-mode case. For multi-mode terminals, that contain more than two types of terminals, the number of combinations will increase:

1) at the start of operation at the process of selecting a mode, to verify:

    a) that MS / MES will log on to the correct (type of) network under varying conditions;
    b) that the handheld provides options to the user that determine the behaviour of the handheld;
    c) that the options that are offered are sufficient and functioning;

2) in MS-only mode, because the terminal needs type approval as a GSM terminal;

3) in MES-only mode, because the handset needs type approval as a S-PCN handset;

4) in MS-mode, with the MES option accessible, to study adverse affects resulting from the concurrently running MES application (pulling out of terrestrial mode without clearing the terrestrial connection etc.);

5) in MES mode with the MS option accessible, to study adverse affects resulting from the concurrently running MS application (pulling out of satellite mode without clearing the satellite link etc.);

6) during operation with transition of the mode of operation, to confirm correct handling of procedures that are related to changing the network to which the handheld is logged on (authentication, MM registration / de-registration, UPT registration etc.).

When a combined GSM / S-PCN terminal is being tested for type approval as GSM terminal, it is connected to the GSM System Simulator. If the MS / MES is set to GSM-only-application, then the test procedures are not influenced by the fact that there is an MES built into the same cabinet, and all the tests can be carried out as for a normal GSM terminal. This applies not only for GSM but also for NMT and probably more cellular system standards. The same applies to the operation in S-PCN-only mode, so that cases 2 and 3 should be easy to cover.

For the other cases, the test objectives need to be defined.

9.2.7.3 Multi-mode terminals and the choice between terrestrial or satellite communications

For a dual-mode S-PCN user equipment, exposed to coverage by only one of the systems that it supports, there is no ambiguity regarding the system to employ. As soon as a user equipment is in the service area of different systems at the same time there needs to be provisions to make a selection decision between the different possibilities.

There may be facilities to make the multi-mode handset select automatically between the different possibilities. Algorithms can be implemented that select terrestrial coverage where that is available, so that use of the scarce satellite resource is optimised. This may create the cheapest communications for the user and help to prevent overload of the S-PCN, see also subclause 9.2.2.1.2.

It may well be that licences for S-PCN contain a restriction to provide service only where the users are not in a PLMN service area. This can be supported easily by such an algorithm, but would need to be justified for regulatory reasons.

For example, where a multi-mode user equipment also supports a cordless telephone implementation, using a cordless telephone connection will in general be preferred by the user for economic reasons. This coincides with the motivation that regulators may have to optimise use of the scarce satellite frequencies.

Selection by algorithms can be subject to setting by the user. There can be (special) circumstances in which a user would prefer satellite services over terrestrial service (e.g. because that is cheaper).

In conclusion, there seems not to be an argument to require that an S-PCN / MES must always first attempt to establish terrestrial communications, but merely to require that the user can make a pre-setting to determine the type of access that the terminal would attempt, taking account of terrestrial coverage.

There are further aspects related to the support of UPT. In general a multi-mode user equipment may be unable to operate in more than one mode at a time. Therefore a change between communication modes should be accompanied with a change in the address where the S-PCN user is registered as a UPT user. If the terrestrial network and the S-PCN are integrated then a new UPT registration will not take place.

9.2.7.3.1 Application to standardization

For regulatory reasons or for reasons of satellite resource optimisation, an automatic selection algorithm selecting preferably terrestrial communications may be required.

For networks that support UPT, it may be required that multi-mode terminals will have adapted UPT registration facilities to automatically register when switching between modes.

9.2.7.4 Type approval of gateways

If the approach is that the NTP is at the terrestrial interface between the S-PCN and the PSTN / ISDN, the interface between the S-PCN and other networks is unlike other inter-network interfaces subject to essential requirements on:

4a) user safety insofar as this requirement is not covered by (the Low Voltage Directive);

The main issue of this aspect is a reference to the Low Voltage Directive. Apparently this will not require the development of standards by ETSI.

4b) safety of employees of public telecommunications networks operators, in so far as this requirement is not covered by (the Low Voltage Directive);

The main issue of this point is to extend the presumptions of the safety procedures of the Low Voltage Directive to apply to terminals for use at voltages below those given in the Low Voltage Directive (and not excluded from its scope). Since this essential requirement is excluded from the scope of CTRs, this will not require the development of standards by ETSI.

4c) electromagnetic compatibility requirements in so far as they are specific to TTE;

The EMC Directive applies to TTEs (S-PCNs), which assures that a TTE (the S-PCN), in its normal environment and connected to the (fixed) network, has appropriate emission and immunity characteristics for its intended application and in particular is required not to cause interference to telecommunications circuits. This Article 4c should address only those aspects that are more specific to the TTE and which are not covered by the EMC Directive. In the case of type approval of an S-PCN gateway this may apply if the gateway is also an LES.

4d) protection of the public telecommunication network from harm;

Article 4d, according to the Handbook on CTRs [21], may address matters such as terminals that divert network resources to such an extent as to risk degradation, wrong calls, or overload, for instance by excessive automatic calling, too-high power drain, or corruption of charging arrangements. Additional aspects may be related to privacy or data protection and other non-technical aspects of harm. Requirements under 4d should not cover misuse of an equipment by a subscriber, such as fraud, improper operation of leased lines etc. The Handbook on CTRs considers that "as time goes by, public networks can increasingly be expected to be more self-protecting, and there may be less need to protect the network from harm". The alternative approach, as in subclause 9.1.1.8, may present a new case to fixed network operators, in which they may now have to protect themselves in situations where the implication could be that the public finds access to network protocols that allow the creation of subscriptions or reading the subscriber database.

4e) effective use of the radio frequency spectrum, where appropriate;

This requirement applies where the TTE (the S-PCN) is connected to the fixed network via radio. In practice this would mean a microwave link. This subclause does not address the degree in which the S-PCN makes efficient use of the RF spectrum.

4f) interworking of TTE with PTN for the purpose of establishing, modifying, charging for, holding and clearing real or virtual connections;

Article 4f refers to basic call control and was written for real Telecommunication Terminal Equipment (TTE), since that is what the Directives assume to be connected to an NTP. In the case where this is an inter-network interface involving an S-PCN, however, the whole S-PCN network is effectively a terminal and the essential requirement applies to the way in which the S-PCN network interworks with the terrestrial network.

4g) interworking of TTE via the public telecommunications network, in justified cases;

Article 4g is used for end-to-end interaction between similar systems. It would normally apply to voice telephony and other cases once they have been accepted as being justified. In the case of S-PCN, one would expect that a proprietary voice encoding / decoding is applied on the link between satellite and user equipment. It could be required that on the (digital) inter-network interface this should be returned to A-law compressed 64 kbit/s. The other voice telephony characteristics, such as loudness rating, side-tone etc., are very much determined by the user equipment and are in Case 1 not subject to essential requirements. Delay requirements should be considered more in detail.

Until now, such requirements and test methods were prepared for TTE, especially for use in a type approval regime. There are supporting standards available or in an advanced state of preparation for the situations where the NTP is at a user access level, e.g. TBR 4.

However, for inter-network interfaces, the characteristics of this interface are agreed between the operators involved. Normally, these operators will resort to existing standards for these interfaces, but until now essential requirements for application of the TTE Directive in an inter-network interface have not been developed.

In principle, what could happen now through the adoption of an NTP at the inter-network interface is that there will be a new type of NTP with characteristics that differ from the NTPs implemented so far. The specific new characteristic is that it supports network protocols. A practical consequence would be that public network operators should allow access to anybody on the same type of NTP (same type of interface). The standards that would qualify for operation at the inter-network interface are:

- ITU-T inter-network standards that should necessarily be fulfilled as a condition to allow access on this new type of NTP;

- ITU-T specific interworking specifications for the specific S-PCN to publicly available signalling systems;

- additional standards for protection of the fixed network that should necessarily be fulfilled as a condition to allow access to anybody on this new type of NTP.

See also subclause 9.2.2.1 on interworking aspects.

There is not a readily available set of administrative and technical procedures, for the application of such standards because until now network interconnection was agreed between operators and the characteristics of the networks, especially if the network extensions were well known.

The instrument of type approval does not seem to fit for the application of essential requirements to gateways, because it is organised towards the assessment of a specimen, representative of the production envisaged, to meet the provisions of the Directive that apply to it. Interconnection of networks, as we consider it here, is something where multiple terrestrial networks (that are not all identical) connect to a single S-PCN. The S-PCN is "one of a kind". It seems that there would be differences of the interconnections to the various terrestrial networks due to the terrestrial networks themselves, rather than due to the S-PCN. These differences may result in services being offered.

If the exact details of the interface remain to be settled with fixed network operators, then individual standards may have to be published in each Member State for connection of any party, including individuals, to the NTP (88/301/EEC [10]).

10 Systems not supporting mobile voice telephony service

ETSI has already presented (in the ETR 093 [1]) information regarding a number of proposals for NGSO based S-PCNs not supporting real time mobile voice telephony service (called "non-voice" systems hereafter), which have also been regarded as S-PCN, principally because they have the capability to offer data services globally to handheld terminals and thus to offer services which are "PCS-like" in their nature.

In developing this study of the options for standardization of S-PCN, the analysis of these non-voice systems was identified as a matter for study with low priority. To achieve an analysis of the non-voice systems, this clause reviews the areas of standardization identified in the previous clauses as applying principally to the "voice based S-PCNs" (which term is used hereafter to refer to the S-PCNs operating primarily in the 1 - 3 GHz band and analysed in clauses 8 and 9) and considers what might be relevant to non-voice S-PCN and how it could be applied.

In the context of this ETR, the non-voice systems are regarded as those that have never been designed to support, and in principle are not capable of supporting, a real time, bi-directional voice service. It is possible to conceive of the use of a voice based S-PCN system, perhaps operating in the 1 - 3 GHz band, for the provision of non-voice services, even to the level of the provision through the use of that system for a parallel or overlay non-voice network using specific terminals that could not support a voice service. A system of this kind would not be regarded as a "non-voice S-PCN" as discussed subsequently in this clause.

10.1 Applicability of the proposed S-PCN definition to non-voice systems

A general definition of S-PCN is proposed in subclause 5.5. This has been prepared specifically so as not to be dependent on the provision of a voice service or frequency band used.

In consequence, the definition is equally applicable for non-voice systems and may be used to determine whether or not a specific non-voice system is to be regarded as S-PCN within the context of this ETR.

10.2 Applicability of standards

The analysis of the non-voice S-PCNs regarding the applicability of standards can be compared in a parallel manner with the general analysis established in this ETR for the voice supporting S-PCNs. Many of the issues to be considered will be common and, on that basis, the options for standardization can be considered as broadly similar.

The following subclauses address, by reference to clause 9 of this ETR, first the standardization needed to implement the essential requirements and then that which might be considered for possible voluntary standardization.

Because of the low priority nature of this area, the analysis presented in this clause is not as detailed as that presented for the voice based S-PCNs. Areas of interest, which could be considered for further analysis, are presented, but the ideas developed here are at an earlier stage than those in other parts of this ETR.

10.3 Essential requirements

In principle the regime of standards required under the Directives to implement the essential requirements should not be greatly different for non-voice S-PCN terminals as for S-PCN terminals supporting voice. The following subclauses address each of the essential requirements and consider if the standards proposed in subclause 9.1.2 for the voice based S-PCNs would be applicable to the non-voice systems.

Note that subclause 9.1.1 has addressed in detail the manner in which the TTE Directive and the SES Directive can be interpreted. ETSI takes the view that, while a general implementation of satellite data networks might be treated in a different way, those satellite data networks that are also S-PCNs, because they meet the same definition as a voice based S-PCN, will have essentially the same nature. Thus, the arguments presented in subclause 9.1.1 are equally applicable and the same conclusions apply.

ETSI proposes that for non-voice S-PCN, as for the voice based systems, the interpretation of the SES Directive is adopted and the NTP is regarded as the interface between the S-PCN and the terrestrial interconnect point.

10.3.1 Specific essential requirements applying to non-voice systems

The following subclauses should be read in parallel with the analysis of the essential requirements as applying to voice based S-PCNs presented in subclauses 9.1.2.1 to 9.1.2.7. In this subclause only the key differences between the way in which these systems might be treated will be considered.

10.3.1.1 User safety

Essential requirements relating to user safety can be treated identically to those presented in subclause 9.1.2.1. No ETSI standardization is envisaged in regard of user safety for non-voice S-PCN and standards in this area would not be appropriate to a TBR.

10.3.1.2 Protection of employees of PTOs

As in the previous subclause, requirements relating to the protection of employees can be treated identically to those presented in subclause 9.1.2.2. No ETSI standardization is envisaged in regard of user safety for non-voice S-PCN and standards in this area would not be appropriate to a TBR.

10.3.1.3 EMC

Subclause 9.1.2.3 has presented an approach to the treatment of standards relating to EMC which can also be applied to the non-voice systems.

The main difference to be considered between the voice based and the non-voice S-PCNs is the frequency band of their operation. All of the non-voice S-PCNs identified in the ETR 093 [1] are operating or plan to operate in the VHF and / or UHF bands. On this basis, product specific emission and immunity requirements developed for voice-based S-PCN operating in the 1 - 3 GHz range would be unlikely to be of use in defining EMC requirements for the non-voice systems.

The EMC emission and immunity requirements of the non-voice systems will need to be reviewed, compared with the generic EMC specifications and the product family requirements and the possible need for a product specific EMC standard for non-voice S-PCN operating in the VHF / UHF bands determined.

Consideration could be given to clarifying the liaison statement that has been provided from ETSI STC-SES5 to ETSI STC-RES9 to include an analysis of the non-voice systems in their review of EMC requirements for S-PCN.

10.3.1.4 Protection of the public network from harm

Again, it seems likely that similar considerations to those presented in subclause 9.1.2.4 could be applied to the non-voice systems. The consideration of the terrestrial interface as the NTP means that as for the voice based systems, this essential requirement would apply at the non-voice S-PCN's interface with the terrestrial network.

10.3.1.5 Effective use of the spectrum (and orbit)

The broad range of areas that can be considered for possible standardization in this area with regard to the voice based S-PCNs (in subclause 9.1.2.5) can be seen to be, on the whole, independent of the service type for the S-PCN being considered. This is reasonable, as the areas of concern for effective spectrum use should largely be independent of the service being carried (although the actual parameters that might be expressed in a standard may be more dependent).

On this basis, all of the items considered in 9.1.2.5 for application to the voice based systems could also be considered for application to the non-voice systems. The same consideration as made in subclause 10.2.1.2.3 also applies here, namely that the frequency difference between the voice based and the non-voice systems may make the direct application of the standards developed for voice based systems not applicable, but this can be reviewed during the process of developing standards for non-voice S-PCN.

Considering the areas developed in subclause 9.1.2.5, and reviewing their applicability to the non-voice S-PCNs leads to the following:

- utilisation of correct harmonized frequency band. The frequency bands will be different, and it cannot be assumed that a decision regarding the harmonization of S-PCN bands would automatically apply to the non-voice systems; even so, if the band is harmonized then the development of standards similar to those proposed for voice based S-PCN (but taking account of the different frequency bands) seems appropriate;

- local oscillator frequency stability. This is applicable for consideration regarding the non-voice systems, but because of the differing technologies and frequencies, the standards developed for voice based S-PCN could not be applied directly;

- in-band spurious emissions. Standards in this area are applicable to the non-voice systems, but the specification itself is likely to be very different because of frequency band difference;

- emissions when the carrier is suppressed. This also seems applicable to non-voice systems and may in fact be a more stringent requirement if the large majority of data terminals are not expected to be transmitting at any one time (which seems likely in a non-voice system). The use of spot beams on the satellites is less likely, so one satellite may see within a single receiver bandwidth, many terminals that are in a switched-on but not transmitting state;

- avoidance of interference with other radio systems. This is also an area that can be considered for the non-voice systems, but as the frequency bands are different and the systems with which sharing will have to take place are also different, then the substance of standards will need to be different from those developed for voice based S-PCN;

- terminal and network control and monitoring functions. All the standards in this area considered for the voice based S-PCNs are likely to be relevant and will probably be required on the same basis as for the voice systems:

    - no transmit before receive;
    - processor or software monitoring;
    - battery power level monitoring;
    - transmit frequency subsystem monitoring;
    - power on / reset;

- multi-mode terminals. This is an interesting problem also for the non-voice S-PCNs, and its analysis needs to be based on a consideration of what possibilities exist for terminal integration. If the non-voice S-PCNs are also to have a world-wide applicability, then considerations regarding how multi-mode terminals will be type approved and treated at national borders also apply. This area will probably need further study.

10.3.1.6 Interworking of TTE with PTNE for purposes of establishing, modifying, charging for, holding and clearing real or virtual connections

The non-voice S-PCNs described in the ETR 093 [1] generally do not envisage a public network interconnect, although some systems proponents are considering this possibility, at least to the level of PSTN interconnect. It seems possible that once these systems are established, the public network interconnection will develop and interworking with at least the PSTNs, PLMNs, PSPDNs and telex can be envisaged.

This area can be considered for a possible standardization, to meet the essential requirement, in the event that it is required.

10.3.1.7 Interworking of TTE via PTNE, in justified cases

This area would need to be considered for standardization only in the event that the data services provided by the non-voice S-PCNs are regarded as justified cases. In subclause 9.1.2.7, it is noted that the requirement to treat S-PCN services as justified cases is not yet established and this also needs clarification in the case of the non-voice S-PCNs.

10.4 Voluntary standards

Application of voluntary standards for the non-speech applications will enhance the possibilities for users to connect data terminal equipment to the S-PCN / MES and for the S-PCN to interconnect to other networks. Voluntary standards will be useful in the field of services that the S-PCN will support, as well as for the interface characteristics.

10.4.1 Service aspects

The non-voice S-PCN may standardize bearer services (and eventually some teleservices) that it supports. For commercial reasons, the services offered by the S-PCN will most probably include the standard bit rates that ITU-T has standardized (e.g. V.21, V.22, etc.). For reasons related to quality of service (low bit error rate) the S-PCN may offer non-transparent services.

Non-voice S-PCNs may be constructed to support services that extend services from terrestrial networks or can ease access to a terrestrial network by making a link to the S-PCN.

Special provisions may be necessary for S-PCNs that should support the telefax group 3 service, as the satellite link may introduce a delay that creates a problem for some protocols.

10.4.2 Network aspects

General analysis of non-voice systems network aspects is for further study. Integration of messaging services with ERMES may be considered as an issue for a European implementation.

10.4.3 Security aspects

Regarding security of data, non-voice systems may be considered also as part of wireless data processing information systems and security issues may be relevant (e.g. security of stored messages, encryption of transmitted messages etc.) and the relevant Directive may apply [93].

10.4.4 Gateway aspects

The gateway to the PSTN will apply standards that are determined by the characteristics of the PSTN to which it connects. These standards will be agreed between the S-PCN operator and the PSTN operator.

When the non-voice S-PCN connects to an analogue network, it may be necessary to introduce special interworking functions (e.g. consisting of a pool of modems). The standards for these modems result from the service aspects.

10.4.5 User aspects

The same considerations of subclause 9.2.5 apply, special applications are for further study. Control of the non-voice mobile station might take place from the DTE (see subclause 10.4.6). Data calls might be initiated or received automatically without direct user intervention.

10.4.6 Terminal equipment aspects

In data communication, the S-PCN / MES might not include the Data Terminal Equipment (DTE). The S-PCN / MS may instead provide the function of a Data Circuit Endpoint (DCE), offering to the user an R interface (e.g. V.21, V.22, etc.) or an S interface (ISDN interface) to which the user can connect a DTE of his choice.

11 Views on S-PCN standardization expressed by interested communities

At an early stage in the work which has led to this ETR, it was recognised that to obtain a good understanding of the support that might arise for particular options for S-PCN standardization, it could be useful to survey the views of the interested communities upon whom the decisions regarding standardization might have the greatest impact.

To achieve this survey, ETSI has sought the views on S-PCN standardization of the communities of interest through the use of a questionnaire. The questionnaire asked the respondent to consider a substantial set of possible standards for S-PCN and rate them on a scale of 1 (highly desirable) to 5 (highly undesirable) and also to answer some specific questions about S-PCN standardization. The text of the questionnaire is included in this ETR as annex A. The questionnaire was developed by ETSI, based upon the work presented in this ETR, but the communities of interest were not asked to review or comment on the contents of the ETR itself. Thus, this survey of interested communities was seen by ETSI as a method to enhance the quality of this ETR, not as a means of revision of its contents itself with bodies outside of relevant ETSI committees.

The questionnaire was distributed widely to a list of addresses including:

- S-PCN system proponents;
- manufacturers;
- mobile and fixed network operators;
- regulators;
- user groups.

The number of responses was small but the replies are interesting nonetheless. The small response stems more from the fact that the issues relating to S-PCN are very new, and thus many organisations may not have yet established a view, rather than through lack of interest.

In the subclauses that follow, the replies received are analysed in a general way for organisations falling into various classes. The analysis does not attribute any view to a particular organisation, but instead summarises responses in a general way. The analysis mainly highlights where particular support or particular objections were raised to specific proposals, not discussing in detail neutral or non-committal views.

Although, of course, organisations belonging to one particular group, such as system proponents or manufacturers, have no possibility to have their opinions given enhanced weight when considering which standards could be developed, and all ETSI members have an equal right to express their opinions on the development of standards, it has been felt, nonetheless, that it is interesting to consider the survey responses by the class of organisation to find if a particular group might express a specific view on standards development for S-PCN.

11.1 S-PCN system proponents

Replies were received from three of the proponents of the 1 - 3 GHz voice based S-PCNs; no replies were received from non-voice S-PCN proponents.

Essential requirements applying to the S-PCN handset

In general the S-PCN proponents seem to find favour with the majority of the essential requirements proposed for the handset, rating most of the options at highly desirable or useful.

None of the proponents supported a standard on efficient modulation and access (two rated this highly undesirable). One regarded a standard for in-band emission limits as not useful. In a more detailed response, one proponent made the following points:

- that a standard on EMC immunity would not be useful as this should be open to technical-economical optimisation controlled by user demand;

- that interference to other services should be ensured by controlling out-of-band emissions and use of the correct frequencies;

- that efficiency of modulation is a complex system engineering task, to be considered for optimisation and competition between operators, rather than standardization.

Essential requirements applying to the S-PCN gateway

Two of the three system proponents found most of the options proposed for gateway essential requirements as acceptable rating most at highly desirable or useful. Again a standard on efficient modulation and access did not find favour, and one proponent thought that in-band emission limits were not useful.

A third system proponent regarded all standards options proposed in this area as highly undesirable, stating that the technical characteristics of the S-PCN gateways are very similar to gateways serving fixed satellite networks and that existing regulations for the radio and terrestrial interface should be applied to S-PCN.

Regarding PTN interworking, it was felt that the gateway would have to meet the local interface and interworking requirements and established standards already exist. No S-PCN interworking features were felt necessary as S-PCN should be regarded as an extension to terrestrial networks.

Voluntary standards - service aspects

One of the proponents found all but one of the options proposed for service standardization as useful stating that standardization in this area should be based on international standards.

A second proponent indicated that standards defining the teleservices and supplementary services supported would be useful, but that standards on service availability and quality would not be useful. Both of these proponents regarded a standardization of the S-PCN to service provider interface as highly undesirable.

A third system proponent regarded all standards options proposed in this area as highly undesirable, commenting that the items indicated in the questionnaire were generic to communications networks and that they would respond to customer requirements on service quality, if these arise.

Voluntary standards - network aspects

One proponent rated all standards options proposed for network aspects as highly undesirable stating in detailed comments:

- that inter-network interworking requirements to PSTN and PCNs are well established and no S-PCN specific need was identified;

- that regarding numbering and identification, S-PCN is anticipated to be part of a general network evolution, again requiring no specific standards;
- that integration, while important to users, can be implemented through dual-mode terminals and / or intelligent network features and will not require any specific standardization for S-PCN;

- that network management is a regulatory issue for national licensing procedures, if required by specific countries, and no S-PCN standardization need is identified.

The other two proponents gave the following indications:

- regarding interworking with the PSTN, one proponent took a neutral view on all options, one found the proposals useful, indicating that standardization in this area should be based on international standards;

- both proponents were neutral regarding standards on interoperability with PCNs;

- on numbering and identification, one proponent was neutral on all points except for S-PCN support of UPT, which was considered not useful. The other proponent considered rules on IMSI assignment and common European numbering requirements highly desirable, UPT support useful, but a European numbering space for S-PCN not useful;

- options for standards on the integration of S-PCN with GSM / DCS-1 800 were all considered useful by one proponent, except for a possible standard on frequency sharing at the BES by Radio Resource Management (RRM), which was rated not useful. The other found standards on split billing and location area identification highly desirable, a standard on the use of the GSM 'A' interface for S-PCN access useful (provided it was restricted to the call control and mobility management layers), was neutral regarding frequency sharing at the BES by Radio Resource Management (RRM) and rated all other options highly undesirable;

- both proponents found standards options relating to integration with other mobile systems useful or were neutral;

- one had a neutral view on network management options, while the other considered a standard on facilities to exclude communication from the S-PCN to a national territory as highly desirable but facilities to exclude satellite transmissions from the S-PCN to a national territory highly undesirable;

- no views were expressed on standards for technical factors to support billing and charging;

- one proponent regarded standards on network architecture aspects as highly undesirable, whilst the other had no view;

- one proponent regarded standards to support VPNs on S-PCN as highly undesirable, whilst the other had no view.

Voluntary standards - security aspects

One proponent found all standards options proposed for security aspects to be useful.

A second stated that all proposals were highly undesirable as they were regulatory issue for national licensing procedures, if required by the law in specific countries.

A third proponent regarded user confidentiality as highly desirable, most other options as useful, had a neutral view on requirements for protection over the radio interface and had no view on an authentication procedure compatible with GSM and system fault tolerance and survivability standards.

Voluntary standards - gateway aspects

One proponent rated these options as highly desirable, whereas the other two proponents rated them highly undesirable.

Voluntary standards - user aspects

One proponent rated all proposals regarding the user aspects as highly undesirable, a second rated all options as useful except for access to S-PCN for people with special needs (neutral view) and special number support (highly undesirable). A third proponent considered special number support to be useful, had a neutral view on harmonization of tones and access for people with special needs but rated all other options as not useful.

Voluntary standards - S-PCN mobile station aspects

One proponent regarded all standards options proposed here as highly undesirable, except for SIM operation and interfacing which was considered useful. A second proponent indicated that all options were useful except for a consideration of a standard air interface, which was highly undesirable.

A third proponent rated all options undesirable, indicating in a detailed comment that S-PCN is an evolving technology and will build on experience of other mobile systems, but because S-PCN is a first generation system it would not be appropriate to fix too many details in a standard, leaving no room for future development. This proponent stated that it was important to establish an open market for terminal equipment and anticipated that this would be achieved by publishing the radio interface specification and other necessary technical information, and making it available to terminal equipment manufacturers on fair trade conditions.

European S-PCN system specification

None of the proponents regarded the option for the development of a comprehensive European S-PCN system specification favourably, all rating it as highly undesirable. Two of the proponents found the possibility of a comprehensive specification as an extension to GSM to be more interesting, rating it useful, while the third also found this approach highly undesirable.

Detailed questions

- support for voluntary standards beyond the essential requirements;

  Generally the proponents seem to favour a limiting of the development of standards to the essential requirements, although one would favour voluntary standards.

- requirement for standards other than those in the questionnaire;

  None were identified.

- extension to the GSM standards to support S-PCN;

  Two proponents supported this approach, one stating that S-PCN standards in this area should cross-reference to GSM, extending or modifying them for satellite applications. The third proponent did not support the extension of the standards.

- development of a European S-PCN through an organisational approach like GSM;

  None of the proponents supported this approach, generally giving the view that the GSM approach is not applicable, one stating that it would not be beneficial.

- standards for internal S-PCN interfaces;

  This consideration was not supported by any of the proponents.

- possibilities for integrating S-PCN into multi-mode handsets;

  All proponents envisaged possibilities in this area, noting that the main systems of interest for integration are GSM / DCS-1800 / PCS-1900.

- support for S-PCN standardization to support UPT;

  Two proponents noted that the first generation S-PCNs will not be appropriate for UPT support, one noting that they will be available in the pre-UPT era. They indicated, however, that in the long term, UPT support could be considered. The third proponent stated that they would introduce developments beneficial to their customers as they emerged, but did not envisage any UPT related standardization requirements at this time.

11.2 Manufacturers

Replies were received from two manufacturers: one a manufacturer of space segment equipment; one of ground segment / handsets.

Essential requirements applying to the S-PCN handset

The manufacturers seem to find favour with the many of the essential requirements proposed for the handset, rating most of the options at highly desirable or useful, although a number of specific items were not supported.

Neither of the manufacturers supported a standard on efficient modulation and access (both rating this highly undesirable). Neither supported standards for local oscillator frequency stability, one regarded a standard for in band emission limits as highly undesirable and one did not support a standard for carrier suppression.

Essential requirements applying to the S-PCN gateway

Both manufacturers found most of the options proposed for gateway essential requirements as acceptable, rating most at highly desirable or useful. Again a standard on efficient modulation and access did not find favour, and one proponent thought that standards for in-band emission limits, local oscillator frequency stability and antenna profiles and off-axis EIRP limits were not useful.

Voluntary standards - service aspects

The manufacturers had mixed views regarding the options proposed for service standardization. Both regarded standards for service availability and support for supplementary services unfavourably. Both supported as useful standards for teleservices supported and on the interface to the S-PCN service provider. One did not support a possible standard on service quality.

Voluntary standards - network aspects

The manufacturers gave the following indications in this area:

- regarding interworking with the PSTN, both supported the proposals, one rating all as highly desirable and the other rating all as useful;

- one manufacturer regarded standards on interoperability with PCNs as not useful, whilst the other thought that they would be useful;

- considering numbering and identification, the manufacturers were generally in support of the standards proposed, although one considered that S-PCN support of UPT was highly undesirable;

- options for standards on the integration of S-PCN with GSM / DCS-1800 received a mixed response although some standardization in this area was supported. One manufacturer regarded standards on the use of the GSM 'A' interface for S-PCN access and procedures to implement remote S-PCN shutdown as highly undesirable and standards on split billing, call re-establishment, services supported by S-PCN and Radio Resource Management (RRM) as not useful. The other manufacturer regarded standards on speech transcoding, call re-establishment, authentication and ciphering and Radio Resource Management (RRM) as highly undesirable and standards on use of the 'A' interface and split billing as not useful.

- both manufacturers regarded standards options relating to integration with other mobile systems as highly desirable or useful;

- one regarded network management options as highly undesirable, while the other considered a standard on facilities to exclude communication from the S-PCN to a national territory as highly desirable but had a no view regarding facilities to exclude satellite transmissions from the S-PCN to a national territory;

- both regarded standards for technical factors to support billing and charging as useful;

- neither manufacturer supported standards on network architecture aspects;

- one manufacturer regarded standards to support VPNs on S-PCN as not useful, whilst the other regarded this as useful.

Voluntary standards - security aspects

One manufacturer found all standards options proposed for security aspects to be highly undesirable. The other regarded some elements as useful, but had a neutral view on protection over the radio interface and provision for legal tapping of supplementary service parameters and felt that standards for user data and location confidentiality were not useful.

Voluntary standards - gateway aspects

Both manufacturers supported the option for standardization of the sharing of S-PCN access gateways by operators, one as highly desirable and the other as useful. Regarding the requirement for gateway service area definition, one had no view whilst the other regarded this as highly undesirable.

Voluntary standards - user aspects

Generally, standardization in this area was not supported by the manufacturers, with most options being rated as not useful or highly undesirable. Both manufacturers supported standardization regarding special number support. One thought that standards for the user interface, minimum user control procedures, and S-PCN access for people with special needs could be useful.

Voluntary standards - S-PCN mobile station aspects

One manufacturer regarded all standards options proposed here as highly undesirable. The second indicated that most options were useful except for a consideration of a standard air interface, which was highly undesirable and a limitation on automatic call repetition, which was not useful.

European S-PCN system specification

Neither manufacturer regarded the options for the development of a comprehensive European S-PCN system specification and for the possibility of a comprehensive specification as an extension to GSM favourably, both rating them as highly undesirable or not useful.

Detailed questions

- support for voluntary standards beyond the essential requirements;

  One manufacturer supported this, limited to network integration matters. The other thought that this should only be considered once the essential requirements were established.

- requirement for standards other than those in the questionnaire;

  One manufacturer thought that terminal type approval standards should be considered.

- extension to the GSM standards to support S-PCN;

  The general use of the standards was supported, one manufacturer noting that the scope of this should be limited. Regarding the possibility of exploiting the GSM A interface to provide a shared satellite component for multiple operators, one manufacturer felt that this should remain a proprietary matter.

- development of a European S-PCN through an organisational approach like GSM;

  Neither of the manufacturers supported this approach.

- standards for internal S-PCN interfaces;

  This consideration was not supported by one of the manufacturers, stating that it would depend on the architecture choice at the space segment level and would be proprietary. The second manufacturer thought that this should be considered, but that the form would depend upon the level of integration between satellite and cellular systems.

- possibilities for integrating S-PCN into multi-mode handsets;

  One manufacturer did not have plans for nor envisage this possibility, while the other considered this likely, stating that all regional terrestrial cellular standards are possible candidates, but this will be market dependent.

- support for S-PCN standardization to support UPT;

  One manufacturer supported this possibility, whilst the other considered that UPT should only be considered for UMTS / FPLMTS.

11.3 Network operators

Replies have been received by seven network operators, making this group of replies the most numerous. Of these replies four were from mobile network operators, the other from operators having also a mobile services division. Almost all of the replies included some general comments. One operator was not in a position to provide a detailed reply to the questionnaire and another one provided only replies to the concluding questions.

Essential requirements applying to the S-PCN handset

The operators are in favour of these essential requirements, rating them as highly desirable. The only question showing considerable differences in the reply was the essential requirement on efficient modulation and access: two rated this as highly undesirable and not useful, one took a neutral view, the remaining operators considered the issues as one where essential requirements would be highly desirable.

In a detailed response one of the operators stated that:

- the essential requirement on in-band emissions limits defining an envelope mask should be understood to include emission limits defining an envelope mask outside the frequency band used by the S-PCN terminal;

- the essential requirement on avoidance of interference to terrestrial and space systems (including Radioastronomy) could be generalised into "compatibility criteria with the other permitted services or systems" in order to cover both the interference cases to and from the other services;

- the essential requirement on the multi-mode handset is highly desirable when considered as a sub-case of the essential requirement on the carrier suppression when the handset is switched-on but not transmitting, to limit interference within a network (idle mode suppression).

Essential requirements applying to the S-PCN gateway

These essential requirements received in general a high grade of desirability (most of the grades are highly desirable or useful). Again the question raising different answers is the efficient modulation and access: one operator considers the essential requirement on efficient modulation and access as highly undesirable, one takes a neutral view, the others consider this issue as highly desirable or useful.

The essential requirement on interworking of TTE via PTN, in justified cases, receives positive answers. One operator considers it as not useful.

In a detailed response one of the operators stated that:

- the essential requirement on antenna gain profile mask (to protect other satellite systems) should be considered as highly undesirable in transmitting mode as it should be already covered by EIRP mask. In receiving mode it should considered as useful;

- the essential requirement on avoidance of interference to and from terrestrial systems should be covered as an EMC harmonized standard.

Voluntary standards - service aspects

Three operators quoted these standards as highly desirable or useful, two quoted them as not useful or highly undesirable. The standard regarding the requirements for teleservices supported received all positive answers.

In a detailed response one of the operators stated that:

- the requirements for teleservices are considered useful and the network capabilities must be specified to comply with the inter-working and air interface requirements but a minimum set of teleservices is highly undesirable.

Voluntary standards - network aspects

Three operators are in favour of almost all the standards in this subclause, considering them as highly desirable or useful while two operators have less uniform grades in their answers. Of the first group there is one operator that has a neutral position on the network management aspects and one considering split billing not useful.

Only one operator does not favour the standard on an additional GSM layer 3 procedure to implement remote S-PCN MS shut down, considering it as not useful. The other replies on this item rate it as highly desirable or useful.

The standard on speech transcoding is considered useful. Only one operator grades it as highly undesirable.

In a detailed response one of the operators stated that:

- the S-PCN support of UPT is important in the long term, but not important in the short term;

- frequency sharing is essential but a standard on Radio Resource Management (RRM) is not desirable;

- their position on the interworking function to support roaming is neutral. This issue should be studied later for other mobile systems but a standard on the roaming capability is an essential item to be included in the issue on integration aspects with GSM / DCS-1800.

Voluntary standards - security aspects

Standards in this area have been given a positive or neutral reply by the operators community.

One operator considers not useful a standard on split billing as related to user location confidentiality.

One operator considers not useful a standard on the provisions for supplementary services parameters and on positioning information as related to requirements to allow legal tapping of communications.

Voluntary standards - gateway aspects

Standards in this area have been given a positive (highly desirable) or neutral reply by the operators.

Voluntary standards - user aspects

The replies show a uniform consideration of a standard on special number support as useful or highly desirable.

The replies to the other points are mixed: one operator considers the majority of the standards in this part as not useful. One operator considers almost all the standards identified as highly undesirable. Two operators considers the majority of standards in this part as highly desirable.

Voluntary standards - S-PCN mobile station aspects

Four operators consider the standards in this area as highly desirable or useful. One has graded most of the standards as highly undesirable.

In a detailed response one of the operators stated that:

- the standard on echo return loss must be consistent with standards on interworking with PSTN, inter-operability with PCNs, integration aspects (with GSM / DCS).

European S-PCN system specification

One operator considers an original European S-PCN system specification as highly desirable. One considers it as useful; one has a neutral position and two provide negative answers considering it as an highly undesirable set of specifications.

Four operators are in favour of a comprehensive European system specification as an extension of GSM, considering the issue as highly desirable. One considers the specification as highly undesirable.

Detailed questions

- support for voluntary standards beyond the essential requirements;

  All but one replies were positive.

- requirement for standards other than those in the questionnaire;

  One operator envisages the development of standards to support multiple access schemes, including CDMA and ATDMA, and support of future GSM services such as the Packet Radio Service.

- extension to the GSM standards to support S-PCN;

  All but one replies were positive.

- development of a European S-PCN through an organisational approach like GSM;

  Five replies were received: two operators replied positively and three negatively.

  Two other replies, given in form of comment stated respectively that:

  - a European system specification would not be beneficial to S-PCN and that ETSI and ITU should work closely together to establish global standards on this subject;

  - the market in Europe is not sufficient to support a programme of standardization of equipment or air interface similar to GSM;

- standards for internal S-PCN interfaces;

  Four replies were received: one is positive (stating that interfaces to be considered should be primarily those applicable to the space segment determining the quality of service); three replies were negative.

- possibilities for integrating S-PCN into multi-mode handsets;

  All the replies envisage a multi-mode GSM / DCS S-PCN handset.

- support for S-PCN standardization to support UPT;

  The replies consider this option as an attractive one.

11.4 Regulators

Replies were received from two regulators.

Essential requirements applying to the S-PCN handset

The regulators seem to find favour with the many of the essential requirements proposed for the handset, rating all but one of the options at highly desirable or useful. There was only a divided view on immunity requirements (highly desirable / not useful).

Essential requirements applying to the S-PCN gateway

Both regulators found all but two of the options proposed for gateway essential requirements highly desirable or useful.

There was a divided view on immunity requirements (highly desirable / not useful) and on interworking of TTE via PTN in justified cases (useful / not useful).

Voluntary standards - service aspects

The regulators had diverting views regarding the options proposed for service standardization. One regulator rated all these standards as highly desirable, the other rated all these standards as not useful.

Voluntary standards - network aspects

The regulators gave the following indications in this area:

- regarding interworking with the PSTN, both supported all the proposals with the same rating as highly desirable;

- one regulator regarded all the proposed standards on interoperability with PCNs as highly desirable, whilst the other took a neutral view on all of them;

- considering numbering and identification, the regulators were generally in support of the standards proposed, rating each of them as highly desirable or useful;

- options for standards on the integration of S-PCN with GSM / DCS-1800 received a mixed response although some standardization in this area was supported. In general the options presented here were considered with a neutral view or seen as not useful, with a few exceptions: one regulator considers a standard on speech transcoding, as well as on authentication and ciphering procedure on S-PCN access and additional GSM layer 3 procedures to implement remote S-PCN MS shutdown (the latter under essential requirements) as highly desirable. Both regulators appreciate a standard on means to perform frequency sharing and co-ordination at BES by Radio Resource Management (RRM) (highly desirable / useful);

- regarding standards options relating to integration with other mobile systems, one regulator considered all the proposed standards as useful, whilst the other had a neutral view on every proposal;

- all network management options were considered as highly desirable by both the regulators;

- standards for technical factors to support billing and charging were considered by one regulator as highly desirable, whilst the other maintained a neutral view;

- one regulator rated standards on network architecture aspects as highly desirable, whilst the other maintained a neutral view;

- regulators regarded standards to support VPNs on S-PCN with a neutral view or no view.

Voluntary standards - security aspects

Both regulators considered almost all the proposed standards as highly desirable or useful. The only exception is system fault tolerance and survivability which was rated by one regulator as useful and on which the other maintained a neutral view.

Voluntary standards - gateway aspects

There was no clear common view of both regulators on gateway aspects. Whilst one regulator maintained a neutral view on the need for such standards, the other felt that a requirement for gateway service area definition is highly desirable and a standard on sharing of S-PCN access gateways by network operators was useful.

Voluntary standards - user aspects

On standards for "user interface", "minimum user control procedures for call set-up", "user indications and responses necessary to ensure user co-operation in ensuring operation of the handset to achieve a usable link" and on "procedures for supplementary services access and control", one regulator has a neutral view whilst the other felt that all these were highly desirable.

Both regulators consider standards for harmonization of tones as useful.

A standard on national language support was considered highly desirable / useful.

Both regulators consider a standard on special number support as useful.

Standards on "system and user response times" as well as on "access to S-PCN for people with special needs" were considered useful by one regulator whilst the other had a neutral view on both.

Voluntary standards - S-PCN mobile station aspects

In general, both regulators regard all the proposed standards as highly desirable, but there are a few exceptions:

- one regulator had a neutral view on "limitation of automatic call repetition";

- the other regulator had a neutral view on "echo return loss" and rated "SIM operation and interfacing" as useful.

European S-PCN system specification

Both regulators consider a comprehensive European system specification as an extension to GSM as useful.

An original comprehensive European system specification for an S-PCN is considered highly desirable by one regulator and as useful by the other.

Detailed questions

- support for voluntary standards beyond the essential requirements;

  Both regulators support this; one regulator pointed out that voluntary standards are essential in order to allow for an open system, like GSM or DCS-1800.

- requirement for standards other than those in the questionnaire;

  One regulator expressed no view, the other felt that standards should be developed for bearer services supported, for network capabilities needed, for access and network signalling and for the mobile application part.

- extension to the GSM standards to support S-PCN;

  This was supported by both regulators. One regulator amplified that GSM standards should be used as far as practicable.

- development of a European S-PCN through an organisational approach like GSM;

  Both regulators supported this approach.

- standards for internal S-PCN interfaces;

  Neither of the regulators expressed an opinion on this.

- possibilities for integrating S-PCN into multi-mode handsets;

  Neither of the regulators expressed an opinion on this.

- support for S-PCN standardization to support UPT;

  Both the regulators supported such standardization.

- general comments

  One regulator added the following comment: "Regarding Type Approval standards, the relevant Directives are: 91/263/EEC and 93/97/EEC. If a de facto standard is to be avoided, S-PCN terminals must be considered as being indirectly connected to the Public Telecommunications Network. In this way, an approach similar to that of the GSM can be followed by establishing an universal access and the associated requirements according to the Article 4f of the TTE Directive".

11.5 User community

No replies were received from user community representatives.

12 Conclusions

The ETSI activity on S-PCN standardization has to be considered with due consideration of a time frame that takes into account the S-PCN implementation and evolutionary perspective. This clause identifies a time frame for the process in such a way that, if required, the key objectives of standardization presented in clause 8 can be met in a timely manner.

Clause 8 of this ETR has analysed a comprehensive range of possible objectives in Europe, in a number of different areas, that could be supported by technical standards. This review of objectives has led to the elaboration of a detailed set of technical standards that could be considered for implementation, either as essential requirements or as voluntary standards. These are presented in clause 9 and summarised in annex C.

12.1 Standardization principles

The current approvals regime is considered to be inappropriate and potentially damaging to the development of S-PCN markets. The existence of competition between different networks should be sufficient to create an open and competitive market in handsets.

S-PCN is not analogous to GSM because:

- the development of S-PCN is being led inside and outside Europe by commercial initiatives;
- there will be different competing systems using different technical specifications;
- roaming is not a requirement because all S-PCN networks will provide coverage throughout all or almost all the world.

Requirements other than the essential requirements will only hinder the development of S-PCN within Europe. The approach to standards and approvals for S-PCN should take account of the inevitable changes that will result from the liberalisation of telecommunications infrastructure and voice services from 1998. These changes will include the removal of the distinction between public and private networks on which some approvals requirements are based, and will coincide with the introduction of S-PCN.

It is recommended that:

a) the principle of the free circulation of S-PCN handsets should be applied to guarantee their freedom of use without additional licensing procedures;

b) every effort should be made to achieve free circulation and use of handsets throughout the world, not just throughout Europe;

c) pan-European approvals and preferably global approvals for handsets should be based on essential requirements concerning safety, EMC and the effective use of the radio spectrum, orbital resources and avoidance of interference and certain other essential functionalities. Although the different S-PCN systems will use different frequencies, there should be a closely harmonized set of approval requirements for all the different systems. These requirements should be produced as European standards in co-operation with standardization bodies in other regions.

d) the gateway satellite earth stations should not be subject to pan-European approvals or to equivalent national approvals based on the current essential requirements, but to whatever approval (if any) and licensing arrangements are imposed in the country in which they are located. The reasons are:

    - the gateway stations are not production items but purpose built. There would be no benefit in pan-European approval only additional costs, delays and restrictions;
    - the signalling systems between the gateway stations and the terrestrial networks are expected to comply with existing standards;

e) there should be no requirement for the publication through a formal standardization body, such as ETSI, of the details of the handset interface protocols because:

    - S-PCN networks are not monopolies, and competition will the ensure the availability to manufacturers of necessary information;
    - confidentiality between the competing systems will stimulate innovation in service features;
    - there will be different competing proprietary interfaces and no prospect of harmonization on a global scale. In this respect S-PCN is unlike GSM;

f) account should be taken of the fact that the regime under which multi-mode S-PCN handsets will be type approved, and the possibilities for the implementation of a world-wide approach to mutual recognition of such type approvals, is likely to have a major impact on the possibilities for the world-wide operation and use of S-PCN;

g) it should be ensured that S-PCN supports interconnection and interworking with the public networks;

h) the development of suitable numbering and addressing requirements of S-PCN should be given due attention, taking into account the international nature of S-PCN and its service organisation through service providers. These considerations should also address UPT support.

12.2 ETSI activities

In the time frame of S-PCN implementation and evolutionary perspective, relevant ETSI activities are shown in figure 43. The time frame considered spans over a period of 10 years centred around the foreseen start of operation of S-PCN system proposals. The start of operation shown results from some indication given to ETSI from system proponents in the descriptions of the ETR 093 [1] and are assumed as the earliest possible dates. Figure 43 comprises international activities and formal events external and internal to ETSI (public enquiry, publication of standards) identified to be relevant to S-PCN. The events, actions and activities have been ascribed to five groups:

- system proponents;
- USA / FCC;
- bodies external (to ETSI);
- ETSI;
- test houses.

The following subclauses review the main European activities. Activities outside of Europe are discussed in annex A.

European activities identified are:

- development and conclusion of the SAINT project within the framework of RACE phase II (subclause 7.2.3);
- development and conclusion of the COST 227 project (subclause 7.2.4);
- CEPT activities (subclause 7.2.2) such as Spectrum Engineering WG results on the compatibility between MSS and other radio systems in the 1 610 - 1 626,5 MHz band;
- basic research projects of the European Space Agency (ESA) in regard to Satellite Personal Communications (SPC).

Related current and planned ETSI activities are:

- ETRs on S-PCNs options for standardization (ETR 093 [1], this ETR);
- "envelope" ETS on S-PCN voice systems operating in the 1,6 / 2,4 GHz band (subclause 7.1.1);
- "envelope" ETS on S-PCN voice systems operating in the 2 GHz band (subclause 7.1.1);
- "envelope" ETS on S-PCN data-only systems operating below 1 GHz (subclause 7.1.1);
- ETS on S-PCN Network Control Functions (NCF) (subclause 7.1.1);
- harmonized ETS(s) on S-PCN handsets;
- ETS(s) addressing essential requirements further than those in the "envelope" standards (subclause 9.1);
- ETS(s) addressing the essential requirements applying across the NTP, (i.e. the S-PCN / PTN interface);
- ETS(s) addressing the essential requirements applying to the S-PCN terrestrial interface with the PTN, in conjunction with ETSI TC-SPS;
- ETS(s) on S-PCN addressing issues further than the "essential requirements", subclause 9.1.2;

- ETS(s) on S-PCN numbering and addressing requirements (subclause 9.2.2.1.3);

- ETS(s) on GSM-satellite interworking (subclause 7.1.2);

- ETRs on UMTS satellite component (subclause 7.1.3.1);

- ETSs on UMTS satellite component (subclause 7.1.3).

Activities relevant to the test houses are:

- development of necessary Special Test Equipment (STE) and certification of test houses. These are necessary to have the technical facilities by which manufacturers of TTE may obtain "conformance test reports" to be used as a base for the process of "certification of conformity", leading to "type approval".

The identification of the duration requirements for ETSI-allocated activities has been based on the assumption that following the approval of an ETS, the time between the beginning of the Public Enquiry (PE) and Publication (P) is one year. Also, when events are proposed, the start of the events is placed at the earliest possible stage (compatible with other internal / external events). Since time intervals have been extended backward from the needed ETS publication date, shorter public enquiry to publication periods results in more flexibility in allocating ETSI phased specification drafting tasks.

The result, summarised under the general heading of "ETSI activities", marks the general time frame within which Terms of Reference (ToR) for standardization activities could be established and phased ETSI work could evolve. The overall available time is 4 years from the end of 1994. ToR have to be consistent with the decisions on the regulatory regime for S-PCN in the EEA, especially with regard to what is discussed in subclause 9.1.1. The assessment of the S-PCN regime is therefore essential prior to any possible finalization of ETSs. In any case, if S-PCN service is to begin around 1998 then the type approval regime will be needed by then, although S-PCN systems could operate for some time on the basis of national licensing, particularly during the experimental phase.

Within the ETSI time frame the WRC-95 has a position within the phase of ToR preparation that makes it possible to consider a European co-ordinated contribution to the WRC-95 as a part of the activities on S-PCN.

The most pressing ETSs are the envelope standards currently being developed by ETSI STC-SES5 as they impact on the free circulation of S-PCN handsets in Europe.

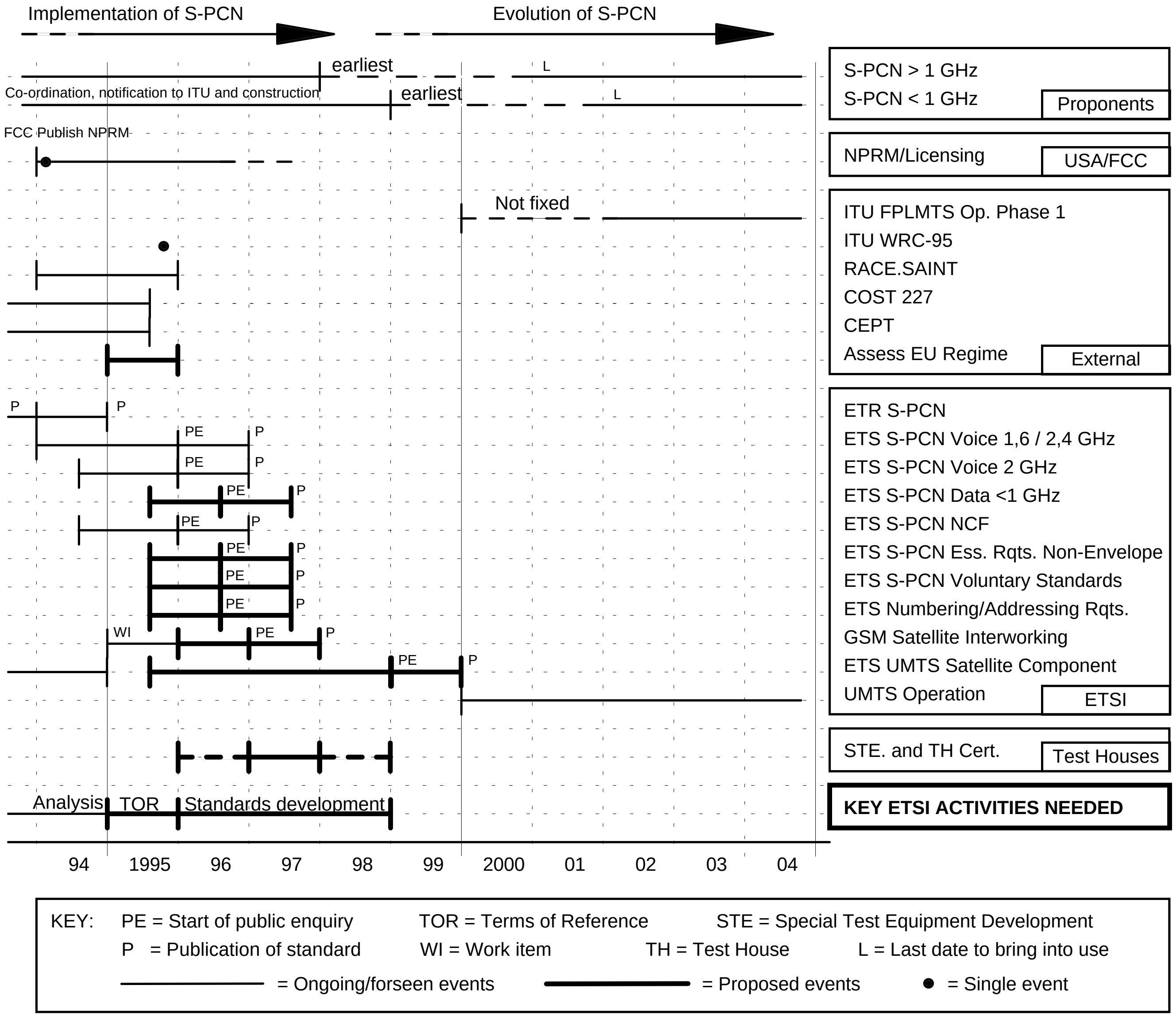


Figure 43: Time frame for ETSI standards

Annex A: S-PCN standardization activities outside of Europe

In clause 11, a number of key activities relevant to S-PCN standardization in Europe have been identified. In addition, there are certain activities in the international area (i.e. outside of Europe) that also need to be kept in mind. The international activities that have been identified are:

- development, ITU frequency co-ordination process and start of operations of S-PCN systems already proposed for the systems operated above 1 GHz (ETR 093 [1]), taking into account the requirement to bring into use the first assignment within nine years of the date of Advanced Publication (AP) (see subclause 6.2.1.1.2);

- publishing of NPRM (January 1994) and resulting licensing process in USA (subclause 6.3.1.1);

- development, approval and publishing of ITU Recommendations on FPLMTS, eventually leading to start of operation (subclause 7.2.1);

- ITU WRC-95 conference.

Annex B: Text of questionnaire sent to the interested parties

The following is the text of the questionnaire on S-PCN standardization sent to interested parties by ETSI Project Team 37V (PT 37V):

S-PCN - Options for Possible European Standardization

Survey of the Views of the Interested Communities

1. General Information About Organisation

This information is needed to present the analysis of replies in a structured way.

S-PCN System Proponent	☐	Mobile network operator	☐
Manufacturer - space segment	☐	Fixed network operator	☐
Manufacturer - ground segment / handsets	☐	Administration / Regulator	☐
User group	☐	Other (please state)..............................	☐

Country .... ETSI Member YES / NO

2. Details of Organisation

The provision of this information is voluntary

Organisation Name: ....

Address: ....

....

....

Contact Name: ....

Contact Telephone: ....

Contact Fax: ....

Are you prepared for your reply to be seen outside of ETSI PT 37V?

Yes ☐ No ☐

3. Options for Possible Standardization

PT 37V have identified the following as amongst the possible options for standardization of S-PCN. Please rate each option according to the view of your organisation, using the following rating scale:

1 = Highly desirable 2 = Useful 3 = Neutral view
4 = Not useful 5 = Highly undesirable X = Don't know

Standard	Rating 1 - 5
Essential Requirements - Standards for S-PCN Mobile Stations	
S-PCN specific EMC standards - essential requirement 4(c)	
Out of band emission limits defining an envelope	
Immunity requirements	
Effective use of the RF spectrum and orbit - essential requirement 4(e):	
Use of correct harmonized frequencies - ensuring that the handset operates within a harmonized band (if one should be implemented)	
Local oscillator frequency stability	
In-band emission limits defining an envelope mask	
Carrier suppression when the handset is switched on but not transmitting, to limit interference within a network (idle mode suppression)	
Mobile station cannot transmit unless it receives a valid network broadcast signal	
Avoidance of interference to terrestrial and space systems (inc. Radioastronomy)	
Efficient modulation and access; possibly a requirement on information bit/s/Hz (or some other approach, please state ....)	
Network control functions to ensure remote switch off and barring of mobile stations (for regulatory or other purposes e.g. malfunction)	
Multi-mode handsets including non S-PCN "fellow radio stations" - to ensure that the "fellow radio station" is not able to transmit until after receiving a valid signal from its network (to facilitate a world-wide S-PCN type approval scheme)	
Essential Requirements - Standards for S-PCN Gateways	
S-PCN specific EMC standards - essential requirement 4(c)	
Out of band emission limits defining an envelope	
Immunity requirements	
Protection of the public network from harm - essential requirement 4(d): either based on existing Access standards (e.g. ETSI TBRs) or new Access standard developed for S-PCN	
Effective use of the RF spectrum and orbit - essential requirement 4(e):	
Use of correct harmonized frequencies - ensuring that the handset operates within a harmonized band (if one should be implemented)	
Local oscillator frequency stability	
In band emission limits defining an envelope mask	
Antenna gain profile mask) to protect other	
Off axis EIRP limits) satellite systems	
Avoidance of interference to GSO satellite systems when the S-PCN is NGSO	
Avoidance of interference to and from terrestrial systems	
Efficient modulation and access	
Interworking of Terminal Equipment (TE) with Public Telecommunications Network Equipment (PTNE) - essential requirement 4(f): either based on existing Access standards (e.g. ETSI TBRs) or new Access standard developed for S-PCN	
Interworking of TE via PTN, in justified cases - essential requirement 4(g): either based on existing Terminal standards (e.g. ETSI TBRs) or new Terminal standard	

Standard	Rating 1 - 5
Voluntary Standards - Service Aspects	
Service availability	
Service quality	
Requirements for teleservices supported (e.g. telephony, emergency calls, etc.)	
Minimum set of supplementary services supported (e.g. call diversion, call forward etc.)	
Standard on the interface from the S-PCN to the S-PCN Service Provider	
Voluntary Standards - Network Aspects	
Interworking with PSTN	
General requirements for interworking and terminology	
Description of services available	
Mapping of services	
Description of interworking scenarios (ITU-T Q.41/Q.14)	
Procedures for interworking	
Inter-operability with PCNs	
System selection algorithm (call set-up routing)	
Routing of traffic to preserve the quality of connection	
Principles on billing and charging (related to routing)	
Numbering and identification	
Rules to assign IMSI to S-PCN MS (SIM)	
European Numbering Space for S-PCN use	
Common European numbering requirements for mobile, including S-PCN (e.g. emergency, internationals access codes)	
S-PCN support of UPT	
Integration Aspects (integration with GSM / DCS-1800)	
Use of the GSM / DCS A interface to provide S-PCN access (Base Earth Station - BES, general aspects)	
Speech transcoding	
Split billing due to S-PCN access (to maintain location confidentiality)	
S-PCN Location Area identification	
S-PCN call re-establishment procedure	
Authentication and ciphering procedure on S-PCN access	
Services supported by S-PCN access	
General Network Management Requirements for S-PCN access (BES)	
Additional GSM layer 3 procedure to implement remote S-PCN MS shut down (under the essential requirements)	
Means to perform frequency sharing and co-ordination at BES by Radio Resource Management (RRM)	
"Integration" Aspects (integration with other mobile systems)	
Inter-working function to support roaming	
Definition of a minimum set of functionalities to support integration	
Network Management Aspects	
Facilities to exclude satellite transmissions from the S-PCN to a national territory	
Facilities to exclude communication from the S-PCN to a national territory	
Technical factors to support billing and charging	

Standard	Rating 1 - 5
Network architecture aspects	
Identification of standardized "building blocks" of S-PCN	
Standards to support Virtual Private Networks on S-PCN	
Voluntary Standards - Security Aspects	
Security aspects	
Organisation and security of subscriber data	
Authentication procedure	
Procedure compatible with GSM	
User data and Location Confidentiality (split billing)	
Requirements for protection over the S-PCN radio interface	
Requirements to allow Legal Tapping of Communications, provisions for:	
Positioning information	
Identity of the terminal and subscription	
Supplementary service parameters	
System fault tolerance and survivability	
Voluntary Standards - Gateway Aspects	
Requirement for gateway service area definition	
Sharing of S-PCN access gateways by network operators	
Voluntary Standards - User Aspects	
Standardized user interface (keypad, display, etc.)	
Minimum user control procedures for call set-up, etc.	
User indications and responses necessary to ensure user co-operation in ensuring operation (e.g. position and orientation) of the handset to achieve a usable link	
Procedures for supplementary services access and control	
Harmonization of tones	
Tones generated in the S-PCN Mobile Station	
Tones generated by the network	
National language support for system messages and announcements - messages in the user's selected language even when roaming internationally	
System and user response times	
Special numbers support (e.g. emergency services, operator assistance, international access)	
Access to S-PCN for people with special needs (e.g. disabled, elderly, etc.)	
Voluntary Standards - S-PCN Mobile Station Aspects	
Standard air interface	
Echo return loss	
Sending loudness rating	
Limitation on automatic call repetition	
SIM operation and interfacing	
European S-PCN System Specification	
An original, comprehensive European system specification for an S-PCN	
A comprehensive European system specification as an extension to GSM	

4. Questions

It would be helpful to have your views on the following questions; please continue your answers on a separate sheet if necessary:

Q1. Would you be in favour of voluntary technical standards for S-PCN in addition to those required by the essential requirements of the Terminal and Satellite Earth Station Directives?

Q2. Would you like to see the development of any standards for S-PCN other than those identified in section 3 above? Please specify what you envisage.

Q3. Would you wish to see an extension to the GSM / DCS-1800 / PCS-1900 standards that describe:

- how they can be used to the largest extent possible as an S-PCN;
- how the standard GSM A interface is used to provide connection to a single satellite component for multiple GSM / DCS / PCS operators.

Q4. Do you think that it could be interesting to consider the development of a system specification for a European S-PCN through an organisational approach similar to that taken for GSM (i.e. the establishment of an MoU on implementation and the development of technical standards by ETSI?

Q5. Do you think that it would be relevant to consider the development of standards for interfaces internal to an S-PCN? If so, which?

Q6. Do you have any plans for, or envisage the possibility of integrating S-PCN and other mobile system handsets into a dual or multi-mode handset? If so, from which mobile system would you plan to, or foresee the possibility of, integrating handsets (please quote also non-ETSI standardized systems)?

Q7. Would you support standardization of S-PCN with respect to UPT support to facilitate numbering, identification, billing, etc.?

5. General Comments

Please use this space to provide any other views or comments about possible S-PCN standardization.

Annex C: Cross-reference to standardization options for S-PCN

Table C.1 summarises all of the S-PCN standards options presented in this ETR, cross referencing them to the subclause in the ETR where the technical basis for the standard is discussed.

Table C.1: Cross-reference to S-PCN standardization options

Possible standard **Handset essential requirements**	**Reference Subclause**
S-PCN specific EMC standards - essential requirement 4(c)	
Out of band emission limits defining an envelope	9.1.2.3
Immunity requirements	9.1.2.3
Effective use of the RF spectrum and orbit - essential requirement 4(e):	
Use of correct harmonized frequencies - ensuring that the handset operates within a harmonized band (if one should be implemented)	9.1.2.5.1
Local oscillator frequency stability	9.1.2.5.2
In-band spurious emission limits defining an envelope mask	9.1.2.5.3
Carrier suppression when the handset is switched on but not transmitting, to limit interference within a network (idle mode suppression)	9.1.2.5.4
Avoidance of interference to terrestrial systems	9.1.2.5.5.1
Avoidance of interference to space systems especially Radioastronomy	9.1.2.5.5.2
Terminal control and monitoring functions	
Mobile station cannot transmit unless it receives a valid network broadcast signal	9.1.2.5.6.1.1
Processor or software monitoring	9.1.2.5.6.1.2
Battery power level monitor	9.1.2.5.6.1.3
Transmit frequency subsystem monitor	9.1.2.5.6.1.4
Power on reset state	9.1.2.5.6.1.5
Network control functions to ensure remote switch off and barring of mobile stations (for regulatory or other purposes)	9.1.2.5.6.2

(continued)

Table C.1 (continued): Cross-reference to S-PCN standardization options

Possible Standard Gateway Essential Requirements	**Reference Subclause**
S-PCN specific EMC standards - essential requirement 4(c):	
Out of band emission limits defining an envelope	9.1.2.3
Immunity requirements	9.1.2.3
Protection of the public network from harm - essential requirement 4(d): either based on existing Access standards (e.g. ETSI TBRs) or new Access standard developed for S-PCN	9.1.2.4
Effective use of the RF spectrum and orbit - essential requirement 4(e):	9.1.2.5.1
Use of correct harmonized frequencies - ensuring that the GW operates within a harmonized band (if one should be implemented)	9.1.2.5.2
In-band spurious emission limits defining an envelope mask	9.1.2.5.3
Carrier suppression for interference avoidance	9.1.2.5.4
Avoidance of interference to terrestrial systems	9.1.2.5.5.1
Avoidance of interference to space systems especially Radioastronomy	9.1.2.5.5.2
Interworking of Terminal Equipment (TE) with Public Telecommunications Network Equipment (PTNE) - essential requirement 4(f): either based on existing Access standards (e.g. ETSI TBRs) or new Access standard developed for S-PCN	9.1.2.6
Interworking of TE via PTN, in justified cases - essential requirement 4(g): either based on existing Access standards (e.g. ETSI TBRs) or new Access standard developed for S-PCN	9.1.2.7
Possible Standard: Service Aspects	**Reference Subclause**
Service aspects S-PCN mobile voice telephony specification (Support of telecommunications services) Geographical extension of service Service availability and quality (general) Mobile voice telephony service quality Mobile real time service quality Mobile store and forward data service quality Paging service quality Paging with acknowledgement service quality Two way video service quality (UMTS) Control of RF protection limits as related to service quality	 9.2.1.1 9.2.1.2 9.2.1.3 9.2.1.3 9.2.1.3 9.2.1.3 9.2.1.3 9.2.1.3 9.2.1.3 9.2.1.3
Possible Standard: Network Aspects	**Reference Subclause**
Interworking with PSTN General requirements for interworking and terminology Description of services available Mapping of services Description of interworking scenarios (ITU-T Q.41/Q.14) Procedures for interworking Requirements for the application of Q.14 and Q.41 to preserve the Quality of connection over S-PCN and PSTN Allocation of standard set of access codes for supplementary services	 9.2.2.1.1 9.2.2.1.1 9.2.2.1.1 9.2.2.1.1 9.2.2.1.1 9.2.2.1.1 9.2.2.1.1 9.2.2.1.1

(continued)

Table C.1 (continued): Cross-reference to S-PCN standardization options

Possible Standard: Network Aspects (continued)	**Reference Subclause**
Inter-operability with PCNs	
Specification of a common set of bearer services	9.2.2.1.2
Specification of common set of supplementary services	9.2.2.1.2
System selection algorithm (call set-up routing)	9.2.2.1.2
Specification of a common set of system parameters involved in the Exchange	9.2.2.1.2
of billing data	9.2.2.1.2
Routing of traffic to preserve the quality of connection	9.2.2.1.2
Principles on billing and charging (related to routing)	9.2.2.1.2
Numbering and identification	
Rules to assign IMSI to S-PCN MS (SIM)	9.2.2.1.3
European Numbering Space for S-PCN use	9.2.2.1.3
Common European numbering requirements for mobile, including S-PCN (e.g. emergency, internationals access codes)	9.2.2.1.3
UPT numbering for S-PCN	9.2.2.1.4
Integration Aspects (integration with GSM/DCS-1800)	
Use of the GSM/DCS A interface to provide S-PCN access (BES, general aspects)	9.2.2.2.1
Speech transcoding	9.2.2.2.1.1
Split billing due to S-PCN access (see also confidentiality)	9.2.2.2.1.1
S-PCN classmark	9.2.2.2.1.1
S-PCN mode of operation (card or not card operated)	9.2.2.2.1.1
Access privilege to S-PCN extension	9.2.2.2.1.2
Specification on the use of LAI in an integrated GSM/S-PCN network	9.2.2.2.1.2
S-PCN supplementary service type	9.2.2.2.1.4
Mobility management functional requirements for S-PCN extension	9.2.2.2.1.4
Radio Resource Management (RRM) functional requirements for S-PCN extension	9.2.2.2.1.4
S-PCN call re-establishment procedure	9.2.2.2.1.1
Authentication and ciphering procedure on S-PCN access	9.2.2.2.1.3
Specification of S-PCN encryption algorithm different from the GSM implementation	9.2.2.2.1.3
Use of the GSM SIM security features in the S-PCN MS Services supported by S-PCN access	9.2.2.2.1.3
General Network Management Requirements for S-PCN access (BES)	9.2.2.2.1.1
Remote S-PCN MS shut down	9.2.2.2.1.1
Means to perform frequency sharing and co-ordination art BES	9.2.2.2.1.1
Network Management and Supervision	
BSS fault isolation and recovery,	9.2.2.2.2
Space segment fault detection,	9.2.2.2.2
Spectrum monitoring,	9.2.2.2.2
Mobile station emission monitoring	9.2.2.2.2
Traffic monitoring	9.2.2.2.2
Control of transmission (possible shut down) from mobile terminals	9.2.2.2.2
Means to perform frequency band sharing and co-ordination	9.2.2.2.2
Configuration of channels in the S-PCN service band	9.2.2.2.2
Control of configurable radio link parameters	9.2.2.2.2
BES fault recovery and report	9.2.2.2.2
Integration Aspects (integration with other mobile systems)	
inter-working function	9.2.2.2.4

(continued)

Table C.1 (continued): Cross-reference to S-PCN standardization options

Possible Standard: Security Aspects	**Reference Subclause**
Functions/data of the S-PCN MS removable device:	
IMSI	9.2.3.1
Temporary IMSI	9.2.3.1
User authentication related data	9.2.3.1
Timers for network operation	9.2.3.1
Authentication algorithm	9.2.3.1
Ciphering key generation algorithm	9.2.3.1
Storage memory for calling numbers and messaging	9.2.3.1
Specification of the S-PCN MS to removable device interface	9.2.3.1
Security aspects	
Authentication procedure compatible with GSM	9.2.3.1
Security of transfer and storage of authentication data across the S-PCN	9.2.3.1
Availability of authentication data across the S-PCN	9.2.3.1
User data and Location Confidentiality	
Access to accurate position information by a legitimisation code	9.2.3.2
Split billing	9.2.3.2
Requirements for protection over the S-PCN radio interface	9.2.3.3
Requirements to allow Legal Tapping of Communications, provisions for:	
positioning information	9.2.3.4
identity of the terminal and subscription	9.2.3.4
supplementary service parameters	9.2.3.4
Possible Standard: Gateway Aspects	**Reference Subclause**
Gateway aspects	
Gateway networking	9.2.4.1
network interconnection	9.2.4.1
network access	9.2.4.1
resource assignment	9.2.4.1
satellite resource sharing and co-ordination	9.2.4.1
network resource sharing and co-ordination: Specification of:	
TTC&M	9.2.4.1
the positioning information reference monitoring and correction	9.2.4.1
space segment fault isolation and recovery	9.2.4.1
OBP and ISL routing tables maintenance	9.2.4.1
spectrum monitoring	9.2.4.1
GW configuration	9.2.4.1
GW co-ordination	9.2.4.1
GW fault isolation and recovery	9.2.4.1
S-PCN MS fault isolation and recovery by the GW	9.2.4.1
System operation data collection and analysis	9.2.4.1
Billing (consistency, data collection)	9.2.4.1
Gateway operation	
allocation of MSs to GWs and GW coverage area definition	9.2.4.2
(geographical distribution of service channels)allocation of calls to	9.2.4.2
GWs	9.2.4.2
GW interfaces constraints	9.2.4.2
Algorithm when it is necessary to ensure compliance with national or	9.2.4.2
regional carriers rights	9.2.4.2
GW management of service channels to achieve effective use of the spectrum resources	9.2.4.2
Operations and Maintenance	9.2.4.2
Interface to the Operator (O&M)	9.2.4.2
GW access and sharing among operators	9.2.4.2
operator issues	9.2.4.2
protection of other satellite networks	9.2.4.2

(continued)

Table C.1 (concluded): Cross-reference to S-PCN standardization options

Possible Standard: User Aspects	Reference Subclause
Standardized user interface (keypad, display, etc.)	9.2.5.5
Minimum user control procedures for call set-up, etc.	9.2.5.2
User indications and responses necessary to ensure user co-operation in ensuring operation (e.g. position and orientation) of the handset to achieve a usable link	9.2.5.3
Procedures for supplementary services access	9.2.5.4
Harmonization of tones	
Tones generated in the S-PCN Mobile Station	9.2.5.6
Tones generated by the network	9.2.5.6
National language support for system messages and announcements - messages in the user's selected language even when roaming internationally	9.2.5.6
System and user response times	9.2.5.8
Access to S-PCN for people with special needs (e.g. disabled, elderly, etc.)	9.2.5.10

Annex D: Security aspects - system fault tolerance and survivability

The security of the public mobile system is also related on the availability of the service it provides. The fault tolerance and the system survivability are two important requirements. The capability to cope with general emergency situations is a direct foreseeable consequence of some features of S-PCN and gives rise to a number of requirements offering options for standardization. These "backup" and "emergency" functions, particular to S-PCN, are due to the following service and system issues:

- service features:
  - capability to provide service to large areas without infrastructure in place;
  - independence from local events causing unavailability of (fixed or mobile) communications infrastructure;
  - different mobiles supported (terrestrial, aeronautical and maritime), allowing emergency use in different environments;
  - positioning information available at the user terminal and at the ground station;

- system features:
  - number of satellites and service elevation angle (ETR 093 [1], annex B: Radio Coverage)
  - possible ISL routing capability (reducing the effect of unavailability of a single GW ground station);
  - multi-satellite / multi-ground-station network serving a single large area;
  - relatively small orbital period of some constellation (reducing the effect of coverage gaps and averaging the effects of faults over the service area);
  - wide latitude coverage (averaging the effect of gaps, or in orbit failures, over populated and non-populated areas);
  - possible advanced network management functions.

Because of the system architectures, particularly those using multi-satellite constellations, S-PCN systems may provide a high degree of both availability and survivability, as pointed out in ETR 093 [1], annex C. One of the historical origins of the multi-satellite communications systems can be traced back to defence applications where the survivability is one of the most important parameters. In this context the high degree of survivability may be obtained by a "flooding" routing that does not apply in a deterministic way, having as a consequence a reduction in end-to-end throughput (see ETR 093 [1], subclause 5.2.5.3.3). In these "flooded" systems the failure of one or more satellites or of some part of the ground infrastructure has a smooth impact on the service availability. This also means that the availability requirements for a single satellite may be reduced in a civil communications system to obtain a cost effective design.

Availability is higher by increasing the number of satellites. Given a constellation the effect of single or multiple satellite failures (causing radio coverage gaps) or ground stations failure is not only related to the number of failures but also to their distribution, the management of spares and the amount of redundancy provided by network design. As a simple example, figure D.1 shows the system unavailability (in minutes) due to a single satellite failure as a function of the orbital altitude and coverage elevation angle for a circular orbit.

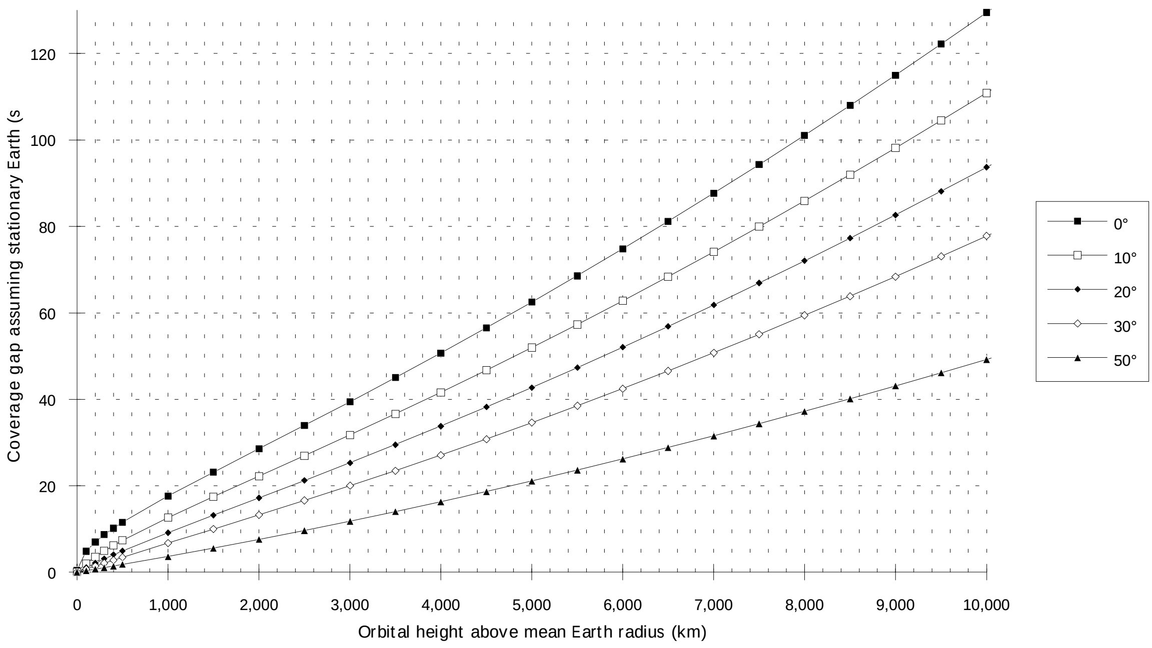


Figure D.1: System unavailability caused by a single satellite failure as a function of orbital altitude for a circular orbit

It can be seen from figure D.1 that, for a 1 000 km orbit constellation, the average time gap caused by a single satellite failure (assuming a coverage elevation angle between 20° and 30°) is between 7 and 9 minutes.

The capability to provide service with no infrastructure is the main difference when a comparison with cellular is made from the survivability side. This makes S-PCN a candidate to implement support for emergency communications.

The use of S-PCN as a "backup" could require network management functions such as:

- control the use of the resources by parties in order to share the services among may different service requests as a result of an emergency;
- allocate resources to a class of parties in the controlled area on priority or exclusive basis;
- free resources to be used by a class of parties (in an emergency);
- detect and isolate faults in ground stations and use of alternate ground stations.

A standard on the level of service maintained by the system also during emergency situations, including fault tolerance requirements, would assure the development of applications for S-PCN to be used as communications system for situations where other infrastructures are temporary or, in the medium term, out of order.

Several organisations and programmes, e.g. the EU Dedicated Road Infrastructure for Vehicle safety in Europe (DRIVE) programme, may benefit from a survivable system possibly providing world-wide access to small-size stations.

The standard may specify, among other parameters:

- the level of service under normal operating conditions;
- how system component failures affect the performance of the S-PCN (this may be broken down in several parts for multi-satellite systems);
- network management "backup" functions such as those described above, including management of system spare resources;
- the provisions and handling of emergency signals generated by handheld voice or automatic data-only terminals.

D.1 Possible applications of survivable communications via S-PCN

Certain public communications needs can benefit from a survivable system. The last point in the previous clause may be relevant to some other EEA programmes. The identification of relevant areas in such programmes which could benefit by S-PCN media technology is important within the general objective of obtaining an EEA co-ordinated approach to S-PCN.

In the DRIVE programme, a part of the application-oriented transport telematics STIG (Systemes Telematiques d'Interet General) programme, the interest in European standards, developed by ETSI and CEN / CENELEC is stressed [85]:

> "There is a particular need to establish standards for vehicle-to-roadside communications and for communications between operators, both nationally and internationally. The automotive industry has an urgent requirement for standards for in-vehicle equipment so that it can adjust its designs accordingly. Standardization should therefore proceed as quickly as possible, bearing in mind the need for validation of trial specifications in the pilot projects. The standards will in due course be adopted by the established European bodies: CEN / CENELEC and ETSI".

Some areas where S-PCN could be considered in the DRIVE framework have been here identified. They include:

- Area 5: Driver Assistance and Co-operative Driving;
- Area 6: Freight and Fleet Management;
- Area 7: Public Transport Management.

In the DRIVE projects there is already a consideration of the possible use of the satellite technology. Table D.1, based on the last report of the DRIVE project [75] shows that DRIVE projects already anticipate the use or development of GSM or satellite communications.

Table D.1: Advanced Transport and Telematics (ATT) projects anticipating the use of satellite or GSM technologies, to be considered for S-PCN fault tolerance and survivability

Number	Name	Project full title
v2012	PROMISE	PROmeteus CED 10 Mobile and Portable Information Systems in Europe
v2013	SOCRATES 2	kernel project
v2014	ICAR	Integrated Confined Area RTI communication system
v2018	QUARTET	QUadrilateral Advanced Research on Telematics for Environment and Transport
v2023	PHOEBUS	Project for Harmonizing Operations of the European BUS
v2033	LAMD	Euro-Project
v2034	FRAME	Freight Management in Europe
v2037	PORTICO	Portuguese Road Traffic Innovations on a COrridor
v2041	CITRA	System for the Control of Dangerous Goods Transport in International Alpine Corridors
v2043	ARTIS	Advanced Road Transport Informatics in Spain
v2047	PLEIADES	Paris London Corridor
v2051	IFMS	Integrated Freight Logistic Fleet & Vehicle Management System
v2054	CITIES	Co-operation for Integrated Traffic Management and Information Exchange Systems
v2055	RHAPIT	Rhine / Main Area Project for Integrated Traffic Management
v2056	CORD	Strategic Assessment of ATT Implementation

A detailed investigation on the significance of S-PCN standards on the projects on Advanced Transport and Telematics (ATT) and other EEA transport programmes is for further work. A general consideration of the survivability and service features of S-PCN should be important for standards relevant to ATT projects such as a standard on general requirements for the use of S-PCN by ATT.

History

Document history	
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