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Technical Report

Radio Equipment and Systems (RES); Radio Local Loop (RLL) Co-ordination Group; Survey of ETSI activities and recommendations for the ETSI work programme

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Radio Equipment and Systems (RES).

Introduction

There has been a rather varied history of putting radio systems into service for Radio in the Local Loop (RLL) applications. There are currently both purpose-designed systems and those pressed into service in an ad-hoc way, based on existing radio technologies intended first of all for other uses. This fact tells us that there is apparently a well-established but perhaps not overwhelming demand for RLL systems at present, and that both manufacturers and operators have been seeking cost-effective solutions to their short term needs.

Traditional local loop services, those that can today be delivered over several kilometres of copper pair cable, account for about 90 % of Public Telecommunications Operator (PTO) revenue (see ITU-T Handbook on Mobile Radio [22]). As a result, these have so far been the main focus in both ad-hoc and purpose-designed RLL systems; and basic voice telephony service (POTS) will certainly continue to be an essential part of any new RLL system. However, some of the more recent RLL systems are looking beyond basic voice telephony, whether digital or analogue. This is perhaps prompted by the development of technologies such as Asymmetric Digital Subscriber Line (ADSL) and Very high speed Digital Subscriber Line (VDSL) for delivering high-bandwidth digital carriers over copper cables. There are PTOs who already have these technologies waiting in the wings for the rise in customer demand and the right regulatory regime.

Unlike the previous ETSI report on RLL, ETR 139 [1], it is not the intention of the ETSI RLL Co-ordination Group (ERCG) to concentrate on RLL and its development in the short term. The aim of the committee is to set a longer term vision of where RLL systems should develop by the early years of the twenty-first century, and propose a means to achieve this. Our aim is to provide new services to consumers and to encourage competition for existing PTOs with established copper pair and cable plant.

In the first part of the present document, clauses 4 to 6, the reader will find examples of existing RLL systems, both ad-hoc and purpose-designed. This part deals with a survey of the standards currently existing or in development for RLL systems and the radio spectrum available. It provides a summary of each system, its relationship to the other systems described here, and offers some comment on the way in which the systems may be relevant in future RLL developments. The purpose of this part of the report is to record the background information leading to the committee's vision of the future of RLL.

In the second part of the present document, clauses 7 and 8, we put forward the view that most of the large European PTOs see their fixed networks evolving by the early years of the twenty-first century to provide broadband services to the home, see Full Services Access Networks Conference [21]. In this sense the term "broadband" implies systems capable of delivering data rates to the customer of greater than 2 Mbit/s on a continuous basis, and peak data rates in the region of 20 Mbit/s. It is this definition of broadband that we adopt in the present document. Most of the systems described in the first part of the present document may be classified as "narrowband" in this respect. The systems that are broadband are all incorporated into the report's recommendations.

In the final part of the report, clauses 9 and 10, the reader will find proposals for the development of Broadband Radio Access Networks (BRAN) to mirror the projected development of residential broadband fixed access networks. Although it may be said that the demand for broadband services to the home is not yet developed or certain, the reader should remember the success of GSM. GSM is an example of the success that may be achieved by developing the standards for new systems before the demand becomes too great. BRAN are in a sufficiently early stage of market development right now for ETSI to contribute to their success by starting on the road as soon as possible towards the correct degree of standardization.

1 Scope

The present document records information on existing work on radio in the local loop (RLL). To do this, the present document gives details of activities within ETSI and some activities in other important organizations. In this respect, the ERCG's Terms of Reference include the following:

3) The group shall study and report on the current activities within ETSI relating to RLL, including reference models and terminology. ETR 139 [1] shall be taken into account.

4) The group shall study and report on the current and foreseeable activities of manufacturers, national authorities, international authorities and operators.

The reader will find a treatment of these objectives in clauses 4 to 8.

The second purpose of the present document is to put forward a programme for ETSI to create any standards needed for future RLL requirements. In this respect, the ERCG's Terms of Reference include the following:

6) The group shall include in its final report recommendations for future standardization activities within ETSI, required to facilitate the implementation of RLL systems.

Such recommendations shall cover:

- *the scope and objectives of future RLL standardization activity;*
- *the relevant committees to carry out the work;*
- *target time scales for the work;*
- *proposals for joint action between ETSI and ERC on spectrum regulation matters in line with the ETSI-ERC MoU; and*
- *recommendations for future RLL co-ordination work.*

The reader will find in clauses 9 and 10 proposals for future ETSI standardization activities.

2 References

References may be made to:

a) specific versions of publications (identified by date of publication, edition number, version number, etc.), in which case, subsequent revisions to the referenced document do not apply; or

b) all versions up to and including the identified version (identified by "up to and including" before the version identity); or

c) all versions subsequent to and including the identified version (identified by "onwards" following the version identity); or

d) publications without mention of a specific version, in which case the latest version applies.

A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] ETR 139: "Radio Equipment and Systems (RES); Radio in the Local Loop (RLL)".

[2] ETR 310: "Radio Equipment and System (RES); Digital European Cordless Telecommunications (DECT); Traffic capacity and spectrum requirements for multi-system and multi-service applications co-existing in a common frequency band".

[3] ETS 300 765-1: "Radio Equipment and Systems (RES); Digital Enhanced Cordless Telecommunications (DECT); Radio in the local loop (RLL) Access Profile (RAP); Part 1: Basic telephony services".

[4] I-ETS 300 235: "Radio Equipment and Systems (RES); Technical characteristics, test conditions and methods of measurement for radio aspects of cordless telephones CT1".

[5] I-ETS 300 131, Edition 2: "Radio Equipment and Systems (RES); Common air interface specification to be used for the interworking between cordless telephone apparatus in the frequency band 864,1 MHz to 868,1 MHz, including public access services".

[6] ETS 300 765-2: "Radio Equipment and Systems (RES); Digital Enhanced Cordless Telecommunications (DECT); Radio in the local loop (RLL) Access Profile (RAP); Part 2: Advanced services".

[7] ETR 308: "Radio Equipment and Systems (RES); Digital Enhanced Cordless Telecommunications (DECT); Services, facilities and configurations for DECT in the local loop".

[8] Radio Fixed Access - Increasing the choice (UK Radiocommunications Agency).

[9] UK Spectrum Strategy (UK Radiocommunications Agency).

[10] La Boucle Locale Radio (Direction Générale des Postes et Télécommunications).

[11] ETS 300 636: "Transmission and Multiplexing (TM); Time Division Multiple Access (TDMA) point-to-multipoint digital radio systems in the frequency range 1 to 3 GHz".

[12] EN 301 055: "Transmission and Multiplexing (TM); Digital Radio Relay Systems (DRRS); CDMA point-to-multipoint digital systems in the band 1 to 3 GHz".

[13] DEN/TM-04045: "Transmission and Multiplexing (TM); Frequency Division Multiple Access (FDMA) point-to-multipoint Digital Radio Relay Systems (DRRS) in the band 1 to 3 GHz".

[14] EN 301 021: "Transmission and Multiplexing (TM); Time Division Multiple Access (TDMA) point-to-multipoint digital radio systems in the frequency range 3 to 11 GHz".

[15] DEN/TM-04042: "Transmission and Multiplexing (TM); DS-CDMA point-to-multipoint digital systems in the band 3 to 11 GHz".

[16] EN 301 080: "Transmission and Multiplexing (TM); Frequency Division Multiple Access (FDMA) point-to-multipoint Digital Radio Relay Systems (DRRS) in the band 3 to 11 GHz".

[17] DTR/TM-04038: "Transmission and Multiplexing (TM); Point-to-multipoint radio relay systems (1 to 3 GHz) in the access network".

[18] "Future of Cordless Telephony in the UK" (UK Radiocommunications Agency).

[19] ETR 306: "Transmission and Multiplexing (TM); Access networks for residential customers".

[20] ERO report 25: "CEPT Report concerning the frequency band 960 MHz to 105 GHz and associated European table of frequency allocations and utilisations".

[21] Full Services Access Networks Conference. London Mariott Hotel, 20th June 1996.

[22] Draft ITU-T Handbook on Mobile Radio.

[23] ETS 300 444: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Generic Access Profile (GAP)".

[24] 91/287/EEC: "Council Directive of 3 June 1991 on the frequency band to be designated for the co-ordinated introduction of digital European cordless telecommunications (DECT) into the Community".

[25] 91/288/EEC: "Council Recommendation of 3 June 1991 on the co-ordinated introduction of digital European cordless telecommunications (DECT) into the Community".

[26] EC Mandate M/215, BC-T-340: "Standards for Access Networks".

[27] TIA/EIA-662: "Personal Wireless Telecommunications - Interoperability Standard (PWT)".

[28] TIA/EIA-696: "Personal Wireless Telecommunications Enhanced - Interoperability Standard (PWT-E)".

[29] Council Directive 83/189/EEC (28 March 1983) laying down a procedure for the provision of information in the field of technical standards and regulations.

[30] ITU-R Recommendation F.747: "Radio-frequency channel arrangements for radio-relay systems operating in the 10 GHz band".

[31] MPT 1560 Specification (June 1996): "Performance specification for digital multipoint video distribution systems transmitters and transmit antennas operating in the frequency band 40,5 to 42,5 GHz".

[32] ETS 300 175 parts 1 to 9: "Radio Equipment and Systems (RES); Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI)".

[33] DA96-1704, 1996.10.16: Federal Communications Commission, "Spectrum Inventory Table, 137 MHz to 100 GHz".

[34] "Global Multimedia Mobility - A Standardisation framework for Multimedia Mobility in the Information Society".

[35] ERO/EC study: "WLL".

[36] European Commission (1993a): "Developing Universal Service for Telecommunications in a Competitive Environment" (Brussels: European Commission.) [COM (93) 543 Final (15.11.1993)].

[37] Ovum Research: "Interactive Multimedia Services to the Home: the Competitive Challenge," October 1996.

[38] TR 101 031: "Radio Equipment and Systems (RES); HIgh PErformance Radio Local Area Networks (HIPERLAN); HIPERLAN Requirements and architectures for Asynchronous Transfer Mode (ATM) and broadband access applications".

[39] ITU-T Recommendation V.34: "A modem operating at data signalling rates of up to 33 600 bit/s for use on the general switched telephone network and on leased point-to-point 2-wire telephone-type circuits".

[40] ETR 93: "Satellite Personal Communications Networks (S-PCN); Possible European standardization of certain aspects of S-PCN; Phase 1 report".

[41] ETR 177: "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".

[42] ETR 279: "Satellite Personal Communications Networks (S-PCN); Need and objectives for standards in addition to the ETSs on essential requirements".

[43] ITU-R Recommendation SM.329-6: "Spurious emissions".

[44] ITU-R Recommendation PN.530-5: "Propagation data and prediction methods required for the design of terrestrial line-of-sight systems".

[45] ITU-R Recommendation PN.452-6: "Prediction procedure for the evaluation of microwave interference between stations on the surface of the earth at frequencies above about 0,7 GHz".

[46] ITU-T Recommendation F.701 [46]: "Teleconference service", Published in the Blue Book as F.710 (11/88), then renumbered as F.701 Blue Book Fasc. II.5.

[47] ITU-T Recommendation F.755: "Point-to-multipoint systems used in the fixed service".

[48] ITU-T Recommendation F.756: "TDMA Point-to-MultiPoint systems used as radio concentrators".

[49] ITU-T Recommendation F.1098: "Radio-frequency channel arrangements for radio-relay systems in the 1 900 MHz to 2 300 MHz band".

[50] ITU-T Recommendation G.821: "Error performance of an international digital connection operating at a bit rate below the primary rate and forming part of an integrated services digital network".

[51] ITU-T Recommendation G.826: "Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate".

[52] ITU-T Recommendation G.827: "Availability parameters and objectives for path elements of international constant bit-rate digital paths at or above the primary rate".

[53] ETS 300 421: "Digital Video Broadcasting (DVB); DVB framing structure, channel coding and modulation for 11/12 GHz satellite services".

[54] ETS 300 429: "Digital Video Broadcasting (DVB); DVB framing structure, channel coding and modulation for cable systems".

[55] ETS 300 328: "Radio Equipment and Systems (RES); Wideband transmission systems; Technical characteristics and test conditions for data transmission equipment operating in the 2,4 GHz ISM band and using spread spectrum modulation techniques".

[56] ITU-R Recommendation F.746: "Radio-Frequency Channel Arrangements for Radio-Relay Systems".

[57] I-ETS 300 220: "Radio Equipment and Systems (RES); Short range devices; Technical characteristics and test methods for radio equipment to be used".

[58] I-ETS 300 440: "Radio Equipment and Systems (RES); Short range devices; Technical characteristics and test methods for radio equipment to be used in the 1 GHz to 25 GHz frequency range".

[59] TBR 41: "Satellite Personal Communications Networks (S-PCN); MES, including handheld earth stations, for S-PCN in the 1,6/2,4 GHz bands under the MSS: terminal essential requirements".

[60] TBR 42: "Satellite Personal Communications Networks (S-PCN); MES, including handheld earth stations, for S-PCN in the 2,0 GHz bands under the MSS: terminal essential requirements".

[61] ETS 300 733: "Satellite Earth Stations and Systems (SES); Satellite Personal Communications Networks (S-PCN); Mobile Earth Stations (MESs) including handheld earth stations, for S-PCN in the 1,6/2,4 GHz bands, providing voice and/or data communications under the Mobile Satellite Service (MSS)".

[62] ETS 300 734: "Satellite Personal Communications Networks (S-PCN); MES, including handheld earth stations, for S-PCN in the 2,0 GHz bands, providing voice and/or data communications under the MSS".

[63] ETS 300 735: "Satellite Personal Communications Networks (S-PCN); Network Control Facilities for MES, including handheld earth stations, for S-PCN in the 1,6/2,4 GHz and the 2,0 GHz bands, providing voice and/or data communications under the MSS".

[64] ERC/Recommendation 10-01 (rev 1992): "Wide band data transmission systems using spread-spectrum technology in the 2,5 GHz band".

[65] ERC/Recommendation 12-05: "Harmonised radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 10,0 - 10,68 GHz".

[66] ERC/Recommendation T/R 13-01 (Montreux 1993): "Preferred channel arrangements for fixed services in the range 1-3 GHz".

[67] ERC/Recommendation T/R 13-02: "Preferred channel arrangements for fixed services in the range 22,0 - 29,5 GHz".

[68] ERC/Recommendation 14-03: "Harmonised radio frequency channel arrangements for low and medium capacity systems in the band 3 400 MHz to 3 600 MHz".

[69] ITU-R Recommendation F.748 (revised): "Radio-frequency channel arrangements for radio-relay systems operating in the 25, 26 and 28 GHz bands".

[70] ERC/Recommendation T/R 22-02 (Lecce 1989): "Frequency band to be designated for the European Digital Cordless Telecommunication System (DECT)".

[71] ERC/Recommendation 22-03: "Provisional recommended use of the frequency range 54,25-66 GHz by terrestrial fixed and mobile systems".

[72] ITU-R Recommendation F.749: "Radio-frequency channel arrangements for radio-relay systems operating in the 38 GHz band".

[73] ERC/Recommendation T/R 52-01: "Designation of a harmonised frequency band for multipoint video distribution systems in Europe".

[74] ITU-R Recommendation F.1099 (revised): "Radio-frequency channel arrangements for high-capacity digital radio-relay systems in the 5 GHz (4 400-5 000 MHz) band".

[75] ERC/Decision (94)01: "ERC Decision on the frequency bands to be designated for the coordinated introduction of the GSM digital pan-European communications system (GSM)".

[76] ERC/Decision (94)03: "ERC Decision on the frequency bands to be designated for the coordinated introduction of the Digital European Cordless Telecommunications system (DECT)".

[77] ERC/Decision (95)03 (1st December 1995): "ERC Decision on the frequency bands to be designated for the introduction of DCS 1800".

[78] ERC/Decision (96)03 (7th March 1996): "ERC Decision on the harmonised frequency bands to be designated for the introduction of High Performance Radio Local Area Networks (HIPERLANs)".

[79] ITU-R Recommendation F.1100: " Radio-frequency channel arrangements for radio-relay systems operating in the 55 GHz band".

[80] ITU-R Recommendation F.283: "Radio-frequency channel arrangements for low and medium capacity analogue or digital radio-relay systems operating in the 2 GHz band".

[81] ITU-R Recommendation F.382: "Radio-frequency channel arrangements for radio-relay systems operating in the 2 and 4 GHz bands".

[82] ITU-R Recommendation F.383: "Radio-frequency channel arrangements for high capacity radio-relay systems operating in the lower 6 GHz band".

[83] ITU-R Recommendation F.384 (revised): "Radio-frequency channel arrangements for medium and high capacity analogue or digital radio-relay systems operating in the upper 6 GHz band".

[84] ITU-R Recommendation F.385: "Radio-frequency channel arrangements for radio-relay systems operating in the 7 GHz band".

[85] ITU-R Recommendation F.386: "Radio-frequency channel arrangements for radio-relay systems operating in the 8 GHz band".

[86] ITU-R Recommendation F.497 (revised): "Radio-frequency channel arrangements for radio-relay systems operating in the 13 GHz frequency band".

[87] ITU-R Recommendation F.595 (revised): "Radio-frequency channel arrangements for radio-relay systems operating in the 18 GHz frequency band".

[88] ITU-R Recommendation F.635 (revised): "Radio-frequency channel arrangements based on a homogeneous pattern for radio-relay systems operating in the 4 GHz band".

[89] ITU-R Recommendation F.636: "Radio-frequency channel arrangements for radio-relay systems operating in the 15 GHz band".

[90] ITU-R Recommendation F.637: "Radio-frequency channel arrangements for radio-relay systems operating in the 23 GHz band ".

3 Abbreviations and definitions

3.1 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ACTS	Advanced Communications Technologies and Services (European research programme)
ADPCM	Adaptive Differential PCM
ADSL	Asymmetric Digital Subscriber Line
ASIC	Application-Specific Integrated Circuit
ATM	Asynchronous Transfer Mode
AWACS	ATM Wireless Access Communication System (under ACTS)
B-ISDN	Broadband ISDN
BLANC	Broadband Local Access Network Connection
BRAN	Broadband Radio Access Networks
BRI	Basic Rate Interface (i.e. the ISDN 2B+D interface)
BS	Base Station
BSC	Base Station Controller (GSM)
BTS	Base (station) Transceiver System (GSM)
BWA	Broadband Wireless Association
CABSINET	Cellular Access to Broadband Services and Interactive Television (under ACTS)
CAI	Common Air Interface
CATV	Cable Access Television (originally Community Antenna Television)
CCS	Central Controller Station (TM4)
CDMA	Code-Division Multiple Access
CFP	Call For Proposals (DAVIC)
CLI	Calling Line Identification
CPE	Customer Premises Equipment
CPN	Customer Premises Networks
CRS	Central Radio Station (TM4)
CS	Central Station (TM4)
CT1	First Generation Cordless Telephone (CEPT)
CT2	Second Generation Cordless Telephone (ETSI)
CTA	Cordless Terminal Adapter (DECT)
DCS	Digital Cellular System
DCS 1800	Digital Cellular System at 1800 MHz
DECT	Digital Enhanced Cordless Telecommunications (system)
DLC	Data Link Control (protocol layer)
DRRS	Digital Radio Relay System
DS-CDMA	Direct Sequence CDMA
DSI	Detailed Spectrum Investigation
DVB	Digital Video Broadband (consortium)
EE	Equipment Engineering (ETSI Technical Committee)
EHF	Extremely High Frequency (30...300 GHz)
EIA	Electronic Industry Association (USA)
EII	European Information Infrastructure
EMC	Electro-Magnetic Compatibility
EMS	Element Management System
EP	ETSI Project
EPIC	European Project on Information Infrastructure Co-ordination Group
EPIISG	European Project for Information Infrastructure Starter Group
ERCG	ETSI RLL Co-ordination Group (originator of the present document)
ESMR	Enhanced Specialized Mobile Radio
FDD	Frequency Division Duplex
FDMA	Frequency-Division Multiple Access

FH-CDMA	Frequency-Hopping CDMA
FP	Fixed Part (DECT)
FPLMTS	Future Public Land Mobile System
FRANS	Fibre Radio ATM Networks and Services (under ACTS)
FS	Fixed Service
FWA	Fixed Wireless Access
FWT	Fixed Wireless Terminal (GSM)
GAP	Generic Access Profile (DECT)
GII	Global Information Infrastructure
GMM	Global Mobile Multimedia (project)
GPRS	General Packet Radio Service (GSM)
GRAN	Generic Radio Access Network
GSM	Global System for Mobile communication
HIPERLAN	HIgh PErformance Radio LAN
ICT	Information and Communication Technologies
IEEE	Institute for Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IMT2000	International Mobile Telecommunications in the 2 000 MHz band (ITU)
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISM	Industrial Scientific and Medical
IT	Information Technology
LAN	Local-Area Network
LDO	Local Distribution Operator
LE	Local Exchange
LEO	Low Earth Orbit (satellite)
LMCS	Local Multipoint Communication Service (Canada)
LMDS	Local Multipoint Distribution Service (USA)
MAC	Medium Access Control (protocol layer)
MBS	Mobile Broadband System
MCS	Multimedia Communication Service
MEDIAN	Wireless broadband CPN/LAN for professional and residential multimedia applications (under ACTS: Note that this is not an acronym)
MMDS	Microwave Multipoint Distribution Service (USA)
MoU	Memorandum of Understanding
MPEG	Motion Picture Experts Group
MS	Mobile Service
MSC	Mobile Switching Centre (GSM)
MSS	Mobile Satellite Service
MVDS	Multipoint Video Distribution System
NCF	Network Control Facilities (SES)
NII	National Information Infrastructure (USA)
NPRM	Notice of Proposed Rule Making (FCC)
OA&M	Operation, Administration and Maintenance
OFDM	Orthogonal Frequency Division Multiplexing
PACS	Personal Access Communications System
PAMR	Public Access Mobile Radio
PBX	Private Branch eXchange
PCM	Pulse Code Modulation
PCN	Personal Communications Network (Europe)
PCS	Personal Communications Services (USA)
PDN	Public Data Network
PE	Public Enquiry
PHS	Personal Handyphone System (Japan)
PHY	Physical Layer (protocol layer)
P-MP	Point-to-MultiPoint
PMR	Private Mobile Radio
PON	Passive Optical Network
POTS	Plain Ordinary Telephone Service
PP	Portable Part (DECT)

P-P	Point-to-Point
PSTN	Public Switched Telecommunications Network
PTO	Public Telecommunications Operator
PWT	Personal Wireless Telecommunications (system)
PWT-E	PWT - Enhanced
QPSK	Quadrature Phase Shift Keying
RACE	Research into Advanced Communications in Europe
RAP	RLL Access Profile (DECT)
RCU	Routing Control Unit
RF	Radio Frequency
RFA	Radio Fixed Access (UK DTI)
RFP	Radio Fixed Parts
RH	Radio Hub
RLL	Radio in the Local Loop
RR	Radio Repeater
RS	Repeater Station (TM4)
RT	Radio Termination
SAMBA	System for Advanced Mobile Broadband Applications (under ACTS)
SDMA	Spatial Division Multiple Access
SECOMS	Satellite EHF Communications for Mobile Multimedia Services (under ACTS)
SG	Study Group
SMATV	Satellite Master Antenna Television
S-PCN	Satellite PCN
SRC	Strategic Review Committee
STF	Specialist Task Force
TA	Terminal Adapter
TDD	Time-Division Duplex
TDMA	Time-Division Multiple Access
TG	Task Group
TIA	Telecommunications Industry Association (USA)
ToR	Terms of Reference
TS	Terminal Station (TM4)
UMTS	Universal Mobile Telecommunications System (ETSI/SMG)
UNI	User-Network Interface
U-NII	Unlicensed National Information Infrastructure (USA)
UPCS	Unlicensed PCS
USO	Universal Service Obligation
VDSL	Very high speed Digital Subscriber Line
VoD	Video on Demand
WACS	Wireless Access Communications System
WAND	Wireless ATM Network Demonstrator (under ACTS)
WARC	World Administrative Radio Conference (now just WRC, q.v.)
WATM	Wireless ATM
WLAN	Wireless Local Area Network
WLL	Wireless Local Loop
WP	Working Party
WRC	World Radio Conference
WRS	Wireless Relay Station (DECT)

3.2 Definitions

For the purposes of the present document, the following definitions apply. Usage of these terms in other contexts may not carry some of the meanings that are established here.

Radio (in the) Local Loop (RLL), Wireless Local Loop (WLL): These terms are used interchangeably by different organizations to designate the use of radio systems to replace fixed cables providing access to telecommunications services. In general these terms imply the ability to deliver service from a PTO's network plant (usually a local exchange or a street cabinet) to a residence or business. This places demands on the access system to be capable of a properly-engineered radio range comparable to the fixed cables it replaces.

Fixed Wireless Access (FWA): This term is often used as a synonym for RLL and WLL. However, it is usually used as a more general term to cover access to telecommunications services in roles that are possibly wider than just local loop replacement.

Point-to-MultiPoint: Point-to-MultiPoint (P-MP) wireless systems are service distribution systems that may be used to provide fixed wireless access to public and private systems. The term is used especially within ETSI's TM Technical Committee (TC) and its Sub-Technical Committees (STC). In general, P-MP systems may be considered as synonymous with FWA/RLL/WLL systems, although the term P-MP implies systems that may have more general application, and Point-to-Point systems may also be used to deliver RLL/WLL service in some cases.

fixed system: Systems in which a user's radio termination would normally be expected to be installed and receive service at some point or points within the coverage area provided by a single radio transceiver. Typically the radio coverage area would encompass a single residence or a business office, or parts thereof, but might also extend further. The radio terminal may still be moved within the coverage area, but would typically be re-sited only on an infrequent basis.

mobile system: Systems in which the radio termination would normally be used within many contiguous or overlapping radio cells, and not tied geographically to a specific location area or single cell. Typically the radio terminal would, on occasions, move location rapidly between different cells without prior warning.

narrowband: Systems delivering service to the end user with a bandwidth of 2 Mbit/s or less.

broadband: Systems delivering service to the end user with a bandwidth of greater than 2 Mbit/s. Typically about 20 Mbit/s or more would be available "instantaneously" but not on a continuous basis, as this bandwidth would be shared between a number of users.

4 Current ETSI programmes

Work in ETSI on matters related to both traditional RLL, and new systems providing new services, is carried out at present in seven areas: Sub-Technical Committees RES03, RES10, SES5, TM4; Technical Committee SMG (GSM and UMTS); the ETSI Global Mobile Multimedia (GMM) project, see [34]; and the European Project on Information Infrastructure Co-ordination Group (EPIC). Members of these committees have provided the information in this clause to summarize their work.

Of the committees, only work in STCs RES10 (subclause 4.2) and TM4 (subclause 4.4) includes broadband wireless access systems. Hence only these committees and their work are included in the recommendations in clause 10. The other committees' work (RES03, SES5 and GSM) only covers narrowband systems. The report's recommendations on broadband fixed radio access networks support the goals of the two projects, GMM and EPIC.

4.1 STC RES03

This subclause summarizes the work of ETSI STC RES03 (Cordless Communications) in the field of RLL. Overall, STC RES03 has responsibility for cordless telecommunications and has developed standards for CT2 and DECT, as well as maintaining standards for CT1. CT2 and DECT are known to be in use in local loop systems. The systems described here are all narrowband under the definitions used in the present document, so in the context of the report's conclusions relating to the development of BRAN, these systems are included as background information.

RES03 was requested to investigate RLL following a Strategic Review Committee (SRC) recommendation in 1992. This resulted in the publication of a study entitled "Radio in the Local Loop" in 1993/4, ETR 139 [1].

Recently, RES03 has become ETSI Project (EP) Digital Enhanced Cordless Telecommunications (DECT), leaving the maintenance of CT1 and CT2 to TC RES.

4.1.1 ETR 139 - "Radio in the Local Loop"

ETR 139 [1], entitled "Radio in the Local Loop", was drafted during 1993 and published in 1994. It set out to define the services and applications for radio access to the local loop; to consider existing standards and technologies in Europe suitable for RLL; to produce an assessment of operational and regulatory issues; and to make recommendations for future ETSI action. It considers the suitability of cordless technologies (including CT2 and DECT), cellular radio standards (including GSM and DCS 1800), microwave Point-to-MultiPoint systems and spread spectrum technologies.

It is still ETSI's only cross-technology review and it draws some general conclusions which are still widely quoted. These recognize the diversity of RLL applications and requirements and, despite the desirability of a single technology to meet all needs, it is admitted that such a universal solution is not foreseen. Unfortunately, some of its recommendations were slow to be implemented: one suggested that a further study (similar to the present ERCG) should be undertaken and that potential standards should be in place by mid 1995.

4.1.2 CT1 and CT2

CT1 I-ETS 300 235 [4] and CT2 I-ETS 300 131 [5] are radio interface specifications designed primarily for short range use by cordless telephones, wireless PBXs and public telepoint systems. CT1 is an analogue standard and CT2 is digital.

ERCG is unaware of any work related to CT1 for RLL application, although we understand that successful RLL work has been carried out based on CT2 technology. No standardization activities have been undertaken under the auspices of ETSI specifically for this purpose, although the CT2 industry association has produced a standard to ensure equipment interoperation.

4.1.3 The DECT system

ETS 300 175 [32] is an air interface standard which may be used for many applications including private cordless telephones, wireless PBXs and key systems, public telepoint pedestrian systems and RLL. Some DECT manufacturers have already installed RLL products based on DECT protocols in advance of the specific standardization by ETSI to produce the DECT RLL Access Profile, the RAP, ETS 300 765-1 [3] and ETS 300 765-2 [6].

The potential of DECT for narrowband RLL applications has long been recognized within ETSI and considerable work has recently been completed by working group RES03R:

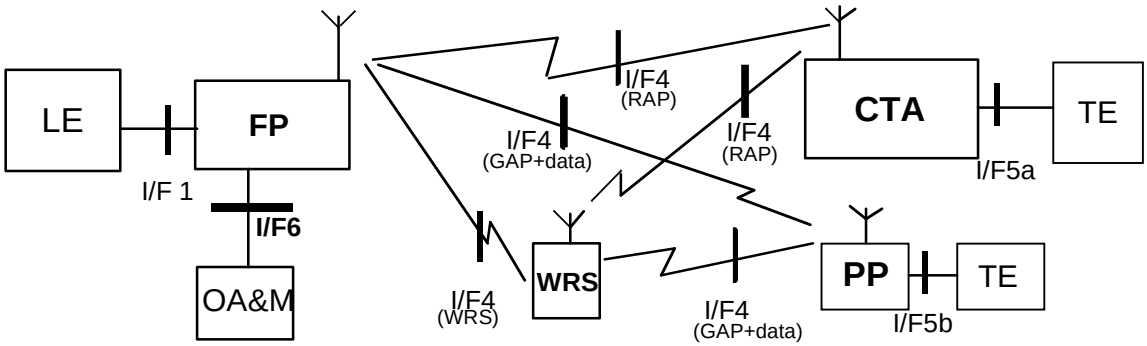
- a review of the services, facilities and configurations required to be supported by DECT for RLL has been published as ETR 308 [7]. Although this work is targeted at DECT technology many of the considerations are equally applicable to other narrowband technologies;

- a review of the spectrum needs and traffic capacity issues of DECT in the RLL application, and how RLL coexists with other DECT applications has been published as ETR 310 [2];

- the DECT RLL Access Profile, RAP. Standardization is divided into two parts, Part 1 "Basic Services" and Part 2 "Advanced Services". Part 1 includes POTS services (unprotected 32 kbit/s ADPCM), a (protected) 64 kbit/s PCM bearer service and over-the-air OA&M services. Part 2 specifies ISDN (including 2B+D) and a data port for packet data services up to 552 kbit/s. It has also been decided to extend the RAP Part 2 to include an ISDN primary rate 30B+D option. However, even this extension, called broadband within the DECT project, does not really meet the definitions of broadband adopted within the present document.

4.1.3.1 Reference model and terminology

The reference model for DECT RLL systems is presented in figure 1. This reference model originated from ETR 139 [1], but was refined for the purpose of the DECT RLL Services, facilities and configurations report (ETR 308 [7]).



TE	Terminal Equipment	I/F1	Local Exchange to FP Interface
FP	Fixed Part	I/F4	DECT Air Interface
WRS	Wireless Relay Station	I/F5a	CTA to Terminal Interface
CTA	Cordless Terminal Adaptor	I/F5b	PP to Terminal Interface
PP	Portable Part	I/F6	Operation, Administration and Maintenance Interface

NOTE 1: In the ETR 139 [1] reference model, two separate entities (i.e. the controller and the Radio Fixed Parts (RFP)) comprise what is called FP in the DECT RLL reference model. In this respect there is no reason to define an I/F3 interface.

NOTE 2: A single CTA can serve more than one TE simultaneously.

Figure 1: DECT RLL reference model

Some fundamental differences between this model and the model originally defined in ETR 139 [1] are:

- the inclusion of non-fixed terminals (in addition to fixed terminal) in the DECT model - in ETR 139 [1], the definition of RLL was restricted to serving fixed terminal equipment;

- the explicit depiction of repeaters (Wireless Relay Stations (WRS)) in the DECT model.

Depending on whether the end-user uses a CTA or a PP, the I/F4 interface can be either RAP, ETS 300 765-1 [3], ETS 300 765-2 [6] or GAP, ETS 300 444 [23]. The Services facilities and configurations report, ETR 308 [7] focuses on RAP and describes the services available at I/F1 that are expected to be provided at I/F5a. The OA&M facilities defined in RAP are only the ones that require information to be transported over the RAP air interface.

4.1.3.2 Range, traffic capacity and efficiency issues

With DECT technology, in a line-of-sight deployment without multipath interference, ranges of up to 5 km are shown to be feasible using 12 dBi antennas at both ends of the link and with reasonable antenna heights ETR 310 [2]. A single hop WRS could extend this range by a further 5 km in a particular direction. By special antenna arrangements and the advance timing CTA option, the range may be increased beyond 5 km ETR 310 [2].

Support of 40 to 60 E average traffic (equivalent speech duplex bearers) at 1 % grade-of-service is realistic for a DECT RLL access site with sectorized gain antennas ETR 310 [2]. Such a site will be equipped with about 6 to 12 DECT radios and can support 400 - 600 POTS or ISDN subscribers with 100 mE average traffic each.

The DECT ISDN service monitors the ISDN layer 3 information, and allocates DECT bearer resources only when and as required by the specific instant ISDN services. The ISDN speech service has the same spectrum efficiency as the POTS speech service, and transmitting a specific amount of data (e.g. a document) via ISDN is much more spectrum efficient and loads in average the radio devices less than via POTS (using a modem). For packet data, transmission over the data port is much more spectrum efficient and, on average, loads the radio devices much less than any modem service or ISDN service.

4.1.3.3 Spectrum issues

The Conférence Européenne des Administrations des Postes et des Télécommunications (CEPT) allocation of the frequency band 1 880 MHz to 1 900 MHz has been reinforced by Council Directive 91/287/EEC [24] stating that "DECT shall have priority and be protected in the designated band" and "recognizing that, subject to system development of DECT, additional frequency spectrum may be required". Further, Council Recommendation 91/288/EEC [25] recommends that the DECT standard should meet user requirements for residential, business, public and RLL applications.

ETR 310 [2] considered the interference potential between DECT RLL and other DECT applications and concludes that the potential for mutual interference between RLL and other services is generally low, except between RLL and public pedestrian systems, which may interfere somewhat more. Potential mutual interference between two DECT RLL systems in the same area is significant and such systems would benefit from synchronization.

The European initial DECT allocation 1 880 MHz to 1 900 MHz provides ten DECT carriers. The second edition of the DECT standard has defined DECT carriers up to 1 937 MHz to allow interoperability where extended allocations are possible or in territories where allocations other than 1 880 MHz to 1 900 MHz apply. Extension of the spectrum to 1 910 MHz would increase the number of available DECT carriers to 16 and extension to 1 920 MHz increases the number to 22.

In many countries and for many scenarios, depending on the number of operators and other factors, ETR 310 [2] indicates that the initial 1 880 MHz to 1 900 MHz, will support reliable and economic deployment of DECT RLL systems effectively coexisting with other DECT applications.

It is recognized that there may be market conditions which favour extension of the spectrum available to DECT for public (or RLL) services. Any justification for further spectrum allocation will depend on the efficient use of the spectrum. Some dedicated RLL systems are allocated 10 MHz to 30 MHz per operator. Compared with the allocation of two 20 MHz bands for two operators for RLL, ETR 310 [2] indicates that a shared allocation of 40 MHz for DECT could support at least four DECT RLL operators, a number of public street system operators and the traffic required by all DECT office and residential systems including anticipated emerging increase of data traffic.

RES03, RES, RES RPM and the SMG Task Force on UMTS frequencies have been addressing the possible extension of DECT frequencies into 1 900 MHz to 1 920 MHz. RES03 believes that although this band was designated by WARC 92 on a primary basis for FPLMTS (hence UMTS), DECT should also be allowed to operate there. However, this view is not universally accepted within these committees.

4.1.3.4 The DECT interoperability air interface approach

DECT RLL employs an interoperability profile standard "Common Air Interface (CAI)" - which in principle means that whilst still being able to offer a useful level of service to the user, the FP (base station) may be manufactured by one manufacturer, the equipment at the subscribers premises by another, and perhaps wireless relay stations by a third. The advantage of multi-vendor sourcing for the operator is apparent and allows the manufacturers to choose to specialize in one segment of the network. Commonality with other DECT products and applications will allow the RLL application to enjoy some benefits of high volume product from the outset.

Furthermore the ability of an FP to support GAP, RAP and WRS applications (figure 1) provides means for integration of fixed and mobile services (MSs), which may prove to be of interest in the emerging deregulated telecommunications markets.

4.1.3.5 Relationship to other work

The Personal Wireless Telecommunications interoperability standards, PWT, Telecommunications Industry Association (TIA)/Electronic Industry Association (EIA)-662 [27] and PWT-E, TIA/EIA-696 [28], in North America, are based on DECT and provide basically the same services as DECT. PWT and PWT-E use the DECT frame structure, MAC, DLC etc., but have a different modulation, different bandwidth and different carrier spacing to meet local regulatory requirements. PWT operates in the USA unlicensed band 1 910 MHz to 1 920 MHz. PWT-E is an extension into the licensed bands 1 850 MHz to 1 910 MHz and 1 930 MHz to 1 990 MHz. These standards will probably be spread also to Latin America, where several countries already have allocated spectrum for DECT services. PWT, PWT-E and DECT do, however, coexist very well in a common spectrum allocation, due to the common frame structure. See ETR 310, annex B [2].

4.2 STC RES10

Traditionally it may be thought that radio LANs, the subject of work in RES10, are not local loop systems, and it is true that section 11 of the ITU Land Mobile Handbook [22] reveals that more than 90 % of the revenue of public telecommunications operators comes from telephony. However, it goes on to state that "while voice traffic will continue to dominate, value-added services, high-speed data, mobility and ultimately video will increasingly be required".

The standards and technologies resulting from the work of RES10 are therefore very pertinent to a forward-looking view of RLL. In the context of the present document's conclusions relating to the development of BRAN, the work of RES10 on broadband fixed wireless access is important, and its development to support RLL, in addition to its support for short-range wireless access, forms a very important part of the report's recommendations.

4.2.1 Current RES10 work

RES10 is currently developing a set of standards for high-speed radio technology (HIPERLANs) that serves a variety of applications, including wireless LANs, mobile wireless ATM access networks and wireless ATM infrastructure networks (see figure 2). The common elements of these standards are the use of microwave frequencies (5 GHz and 17 GHz), and high transmission rates (20 Mbit/s to 150 Mbit/s). Both require advanced RF and digital signal processing technologies. Details of the radio physical layer specifications differ necessarily to accommodate differences in usage as well as differences in regulatory constraints. However, the interface specifications for the wireless DLC layers of HIPERLANs type 2, 3 and 4, based on the ability to support multi-media ATM traffic, can be common; this allows the same user applications to be used over each of these types of network.

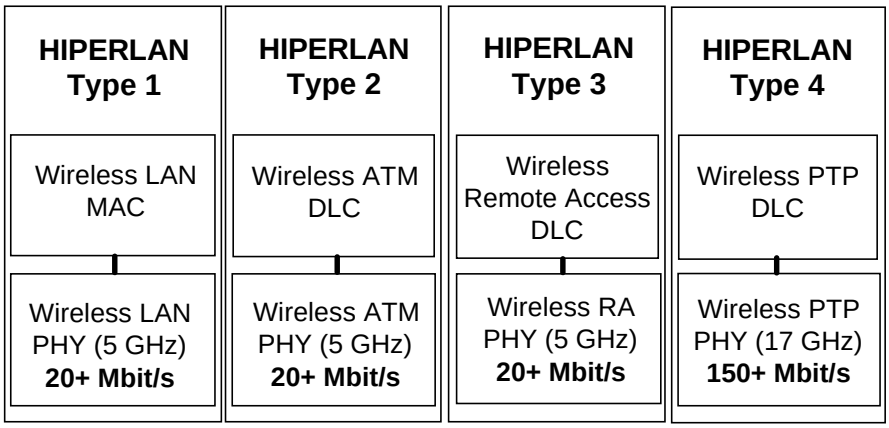


Figure 2: The various HIPERLAN types

The first member of this family (HIPERLAN type 1, wireless LAN) has been completed and was published recently by ETSI. New family members address multi-media access to local and remote wired ATM networks as well as very high speed wireless infrastructures. A report on Requirements and Architectures (TR 101 031 [38]) has been prepared by RES10 to guide the development of future technical standards. In developing these standards, RES10 is working together with the ATM Forum (on ATM interworking) and WIN Forum (spectrum sharing rules) so as to foster the prospect of word-wide standards for HIPERLAN and U-NII applications (see subclause 4.2.4).

4.2.2 Relevance of RES10 work in the local loop domain

HIPERLANs lend themselves to high speed RLL applications, both the Point-to-MultiPoint and the Point-to-Point varieties. In addition, both fixed installations and mobile terminations could be supported, although the data rates would be different. Such RLL systems would form the high end of a spectrum of RLL systems. Examples are given in table 1.

Table 1: Applications of HIPERLANs

Application	Bit rate	Range
Point-to-MultiPoint and Radio Local Loop	20 Mbit/s downlink and 2 Mbit/s uplink or 20 Mbit/s symmetrical	50 m to 5 000 m
Fixed Wireless Access	20 Mbit/s to 150 Mbit/s	50 m to 500 m

4.2.3 Spectrum allocated to HIPERLANs

The spectrum allocated to HIPERLANs is as given in table 2.

Table 2: Spectrum allocated to HIPERLANs

Band	RF Power	Other
5,15 GHz to 5,3 GHz	0 dBW	Non-protected, non-interference
17,1 GHz to 17,3 GHz	-10 dBW	non-protected, non-interference

A major use of wireless access networks lies with ambulant and cordless access. The 5 GHz band allows the design of economically viable mobile systems; this is not the case for the 17 GHz and higher frequencies because of the need to use directional antennas to achieve a realistic operating range.

Based on knowledge of multi-media application needs and using user density figures typical of office applications, RES10 has calculated that, depending on factors such as protocol efficiency and re-use efficiency, 450 MHz would be needed in the 5 GHz band to meet the projected long term demands of multi-media applications, wireless LANs and wireless ATM access systems. Similar figures apply to medical, education and manufacturing environments.

The current designation in the CEPT countries provides for 150 MHz (in some countries only 100 MHz) in the 5 GHz range, on a non-protected, non-interference basis in the range of 5 150 MHz to 5 300 MHz (in some countries to 5 250 MHz). RES10 has initiated discussions with CEPT (SE24) on the possibility of making more spectrum available in the 5 GHz range for new HIPERLAN standards, e.g. to match the USA U-NII allocations.

4.2.4 Relationships to other work

The broadband work in RES10 on HIPERLAN type 3 is related closely to the TM4 broadband Point-to-MultiPoint work (see subclause 4.4.2.2) and to the work on LMDS (see subclause 5.1.1).

4.2.4.1 Unlicensed NII band systems

In 1996, the FCC issued a Notice of Proposed Rule Making (NPRM 96-193) in which it proposed to open 5 150 MHz to 5 350 MHz and 5 725 MHz to 5 875 MHz to unlicensed (data) applications as described in the SUPERNet and National Information Infrastructure (NII) band petitions that preceded the NPRM. Whereas the SUPERNet petition showed many similarities to HIPERLAN types 1 and 2, the NII band petition showed similarities to HIPERLANs type 3 and 4. Thus, the proposed "Unlicensed NII band" rulemaking in the USA will open up spectrum for in which all HIPERLAN types could be deployed. However, the standardization regime in the USA is different from that in Europe; in the USA many standards may come into existence rather than a single standard or set of common standards as is more typical of Europe. Given the closer focus, European standards and European providers of (broadband RLL) systems stand to gain a significant advantage from early ETSI work on this subject.

4.2.4.2 Relationship of HIPERLANs to UMTS

UMTS, in its various forms, supports a wide range communications services, from cordless services to wide area cellular services. The range of bit rates, with a maximum of 2 Mbit/s, supported by UMTS is geared primarily towards voice and low quality video as well as data services. However, because of spectrum limitations as well as for economic reasons, UMTS will not be able to meet the bandwidth demands of true, high resolution multi-media communications which require peak rates in the range of 10 Mbit/s. The required bandwidth is not available in the planned UMTS frequency range and it is likely that the cost to users of such bandwidth would be excessive.

Furthermore, it is not clear that there exists demand for such services beyond the premises of a business or other organization. On premises, short range wireless networks that do not share spectrum with UMTS are much more attractive and flexible as a solution to multi-media wireless networking. HIPERLANs fill that need.

The possible benefits of a common technology for UMTS and HIPERLANs are obvious: network operators could offer continuous access covering both in-door and outdoor environments and users would need only a single device to access either type of network. This potential technology sharing could be extended to RLL systems.

These relationships are illustrated in figure 3.

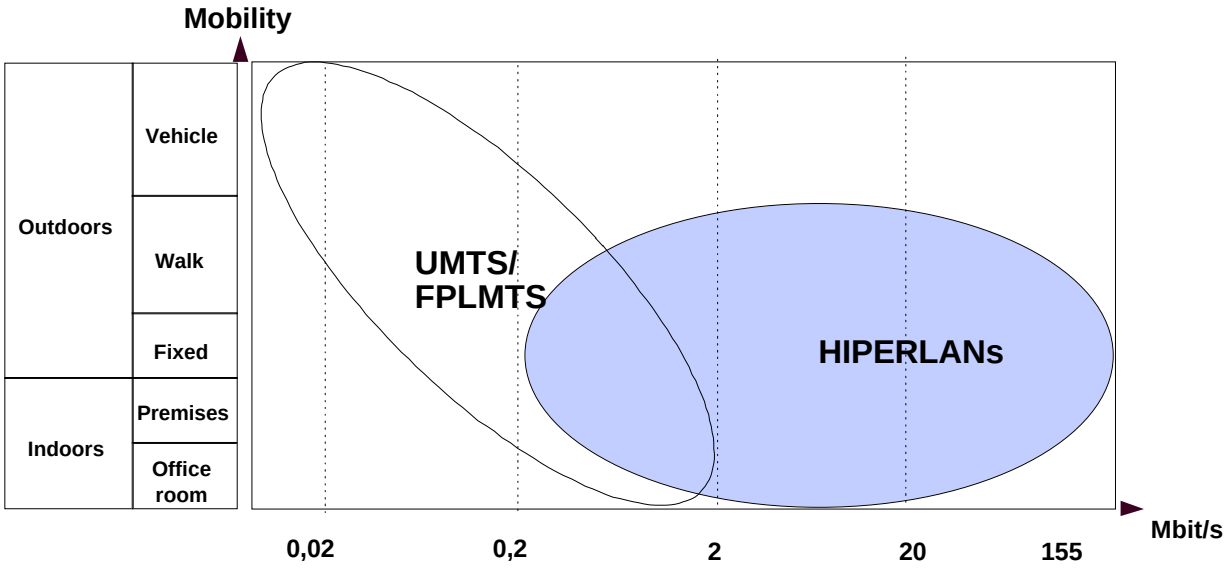


Figure 3: The relationship between HIPERLANs and UMTS/FPLMTS

4.2.4.3 Relationship of HIPERLANs to MBS

MBS, the Mobile Broadband System, is typically equated with the 60 GHz band. However, the core of the MBS work is a systems design that is independent of the actual frequency at which its transceiver is operated. The MBS project demonstrated designs for a 60 GHz radio, for high speed medium access and ATM interworking that support high data rates efficiently and with preservation of quality of service. These results will be considered by RES10 in its specification of HIPERLAN types 2, 3 and 4.

However, the MBS project did not prove that 60 GHz technology could be used for systems that operate while in motion. In fact the economics - device cost, operating range, and need to use directional antennas make the use of frequencies above 6 GHz economically unattractive for such systems.

4.3 TC SMG

There is no specific program within TC SMG to create standards for RLL applications. However, although RLL standards are not being developed, GSM, DCS and other cellular radio systems, including CDMA (IS-95) are very well suited to certain narrowband RLL applications and usage (that is narrowband under the definition used in the present document, not necessarily as used within TC SMG or elsewhere). A number of manufacturers have RLL-capable systems, some tailored specifically to the RLL market, which have already been deployed in several parts of the world.

GSM is originally designed for wide-area cellular applications and is highly optimized in this application. It supports stationary users, users travelling at high speed, and is designed to work well in a multi-path propagation environment. It is able to support areas of low population density, and areas of high population density via the use of microcells. This flexibility makes it very versatile in the range of populations GSM is able to economically cover. Because the GSM system is designed to provide mobile voice services, it needs development to meet demands for RLL services to match the current capabilities of the local loop. In this respect, GSM local loop systems are narrowband systems. In the context of the report's recommendations concerning BRAN, information on GSM's use as a RLL system is included here for the complete information of the reader.

4.3.1 Support for near-term local loop services via GSM

GSM is able to provide RLL services that satisfy many of today's RLL market requirements. It is particularly suited to the provision of voice telephony, certain digital services (such as short message service and low speed digital connections for computers), and many supplementary services (e.g. call forwarding, call barring, CLI, call hold, call waiting, advice of charge and multiparty). The Phase 2+ services called "Enhanced Full-Rate Codec", "compression of user data", "High-Speed Circuit-Switched Data" and priority set-up (Advanced Speech Call Items) are expected to enhance GSM and its ability to provide RLL services. GSM can therefore provide a RLL voice telephony service which can match the services provided by today's POTS/analogue service. Data specific services, providing relatively high data rates, are currently being standardized, for example the General Packet Radio Service (GPRS). However, higher-speed circuit-switched data services such as those provided by 28,8 kbit/s modems (ITU-T Recommendation V.34 [39]) and their forthcoming 33,6 kbit/s and 56 kbit/s successors are likely to place greater demands on already scarce GSM radio spectrum.

Operators wishing to provide RLL service using GSM may either use:

- existing GSM infrastructure (figure 4);
- proprietary RLL systems, requiring additional spectrum to be allocated and additional MSC functionality for interconnection to the PSTN/ISDN (figure 5); or
- GSM radio infrastructure (the GSM air interface), requiring functionality normally provided by the MSC to be provided by the BTS and/or the BSC, and functionality for interconnecting to the PSTN/ISDN to be provided by the BSC (figure 6).

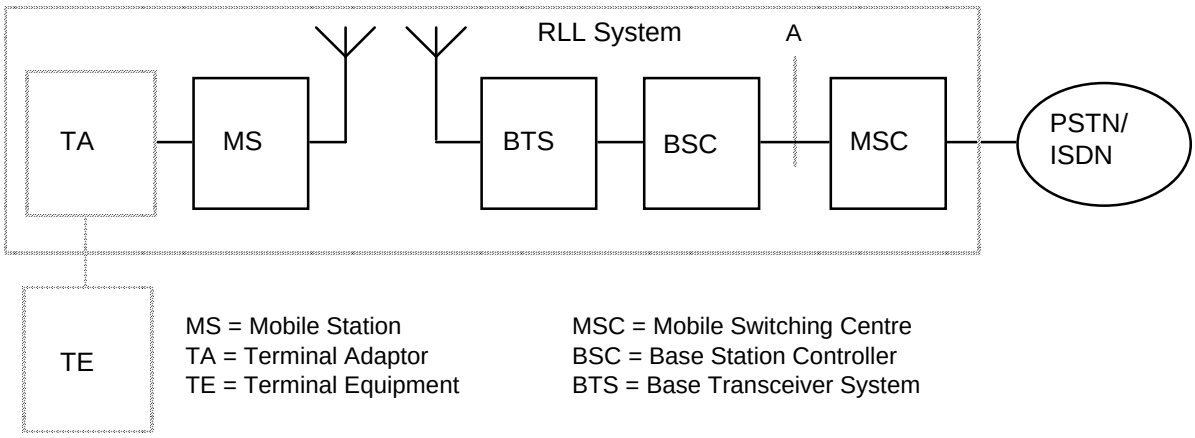


Figure 4: Use of GSM infrastructure to provide RLL services

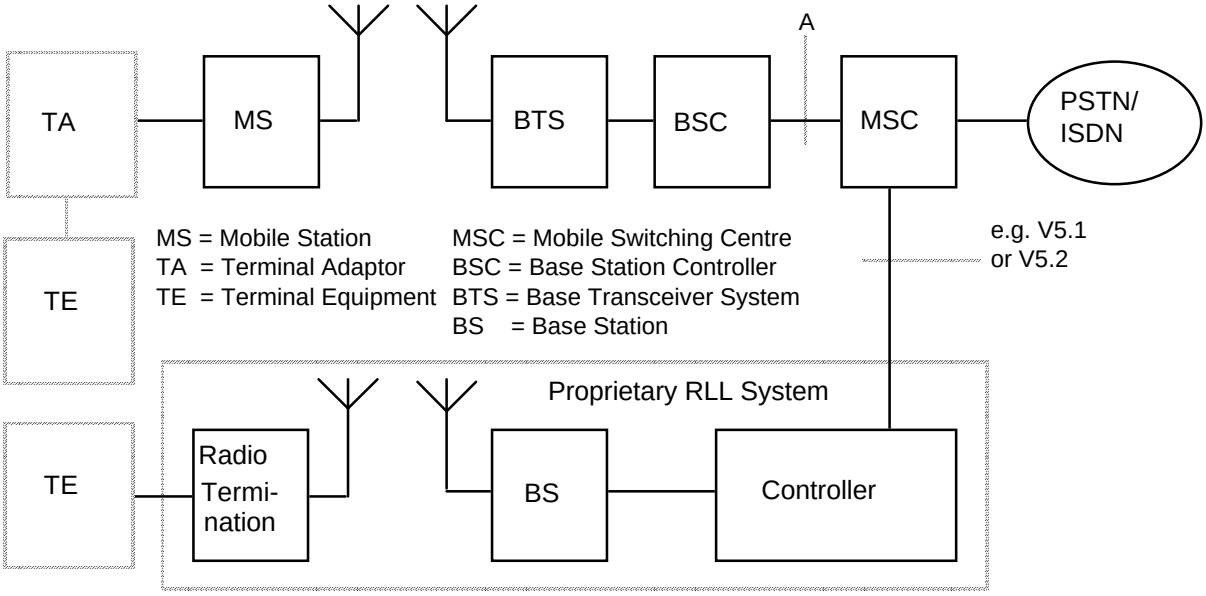


Figure 5: Use of a proprietary RLL system connected to the MSC

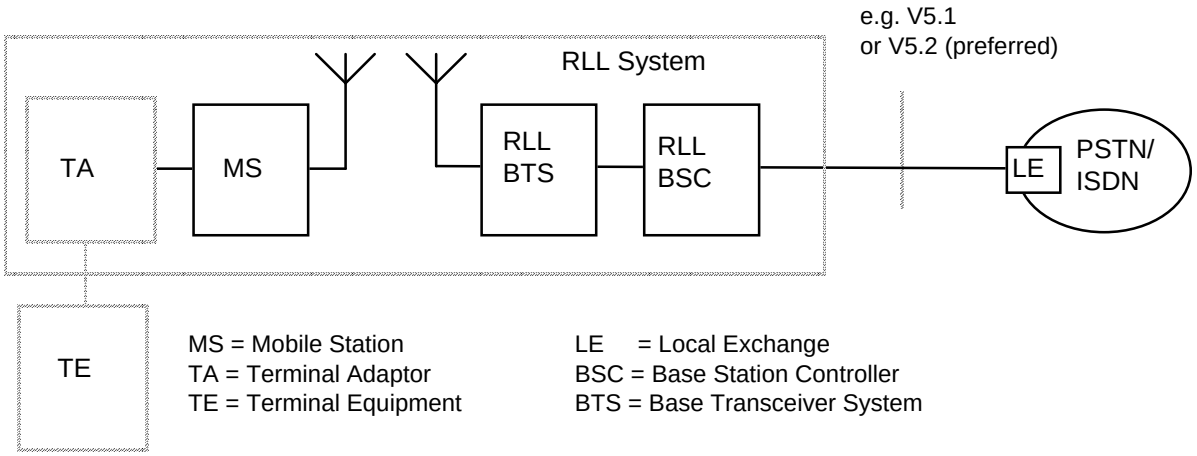
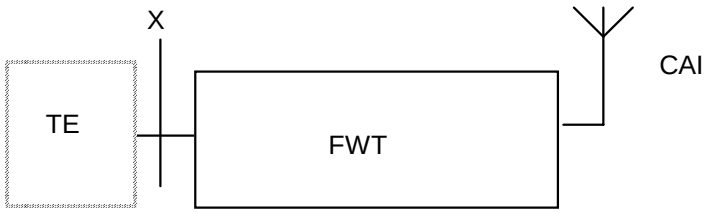


Figure 6: Use of GSM radio infrastructure (modified BSC and/or BTS) to provide RLL services

It is also attractive to combine functionality in the subscriber equipment (figure 7) in order to meet equipment cost targets.



FWT = Fixed Wireless Terminal (Combined TA and MS functionality)
X = Local PSTN interface specification
CAI = Common Air Interface, e.g. GSM

Figure 7: Combination of functionality for the subscriber equipment

However, GSM systems are not really suited to some RLL requirements:

- attaching existing terminals an adaptor is needed within the mobile terminal;
- transport of fax and modem tones directly group three fax machines and modems are only supported right now up to 9 600 bit/s, again with special adaptors within the mobile terminal.

4.3.2 Support for future local loop services via GSM

Even today, some ISDN digital services (e.g. those requiring the transport of high data rates) are currently beyond GSM's capabilities. The amount of bandwidth available to a single RLL user is limited. However, there is scope for GSM systems to provide novel services that may not be available in the normal local loop, such as Short Message Service.

4.3.3 Related standards

In addition to GSM and DCS in their appropriate bands, USA-PCS equipment in the 1 900 MHz band may also be considered for RLL applications in countries where that spectrum allocation is available.

TC SMG is also going on to develop the UMTS specification which includes RLL aspects. UMTS is discussed elsewhere in the present document.

4.3.4 Conclusion

GSM is very well suited for situations where the demand for RLL service does not exceed that of the current local loop, and where ISDN or other high-speed circuit-switched applications are not essential. For example, in territories where the provision of basic telephone service is required to a population that is not yet serviced by extensive wired access. Emerging economies are the main areas where this sort of market exists; however, some liberalized operators are actively considering employing GSM/DCS and CDMA cellular systems for RLL applications.

Expansion in the use of the PSTN for data services, for example for Internet access, presents more of a challenge to GSM as a local loop technology. The imminent availability of 56 kbit/s modem technologies operating over the normal copper-pair local loop could only be matched by GSM at the expense increased use of the radio spectrum, in both increased call duration typical of data calls and increased use of bandwidth. Such usage, combined with the rising demand for GSM as a voice telephony service would almost certainly lead to the need to allocate more spectrum in order to preserve GSM's grade of service.

Nevertheless, GSM already has a large customer base in many parts of the world, ensuring that it will continue to be developed. However, its technical capabilities ensure that RLL usage will be largely confined to those areas where the demand is just for basic POTS voice service, possibly with the addition of low-bandwidth data services. Far from it being a limiting factor, however, the market for this type of service throughout the world is very large.

4.4 TC TM4

Sub-Technical Committee TM4 is concerned with radio-relay systems, and prepares standards for Point-to-Point (P-P) and Point-to-MultiPoint (P-MP) equipment. TM4 standards specify the radio-frequency parameters of the equipment in such a way that spectrum management authorities and operators can plan the deployment of systems which will coexist and provide the required quality of service for the operator combined with the maximum spectrum efficiency. TM4 standards do not enable inter-operability between conforming equipment from different manufacturers.

TM4's P-MP standards have so far all been for radio access systems (including RLL) operating at the borderline between narrowband and broadband service. They have recently initiated studies on broadband P-MP systems. TM4's experience is therefore very relevant within the context of the report's conclusions concerning the development of BRAN.

4.4.1 Current Point-to-MultiPoint standards in TM4

4.4.1.1 Standards in progress

TM4 is developing standards for P-MP systems in the frequency ranges below 1 GHz TM4 P-MP standard [29], 1 GHz to 3 GHz, ETS 300 636 [11], EN 301 055 [12], DEN/TM-04045 [13], 3 GHz to 11 GHz, EN 301 021 [14], DEN/TM-04042 [15], EN 301 080 [16], and 24,25 GHz to 29 GHz, TM4 broadband standard 24 GHz to 29 GHz [30]. In each frequency range standards with TDMA, DS-CDMA, FH-CDMA and FDMA access methods are being developed, and for the 1 GHz to 3 GHz, 3 GHz to 11 GHz and 11 GHz to 60 GHz ranges, antenna standards are also being developed. In addition there is an authorized work item on "Broadband Local Access Network Connections" (BLANC). The status of the standards is as shown in table 3.

Table 3: TM4 Standards Status

Standard	Status
P-MP below 1 GHz for rural use	Initial approval by TM4 likely October 1997
TDMA 1 GHz to 3 GHz	Approved by vote October 1996. Now ETS 300 636 [11]
DS-CDMA 1 GHz to 3 GHz	Initial approval by TM4 November 1996
FDMA 1 GHz to 3 GHz	Initial approval by TM4 June 1996
FH-CDMA 1 GHz to 3 GHz	Initial approval by TM4 likely November 1997
TDMA 3 GHz to 11 GHz	Initial approval by TM4 June 1996
DS-CDMA 3 GHz to 11 GHz	Initial approval by TM4 likely May 1997
FDMA 3 GHz to 11 GHz	Initial approval by TM4 November 1996
FH-CDMA 3 GHz to 11 GHz	Initial approval by TM4 likely November 1997
1 GHz to 3 GHz antennas	Initial approval by TM4 likely May 1997
3 GHz to 11 GHz antennas	Initial approval by TM4 likely May 1997
11 GHz to 60 GHz antennas	Initial approval by TM4 likely November 1997
24,25 GHz to 29 GHz	Initial approval by TM4 of part 1 ("Basic Parameters") and part 2 ("FDMA") likely June 1997
BLANC	Work suspended pending start of Broadband project

NOTE: There is a clear overlap between the P-MP standard in the 24,25 GHz to 29 GHz band and the BLANC work item. Whilst the BLANC programme has been suspended pending a decision on the establishment of an ETSI BRAN project, work on the 24,25 GHz to 29 GHz standard continues.

4.4.1.2 Functional description of TM4 P-MP systems

P-MP systems being standardized in TM4 are explicitly intended for access networks, i.e. are for "radio local loop." Subclause 4.4.3 gives extracts from the text of the standard introduction to the TM4 documents.

Figure 8 shows the reference system architecture assumed in the TM4 standards.

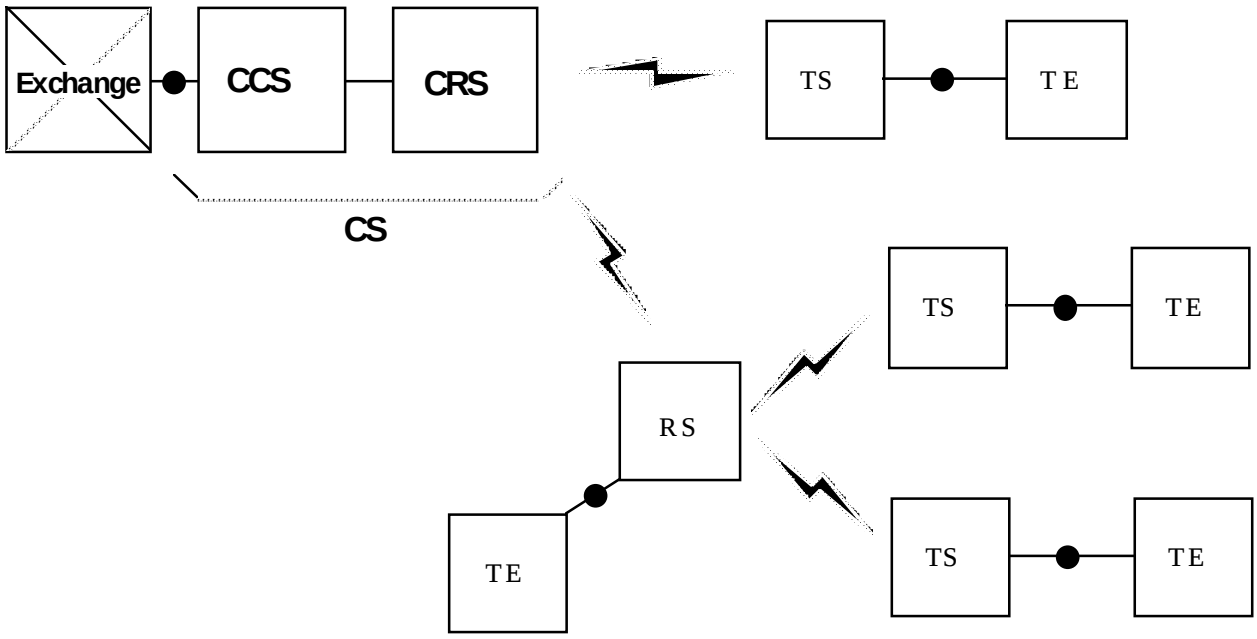


Figure 8: The TM4 reference model

The functional blocks in the above figure are given in table 4.

Table 4: Functional blocks in the TM4 reference model

Block	Function
CCS	Central Controller Station
CRS	Central Radio Station
CS	Central Station
TS	Terminal Station
RS	Repeater Station
TE	Terminal Equipment
•	System boundary

The TM4 documents do not explicitly define the boundary of the Point-to-MultiPoint system; in the figure a blob has been added to the Exchange: CCS, TS:TE, and RS:TE interfaces to indicate where the P-MP system finishes. The TE is of course the customer's terminal equipment. The CS can be separated into two parts as shown in order to provide a more efficient interface if the radio part of the central station needs to be located remote from the exchange.

4.4.2 Additional work in progress in TM4

4.4.2.1 ETR on Point-to-MultiPoint radio relay systems

This activity is a comparison among different techniques aimed at compiling a report, DTR/TM-04038 [17] which compares TDMA, DS-CDMA, and FDMA access technologies for P-MP systems.

4.4.2.2 Digital radio relay systems for Broadband Local Access Network Connections (BLANC)

This activity started at the TM4 meeting in Paris, 23 - 27 October 1995. It is initially aimed at developing an ETR on the topic, with the final aim of defining the essential requirements for a range of wireless access systems, including broadband access. TM4 considers that these are the issues on which input is required:

- radio issues;
- network architecture;

- service issues;
- market issues; and
- co-ordination with other work.

The work is now suspended pending a decision on the establishment of an ETSI Project on BRAN.

4.4.3 Standard introduction to a TM4 P-MP standard

The paragraphs below are extracted from typical TM4 P-MP standards and explicitly show that they are intended for RLL.

> *The main field of application of Point-to-MultiPoint (P-MP) systems is to provide access to both public and private networks (PSTN, PDN,...). By means of P-MP systems the network service area may be extended to cover both distant and scattered subscriber locations; and the systems may be applied to building new access networks covering both urban and rural areas.*
>
> *Subscribers are offered the full range of services by the particular public or private network. Subscribers have access to these services by means of the various standardized user network interfaces (2-wire loop, new data services).*
>
> *P-MP systems provide standard network interfaces and transparently connect subscribers to the appropriate network node.*

4.4.4 Related work

The work of TM4 on the detailed requirements for wireless access networks is complementary to the work of RES10 on standards and technologies for broadband networks using ATM. Together TM4 and RES10 address a very wide range of forward looking RLL uses. These include licensed as well as unlicensed uses; the latter being related to the unlicensed spectrum for HIPERLANs in Europe and unlicensed NII networks in the USA. This potential synergy should be exploited in order to foster European interests in this area.

Outside ETSI, the work in North America on LMDS (LMCS in Canada) for broadband multi-media distribution in the 27 GHz band has a direct relationship to TM4's BLANC programme.

4.5 The EPIC project

The entire work of the EPIC project and of its starter group, EPIISG, looks far beyond the scope of wireless loops, into an entire European Information Infrastructure. However, a part of the programme, EPIC project 1.1 led by TC/TM, has surveyed the current access networks for residential customers and has reported ETR 306 [19]. This survey covers both wired and wireless access networks, but does not include some that have very high bit-rate and are considered of little interest to the residential customer.

The specific wireless access networks that the EPIC project 1.1 report covers are:

> GSM/DCS 1800, DECT, UMTS, P-MP (TM4), CT2, DECT, HIPERLANs, ACTS/WAND, ACTS/MEDIAN, 2,5 GHz Wireless LANs, (ETSI and IEEE 802.11), ATM Forum developments, SMATV, MMDS/LMDS, Terrestrial broadcasting.

At present, the EPIC project does not have an elaborated follow-on programme from this initial "inventory" activity into access networks. However, it is expected that a new programme will be elaborated in this area to address the gaps and overlaps in the access networks area to support a comprehensive European information infrastructure.

It may be expected that any work initiated as a result of this study should be integrated fully with the requirements to deliver services from the EII via wireless means.

4.6 STC SES5 (reorganized as Task Force S-PCN/UMTS)

The use of satellites to deliver RLL service via Satellite-PCN terminals is certainly possible, although the engineering of such systems is rather different from the engineering of terrestrial RLL systems. STC SES5 was responsible for the 'standardization" of mobile satellite earth stations, including Satellite-PCN (big LEO) terminals. The committee specialized in developing "Envelope" standards for the implementation of Pan-European conformance testing and type approval regime.

NOTE: The "Envelope" standardization approach is to meet basic objectives, in which the markets are generally left to be the main "regulator" and in which the main specifications are proprietary in nature and left primarily to the commercial decisions of the industrial and manufacturing concerns.

The S-PCN system provides a link between mobile and fixed subscribers and the PSTN via a dedicated ground stations and local gateways.

The S-PCN terminals (mobile or fixed) are able to access telecommunications services (voice, data, fax, paging and geographical positioning) globally, particularly in regions where terrestrial wireless and/or wireline infrastructure do not exist, and will often complement terrestrial-based mobile or fixed systems. However, these are all narrowband services within the definitions of the present document and the work in SES5 is therefore not included in the final recommendations in clause 10.

4.6.1 Current S-PCN work

4.6.1.1 Development of "envelope" standards

Following the WARC 92 allocation of Mobile Satellite Service (MSS) spectrum in the 1,6 and 2,0 GHz bands, the ETSI TC SES embarked on a two phase study on possible European standardization of certain aspects of S-PCN, reported in ETR 93 [40] and ETR 177 [41] respectively.

Subsequently, the STC SES5 was given the responsibilities to produce three "envelope" S-PCN ETSs which would cover a number of S-PCN systems within these MSS bands (table 5). These systems will employ a variety of technologies (TDMA, CDMA etc.), each operating as independent systems within their allocated bands.

Table 5: SES5's "Envelope" Standards

Standard	Frequency band	Status
ETS 300 733 [61]	S-PCN 1,6 GHz	Voting commenced February 1997
ETS 300 734 [62]	S-PCN 2,0 GHz	Voting commenced February 1997
ETS 300 735 [63]	S-PCN 1,6/2,0 GHz (NCF)	Voting commenced February 1997

Two of these ETSs specify minimum performance requirements (unwanted emissions and control and monitoring functions) for terminals operating in each of the 1,6 and 2,0 GHz bands, to protect terrestrial and other satellite radio services from harmful interference.

The third ETS, covering both MSS bands, specifies minimum required Network Control Facilities (NCF) for the terminal to ensure suppression of unwanted transmission to protect other users of the spectrum.

4.6.1.2 Development of S-PCN Harmonized standards

Following a mandate from the European Commission to prepare S-PCN "Harmonized standards", TC SES has started to transform ETS 300 733 [61] and ETS 300 734 [62] into TBR 41 [59] and TBR 42 [60]. The TBRs started their Public Enquiry in February 1997.

4.6.2 Additional studies

In the framework of the same mandate, the need and objectives for additional S-PCN standardization activities are currently being investigated, in an ETR 279 [42]. The report is due for publication in March 1997.

The study provides information on current thinking on which standards, in addition to the above "envelope" standards, are needed to assure short and long term suitability of S-PCN systems in the European commercial, operational and regulatory environment.

The issues under considerations are:

- numbering;
- security;
- interconnections and interworking with terrestrial networks;
- evolution towards the UMTS satellite component; and
- human factors.

4.7 Universal Mobile Telecommunications System (UMTS)

The Universal Mobile Telecommunications System (UMTS), Europe's version of FPLMTS/IMT2000, has grown over the years of its gestation period into a wide-ranging concept without enough focus or perspective yet to allow the standards to be written. Perhaps the clearest perspective lies in Japan, where growing demands for mobile wireless spectrum are spurring Japanese industry into making concrete system proposals. The weakest perspective lies in the USA, where parts of the UMTS spectrum have been allocated to the emerging PCS service and the view beyond that appears to be limited.

4.7.1 The key features of UMTS

The following eight items summarize what are considered by the UMTS community to be its most important aspects, equivalent to the "6 bullet points" agreed for GSM about 10 years ago.

- UMTS is a third generation system and must make a sufficient technology step to differentiate it from second generation systems, and will have to co-exist with GSM. UMTS is not an "extended GSM" and the future should not necessarily be compromized for the sake of evolution from GSM;
- UMTS is a wireless mobile system. Mobility must include personal and terminal and service mobility to permit roaming and "Service Mobility" for the user to take his services with him. Wireless access must be spectrally efficient to support all envisaged services;
- UMTS will allow for service creation, unlike second generation systems which defined exact services, hindering differentiation and competition. Service creation utilizing the latest IT techniques should allow the creation of innovative services and individualized service profiles and the ability to download them to subscribers;
- evolution within the standard is essential to allow innovation in service and technology. Ideally, we will never need a fourth generation!
- Convergence and Integration are a major theme. The standard must provide an integrated approach to wireless services, e.g. WLL, cordless, cellular and satellite service access. Telecoms and IT convergence offer mobile access to the "information society". Convergence with banking applications may also be desirable;
- the ability to support secure global cross-standard roaming should be provided. Security and fraud control must be controlled from the home network wherever you are through the integration and development of MAP, IS41 and INAP signalling protocols;
- UMTS should support "Global Multi-Media" (GMM) Information Society services. Services can be added during a call. This is unlikely to require ATM-like switching and transmission over the radio interface and the telecoms Infrastructure. Billing must reflect usage and be understandable to the user;
- intelligence is likely to be distributed through the network for efficient support of information based services. Java-like techniques should provide flexible, modular service creation.

Virtual home environment describes a service that moves with you, so that the user interfaces with the service rather than the terminal, feeling at home when roaming, with familiar service offerings and MMI.

4.7.2 UMTS and RLL

Although UMTS is a mobile system, we have seen that the key features of UMTS currently include the concept of "Convergence and Integration" This includes the RLL service amongst other largely mobile applications.

The conclusions of ETR 139 [1], that multiple standards will be required even for fixed access, suggest that UMTS is being highly ambitious in including all of these applications within the scope of a single system. The present document does not consider either narrowband or broadband RLL applications as part of the proper scope of UMTS, which is first and foremost a mobile system and therefore unlikely to meet the demands of a FS in a satisfactory way. However, this consideration should not lead to ignoring the possible synergies to be obtained from sharing technology across many different applications such as high speed data networks, broadband access systems and, indeed, UMTS. Future RLL standards should take into account UMTS standards development, in a complementary fashion, wherever possible.

4.8 The Global Multimedia Mobility (GMM) project

ETSI's Global Multimedia Mobility (GMM) project [34] concluded that the definitive trend in telecommunications is for users to have access to a diversified range of service offerings anywhere, at all times and on personalized terms and conditions. They expect that innovations in service offerings will be fuelled by healthy competition involving all players in the market. The term telecommunications here includes the Information Technology and Broadcast Entertainment industries as well as traditional public/private (fixed/mobile) telecommunications networks. It is highly likely that there will be many separate networks (partly due to historical reasons) which together will answer all the requirements for personal and mobile communications, which are key to the success of European/Global Information Infrastructure (EII/GII).

The GMM standardization framework complements the work performed for the Information Infrastructure in ETSI and has four domains which are closely related to the business roles in the EII/GII enterprise model: user terminal equipment (fixed, mobile, consumer etc.), access networks, core transport networks and applications services. It embraces personal communications as a whole (not only mobile communication systems) i.e. it includes terminals and networks which support both personal and terminal roaming.

With respect to access networks, the GMM project's report concludes that services will be available to users through a variety of different access networks (currently characterized as public/private (fixed/mobile) networks, a distinction which it is expected will gradually disappear) which in turn will be attached to one or more core transport networks. The dynamic use of several different access networks in parallel also allows for high bit-rate services to be gradually introduced according to market demand and to the availability of high bit-rate core transport networks.

5 Current non-ETSI programmes

It is important for ETSI to be aware of the work elsewhere on RLL systems. In many cases, ETSI should co-operate with other bodies rather than duplicate the efforts and arrive at different although equally effective solutions. Most of the work described in this clause has, at least in part, direct relevance to the present document's recommendations for the development of broadband radio access network technologies. Co-operation between ETSI and the relevant bodies is highly recommended.

5.1 Work in North America

This subclause presents a brief summary of RLL work currently going on within North America. Regulation of wireless access is performed within the USA Federal Communications Commission (FCC) (see subclause 6.4.3). However the real work on standards happens in groups other than the FCC. Within the USA, standards are set by industry committees such as TIA, American National Standards Institute (ANSI), EIA, IEEE and Bellcore. A brief synopsis of RLL activities within each of these organizations is provided below.

5.1.1 EIA and TIA

The following systems and activities within the EIA (Electronic Industries Association) and TIA (Telecommunication Industry Association) are relevant to RLL. However, only the LMDS and MMDS systems are capable of providing broadband service under the definitions used in the present document.

PACS (Personal Access Communications System): PACS is a low power wireless communications system designed to interoperate with existing switching and transmission infrastructure. The PACS air interface has been standardized by ANSI and TIA. The reference standard is ANSI-J-STD-014 June 1995. PACS operates in the 1,85 GHz to 1,99 GHz PCS band and is an amalgamation of PHS and WACS.

PWT-E (Personal Wireless Telecommunications Enhanced): This is an interoperability standard (TIA/EIA-696) which is being developed by the TIA Engineering Subcommittee TR41.6. This standard is based in large part on ETS 300 175 [32] standard for DECT. Changes have been made to conform to the North American national regulations, market conditions and telephone requirements. An intent of this standard is to maintain a high degree of commonalty with the ETS 300 175 [32]. This ETS is applicable over the licensed frequency bands 1 850 MHz to 1 910 MHz and 1 930 MHz to 1 990 MHz. It may also operate in the unlicensed band of 1 910 MHz to 1 930 MHz.

LMDS/LMCS (Local Multipoint Distribution Service/Local Multipoint Communication Service): These are proposed outdoor fixed broadband wireless access systems. The FCC recently proposed a frequency band of 27,5 GHz to 28,35 GHz with a bandwidth of 850 MHz for downstream traffic and 150 MHz for upstream traffic. In Canada, Industry Canada is initiating a licensing process for the same band involving 500 MHz bandwidths.

The following preliminary service requirements have been defined for LMDS:

- maximum peak downlink bit rate per residential subscriber: 30 Mbit/s;
- maximum bit rate per business subscriber: 155 Mbit/s;
- a subscriber may receive up to 4 simultaneous services (e.g. channels) on 4 different set-top boxes including broadcast services such as digital television or near video on demand;
- residential subscribers per radio cell: 200 to 500;
- maximum power -52 dBW/Hz (per FCC proposal docket no. 92-297 1996).

DAVIC (see subclause 5.7) is standardizing LMDS systems.

MMDS (Microwave Multipoint Distribution Service): This is an existing analogue Wireless Cable, Pay and Instructional TV transmission system operating in the 2,1 GHz to 2,162 GHz and 2,5 GHz to 2,686 GHz bands. It was first deployed in 1982. DAVIC (see subclause 5.7) is standardizing MMDS systems.

IS-95 (CDMA cellular): Enhancements to IS-95 have recently been adopted which relate to RLL, for example the provision of additional signalling to fixed wireless terminals for maintenance signalling, for battery status monitoring and for terminal loop testing. Also work is in progress on higher data rates than the current 14,4 kbit/s, aiming to support up to 64 kbit/s and possibly beyond.

TR 45.5 ad-hoc group 2: This is a new group which is mandated to consider RLL specifications, with high speed data as a key requirement - initially 64 kbit/s, but with aspirations to go higher.

5.1.2 Other bodies

At this time there is no work in process within Bellcore, ANSI or IEEE as far as the ETSI RLL Co-ordination Group has been able to determine.

5.2 The ACTS programme

The European ACTS programme (Advanced Communications Technologies and Services) sponsors research under a number of specific projects. The research results and experience from the practical demonstrators from this programme are valuable resources where the ACTS programmes are relevant to developing ETSI standards. Relevant ACTS projects include:

AWACS (ATM Wireless Access Communications System): This programme aims to develop a system and test-bed demonstration of tetherless public access to B-ISDN services. It supports mobility to slow speed terminals in the 19 GHz band with ranges up to 100 m and providing up to 34 Mbit/s with ATM capability. It will examine enhancements to get cellular-like mobility and aim at using radio access technologies relating to HIPERLAN type 4 specifications. It involves new modem development, virtual office trials and video conferencing.

CABSINET (Cellular Access to Broadband Services and Interactive Television): A system operating at 40 GHz to demonstrate a working interactive cellular system. It features "user friendly in-band interactive return links". It uses MPEG-2 coding and QPSK (Quadrature Phase Shift Keying) modulation, adhering to DAVIC standards in the return link when possible. A TDMA/CDMA spread spectrum IF block will be used to enhance the return link. A trial will include ATM services, VoD with at least ten programmes, news on demand and pay TV.

FRANS (Fibre Radio ATM Networks and Services): This project aims to put in place trials of an optically-supported millimetre wave radio link as the final drop from a Passive Optical Network (PON). Two different systems will be trialled. The first has a 622 Mbit/s downlink and a shared 40 Mbit/s uplink, both at about 30 GHz. The second has a 155 Mbit/s downlink at 30 GHz and a lower speed CDMA uplink at about 2,5 GHz.

MEDIAN (Wireless broadband CPN/LAN for professional and residential multimedia applications): This is a high speed (155 Mbit/s) customer premises LAN pilot scheme. It will use a multi-carrier modulation scheme (e.g. Orthogonal Frequency Division Multiplexing - OFDM) that is adaptive to the transmitted data rates and the radio channel and supports "wireless ATM network extension". It uses the 60 GHz band, to connect to third generation "and further" mobile systems via the ATM interface.

SAMBA (System for Mobile Broadband Applications): This programme continues RACE's MBS (Mobile Broadband System) work. It aims to provide cellular system extension to give multimedia support to mobile users. The trial platform will feature 40 GHz operation with transparent ATM to 34 Mbit/s.

SECOMS (Satellite EHF Communications for Mobile Multimedia Services): Mobile broadband services from geostationary satellites in the 20 GHz to 30 GHz and 40 GHz to 45 GHz bands. Service will be $n \times 64$ kbit/s up to 2 048 kbit/s with high capacity gateways (32 Mbit/s) to service providers. The programme is leading to channel tests, radio technology tests and service demonstrations.

WAND (Wireless ATM Network Demonstrator): This programme will establish a practical demonstration of a wireless ATM customer premises access system and feed the details of the system into RES10 as part of the development of RES10's HIPERLAN specifications. Although the technology is intended for in-premises wireless access, the techniques should be applicable to broadband RLL systems capable of carrying ATM.

The satellite systems developed under ACTS are not, under the definitions of the present document, broadband systems. Their technologies, however, should be of relevance to broadband terrestrial RLL systems. The ACTS terrestrial systems and their technologies are very much related to the BRAN proposals later in the present document.

5.3 Work in ITU

Work in progress related to RLL is currently being conducted by the ITU-R, the Radiocommunication Sector of the ITU. ITU-D, the Development Sector, includes RLL within its Handbook on rural telecommunications. There are no ITU-T (Telecommunications Sector) standardization activities current concerning RLL. The ITU-R Study Groups (SGs), Task Groups (TGs) and Working Parties (WPs) doing the work are listed in table 6.

Table 6: ITU-R activities relating to Radio in the Local Loop (RLL)

Study Group	Topic	Working Parties and Task Groups	
SG1	Spectrum Management	WP 1A -	Engineering principles and techniques
		WP 1B -	Principles and techniques for spectrum planning, and sharing and utilization
		TG 1/3 -	Spurious Emissions
SG3	Radiowave Propagation	WP 3J -	Propagation fundamentals
		WP 3K -	Point-to-area propagation
		WP 3M -	Point-to-Point and Earth-space propagation
SG4	Fixed Satellite Service	WP 4/9S -	Frequency sharing between the fixed-satellite service and the FS
SG8	Mobile Service (MS)	WP 8A -	Land Mobile Service (MS) excluding FPLMTS
SG9	Fixed Service (FS)	WP 9A -	Performance objectives, propagation and interference effects
		WP 9B -	Radio frequency channel arrangements, spectrum utilization, interconnection and maintenance
		WP 9D -	Frequency sharing with other services (except the fixed satellite service)

Article 8 of the ITU-R Radio Regulations contains a table which lists each of the frequency bands from 9 kHz to 275 GHz. For each of the three geographical regions of the world (also defined in article 8), each band is then allocated to one or more Primary Service(s), and (optionally) to one or more Secondary Service(s). Primary services have equal rights against interference (although new links are not allowed to interfere with older links), whilst Secondary services are not allowed to interfere with Primary Services under any circumstances. Within the ITU, RLL (or Point-to-MultiPoint - a standard term is not yet established) is not considered to be a service category; it is part of the Fixed Service (FS), and as such uses the bands allocated to the FS. Similarly, there are bands allocated to the MS, rather than to specific applications such as cellular or cordless systems.

5.3.1 Study Group 1 - Spectrum Management

TG 1/3 has addressed the question of spurious emission limits, including that of FS equipment. This has proved to be an area of contention, since Point-to-Point fixed link equipment, which is (generally) designed to meet higher performance objectives because of its (trunked) core network role, can meet tighter spurious emission limits than Point-to-MultiPoint (RLL) fixed systems which are designed for a different purpose. Therefore, the attempt to apply the same spurious emission limits to all FS equipment was not supported by the RLL community. The matter was resolved and the revised ITU-R Recommendation SM.329-6 [43] has now been approved by SG1. TG 1/3 therefore no longer meets.

5.3.2 Study Group 3 - Radiowave Propagation

SG3 produces all the recommendations and tools for determining the propagation of radio systems. This includes:

- Recommendation PN.530-5 [44]; and
- Recommendation PN.452-6 [45].

There is also a draft new Recommendation which may be useful to RLL, namely:

- "Propagation data and prediction models for the planning of indoor radio communication systems and radio local area networks in the frequency range 900 MHz to 100 GHz".

5.3.3 Study Group 4 - Fixed Satellite Service

SG4 includes the WP 4/9S, which links with SG9 to address the sharing scenarios between the FS and the fixed satellite service. In particular, this includes the sharing in the 18 and 28 GHz bands, which may be of future relevance to the RLL work.

5.3.4 Study Group 8 - Mobile Service (MS)

SG8 is currently producing a land mobile handbook [22], which includes details of various wireless access systems. They have also recently agreed a new Question to be considered within the Study Group, on the whole subject of RLL. This does, however, give rise to the potential for overlap with the work of SG9.

5.3.5 Study Group 9 - Fixed Service (FS)

SG9 addresses the FS. WP 9A considers error performance and availability aspects, taking the relevant ITU-T Recommendations (in particular G.821 [50], G.826 [51] and G.827 [52]) and applying them to the fixed radio environment.

WP 9B develops recommendations for the equipment aspects of the FS, in particular for the channel arrangements for the various FS bands. Some of these are obviously aimed towards RLL applications, in particular ITU-T Recommendations F.701 [46]: "Radio-frequency channel arrangements for analogue and digital Point-to-MultiPoint radio systems operating in frequency bands in the range 1,427 GHz to 2,690 GHz (1,5, 1,8, 2,0, 2,2, 2,4 and 2,6 GHz)", F.755 [47]: "Point-to-multipoint systems used in the FS", F.756 [48]: "TDMA Point-to-MultiPoint systems used as radio concentrators" and F.1098 [49]: "Radio-frequency channel arrangements for radio-relay systems in the 1 900 MHz to 2 300 MHz band", which specifically covers the band 2,025 GHz to 2,290 GHz. WP 9B also has a question on consideration of various aspects of Point-to-MultiPoint systems, which has already yielded a Recommendation which contains general information on the implementation of Point-to-MultiPoint systems in the FS.

WP 9D addresses band sharing with other services (except the Fixed Satellite Service, which is addressed by WP 4/9S - see above). This group has undertaken sharing studies as necessary, to determine conditions under which bands could be shared between two (or more) primary services. It has also initiated the ad-hoc WP 7B/9D group, which is addressing sharing issues between the FS and the space science service; this includes the sharing of the 2,025 GHz to 2,290 GHz band which will be used for RLL applications.

5.4 Work in CENELEC

CENELEC and ETSI are currently co-ordinating their activities with respect to the EC mandate M/215 (BC-T-340) [26] on standards for access networks in the ICT field. Although this mandate covers access networks in general, a part is specifically designated for radio access technologies.

The EC mandate M/215 is part of the EC initiative for the opening up of telecommunications networks (including CATV etc.). The intention is to allow users to have and exercise a choice from a range of differing network services.

Under the CENELEC-ETSI agreement, ETSI is responsible for systems and applications aspects of work items and the main CENELEC responsibilities concern safety, EMC and installation rules.

5.5 Work in ETNO

The European public Telecommunications Network Operators' association (ETNO) sees that radio offers considerable potential for the local loop and has already been shown to be cost effective in this role. A survey among ETNO operators revealed that a surprising diversity of radio based solutions were already deployed. The immediate needs of WLL have been partly fulfilled with the existing techniques and systems. This has resulted in a number of operators developing ad-hoc WLL solutions in a number of frequency bands to overcome specific access problems. Although representing fragmented developments, this evidence confirms that ETNO operators see business advantages in bringing services to the customers via radio access.

The ETNO-FM (Frequency Management group) view concerning the development of WLL is as follows:

- WLL represents a potentially major growth area for new radio applications. However, this local loop area has received very limited attention in the harmonization of standards and spectrum allocations;

- the piecemeal, ad-hoc approach to WLL development is far from ideal as it will not realize the full potential of radio in terms of operational effectiveness, manufacturing, economy of scale or the spectrum utilization. A more ideal solution would be a co-ordinated approach among the three main players (manufacturers, operators and regulators), on a pan-European basis developing the ad-hoc use of WLL into a harmonized and standardized complement to wired systems;

- so far wireless access has failed to establish itself as a mainstream alternative to conventional copper local loops. This situation is about to change. Radio in the access network and particularly the WLL could prove to be the next major growth area for radio following on and benefiting from the massive accumulated experience derived during the deployment of the cellular mobile environment;

- it can be seen that the relationship between fixed and mobile networks is to be even more intimate and compelling one than generally expressed today. The user community will rapidly change its attitude to MSs. These will in a few years time be regarded as quite a normal means of access to telecommunications networks, with the additionally and obvious added value of local mobility. It is necessary to ascertain that the main operator of local wired network is entitled to use all cost-effective technical means available in order to fulfil its obligations, e.g. USO. These means will definitely include as an access medium mobile technologies, with associated frequency allocations, and migration of fixed and mobile networks;

- WLL can play a key role in addressing emerging new market opportunities, especially in a competitive environment. However ETNO-FM has identified barriers to the success of this exciting new market. The lack of a common purpose by the operators, manufacturers and radio regulators, and particularly the absence of a recognized spectrum strategy for WLL, is inhibiting proper European standardization and harmonization of services;

- with the potential for very significant and sustained growth in WLL applications sector, co-operative attention now needs to be given to WLL standards, and most importantly to targeted and controlled spectrum development to provide sufficient capacity to accommodate the quantity, quality and diversity of systems and also to secure existing investments already made by PTOs;

- future scenarios of WLL (table 7) include evolutionary paths towards PCS concepts. It is important to identify solutions with which the mobile and fixed system migration and interconnection will allow for evolution towards a PCS environment and real mass market, including modern broadband services, like interactive multimedia.

Table 7: Future scenarios for WLL

Class	Services	Range	Customer Density	System	Frequency Range
Remote rural	Voice and low-rate data (Basic rate ISDN)	1 km to 70 km	low	Point-to-Point	VHF/UHF
Rural	Voice and low-rate data (Basic rate ISDN)	1 km to 25 km	medium	Point-to-MultiPoint	less than 3 GHz
Urban residential	Voice and low-rate data (Basic rate ISDN)	less than 250 m	high	Point-to-MultiPoint	860 MHz to 3 GHz
Urban small business	Voice and low-medium data rates	less than 10 km	medium-high	Point-to-MultiPoint	greater than 3 GHz
Urban/suburban multimedia	Multimedia	less than 2 km	medium-high	Point-to-MultiPoint	mm-wave

ETNO sees three impediments to the future development of radio access systems that should be addressed:

- the absence of a common purpose amongst the European operators, manufacturers and regulators in the development of radio systems for the access network;

- radio regulatory factors;

- the need for a clearly defined spectrum development policy.

5.6 Work in the ATM Forum

The ATM Forum is an international non-profit organization formed with the objective of accelerating the use of ATM (Asynchronous Transfer Mode) products and services through a rapid convergence of interoperability specifications. In addition, the Forum promotes industry co-operation and awareness.

Since its formation in 1991, The ATM Forum has generated very strong interest within the communications industry. Currently, The ATM Forum consists of over 700 member companies, and it remains open to any organization that is interested in accelerating the availability of ATM-based solutions.

The ATM Forum consists of a world-wide Technical Committee, three Marketing Committees for North America, Europe and Asia-Pacific as well as the Enterprise Network Roundtable, through which ATM end-users participate.

The ATM Forum has a Wireless ATM Group which works closely together with ETSI STC RES10.

5.6.1 The Technical Committee

The ATM Forum Technical Committee works with other standards bodies, such as ANSI and ITU-T, selecting appropriate standards, resolving differences among standards, and recommending new standards when existing ones are absent or inappropriate.

The Technical Committee was created as one, single world-wide committee in order to promote a single set of specifications thereby ensuring interoperability between all vendors as ATM products and services become available.

The Technical Committee consists of several working groups, which investigate different areas of ATM technology.

5.6.2 Specifications

The ATM Forum has produced a series of specifications covering such diverse subjects as physical layer operation and audio-visual multi media services. These industry standards play an important role in the emergence of ATM technology as the technology of choice for future infrastructure networking as well as for end-to-end services.

5.6.3 The market awareness committees

The three ATM market awareness committees (North America, Europe and Asia/Pacific) provide marketing and educational services designed to speed the understanding and acceptance of ATM technology. They also:

- co-ordinate development of educational presentation modules and technology papers;
- facilitate exchange of information and requirements between the Enterprise Network Roundtable and the Technical Committee;
- publish "53 Bytes", the ATM Forum newsletter, and co-ordinate publicity of Forum activities; and
- co-ordinate demonstrations of ATM at trade shows, highlighting ATM's ability to solve today's business problems.

5.6.4 The Enterprise Network Roundtable Committee

The Enterprise Network Roundtable, formed in 1993, consists of ATM end-users. This group interacts regularly with the market awareness committees to ensure that ATM Forum technical specifications meet real-world end user needs. In this rapidly-growing organization, topics of discussion are varied, including issues such as interoperability among vendors and migration of the installed base to ATM.

5.6.5 The ATM Forum ambassador program

ATM Forum Ambassadors provide informative presentations to the networking and telecommunications community regarding the Forum and ATM technology. Ambassadors attend ATM Forum meetings regularly, and represent material in a non-vendor-specific manner.

Any organization interested in requesting an educational presentation by an ATM Forum Ambassador can receive a request form using the ATM Forum Fax-on-Demand Service.

5.6.6 Wireless ATM

The ATM Forum has a wireless group (the WATM Group) that works on all aspects of wireless ATM systems. In the area of wireless access, much of its radio related work is conducted in collaboration with ETSI STC RES10 (see subclause 4.4). A common Reference Model is being drafted by members of the WATM Group and RES10 as the basis for a set of specifications of which the Forum will provide the signalling related parts and RES10 the radio related parts.

5.7 Work in DAVIC

The Digital Audio-Visual Council is a non-profit association based in Geneva, Switzerland, aimed at promoting the success of digital audio-visual applications and services based on specifications that maximize interoperability across countries and applications/services.

5.7.1 Introduction

Established in August 1994, the DAVIC membership currently includes more than 200 companies from more than 25 countries around the world and representing all sectors of the audio-visual industries: manufacturing (computer, consumer electronics, telecommunication equipment) and service (broadcasting, telecommunications, CATV) as well as a number of government agencies and research organizations.

The primary instrument is production of technical specifications that maximize interoperability across countries and applications/services.

5.7.2 Specifications and work plan

DAVIC specifications are issued in versions: DAVIC 1.0, DAVIC 1.1 etc. The first version, DAVIC 1.0, allows the deployment of systems that support initial applications such as TV distribution, near video on demand, video on demand and some basic forms of teleshopping. Each later version extends previous versions to provide more functionality while keeping, as far as possible, backwards compatibility with previous versions.

DAVIC 1.1 introduced a work item called "Technologies for transmission to the A1 interface via MMDS (Multichannel Multipoint Distribution System)". MMDS, in DAVIC terminology, was at the time of introduction a one-way radio delivery system at a Radio Frequency (RF) of 10 GHz or less, for radio delivery of broadcast video. The MMDS specification covers the Physical Layer and Medium Access Control Layer for the MMDS system.

DAVIC 1.2 introduced a work item called "Modulation and associated technology to transmit digital audio-visual information over 28 GHz to 40 GHz (LMDS)". This is a specification for the Physical Layer and Medium Access Control Layer for a two-way wireless ATM and MPEG delivery system. The forward channel (towards the subscriber) has a high bandwidth and the return channel has limited bandwidth suitable for making Video on Demand (VoD) requests.

DAVIC 1.3 introduced the idea of "communicative services" to cover voice telephony, audio (and audio/video) conferencing and the like. It also added a return channel to the MMDS specification to permit MMDS to be used for interactive video and telephony services, rather than just broadcasting by radio.

5.7.3 Multimedia mobile wireless systems

DAVIC's future, but as yet unrealized ambitions, include the development of multimedia mobile wireless systems. These are not directly related to the FSs addressed in the present document. However, the services they offer are likely to duplicate the services of a fixed broadband RLL. These services are:

- services for limited bandwidth terminals;
- subsets or extensions of current information representation tools;
- mobile wireless delivery systems;
- A1 interface for mobile applications;
- user-to-network and user-to-server protocols;
- network management system to provide roaming capability.

In general, these systems are characterized by the ability to move between cells at either walking speed or vehicular speeds and by relatively limited bandwidth transmission (such as PHS or PCS). Although such delivery systems cannot offer the full features and functions of the DAVIC 1.0 system, users should be able to access a limited sub-set on a mobile terminal such as a lap-top computer.

5.7.4 DAVIC's future direction

The original aim of DAVIC was to standardize Video on Demand systems. The take-up of VoD services has however been much slower than anticipated and the most recently completed call for proposals (CFP #6, released September 1996 with responses received in December 1996) has initiated work on specifying means to deliver telephony (called "communicative services") and Internet access. The consortium is currently approaching the provision of these services from the viewpoint of a CATV service supplier wanting to add a telecommunications service to a video distribution system, rather than the viewpoint of a telecommunications supplier wanting to use DAVIC-compliant equipment to provide a telecommunications service including video.

The MMDS and LMDS radio distribution specifications that already exist within the DAVIC consortium are not obviously suited to the provision of a "universal service" with guarantees for the percentage coverage of subscribers in any particular territory. It may be that this type of service, characteristic of the sort of service envisaged by European operators for their future broadband telecommunications networks, could be provided via DAVIC standards. However, DAVIC should be regarded as an organization with extensive expertise in the video distribution field but not in telecommunications. This view should apply regardless of the fact that many large organizations with considerable corporate telecommunications expertise are members of DAVIC and contribute to its work. It should be considered that DAVIC's new ventures into "communicative services" and Internet access remains sufficiently new for the membership not to yet have come to grips with the full ramifications of public telephony.

5.8 Work in the DVB consortium

The Digital Video Broadband (DVB) project was initiated in 1993 to develop system architectures for digital television broadcasting using the MPEG-2 standard. Membership totals of over 200 (private and public) in some 25 countries.

DVB is intended to operate over a variety of transport media, including cable, satellite and terrestrial radio. Standards currently exist for cable transmission (ETS 300 429 [54]) and satellite transmission in the 11 GHz to 12 GHz band ETS 300 421 [53]). For terrestrial radio, work is in progress on a digital Multipoint Video Distribution System (MVDS) below 10 GHz. This work is being co-ordinated with the DAVIC MMDS activity.

DVB also intends to provide interactive services including interactive TV, shopping and games.

5.9 Work in the Broadband Wireless Association (BWA)

This is a new European voluntary industry association formed in 1996 to act as a forum for operators, service providers, network operators, manufacturers and others interested in broadband wireless applications; this grew out of an earlier European RACE programme and in particular from interest in MMDS activities. Membership includes broadcasting, mobile, wireless ATM, satellite and terrestrial participants from some ten countries currently. It is "an association for persons interested in Broadband Wireless Technologies ("the Technologies") worldwide with regard to the promotion of the industry and dissemination of information regarding the technical, marketing, regulatory and other issues relating to the technologies." Various technical, commercial and regulatory committees have now been formed and it is understood that liaison arrangements are planned with DVB, DAVIC, CEPT and others.

Care needs to be taken with the abbreviation BWA, since this could also correspond to the generic descriptor Broadband Wireless Access.

6 Radio spectrum assignment and usage

6.1 Current allocation in Europe

The basic document to consider when analysing the RLL current situation in Europe is the CEPT European Radiocommunications Committee (ERC) Report 25 [20] titled "CEPT Report concerning the frequency band 960 MHz to 105 GHz and Associated European Table of Frequency allocations and Utilisations".

This document was published in June 1994 and revised in March 1995. It results both from the ERC/ERO DSI Phase I for the frequency range 3,4 GHz to 105 GHz and from some work undertaken by the CEPT ERC in 1993 for the frequency range 960 MHz to 3 400 MHz.

The document gives a table of frequency allocations and utilizations for the frequency band 960 MHz to 105 GHz expected beyond the year 2008. It is expected that CEPT members countries will endeavour to implement, as soon as possible, as many parts of the table as they are able.

It is also the ERC intention to review periodically and revise as necessary the report and its associated table taking into account the results of the World Radio Conferences.

6.2 ERC Recommendations/Decisions, EC Directives and on-going studies in Europe

ERC and its permanent administrative office, European Radiocommunications Office (ERO), are responsible for matters relating to the allocation and management of radio spectrum, including that for RLL applications. Two ERO/EC activities are related directly to RLL: their Detailed Spectrum Investigations, which have catalogued the radio spectrum, including spectrum used for RLL systems; and their recent survey work on RLL for the European Commission.

6.2.1 ERC Recommendations/Decisions and EC Directives

Considering the present frequency allocations and their related ERC Recommendations and Decisions, only current technologies and standards have been reviewed i.e. cellular, cordless, Point-to-MultiPoint systems, satellites and radio LANs.

6.2.1.1 Cellular

GSM Recommendations and Decisions are as follows:

- ERC/Recommendation T/R 20-08 (Lecce 1989) defines frequency planning and frequency co-ordination;
- ERC/Recommendation T/R 75-02 and ERC/Decision (94)01 [75] allocates the band 890 MHz to 915 MHz paired with the band 935 MHz to 960 MHz to GSM;
- In addition, a draft ERC Decision (ERC/Dec. (96)TT) for an extension of the GSM frequencies in the band 880 to 890 MHz paired with the band 925 to 935 MHz is under consideration with a view to final approval in March 1997.

DCS 1800 Recommendations and Decisions are as follows:

- ERC/Recommendation T/R 22-07 (Montreux 1993) allocates, on a national basis, the band 1 710 MHz to 1 785 MHz paired with 1 805 MHz to 1 880 MHz to DCS 1800;
- ERC/Decision (95)03 [77].

6.2.1.2 Cordless access

CT2 Recommendations and Decisions are as follows:

- there is no ERC Recommendation dealing with CT2, but, within the framework of the DSI phase 2 exercise, the decision to include the CT2 frequency band (864,1 MHz to 868,1 MHz) in the table of European allocations until year 2008 is still under consideration.

DECT Recommendations and Decision are as follows:

- ERC/Recommendation T/R 22-02 [70], ERC/Decision (94)03 [76] and Council Directive 91/287/EEC [24] on the designation of the band 1 880 - 1 900 MHz for DECT.

6.2.1.3 Point-to-MultiPoint

With respect to rural RLL, a liaison statement from ETSI STC TM4 to the ERC requests a frequency band around 500 MHz be allocated to P-MP systems in rural areas.

P-MP Recommendations and Decisions are as follows:

- ERC/Recommendation T/R 13-01 [66]:
  - 1 350 MHz to 1 375 MHz paired with 1 492 MHz to 1 517 MHz for low capacity Point-to-Point and Point-to-MultiPoint systems.
  - 1 375 MHz to 1 400 MHz paired with 1 427 MHz to 1 452 MHz for low capacity Point-to-Point and Point-to-MultiPoint systems.
  - 2 025 MHz to 2 110 MHz paired with 2 200 MHz to 2 290 MHz for traditional multi-channel, multi-hop radio relay systems and also for modern access radio applications.
  - 2 520 MHz to 2 593 MHz paired with 2 597 MHz to 2 670 MHz for Point-to-Point and Point-to-MultiPoint systems for single and multi-hop applications.
- ERC/Recommendation 14-03 [68];
- ERC/Recommendation 12-05 [65];
- ERC/Recommendation T/R 13-02 [67];
- ERC/Recommendation T/R 52-01 [73].

6.2.1.4 Other related ERC/Recommendations and Decisions

Other ERC Recommendations and Decisions relevant to RLL are as follows:

- ERC/Recommendation 10-01 (rev 1992) [64];
- ERC/Recommendation 22-03 [71] (Table designating 59 GHz to 62 GHz for Radio LANs);
- ERC/Decision (96)03 [78].

6.2.2 Spectrum planned or under consideration for RLL

There are some parts of the spectrum that are not yet covered by an ERC Recommendation or Decision, but which may be allocated for use by RLL systems, or which may allow RLL usage in combination with another service. These are:

- The German authorities plan to allocate two 504 MHz blocks within the 26 GHz band for RLL systems (see subclause 6.3.3.2). This spectrum relates to the TM4 activity to develop standards for P-MP systems in the frequency range 24,25 GHz to 29 GHz, see DEN/TM-04043 (see subclause 4.4.1.1).
- CEPT/ERC intends to issue by mid-1997 a new Decision on UMTS, designating the bands 1 900 MHz to 1 980 MHz, 2 010 MHz to 2 025 MHz and 2 110 MHz to 2 170 MHz for terrestrial UMTS applications. The Decision will also allocate 1 980 MHz to 2 010 MHz and 2 170 MHz to 2 200 MHz for satellite UMTS components. Discussions are still on-going on the possibility to share the 1 900 MHz to 1 920 MHz band with DECT on a national basis.

6.2.3 On-going WLL studies

ERO has completed a study (ERO/EC study [35]), funded by the European Commission, on the expected development of Wireless Local Loop (WLL) in Europe and the related spectrum needs. The report provides up to date information about the ERC views on the requirements, the technology options and the spectrum needs.

ERO/EC have identified WLL as being of major significance for Europe as it would address the following aims:

- to improve telephone penetration;
- to improve economics of rural telecommunications; and
- to foster telecommunications competition.

The following study objectives were recognized:

- to inform less informed (national) authorities;
- to determine spectrum requirements for WLL systems; and
- to promote harmonization for WLL.

The study, as part of which a survey has been carried out of the opinions of interested organizations, does not attempt to make spectral efficiency comparisons and does not propose standardization activities.

6.3 Current situation on RLL licensing in Europe

6.3.1 General

In some countries there is now recognizable growth in new fixed wireless access connections. Yet studies carried out in Europe have indicated relevant barriers for maximizing the RLL market potential to the full. Today some countries with their regulatory scheme are more "advanced/developed" in the deregulation and liberalization process than others and this concerns RLL, too.

However, even the definition of RLL has regulatory implications. Much of the work on DECT, for example, has been focusing on what is technically sensible - but several questions remain unanswered on what is permitted from a regulatory view point. The ETR on Services, Facilities and Configurations, ETR 308 [7] illustrates some of the issues including: the place of mobility in the local loop, several issues around Network Termination Point, responsibility for keeping a clear radio path to the subscriber, distinction between network equipment and terminal equipment, questions of concentration in the air, emergency call aspects, added delay and spectrum issues concerning repeaters and spectrum sharing between RLL and other services.

Whilst in the short term, for narrowband RLL systems that are already being planned or deployed, standardization and harmonization may slow down service introduction, the expansion and evolution of RLL in the longer term may benefit from some common basis like harmonized European Standards, proper frequency management, harmonized licensing schemes and an understanding the real market needs.

ITU gives, in its Radio Regulations, the statutory requirements for terms and definitions for various radio services and also general rules for the assignment and allocation for use of frequencies. Frequency allocations are based on the categories and status of services and their allocations. While the administrations are in a position of deciding the national telecommunications policy, the rapid introduction of new services and new products tend to be restricted by regulatory provisions based on earlier technology and systems.

The views expressed hereinafter under subclauses 6.3.2, 6.3.3, and 6.3.4 are those of their authors. It does not mean that they are necessarily shared by all parties in the relevant country, or by ERCG.

6.3.2 The views of the UK (Radiocommunications Agency)

6.3.2.1 Radio Fixed Access (RFA)

The UK government has made available spectrum at 2 GHz and 10 GHz for wireless local loop services based upon Point-to-MultiPoint (P-MP) technologies. These FSs are in internationally recognized parts of the spectrum for Point-to-Point and Point-to-MultiPoint services and are known in the UK as Radio Fixed Access (RFA). Licenses to provide these services were granted during February 1996 as a result of a consultative process, see [8]. In addition to these there are operators licensed to provide residential and small business telephony services in the bands at 3,4 GHz and 4 GHz. The licensed operators can be divided in three sections covering:

- rural services (up to ISDN BRI) in the 2 GHz band;
- residential and small business telephone services (up to ISDN BRI) in the 3,4 GHz and 4 GHz bands;
- business services (ISDN BRI and above up to around 2 Mbit/s) in the 10 GHz band.

The P-MP technologies use or are expected to use multi-access methods based on any one of the techniques currently undergoing standardization within ETSI STC TM4, namely TDMA, FDMA and CDMA.

6.3.2.2 ISM 2,5 GHz band

Within the UK, there are currently RLL telephony services being operated in a geographically restricted area in the 2,5 GHz ISM band. This service utilises equipment that has been approved to ETS 300 328 [55] (Wideband data transmission systems operating in the 2,4 GHz to 2,5 GHz ISM band and using spread spectrum modulation techniques) although it is not an ETS specifically for RLL equipment. This operation is not preferred in the UK due to the lack of protection afforded a service in this band.

6.3.2.3 Broadband services

Looking to the future, there is currently a lot of interest in services providing Broadband Local Access Network Connection (BLANC). These would provide the subscribers with interactive multimedia services, Internet connections, video on demand, high speed data services, all requiring varying high data rates.

Work on standardization activities in these areas has been initiated in ETSI STC TM4 where P-MP solutions are being considered. Important questions are being asked about the radio, network, services and market issues and the UK Radiocommunications Agency has been considering spectrum availability for these services and the appropriateness of frequencies around the 27,5 GHz to 29,5 GHz band and the 40,5 GHz to 43,5 GHz band.

The UK RA in its document "UK Spectrum Strategy" [9] published by the UK RA on behalf of the UK DTI in 1996 (second edition May 1996) is proposing to make available the 42,5 GHz to 43,5 GHz band and is considering increasing access to the 42 GHz where cable Local Distribution Operators (LDOs) are not likely to use MVDS. The sharing issues (radio astronomy) are not considered to be too onerous and work is underway to resolve these.

The second band under consideration is the 27,5 GHz to 29,5 GHz band where current USA LMDS operates. However the sharing difficulties in this band are more complicated with satellite co-primary services and are likely to be more difficult to resolve.

Within the UK some thought has already been applied to interactive services in the consideration of a UK national specification, MPT 1560 [31], relating to digital MVDS which is currently undergoing the EC barriers to trade procedures under Directive 83/189/EEC [29]. In this document, the provision of interactivity and telephony has been foreseen with spectrum reserved for return channels.

6.3.3 The views of Germany (BAPT)

6.3.3.1 DECT

RLL systems using DECT are currently tested in Germany on local cellular networks for provision of speech services and mobility. New DECT technology providing for ISDN services will be available in approximately 1997. DECT technology is therefore suitable for planned future applications. The spectrum of 20 MHz (1 880 MHz to 1 900 MHz) currently available for DECT applications will be used on a shared basis by licensed public network operators and private DECT users. A substantial increase in the amount of data (i.e. Internet) traffic carried results in an increase in the spectrum required (see below).

Possible solutions are:

- attachment of technical requirements (e.g. synchronization of networks) to licenses;
- extension of the frequency band by 20 MHz (already proposed by the Federal Ministry of Posts and Telecommunications within the CEPT).

The objective for the German Administration is not to limit the number of licensees.

In principle, the licensing of DECT RLL systems for operation in the 1 880 MHz to 1 900 MHz frequency band alongside privately-operated DECT systems is feasible.

It is not necessary to limit the number of licensees within a given geographical area. Potential restrictions in capacity at vulnerable locations (airports, railway stations, etc.) can be avoided by means of regulatory conditions and/or technical requirements attached to the licenses.

On the basis of the market forecasts, the spectrum currently available is sufficient to accommodate the estimated requirements for the next 3 to 5 years. An extension of the DECT frequency band by 20 MHz has already been proposed in order to accommodate any future increase in frequency requirements as a result of emerging increase of data (i.e. Internet) traffic carried and of a rise in the number of DECT RLL access lines. Following the German Administration recommendation, the manufacturing industry was promptly informed of this proposal and it was recommended that equipment be designed and manufactured for operation in the 1 880 MHz to 1 920 MHz frequency band.

According to the German Administration, a European consensus on this subject should be reached. However, so far this has not been possible, and the subject of extending the DECT frequency band currently remains a national issue.

The use of DECT technology for wireless local loop systems is the first step in the movement from existing mobile radio systems towards third-generation mobile radio.

6.3.3.2 Other systems

The following frequency bands should in addition be allocated for RLL:

- 3,4 GHz to 3,6 GHz for CDMA, TDMA and FDMA systems; and
- 26 GHz band for CDMA, TDMA and FDMA systems.

It is planned to allocate 2×100 MHz in the frequency band 3,4 GHz to 3,6 GHz and 2×504 MHz in the 26 GHz frequency band for Point-to-MultiPoint RLL systems. These two frequency bands are still currently occupied by Point-to-Point radio-relay systems. There is however sufficient spectrum available to accommodate both the Point-to-Point and the Point-to-MultiPoint systems.

Type approval specifications will be available shortly for Point-to-MultiPoint radio relay in the 26 GHz band. An ETSI specification for Point-to-MultiPoint radio relay systems in the 1 GHz to 3 GHz band was approved in October 1996, ETS 300 636 [11] and it is anticipated that suitable TDMA, CDMA and FDMA systems will be available in 1997. The transmission rates feasible using current Point-to-MultiPoint radio relay systems range from a few kbit/s to 8 Mbit/s.

The German administration plans to grant licenses for the operation of telecommunications networks as of the end of October 1996. Anyone who wishes to provide network services for the public may enter the market as a service provider, provided that the appropriate license has been granted. As from the 1st January 1998, licenses for the provision of voice telephony services for the public will also be granted. The aim in Germany is not to limit the number of licensees.

6.3.4 DGPT public consultation (France)

In recognition of forthcoming deregulation of the telecommunications market and the numerous technological developments taking place in the WLL arena, the DGPT has issued a public consultation document entitled "La Boucle Locale Radio" [10].

NOTE: From January 1997, DGPT was re-organized and is now called ART (Autorité de Régulation des Télécommunications).

This consultation was motivated by the following considerations:

- WLL can be perceived as a factor in the development of multimedia services and the introduction of new services;
- it is seen as a means of stimulating the introduction of competition in the local loop;
- it may also contribute to reducing the cost of operator universal service obligations;
- the introduction of WLL would open up an important potential market for network operators and equipment manufacturers.

The consultation document draws attention to the main technologies involved which include fixed Point-to-Point systems, Point-to-MultiPoint systems, DECT systems, CT2, cellular, audio-visual broadcast systems and satellite delivery systems. Views are sought on the introduction of WLL systems with regard to the following main issues:

- frequencies available in France in relation to European harmonization of frequencies and allocations made in other countries;
- licensing conditions with regard to geographic areas: should licenses be issued locally, regionally or nationally;
- how the licenses should be allocated to the different prospective operators.

6.4 Other considerations, regional and worldwide

6.4.1 ITU - the International Telecommunications Union

The different frequency bands are allocated to services and not to specific systems. The services which are relevant to RLL applications are the FS and the MS. The method of assignment is a complex issue. It depends at first on the type of service. According to the method for assignment used for MSs, fixed radio stations can be implemented in the same bands. Furthermore, many of the candidate frequency bands for RLL applications are co-primary allocated to fixed and MSs.

Therefore, worldwide harmonized frequency allocations are not easy to achieve. For example, the agreement achieved during WARC 92 on frequency harmonization of the Future Public Land Mobile System (FPLMTS) in the three regions is still not achieved.

One of the best reference documents for spectrum designated for the FS as a whole is ITU-R Recommendation F.746 [56]. Table 8 is a condensed summary of the frequency bands listed in Recommendation F.746 [56], showing the specific Recommendations covering them.

Table 8: Fixed service (FS) frequency bands listed in ITU-R Recommendation F.746

Frequency band	Recommendation(s)
1,427 GHz to 2,7 GHz	F.283 [80], F.382 [81], F.701 [46], F. 746 [56] and F.1098 [49]
3,6 GHz to 4,2 GHz	F.382 [81] and F.635 [88]
4,4 GHz to 5,0 GHz	F.746 [56] and F.1099 [74]
5,85 GHz to 8,5 GHz	F.383 [82], F.384 [83], F.385 [84] and F.386 [85]
10,38 GHz to 10,68 GHz	F.746 [56] and F.747 [30]
10,7 GHz to 13,25 GHz	F.387, F.497 [86] and F.746 [56]
14,25 GHz to 15,35 GHz	F.746 [56] and F.636 [89]
17,7 GHz to 23,6 GHz	F.595 [87] and F.637 [90]
24,25 GHz to 29,5 GHz	F.748 [69]
31,0 GHz to 31,3 GHz	F.746 [56]
36,0 GHz to 40,5 GHz	F.749 [72]
54,25 GHz to 58,2 GHz	F.1100 [79]
NOTE: The frequency bands shown in the table above are not necessarily covered continuously within any one Recommendation where several Recommendations are listed.	

Two new draft Recommendations, corresponding to the European channel arrangements in the ranges 1 350 MHz to 1 517 MHz and 2 520 MHz to 2 670 MHz respectively, have been approved by the WP 9B in March 1996.

6.4.2 FCC - the Federal Communications Commission (USA)

The FCC's main role is to allocate frequency spectrum and with that set a few basic rules on non-interference. Currently the FCC has allocated the frequency bands listed in table 9 for RLL and related applications.

Table 9: FCC-allocated frequency bands for RLL and related applications

Frequency band	Application
862 MHz to 866 MHz	Rural Radio (BETRS - CO: Basic Exchange Telephone Radio System - Central Office)
800 MHz to 900 MHz	Cellular and Fixed Cellular
953 MHz to 960 MHz	CANADA: proposed fixed wireless local loop
1,85 GHz to 2,2 GHz	Personal Communication Services
2,1 GHz to 2,162 GHz and 2,5 GHz to 2,686 GHz	Microwave Multipoint Distribution System - MMDS
3,4 GHz to 3,7 GHz	Fixed wireless band as per the CITEL PCC III proposal
4,66 GHz to 4,685 GHz	General Wireless Communication Services
5,15 GHz to 5,35 GHz and 5,725 GHz to 5,875 GHz	Unlicensed National Information Infrastructure/SUPERNet.
27,5 GHz to 28,35 GHz	Local Multipoint Distribution Services - LMDS (LMCS in Canada)
29,1 GHz to 29,25 GHz	LMDS (pending rule making docket 92-297)
40,5 GHz to 42,5 GHz	Short Range Wireless
47,2 GHz to 48,2 GHz	pending rule making docket 94-124

For further details, the FCC publishes a spectrum inventory, DA96-1704 [33] which is also available via its WWW site at http://www.fcc.gov/.

6.4.3 CITEL - the Inter-American Telecommunication Commission

This is an organization established several decades ago under the auspices of the Organization of American States (OAS). CITEL comprises some thirty signatories, with a working mandate broadly similar to CEPT, at least in respect to its third Permanent Consultative Committee (CPP/PCC III). The latter is without dispute the forum for spectrum and associated regulatory considerations for all the Americas, including the Caribbean region. (It is interesting to note that there is as yet no similar institution to CEPT or CITEL for South East Asia, where there is very significant interest and economic and social need for fixed wireless access technology, as indeed is the similar case for the African continent.)

There is very considerable interest within CITEL in the benefits to be gained by rapid adoption of fixed wireless access technology. This covers both terrestrial cellular (radio) and potential satellite, including Low Earth Orbit (LEO), approaches. CITEL has sanctioned wireless access adoption in the PCS 1900 band, and has recently decided to undertake detailed studies of the sharing and co-ordination issues associated with the potential use of the intermediate 1 910 MHz to 1 930 MHz UPCS ("unlicensed" PCS) band; this work includes further study of the efficacy of new sharing etiquettes and mix of TDD and FDD systems in the same geographical area. Importantly, the 3,4 GHz to 3,7 GHz band has been identified as particularly suitable for FWA in this region, with a conscious decision not to stipulate any particular interface standard(s). Higher frequency bands are under consideration, and for this various sharing studies are underway and planned.

6.5 RLL spectrum: current situation and needs

6.5.1 Current situation

6.5.1.1 General

The current situation in Europe covers only limited deployment of RLL and have had, until now, a limited implication on spectrum needs for the future. This may however change drastically in the near future in Europe due to the deregulation and the emergence of new operators offering new services mainly in the local loop where the investment can be limited and, thanks to the radio technology, follow the market demand.

Therefore, as a general point, it might be useful to survey the RLL systems deployed, being introduced, being planned and developed in the different frequency bands. These are the followings.

6.5.1.2 Current situation below 1 GHz

Systems are being deployed within and outside Europe which utilize mobile-based architectures e.g. 450 MHz and 850/900 MHz. The largest installed base uses analogue systems.

6.5.1.3 Current situation in the 1 GHz to 10 GHz band

The spectrum allocations for digital mobile (1 800 MHz in Europe, 1 900 MHz in North America) are addressed elsewhere.

There is spectrum used for RLL application in the 1,5 and 2 GHz areas within and outside Europe, and this is receiving considerable attention for proposed new equipment developments.

In the 3,5 GHz region, the first European commercial deployments have commenced. Within CEPT considerable effort has been extended to attempt harmonization of the 3,4 GHz to 3,6 GHz band. A suitable ERC/Recommendation 14-03 on Harmonized RF for low and medium capacity systems in the band 3,4 GHz to 3,6 GHz has been recently approved. This compromise plan takes account of the sharing needs between P-P, P-MP and Electronic News Gathering/Outside Broadcast (ENG/OB) services.

In the Americas, considerable interest in the 3,5 GHz exists. The recent CITEL preliminary decision to allocate 3,4 GHz to 3,7 GHz to RLL use is significant. This body also identifies current 800 MHz and 1 900 MHz bands, but discourages uses of 2 GHz to 3 GHz band.

6.5.1.4 Current situation in the 10 GHz to 20 GHz band

The 10,00 GHz to 10,68 GHz band has also received consideration by CEPT. ERC/Recommendation 12-05 [65] on harmonized radio frequency channels arrangements for digital terrestrial fixed systems operating in the band 10,00 GHz to 10,68 GHz has been prepared. In the UK three operator licenses in this band have recently been awarded.

Outside Europe the 10 GHz band is more problematic, and more study is needed.

6.5.1.5 Current situation above 20 GHz

The 28 GHz band is currently targeted by LMDS/MVDS proponents. The extent to which RLL may be able to exploit this band is unclear, but would appear to merit considerable attention. The final results of the NPRM process in FCC for LMDS are to be considered.

CEPT now has a specific task as part of the preparations for WRC 97 for the identification and protection of allocations appropriate to wireless access systems including links above 30 GHz. Also within CEPT, FM Project Team 29 has recently initiated work to investigate the possibility of introducing harmonized spectrum substantially below 40 GHz for MVDS, MMDS and MCS. Additionally, they are to look at spectrum requirements, planning matters, and issues related to the possible convergence of broadcasting and Point-to-Point telecommunications with regard to these systems.

ERO is also presently conducting a study on the frequency range 20 GHz to 30 GHz.

6.5.2 Spectrum needs

6.5.2.1 General

It is clear that there will not be a single standard nor a single technology to cover all RLL applications and therefore not a single RLL harmonized frequency band.

So far, the frequency bands most suitable for RLL are an important issue both for fixed and mobile operators. A harmonized usage of the bands for RLL systems together with harmonized RLL standards is needed in order to benefit from the economy of scale, but it is important that spectrum developments are flexible and not proved to be restrictive to further developments. The spectrum should be managed in such a way that it can accompany the rapid development of the market especially the growing demand for new fixed and mobile RLL systems and services.

An other important issue is that the availability of radio frequency spectrum, i.e. an adequate number of frequency channels, is needed for operators to offer a good quality radio based service and to secure the investments made on the radio access network infrastructure.

A large spectrum demand exists not only for established operators, but evidently most of the new demand is from new operators and especially from mobile (cellular and cordless) operators intending to provide their own mobile and fixed links.

6.5.2.2 Spectrum needs below 1 GHz

Frequencies below 1 GHz are of prime importance to mobile systems, mainly due to better propagation and penetration characteristics. However, current mobile systems in this band, like GSM, can only satisfy a part of the RLL market offering. Therefore it seems that extension of mobile systems to FSs could be provided assuming that:

- the service to "truly" mobile terminals should not be affected; and
- the regulators should control the development of such "mobile" systems so that the spectrum efficiency is kept optimal, in particular in very densely populated areas.

To satisfy this "fixed" application of mobile systems, new extension bands in the vicinity of the current bands are desirable.

Finally, in these densely populated areas, RLL applications with no mobility but using the mobile cellular networks and spectrum, should be discouraged while they can be accepted without difficulty in low densely areas as a complement to MSs and at a very low cost.

6.5.2.3 Spectrum needs in the 1 GHz to 3 GHz band

In the short term, and because of the high success of second generation of mobile cellular systems and their already foreseen limitation in capacity, it is necessary for RLL systems in urban areas to go to higher bands (above 1 GHz), business-wise preferably in the range of 1 GHz to 3 GHz.

In some countries there is an urgent need for DCS 1800 frequencies to be allocated to complement GSM and support RLL applications.

Some administrations feel that there is a need to consider extension bands for DECT when it is used in a wider concept than originally anticipated (e.g. RLL and mass market), although a consensus view has yet to emerge on this matter in Europe.

Finally it is fair to say that DECT and DCS 1800 are both candidates for RLL application.

Capacity studies on DCS 1800 to support RLL application have to be considered in a similar way that it has been achieved for DECT. According to the result, extra capacity over the present ERC/Decision (2×20 MHz as a minimum) for DCS 1800 can be requested as it has already been requested for DECT.

About UMTS, the question remains on whether UMTS is intended to support RLL application and if yes, whether UMTS reserved frequency bands can be used for it.

New digital Point-to-Point and Point-to-MultiPoint fixed radio link systems are currently being deployed with low and medium capacities. There is an urgent need to study the compatibility problem when new systems using different access methods (FDMA, TDMA and CDMA) and existing systems are sharing the same band.

In the medium and long term there is a need for low and medium capacity Point-to-Point and Point-to-MultiPoint systems and for longer hops.

6.5.2.4 Spectrum needs above 3 GHz

With regard to the range of 3 GHz to 10 GHz bands, RLL represents a growing area for the fixed access with low and medium capacity and with higher bit rates. The bands at 3,4 GHz and 10,5 GHz are emerging on a de-facto basis for this kind of use.

In urban areas, where short ranges are required, it gives the opportunity to use higher frequency bands.

For the bands above 10 GHz new system are developed for wideband and non-voice services both for business customers and residential users. New systems, both P-P and P-MP are under development for the bands at 15, 18, 26 and 38 GHz.

In general the bands above 3 GHz need to be studied further in the light of emerging high interest in RLL and especially future wide band services, e.g. multimedia using ATM, etc. both for business and residential users.

6.6 Spectrum management

Spectrum management issues will have an important impact on the development of RLL services an should be engaged far in advance before ETSI starts any standardization work.

In particular RPM stresses the important role of the points detailed in this subclause.

6.6.1 Spectrum harmonization

Harmonization of spectrum and timely availability should be the main objective to benefit from the market size and the interoperability between networks.

However, in some cases, national initiatives may favour innovative solutions.

6.6.2 Frequency allocation

Frequencies should be allocated in a fully transparent way according to the justified needs and the licence conditions and taking due account of the spectrum efficiency.

6.6.3 Flexibility and sharing studies

This is an important issue which has a direct impact on the technical design and on the standard. Studies based on models to compare standards types for RLL e.g. cellular vs. cordless or license type vs. spectrum fees or even spectrum bandwidth vs. traffic/km^2. should be undertaken so that a better understanding of the spectrum efficiency can be achieved.

6.6.4 Spectrum sale

The view expressed here is that of the ETSI Radio Policy Matters committee (RPM). It is not necessarily shared by ERCG or ERCG members, where the matter was not discussed in detail.

RPM agrees on the principle that spectrum should be paid by the users and that the revenues should cover the cost of the management, the re-farming and the control of the spectrum.

However, RPM recommends that very detailed studies should be conducted prior to any decision on this very important issue which can either stimulate or completely confuse and finally jeopardize the RLL market. In particular, experiences, like the USA PCS auctions and systems based on variable fees according to the considered part of the spectrum and the usage, should be analysed carefully, bearing in mind the main criteria, i.e. the spectrum efficiency.

6.6.5 Multi-application (private/public), multi-service systems

Some authorities believe that unregulated spectrum is unsuitable for public fixed telephony services as the operator is unable to give any undertaking of grade of service when other use of the same spectrum is indeterminate and spectrum congestion might well increase after the RLL system is first connected. An example of such a multi-application (private/public) is DECT.

Some suggestions of partitioning the spectrum rather than sharing between public and other applications have been voiced, possibly in connection with an extension to spectrum already allocated (e.g. DECT).

Some views include (UK DTI [18]): "[DTI] sees no need to use limited CT2 and DECT spectrum for RFA. Nonetheless, DTI is keen to see the fullest use made of CT2 and DECT spectrum and technology and see scope for use of CT2 and DECT beyond the current self-provision systems. These public access applications might include the licensing of CT2 and DECT for the commercial provision of third party cordless PABX services, subject to certain geographic constraints to minimize the effect on availability of spectrum and grade of service for private users of CT2 and DECT".

Questions have also been raised about the compatibility of different types of service within a shared application. For example to what extent is a very bursty frame relay or packet system for Internet access say compatible with POTS voice circuits?

These issues highlight the necessity to undertake studies on multi-application, multi-service systems in the same frequency band in view of the greater spectrum efficiency and flexibility they could provide.

7 The future of access networks

The ETSI RLL Co-ordination Group has a vision of the way in which access networks will develop in the future. This leads to our conclusion that BRAN should be developed by ETSI. In this clause, we outline the vision and what it means for RLL.

7.1 The rise of new telecommunications services and providers

The type of telecommunications service that many telephone users now obtain in a developed economy is about to change. Perhaps this change will be slow, or perhaps not. However, it is almost inevitable. This change will happen for these reasons:

- the likely rise in user demand for high-bandwidth packet-oriented services such as Internet access, whose delivery over current low-bandwidth copper loops is presently adequate but is not optimal;
- the likely rise in demand for circuit-oriented services such as video that exceed the bandwidth of the current local loop;
- the imminent de-regulation of telecommunications service providers, creating the pressure for innovation in service provision to compete with existing, traditional telephone service providers; and
- the response of the existing PTOs to these scenarios.

The likely demand put forward in the first two of these points is currently weak but nevertheless present, see Ovum Research [37]. This is characteristic of a stage in market development where unfamiliar new services are offered and the market is not yet prepared or educated sufficiently to create a wide demand. It is the third of these points that is likely to create the pressures for new service providers to promote demand for new services in order to create for themselves a business. In response to the new PTOs, existing operators are also likely to develop and compete for these new markets in order to avoid losing their pre-eminent positions, see Full Services Access Networks Conference [21].

We should also recognize that the formation of the EPIC project is a consequence of wider recognition within ETSI of the developing needs for a new information infrastructure. Wireless access, both in its narrowband and in its broadband incarnations, will be an essential part of this development.

Existing narrowband, circuit-switched RLL developments therefore need to be continued where the market demand exists, unhindered by any attempt at additional standardization by ETSI. However, the foreseen rise in demand for broadband services leads us to conclude that there will soon be a significant challenge to be faced by existing narrowband RLL systems from the advent of new broadband fixed delivery mechanisms. The future belongs to the broadband variant: multi-media applications and computer communications are bursty in nature. Circuit switching in the narrowband copper-based local loop cannot support such uses effectively, nor can its radio counterpart, today's narrowband radio access network.

Broadband systems on the other hand, if properly designed, can allocate capacity to specific users "instantly" and given sufficiently large numbers of users, they can take advantage of statistical multiplexing effects to serve each user adequately with a fraction of the capacity needed to handle peak rates of all users simultaneously. The emergence of Asynchronous Transfer Mode (ATM) networks exemplifies this trend. The equivalent in the wireless domain would be an access system that is ATM compatible and serves many tens of users with one or more broadband channels, the capacity of each being allocated on demand rather than on a fixed basis.

However, one key thing we should still recognize in this new broadband world is the value of voice communications. Offering a customer broadband access without being able to (efficiently) provide POTS is likely to result in rejection. The broadband systems of which we talk here have to provide POTS as well, in order for there to be significant customer acceptance.

7.2 New mechanisms for delivering new services

In deciding what are the technical characteristics of a new broadband wireless access programme, we should perhaps summarize the likely competitors and their characteristics as compared to those of a broadband wireless access mechanism.

7.2.1 An access service for the information age

We propose here that typically a user will expect to have available an instantaneous high bandwidth delivered by his access mechanism, but will only need to have access to an average bandwidth that is much lower. He expects a large document to be delivered very quickly so that he can commence reading and digesting its contents. However, the period over which he is looking at the information in local storage means that the average bandwidth required to deliver a good service is low, even though the instantaneous bandwidth required is high.

The average bandwidth required is constrained by the user's ability to read and assimilate information, but the instantaneous bandwidth required is dictated by the user's patience in waiting for complete documents to be delivered.

Of course it could be envisaged that information processing, selection and summarizing could be performed automatically by computer at the customer's premises and that a much larger average bandwidth could be required in this case. This is the "power user" scenario. However, it is expected that these sorts of user will remain as infrequent as today's power user and the vast majority of information users will conform to the model of low average bandwidth. An alternative, of course, is for information access providers to offer automatic information selection and summarizing in their own networks to meet the needs of their power users, so limiting the need for precious access bandwidth.

7.2.2 ADSL/VDSL over copper pair

Currently some telecommunications operators are well advanced in their trials with ADSL and seem to be watching the development of VDSL with great interest. On the surface, this service will deliver perhaps 6,5 Mbit/s to 26 Mbit/s of continuous bandwidth to each user. However, any reasonable, economic infrastructure has to present a bottleneck at some point. The impression that an unshared access mechanism with a high bandwidth gives a continuous service at that same bandwidth is mistaken. Eventually backbone bandwidth is still shared between a number of subscribers and the characteristics of ADSL/VDSL become very similar to using shared resources, i.e. radio spectrum, at the access point rather than the backbone.

7.2.3 Cable modems

Cable modems are already available in some parts of the world for providing access to the Internet. In this case, the local cable plant and its multiple access protocol provides some bandwidth bottleneck as well as any data communications backbone. The availability of radio spectrum on a cable is not constrained in the same way as is the availability of radio in the æther. However there are still constraints to do with the bandwidth of the cables and their distribution amplifiers, and the intermodulation products that occur.

In the end, a broadband information service delivered over a cable system is rather similar in its characteristics to ADSL/VDSL over copper pair. The high bandwidth available at the user's premises may only be used intermittently as part of an average demand that is much lower.

7.2.4 Wireless access systems

In wireless access systems like cable access systems, bandwidth limitations exist in both infrastructure and access mechanism. However in a system where these are properly matched, and matched to the needs of a population of users, it seems that the service delivered is not in any material way impaired by the extra bottleneck. The need to match the access bandwidth statistically to the needs of a population of users is perhaps most critical in the case of an information service provided using radio as the local loop. However it is expected that this will not diminish the overall service available compared to that available via the alternative access mechanisms.

7.2.5 Different access mechanisms deliver similar service characteristics

It seems then that all of the potential systems for delivering tomorrow's broadband information services are ultimately capable of delivering the sort of service from an information infrastructure that seems appropriate for most users' requirements.

This would argue then that BRAN should be put into place to complement the forthcoming broadband access mechanisms through copper pair and cable, and provide the competition between access service providers to keep service levels high and costs low. This is the main subject of the recommendations in clause 10.

7.3 Strategic requirements for a fixed broadband radio access network

A wireless access system should be capable of true wide-area deployment, over an area that is in principle unlimited (such as a large city needing many cells). It is required to provide FSs only; that is, the network termination to which the user's terminal is connected is permanently fixed to the structure of a building.

An operator using wireless access should be able to provide a similar set of bearer services and a similar grade of service to his competitor using any other broadband access technology (e.g. fibre), though there may be limitations on the penetration of the potential user base which can be served. The service will be primarily for residential consumers and Small and Medium size Entreprises (SMEs).

The system should be capable of providing premium broadband services. for example high bit-rate services with variable symmetry and transfer rates, as needed to support ATM. It should also be capable of efficiently providing "toll quality" POTS.

The system should be economically viable in low to medium penetrations (1 % to 20 %) of households in typical semi-rural, suburban, urban and dense urban environments in most of the world, but in particular Europe, the Americas, and the Asia-Pacific countries. This judgement should take account not only of the costs of "base-stations" and "customer premises terminations" (RTs) but any necessary "backhaul" connecting the base-stations to (e.g.) switches. In practice this means that a high proportion of the network investment should be in the customer termination equipment.

The system should permit flexible RTs, which will support both a wide range of bandwidth to be accessed at a single physical network port; and a single RT to support efficiently one or several physical network ports.

The system should also meet the needs of small and medium size enterprises who usually require communications bandwidth at a different time of the day from residential consumers and can efficiently share network infrastructure.

A road-map is needed to reach full equipment inter-operability, but it is not yet clear if this needs to be followed to its conclusion by standards and system developers. However, if the entire road-map is followed, the standards should provide a basis for an operator to procure equipment conforming to a profile of the base specification which will allow RTs from one supplier to be attached to and interwork with base stations supplied by another, for at least a basic set of bearer services.

Other requirements also relate to:

- support of standard CPE interfaces (especially ATM);
- support of appropriate network management features;
- conformance of network services to ATM standards;
- cell capacity and range to meet economic requirements;
- cost especially of customer equipment;
- spectrum efficiency; use of appropriate spectrum to enable operator to meet availability requirements economically;
- support of flexible billing options (or at least no limitation in billing options);
- simple RT installation;
- minimum of no requirement for frequency planning;
- use of demand assignment to share spectrum efficiently;
- smooth upgrade of network capacity from initial "coverage-dominated" to eventual "capacity dominated".

The needs of a number of market sectors should be considered including at least the following:

- established public telecommunications operators building shared networks to carry at least third-party provided services as well as Point-to-Point switched connections;
- new public telecommunications operators;
- Private network operators;
- provision of video services including video-on-demand; and
- builders and users of wideband computer networks.

8 Other relevant issues

Given the need for standards for BRAN, a number of questions arise about the scope of the standards needed. Should the air interface be standardized or not? Should standards be purpose-specific or adapted for other standards originally intended for other purposes?

8.1 Common Air Interface versus coexistence

DECT provides a case in point to address this question. Being derived from a mobile technology, DECT RLL employs a "Common Air Interface (CAI)" - which in principle means that the FP (base station) may be manufactured by one manufacturer, the equipment at the subscribers premises by another, and perhaps wireless relay stations by a third whilst still being able to offer a useful level of service to the user. The advantage of multi-vendor sourcing for the operator is apparent and allows the manufacturers to choose to specialize in one segment of the network. Commonality with other DECT products and applications, allows the RLL application to enjoy the benefits of high volume product from the outset.

Further, the commonality with a mobile application of the same technology allows the service provider to offer a mix of truly stationary services and "peripheral mobility" services; the latter allow the user some freedom to move with his access device within a small area, e.g. around a house or small neighbourhood or around a campus.

However, a CAI standard has some disadvantages - and some argue that, for RLL where both ends of the radio path are controlled by the operator, a CAI is unnecessary. CAI standards take longer to specify than co-existence standards and, even though DECT RLL is based upon the DECT base standard, there is an on-going debate as to which facilities should be mandatory in order to ensure that the user receives an acceptable minimum service: under-specify, and some equipment mixes yield inadequate service; over-specify, and operators with minimal service requirements pay too much. Also, the scope for innovation in implementation is constrained by the framework of DECT whereas a coexistence standard would permit more scope for innovation and specifically tailored solutions for specific markets. Whether the competitive benefits of multi-vendors and larger volumes outweigh the benefits of greater opportunities for innovation remains an unanswered question.

In the final analysis, the best solution to this conundrum may be a coexistence specification with a separate optional basic common air interface providing a standardized set of basic services or access procedures, as it allows commonality and therefore re-use and efficiency of scale without "fixing the future".

8.2 Ad-hoc versus purpose-designed standards

Can standards not originally intended for RLL be later applied to RLL? The answer to this rhetorical question is clearly "yes". We see that CT2, DCS 1800 and GSM technologies can be used for RLL although the RLL application was not in mind when the standard was drafted. However, the answer is less obvious in the case of other standards such as those of RES08 and RES10.

RES08 has drafted a number of standards for low power devices. Such standards were not intended for RLL applications but there is no technical reason why equipment compliant with the relevant generic standards (I-ETS 300 220 [57] and I-ETS 300 440 [58] for short range devices in the 25 MHz to 1 000 MHz and 1 GHz to 25 GHz bands, respectively) should not be used for RLL purposes. In some circumstances, these devices can radiate up to 500 mW. Such use would be subject to licensing by national authorities.

RES10 has issued the second edition of ETS 300 328 [55], a certification standard for spread spectrum systems operating in the 2,4 GHz ISM band. Equipment conforming to this standard and equipped with suitable antenna systems can provide wireless access services at high bit rates, and such equipment is already in service. According to the definition used in this document, such systems could be considered broadband access systems.

However, although systems based on these standards may fill a short term market need, it is unlikely that they will be able to compete with systems designed specifically for the RLL application and operating in dedicated spectrum.

8.3 Technology trends

If the proposals contained within the present document are to be viable, they should take into account current technology trends. The following factors are considered worthy of note in this context:

- Continued steady progress in MMIC technology, both gallium arsenide and silicon, with particular impact on the low mm-wave bands. Similarly, greater availability and economy of scale for power amplifier devices and modules for the higher frequencies.

- Greater use of more flexible, software-driven RF architectures ("software radios"). This trend is already underway for cellular mobile and has started for narrowband wireless access.

- More widespread use of adaptive antenna technology for cellular mobile systems, and likely use in wireless access systems - mainly central but possibly also in simpler form for terminal stations. SDMA is promising in terms of enhanced cell capacity, and adaptive technology can provide interference reduction, counter multi-path and effect greater link margins (up- and/or down-link) - some limited penetration for cellular mobile of fibre feeds for antenna-mounted equipment (base stations) and optical control of phased array antennas; and of high-temperature superconducting filters and diplexers for base stations for enhanced selectivity and RF range.

- Introduction of innovative, top-level architectures for mobile and fixed wireless access systems. This includes decentralization of system intelligence down to base stations (e.g. Wireless Intelligent Services Distributed Network - WISDN) for mobile systems connected directly to the PSTN. Also possible use of more flexible, resilient arrangements featuring new slave/master stations (e.g. Time Space Radio's approach or some PAMR/ESMR systems using the PMR repeater concept).

- Much wider use of cell enhancers and repeaters for cellular deployments, including some with greater autonomy and flexibility. This includes wireless access.

- Steady progress and standardization in compression technologies - for video signals, in particular. This has clear impact on wireless access bandwidth demands, making wireless access more feasible - as does, for example, ADSL with wireline by increasing available bandwidth.

- Greater use of adaptive equalization for mobile and fixed wireless systems. This also relates to points below.

- Wider use of direct RF channel processing, and steady progress on analogue-to-digital converters and digital signal processor speeds.

- Faster, cheaper methods for ASIC prototyping and medium volume production.

- Significantly reduced memory costs, and wider use of downloading for not only OA&M software but also for the central station and even terminal station functionality. This allows cheaper evolution paths when combined with "software radio" concepts and eases upgrades/fixes, even adaptation to market change needs etc. This advantageous trend is becoming prevalent in the avionics industry for safety-critical applications, so should be acceptable for telecommunications.

- In networking in the short term, wide use of ATM to support current LAN backbone and collapsed backbone arrangements. In the medium term, next generation LANs will likely use switch-based architectures rather than traditional shared media architectures. There are clear parallels here with wireless as an alternative/additional access medium.

Clearly several of these interact in a fairly obvious manner, in some cases with considerable potential leverage on performance and/or costs.

8.4 Conclusion

A large share of the current demand for wireless access focuses on telephony and low rate ISDN services. These can be met by current systems or by derivatives of them. This is the case for GSM, DCS and DECT as well as a number of proprietary radio systems.

However, the future demand will shift towards broadband systems that are capable of supporting not only voice and low rate ISDN but that will handle multiple megabit services for multiple users efficiently. Initially, equipment designed to operate in the ISM bands may be used to short term market needs.

In the longer term, such systems should be standardized at various levels to assure flexibility in the use of spectrum and equipment, to allow network providers to offer different types and levels of service and to stimulate the development a broad range of services independently of the underlying delivery networks.

Synergy with other network types and technologies such as local wireless ATM access networks and wide area multi-media services should be investigated as part of the work programme to develop these standards.

9 The ERCG reference model

9.1 Description

Figure 9 illustrates a possible logical representation of a generic Broadband Radio Access Network. This model will evolve during the standardization process and represents only a starting point. The purposes of the model are:

- to introduce and propose some terminology which can be used in relevant standards;
- to indicate the extent of the radio access network;
- to identify relevant interfaces - both internal and external; and
- to form a basis for discussing demarcation between such concepts as operators equipment, customers equipment, access network, public network.

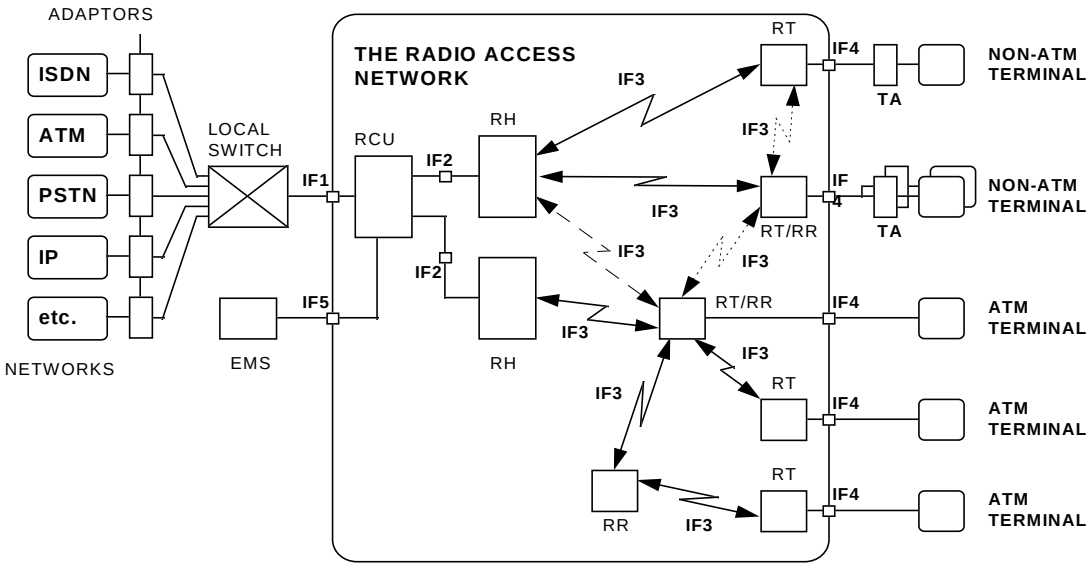


Figure 9: Broadband radio access network general system architecture

The Radio Access Network, depicted in the enclosed part of the figure, provides a means of communication between Terminals, typically on customers premises, and a Local Switch, typically operated by a telecommunications operator and connected to one or more public networks. The Radio Access Network is a network element from an Operation, Administration and Maintenance viewpoint and should provide appropriate communication via interface 5, to an external Element Management System which will be part of the operator's umbrella Network Management System.

The Radio Access Network supports ATM while other non-ATM services may be supported by means of adapters to non-ATM terminals and networks.

The telecommunications networks which may be accessed in this way include one or more such networks as:

- Public Switched Telephone Networks (PSTN);
- Asynchronous Transfer Mode (ATM) networks;
- Integrated Services Digital Networks (ISDN); and
- Internet Protocol (IP) networks.

Such networks are connected with the trunk side of an ATM switch through suitable adapters.

The Radio Access Network comprises the following components:

- A **Routing Control Unit (RCU)** which presents an interface to the switch which complies with an appropriate standard such as V5 or VB5 via interface 1. The RCU also presents OA&M information via interface 5 to an external Element Management System (EMS). The RCU may be physically distributed and the Radio Access Network may include more than one RCU associated with the switch to provide a degree of fault tolerance and redundancy. The RCU's principal function is to control the routing of traffic through the Radio Access Network, including optionally the provision of diverse routing between Radio Terminal Stations (RT) and the Switch to avoid local network congestion, faults, or (temporary) obstruction of line-of-sight radio paths. Such alternative paths are indicated by broken lines in figure 9. The RCU communicates with a number of Radio Hubs (RH) via Point-to-Point links (fibre, copper, microwave, etc.) via interface 2.

- Several **Radio Hubs (RH**), distributed so as to be able to provide coverage throughout the service area of the Radio Access Network. These communicate via air interfaces (interface 3) with Radio Terminal Stations (RT) and Radio Repeaters (RR) or units which combine the functions of both RT and RR.

- **Radio Terminations (RT**), normally located on or near customers premises, which communicate with the Radio Hubs (possibly via one or more Radio Repeaters) and present fixed connections for customers' terminals. This connection (interface 4) represents the Network Termination Point: the demarcation between the operator's and the customers' responsibility. Multiple terminals may be connected to, and supported simultaneously by, one RT. ATM terminals will be supported directly at interface 4. Non-ATM terminals may be supported via an appropriate Terminal Adapter. The network may be designed so that each RT communicates via interface 3 to a unique Radio Hub (RH) either directly or through a Radio Repeater (RR).

- **Radio Repeaters (RR)** emulate one or more RTs as seen by the RH and which emulate a RH as seen by a RT. The network may possibly allow RRs and if so may or may not allow cascading of RRs. RRs may support the direct connection of terminals - through interface 4 - subject to the same considerations as for RTs.

A Radio Access Network may with advantage allow communication between RTs of different customers without passing via the switch but in such cases appropriate signalling and control would have to be passed to the switch for network control and possibly for charging purposes. This would allow some spectrum saving since an internal call would otherwise potentially occupy twice the bandwidth. However this represents a major change in access network functionality and requires further study. Radio paths implying routing within the Radio Access Network are shown dotted in figure 9.

9.2 Designation of interfaces

The above model contains the following interfaces:

- IF1 ATM switch to Access Network interface conforming for example to V5 or VB5 standards.
- IF2 RCU:RH interface, may not require standardization.
- IF3 Air interface, for standardization.
- IF4 Standard ATM user - network interface, UNI.
- IF5 Management interface, which should conform as far as possible to standards being developed for ATM access networks.

10 Conclusions and recommendations

The ETSI RLL Co-ordination Group has reviewed RLL work inside and outside ETSI and concluded that there is a need to develop standards to enable network operators to deliver broadband services using radio. Such standards will be particularly important in the development of new consumer services and to encourage competitive service provision. This proposal and others that have arisen as a result of the committee's work are elaborated below.

10.1 Broadband Radio Access Networks (BRAN) project

It is recommended that ETSI create a BRAN project. A detailed proposal for the project's Terms of Reference is contained in annex A.

The BRAN project should develop standards for high speed radio access networks that are capable of supporting realistic multi media services and serving a large number of users. Development of these standards should always be based on available spectrum. Therefore, the project should work closely with the ERC on this subject, through the Radio Policy Matters committee.

These standards should allow manufacturers, network providers and service providers maximum flexibility in design, deployment and use. Therefore, operation in licensed as well as unlicensed spectrum should be supported. The project should consider that operators using its standards may have to discharge Universal Service Obligations (USO), see European Commission document [36] and should standardize accordingly.

It is important that these standards should efficiently support POTS service as well as service-independent broadband access. As technology develops, it will be possible to provide a increasing range of services to users; this sort of evolution should be anticipated and enabled. The first standards should be developed to support POTS and a service-independent ATM transport at an agreed data rate. Timely deployment of the first systems and low cost should be considered as critical factors for success.

The ultimate scope of the BRAN project should be limited to the minimum set of standards needed to assure that market needs are fulfilled. Such a minimum set should include one or more basic radio subsystem standard(s) and one or more service access standards that allow a broad range of services and applications to be supported over one or a few basic air interfaces. Where possible, use should be made of specifications, standards and expertise available in other fora.

The project should take on work currently done in RES10 and the work in TM4 concerned with broadband radio access. This work, as well as the expertise of the two STCs can be merged to provide a better basis for ETSI's standards for BRAN. The project should liaise with the main bodies developing standards for wired networks and services. This includes ATM networking as well as Internet applications but other relevant organization such as DAVIC should be consulted as well.

The detailed organization of the work in the new BRAN project should be left to the project members. However, given the emergent nature of this area of work, attention to market factors, spectrum issues and deployment issues will be as important as the technical work to be done.

10.2 Common Air Interface versus coexistence

The RLL Co-ordination Group was not able to reach a conclusion on the issue of whether the project should produce standards for coexistence (such as those from TM4) or for a Common Air Interface. Views on the matter were evenly divided amongst those expressing an opinion. What was decided, however, was that the framework produced by the project should at least include standards for coexistence, as well as a road-map to obtain inter-operation with a CAI. It is left up to the project itself to make its own decisions on how far down the road to CAI it should go.

10.3 Mobility in Broadband Radio Access Networks (BRAN)

ERCG has concluded that the identified *requirement*, leading to the proposal for the BRAN project, is for a fixed radio access system, as defined under subclause 3.2. This arises out of consideration of the dominant customer's likely environment (see clause 7). However, it is recognizable that there are some voices from the RLL community indicating a desire to include mobility within the project, as well as other voices indicating that this is unnecessary and likely to be detrimental to timescale and cost.

It should be recognized that the definition of broadband adopted in the present document (see subclause 3.2) makes it technically very difficult to achieve both mobility and economic radio range simultaneously. Deployment of a fixed system should not under any circumstances be burdened by a requirement for equalization or by a requirement to support handover control mechanisms or by any other mobility-related feature.

It is recommended that the project keep uppermost in its mind that the requirement identified here is for a fixed system. It has to meet residential cost levels and it has to be *deployable* in the year 2000.

10.4 Existing narrowband radio access networks

It is recommended that existing narrowband work within ETSI should continue according to demand. It is clear that the narrowband work currently under way is there to meet today's needs and this should continue to receive ETSI support in the normal way. Additional burdens of harmonization and standardization will almost certainly slow down the introduction of narrowband radio access technologies at a time when these first steps should be encouraged.

10.5 Rural radio access networks

During the work of ERCG a need to support rural RLL has been identified. Systems of this kind should be able to provide customer in rural areas with services up to basic rate ISDN, under non line of sight conditions on distances up to 10 km. This kind of work has been discussed in TM4 and it is recommended that ETSI support this activity and also support the efforts taken in ETNO/FM and CEPT/FM to find a harmonized spectrum allocation below 1 GHz for rural RLL throughout Europe.

The impact of supporting rural access should also be studied by the BRAN project. If it is only possible to support radio access in urban areas where most customers are within a few kilometres of a local exchange or street cabinet, then rural dwellers risk being cut off from the European Information Infrastructure. The project should, if possible, establish a means to trade off user density and range so that low-density rural environments can also be served.

10.6 Recommendations for future RLL co-ordination work

It is recommended that the ETSI RLL Co-ordination Group should be dissolved. It is not required in a future programme as the ETSI BRAN project itself should be tasked with the objective of co-ordinating activities.

Experience shows that previous ETSI projects have worked best where there is already pressure for the activities within ETSI and that the projects can achieve some useful degree of co-ordination. What they have not so far done well is to initiate new activities. They do provide a good forum in which the joint issues can be co-ordinated.

Annex A:
Proposed Terms of Reference for an ETSI / (BRAN) project

First draft: January 9, 1997 (ERCG meeting)

Revision: January 20, 1997 (ERCG/RES/RPM/TM co-ordination meeting)

A.1 Basic definition

The aim of the project is to define the standards for wireless broadband access networks and systems to meet current and future demands. For this project, "broadband" is defined in terms bit rates in the order of 20 Mbit/s. However, these networks shall be capable of efficiently carrying narrowband services like voice and ISDN 2B+D.

Initially, the project should focus on standards for fixed broadband access in which limited mobility may be included. However, this should not delay the early availability of standards or prejudice the cost of implementation. At a later stage, the project may consider the implementation of additional mobility feature.

A.1.1 Scope

The project shall bring together the expertise from TM4 and RES10; this combination will concentrate the available expertise, increase the competitive position of ETSI relative to other bodies working in this field and increase the efficiency of developing standards for broadband access networks as well as avoiding unnecessary duplication of work with in ETSI.

The project supports the GMM targets and is a response to EPIC Project 1.1 of the EII.

It shall complement other activities within ETSI such as:

- RLL;
- the CTM project; and
- DECT, GSM, GRAN.

The project should take note of standardization work in other bodies, noticeably the ATM Forum, the Internet Engineering Task Force and DAVIC, and avoid unnecessary duplication.

The main areas of standardization include the characteristics of the radio equipment involved for central stations and terminal stations. In particular the following aspects are to be considered:

- definition of services to be supported;
- general system architecture and interworking;
- systems' capacity (both of the central and of the terminal stations);
- type of transmission (symmetrical and asymmetrical);
- frequency bands to be used and sharing criteria to be applied;
- transmitter, receiver and antenna characteristics;
- network performance;
- level of standardization of the air interface(s);
- system interfaces (terminal, network and management).

A.1.2 Project life cycle

The project life cycle shall be driven by the need for standards within its scope and area of expertise.

The project has to start early in 1997. The following time scales represent projected service demands.

Table 10: Project phases

Subject	Scope	Completion
Base standards and service profiles	Certification requirements Radio subsystems Service profiles	2Q1999
Subsequent standards and service profiles (see note)	Radio subsystems (as required) Service profiles	2002
Maintenance		2005
NOTE: Technology development and changes in spectrum availability may necessitate the development of new Radio Subsystems standards as well as new Service Profiles.		

A.1.3 Technical objectives

In general, the objective is to produce standards which will enable a similar range of services as will be available on cable media, at a competitive cost and quality of service. The benefit of standardization will enable high volumes resulting in low terminal cost.

Detailed technical objectives include:

- provision of multi-megabit data rates per end user;
- support for multi-media applications and services e.g. Internet and video-on-demand It is noted that such services typically require variable, often very asymmetrical data rates as well as control over quality of service on a per user basis;
- support for low data rate services such as POTS and low rate ISDN;
- interworking with networks such as POTS, ISDN, ATM;
- support for access and communications security consistent with the privacy needs of users and the accountability needs of network operators;
- provision for network management features necessary to support unattended operation and remote management.

In addition, the project shall take into account:

- economic implementation;
- efficient use of spectrum; and
- ease of spectrum management.

In general, the project shall produce standards and specifications that are independent of the licensing regimes which are determined by national authorities.

A.1.4 Market opportunities

The deregulation of the telecommunications market leads to new entrants in the telecommunications market that want direct access to their potential customers rather than being dependent on the infrastructure of the incumbent network operators. In addition, the established operators want to reduce the cost of expanding their networks for offering new services for which the existing infrastructure is not suitable.

Further, demand for broadband communications is rapidly increasing as users add Internet access and remote multi-media applications to their daily routines. This applies for business as well as for private users.

Finally, the developing regions of the world lack the resources and financials to install conventional wired telephone systems. The demand for communications goes beyond a simple telephony as the Internet access becomes an important alternative and enhancement of simple telephony.

All of the above demands can be served efficiently and economically with broadband communications technology. This can provide both dense area coverage as required in access networks and long range Point-to-MultiPoint communications typically needed in rural environments.

Standardization of this technology will enhance market confidence as well as lead to economies of scale and reduced development expenditures for manufacturers. Assuming a 10 % market penetration of wireless access networks, the total equipment market is estimated to be in the range of $5 billion - see the report on the "Full Services Access Networks Conference", June 20th, 1996 [21].

A.2 External relations

The project shall operate as a self contained entity within the ETSI organization and liaise with the relevant projects and TCs as required for developing its deliverables.

A.2.1 Other ETSI TCs and ETSI Projects

The project shall incorporate the appropriate work programmes in ETSI from RES10 (HIPERLANs Wireless ATM Access and Interconnection) and TM4 (Broadband Access) and acquire the relevant expertise from these groups. Other programmes that are not directly related to the provision of broadband access services should be incorporated, if required to maintain a viable body of expertise, to avoid duplication of effort and to exploit economic benefits of commonality.

The project should also take account of the related work in NA, SPS and SMG and TM and liaise with these groups as appropriate. In particular, the project shall liaise with ETSI SMG concerning the specification of UMTS with the objective of leveraging the expertise present in both projects and to assure optimal synergy between the specifications of UMTS and Broadband Access systems.

The project should also consider the work of the Joint Technical Committee EBU/ETSI/CENELEC on Digital Video Broadcasting (DVB).

Liaison with the relevant technical bodies will be required to obtain approval of draft standards containing requirements on the horizontal aspects of the use of the frequency spectrum (up to now RES RPM) and EMC (up to now RES09 and EE4).

A.2.2 Other ETSI committees, groups, etc.

The project shall inform the EPIC and GMM special groups of the progress of its work.

A.2.3 Entities outside ETSI

The project shall determine its regulatory requirements and consult with CEPT/ERC, in close co-operation with (formerly RES) RPM, for spectrum allocation in accordance with the established procedures. This work has high priority and should take account spectrum plans for related services in geographical regions other than Europe.

The project should liaise with the following organizations:

- The ATM Forum (for ATM protocols).
- DAVIC (for video services etc.).
- The Internet Engineering Task Force.
- WINForum (e.g. concerning the 5 GHz U-NII band).
- The ITU-R (for standards development).

- Any other international body engaged in related work.
- The Broadband Wireless Association.
- The RACE and ACTS programmes (to exploit their research).

A.3 Internal organization

The project shall be controlled by a project Committee.

The project shall be managed by a Project Manager with the support of a Project Management Team.

The work programme of the project shall be carried out by Working Groups, see subclause A.5.2.

A.3.1 Project management

The ETSI Board appoints the Project Manager; the Project Committee shall nominate a candidate Project Manager. A deputy Project Manager may be appointed by the Project Committee.

A.3.2 Project management committee

Selected people having specific responsibilities within the Project Committee will support the Project Manager.

A.3.3 Project committee

All ETSI members will be invited to nominate experts to participate in this committee.

This Committee is the forum of ETSI members participating in the project to produce the identified deliverables, one and another according to the Technical Working Procedures of ETSI.

A.3.4 Business development function

The project shall take due note of available market research results and due attention shall be given to the ETSI NBDG (New Business Development Group).

The project shall promote its visibility outside ETSI as appropriate.

The project should take advantage of existing organizations, such as ETNO and the ATM Forum's market awareness committees.

A.4 Deliverables

The output of this project is expected to consist of the following deliverables:

- ETSI Guides for the definition of services and facilities and systems architecture.
- European Norms that define the basic spectrum access, as well as conformance testing requirements.
- ETSI Standards that define the basic system specifications, including service interfaces, air interfaces (to the degree agreed) as well as basic network management functions.
- A series of ETSI Technical Specifications for Service Profiles that define which features from the base specifications are required for specific application types. These should also address interworking functions for various types of infrastructure networks and customer end networks.

A.5 Work organization

A.5.1 Work required under contract with TCs

This still has to be determined by the project.

A.5.2 Working groups within the project

The project shall set up its own Working Groups; it may consider the following proposal.

WG1: Services and Facilities including general Systems Architecture definition, applications of different users, OA&M requirements, etc. This includes requirements for numbering, fraud protection, security and billing aspects.

WG2: Radio Aspects including propagation considerations, spectrum matters, coexistence with neighbouring services, etc. This includes spectrum sharing etiquettes, spectrum masks, spurious emissions and developing standards for mandatory conformance testing and certification of radio equipment.

In particular, this group should liaise with the "horizontal" committee on spectrum matters and EMC.

WG3: Access Networks Group: Basic System standards including air interfaces, Service Profiles and Interworking Functions.

This group should develop the ETSI Standards and ETSI Technical Specifications for Broadband Access Networks and for the various Service Profiles and Interworking functions. This should include voluntary conformance testing requirements and specifications.

A.5.3 Specialist Task Force requirements

For the short term, no need for a specialized task force is envisaged. The project should determine its requirements for assistance once its work items have more clearly defined and agreed.

A.6 Resourcing

A.6.1 ETSI members

At the time of writing this document the following ETSI members have committed themselves to support this Project: Ascom, BT, Lucent Technologies; Nortel.

Commitment of a large number of members is anticipated in view preceding work in RES10, TM4 and the RLL Co-ordination Group.

It should be noted that the success of this standardization work is dependent upon the correct level of participation between experts in radio and non-radio aspects, and between manufacturers, regulators and service providers.

A.6.2 ETSI secretariat

The ETSI Secretariat shall provide a Technical Officer support the project, including processing for approval and publication of the project deliverables and assisting in the Project Management Team of the Project as negotiated with the ETSI Secretariat.

A.6.3 Specialist Task Forces

Proposals for Specialist Task Forces (STFs), including funding and resourcing, are to be processed according to normal ETSI procedures and priorities. Regarding the need for an STF, see subclause A.5.3.

A.7 Working procedures

The project shall follow the ETSI Technical Working Procedures.

History

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