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Foreword

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

This ETR contains the results of a study into the integration of Intelligent Network (IN) and Telecommunications Management Network (TMN) in order to produce harmonised services to network users. This ETR describes how TMN concepts can be used for the management of IN structured networks and considers the applicability of IN concepts for TMN purposes.

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1 Scope and objectives

There is risk that the Telecommunications Management Network (TMN) and Intelligent Network (IN) concepts, and specific networks and/or services that utilise these concepts (e.g. Universal Personal Telecommunications (UPT), Universal Mobile Telecommunications Systems (UMTS), B-ISDN) are considered as separate networks instead of being considered as different aspects of the same telecommunication network. As a result of difference in priorities of issues, it is quite possible that IN and TMN will develop separate concepts for management and creation of services and management services. This may result in a diversion of developments, conflicting modelling concepts, overlap of work, and interworking problems of systems in the future. Therefore, a uniform and coherent way to describe information transfer and to model network functionality should be pursued. Based on this, a synergy of concepts, tools and implementations may be reached.

There is general agreement that a comprehensive harmonisation and/or integration between IN and TMN studies is necessary to prevent a diversion of modelling concepts and to prevent interworking problems of implementations in the future. In this study it is indicated how this harmonisation and integration can be reached. Constraints are indicated that should be followed in the evolution from the current pre-TMN and pre-IN configurations towards a pan-European solution. As a result, it should be possible to provide harmonised services to any network user, fulfilling both the IN and TMN requirements. The ultimate goal is to ensure that a complete integration of the TMN and IN techniques can take place.

This ETSI Technical Report (ETR) contains the intermediate results of this study. It has been produced by a dedicated European Telecommunications Standards Institute (ETSI) Joint NA4/NA6 working group, in the time frame June 1990 to September 1992. Its goal is twofold: firstly it describes how TMN concepts can be used for management of IN structured networks; and secondly it considers the applicability of IN concepts for TMN purposes. This ETR does not cover an analysis of IN related management requirements and/or a definition of management functions or managed objects. Instead, it aims at a comparison and possible integration of IN and TMN architectural and modelling concepts.

The study is based on current views from ETSI and CCITT. As both the work on management ETR and IN is progressing in the relevant bodies, the results of this study should be regarded to present only the current views, as identified by the NA4/NA6 working group. Although this ETR contains the reasonably harmonised view between NA4 and NA6, it is recognised that more extensive work will be done. This ETR will probably form the basis for further ETRs, but should not be viewed as being the ultimate conclusion of the "integration of TMN and IN".

This ETR is structured as follows. Clause 2 contains a list of referenced documents that were used in this study. After a list of definitions in Clause 3, a short introduction to TMN an IN is provided in Clause 4. Based on this information, in Clause 5, IN and TMN architectural concepts are compared and related to each other. In Clause 6, possible ways to integrate the IN and TMN information modelling techniques are indicated. As a result, Clauses 5 and 6 contain proposed enhancements to IN and TMN concepts that should make the integration of TMN possible. Clause 7 provides conclusions and recommendations.

2 References

The following documents were used in the study for this ETR.

[1] ISO/IEC 10040 (1992): "Information technology - Open Systems Interconnection - Systems Management overview". (CCITT Recommendation X.701)

[2] ISO/IEC 9595 (1991): "Information technology - Open Systems Interconnection - Common management information service definition". (CCITT Recommendation X.710)

[3] ISO/IEC 9596-1 (1991): "Information technology - Open Systems Interconnection - Common management information protocol- Part 1: Specification". (CCITT Recommendation X.711)

[4] ISO/IEC 10165-1 (1992): "Information technology - Open Systems Interconnection - Structure of Management Information - Part 1: Management Information Model". (CCITT Recommendation X.720)

[5] ISO/IEC 10165-2 (1992): "Information technology - Open Systems Interconnection - Structure of Management Information - Part 2: Definition of Management Information". (CCITT Recommendation X.721)

[6] ISO/IEC 10165-4 (1992): "Information technology - Open Systems Interconnection - Structure of Management Information - Part 4: Guidelines for Definition of Managed Objects". (CCITT Recommendation X.722)

[7] CCITT Draft Recommendation M.3010 (1991): "Version R5 Principles for a Telecommunication Management network".

[8] CCITT Recommendation M.3020 (1992): "TMN Interface Specification Methodology".

[9] CCITT Draft Recommendation M.3200 (1992): "TMN Management Services: Overview".

[10] CCITT Draft Recommendation M.3400 (1992): "TMN Management Functions".

[11] CCITT Draft Recommendation M.60 (1992): "Maintenance terminology and definitions".

[12] CCITT Draft New Recommendation Q.811: "Lower Layer Protocol Profiles for the Q3 Interface".

[13] CCITT Draft New Recommendation Q.812: "Upper Layer Protocol Profiles for the Q3 Interface".

[14] CCITT Recommendation Q.1200 series, (1991).

[15] CCITT Recommendation I.130 (1988): "Method for the characterisation of telecommunication services supported by an ISDN and network capabilities of an ISDN".

[16] CCITT Recommendation M.30 (1989): "Principles for a telecommunications management network".

3 Definitions and abbreviations

3.1 Definitions

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

Customer: an entity which purchases services offered by another entity.

Customer management service: a management service commercially offered to a customer.

Management Services (MS): a TMN management service is an offering fulfilling specific telecommunications management needs of the TMN user. TMN users may be internal or external to the organisation of the TMN provider. TMN MS is then a management activity which provides for the support of one aspect of operation, administration and maintenance of the network and service being managed. The TMN MS is always designed from the TMN user perception of the management requirements (see CCITT Draft Recommendation M.60 [11]).

Service feature: a specific aspect of a service that can also be used in conjunction with other services/service features as part of a commercial offering. It is either a core part of a service or an optional part offered as an enhancement to a service.

Service processing: the execution of service control and basic call processing functions to provide a service (see CCITT Recommendation Q.1290 [14]).

Service provider: an organisation that commercially provides for services offered to service subscribers.

Service subscriber: an entity that contracts for services offered by service providers (see CCITT Recommendation Q.1290 [14]).

(Service) user: an entity that uses the services provided (see CCITT Recommendation Q.1290 [14]).

For a definition of IN terminology, see the CCITT Q.1200 series of Recommendations [14] (mainly CCITT Recommendation Q.1209 [14]). An extensive list of TMN terminology can be found in CCITT Draft Recommendation M.60 [11]. For ease of reference, a list of abbreviations has been included in Appendix A of CCITT Draft Recommendation M.60 [11].

3.2 Abbreviations

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

API	Application Programming Interface
BM	Business Management
CCAF	Call Control Agent Functional entity
CCF	Call Control Functional entity
CMISE	Common Management Information Service Element
CMIP	Common Management Information Protocol
CS	Capability Set
DFP	Distributed Functional Plane

DSL	Distributed Service Logic
EF	Elementary Function
EM	Element Management
FE	Functional Entity
FEA	Functional Entity Action
GFP	Global Functional Plane
GSL	Global Service Logic
IN	Intelligent Network
INCM	IN Conceptual Model
IF	Information Flow
MAF	Management Application Function
MIB	Management Information Base
M-INCM	Management INCM
M-SIB	Management SIB
NEF	Network Element Function
NEM	Network Element Management
NM	Network Management
O-O	Object-Oriented
OS	Operations Systems
OSF	Operations Systems Function
PP	Physical Plane
SCE	Service Creation Environment
SCEF	Service Creation Environment Function
SCF	Service Control Function
SCP	Service Control Point
SDF	Service Data Function
SIB	Service Independent Building block
SM	Service Management

SMAF	Service Management Application Function
SMCS	Service Management Control Supports
SLP	Service Logic Program
SLPI	SLP Instance
SMF	Service Management Function
SMP	Service Management Point
SP	Service Plane
SRF	Specialised Resource Function
SSP	Service Switching Point
SSF	Service Switching Function
TCAP	Transaction Capabilities Application Part
TMN	Telecommunications Management Network
T-SIB	Telecomminucations services SIB
WSF	Work Station Function

4 Overview of the TMN and IN studies

In the following, a brief overview of the current status of the TMN and IN studies is given, extracted from relevant IN and TMN documents (see Clause 1). It provides or references material that was used in this study.

4.1 TMN concepts

The purpose of the TMN is to support a telecommunication operator in management of its telecommunications network and services. Conceptually, a TMN is a separate network that interfaces a telecommunications network at many different points to send information to and receive information from it and to control its operations. The basis concept behind a TMN is to provide an organised architecture to achieve interconnection between various types of Operations Systems Functions (OSFs) and telecommunications equipment for the exchange of management information through the use of standardised protocols and interfaces. In subclause 4.1.1, the TMN functional architecture is briefly introduced. In subclause 4.1.2, the information modelling concepts that are used are highlighted.

4.1.1 The TMN functional architecture

The TMN functional architecture (see CCITT Draft Recommendation M.3010 [7]) describes the appropriate distribution of functionality within a TMN to allow for the creation of function blocks, from which a TMN of any complexity can be implemented. The model defines the exchange of management information on reference points, defined between the function blocks.

The TMN functional architecture is described by function blocks such as Network Element Functions (NEFs), OSF and Work Station Functions (WSFs). TMN layering allows to identify different OSFs, one per layer. CCITT Draft Recommendation M.3010 [7], Appendix B, describes a TMN Operations System (OS) functional hierarchy, in which the management functionality is considered to be partitioned into 4 layers (element management layer, network management layer, service management layer and business management layer), each of which restricts management activity within the boundary of the layer to a clearly defined rank. Figure 1 provides this functional hierarchy.

In this hierarchy, each layer restricts management activity within the boundary of the layer to a clearly defined rank, that is concerned with some subset of the total management activity.

The Network Element (NE) layer comprises the NEFs. The NEFs include the telecommunication functions which are subject to management.

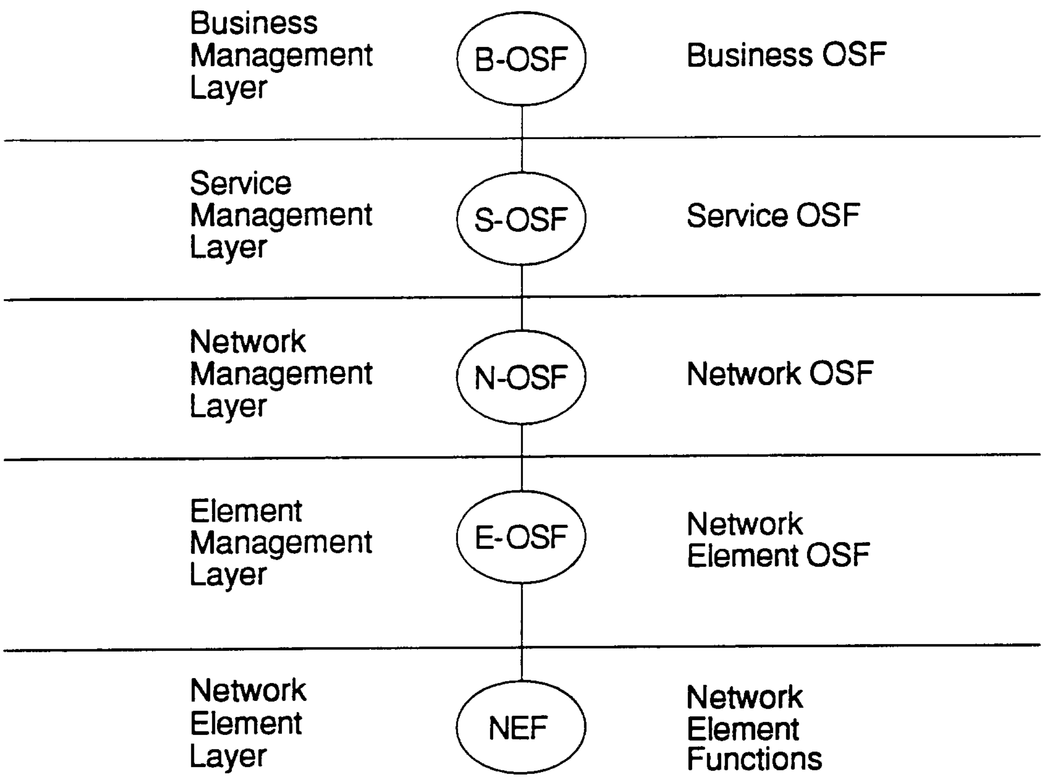

Figure 1: A possible TMN OS functional hierarchy

The Network Element Management (NEM) layer is responsible for the management of a subset of the network elements in the total network. This subset can be based upon certain criteria, for instance geographical criteria. The NEM layer is responsible for the detailed planning, engineering and construction of the NEs. Furthermore, it monitors and controls the resulting equipment and facilities. Hereby, it masks the manufacturer specific management functions for the network management layer. The manufacturer specific data is stored and converted to a uniform format.

The Network Managment (NM) layer is responsible for the technical provision of the services requested by the service management layer. It knows what resources are available in the network, how these are interrelated and geographically allocated and how the resources can be controlled. It has an overview of the network. It is also responsible for (cq. provides for) the range and initial amount of network resources that meets the planned extensions in the range of services offered to the market and the expected grow in service usage by the customers. Furthermore, this layer is responsible for the technical performance of the actual network and will control the available network capabilities and capacity to give the highest accessability and quality of service.

The Service Management (SM) layer is responsible for all negotiations and resulting contractual agreements between a (potential) customer and the service(s) offered to this customer on the one hand, and for extensions (or reductions) in the range of services commercially available offered to the market on the other. On the basis of market analysis it is planned what new services will be offered to the market and under what conditions (time/tariffs, etc.) and what service level agreements (service quality level, complaint handling time, etc.) are possible. After service deployment newly available services are added to the service catalog. This catalog provides a user-oriented view (e.g. a stage-1 description) of the services that are commercially available on the market. No precise knowledge is present on **how** these services will technically be provided. The service management layer relies on the network management layer for the technical provision of a service. Some of the main activities within this layer are service order handling, complaint handling and invoicing.

The Business Management (BM) layer has responsibility for the total enterprise and is the layer at which agreements between operators are made.

Although the exact contents of these layers has not been standardised by ETSI at the moment, it is often found useful to use this layering as the basis for structuring the management functionality in the management network[1)]

In the TMN functional architecture, reference points are defined between the TMN management function blocks. Reference points are conceptual points to model the information exchange between non-overlapping function blocks (see CCITT Draft Recommendation M.3010 [7]). In the next subclause, the information modelling technique adopted by TMN is introduced.

4.1.2 TMN information modelling

CCITT has adopted ISOs OSI systems management (ISO/IEC 10165) principles in its "TMN Information Architecture" (see CCITT Draft Recommendation M.3010 [7]) to describe the information exchange between the function blocks in the TMN functional architecture. These OSI systems management principles are based on an object-oriented paradigm: the management information to be exchanged is modelled in terms of "managed objects". These managed objects are conceptual views of the (physical or logical) resources that are being managed or may exist to support certain management functions, e.g. event forwarding or event logging. A set of objects sharing the same attributes, notifications and management operations is referred to as a "managed object class". Through the definition of the (managed) object classes it is defined precisely what messages can be used to manage the object (syntax) and what these messages mean (semantics). More information on the way of modelling of the managed object classes can be found in GDMO (see ISO/IEC 10165-4/CCITT Recommendation X.722 [6]).

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1) These layering principles were found useful in this ETR. The business management layer will, however, not be referred to in the following text, as these functions are out of the scope of this ETR.

The standards that present guidelines on how to define managed object classes include:

- the "management information model" (see ISO/IEC 10165-1/CCITT Recommendation X.720 [4]) defines the model for managed objects. Here, the attributes, the management operations that can be performed on the objects, the notifications they may emit and the appropriate naming schemes are identified. Based on this, the managed objects and attributes can be identified in a protocol;

- the "definition of management information" (see ISO/IEC 10165-2/CCITT Recommendation X.721 [5]), which defines managed objects and templates that can be imported into a variety of managed object class definitions. Hereby, a consistent definition of attributes, notifications, and management operations is stimulated;

- the "guidelines for the definition of managed objects" (see ISO/IEC 10165-4/CCITT Recommendation X.722 [6]). This ETR provides guidance, methods and notational techniques (templates) for specifying managed object classes and their management information.

The protocols to be used to transfer this information are defined in several "management profile standards" (see CCITT New Recommendation Q.811 [12], CCITT New Recommendation Q.812 [13]). These profiles define all protocols of the corresponding OSI 7-layer stack. The most obvious choice for the application protocol to transfer transaction oriented information is the Common Management Information Protocol (CMIP) see ISO/IEC 9596/CCITT Recommendation X.711 [3]. This general management protocol is specifically devised to carry the operations and notifications to/from the objects. These can simply be mapped to the service primitives of the corresponding Common Management Information Service Element (CMISE), see ISO/IEC 9595/CCITT Recommendation X.710 [2].

The OSI management principles are used for modelling the information exchange between the function blocks; this technique is based on an object-oriented paradigm. All aspects visible on the concerning reference point are modelled in terms of managed objects (classes). For each reference point the instances of the managed object classes (i.e. the managed objects) are arranged in a naming tree. The collection of (managed) objects within an open system is referred to as the Management Information Base (MIB) of that system.

Using the information and guidelines from the systems management standards and the appropriate protocol standards it is possible to fully define all relevant management information on the interfaces. However, to get an idea on what aspects should be modelled, it is often found useful to follow the "TMN interface specification methodology" (see CCITT Recommendation M.3020 [8]). This ETR provides a description of processes leading from a description of services (requirements analysis) towards the Object-Oriented (O-O) specification of the relevant management interfaces. These interfaces are comprised of a specification of the relevant information model(s) and a selection of communication profile(s) to carry the corresponding information between managing and managed system. In the following paragraph, a short overview of this methodology is given.

The management interfaces are to be specified to fulfil the user management requirements. In TMN, these user requirements are described as "TMN management services", a specification of the user requirements in prose (natural language) form. Although these TMN management services are not subject to standardisation, they provide a check list to guide the standardisation process. Herewith, it can be ensured that all the functionality that is necessary to support the perceived usage of the management implementation is covered for. Each TMN management service will contain a specification of the TMN management service components which are used by the TMN management service. Each TMN management component can be decomposed into TMN management functions (see CCITT Draft Recommendation M.3400 [10]), being the smallest part of the TMN management service as perceived by the user of the service. The part of the management service that resides in a single system is called a management process. The interactions that can occur between management processes in different end systems are determined by the (object oriented) specification of the information models on the corresponding reference points. In the description of these information models, extensive use of inheritance is needed to benefit the most from re-use of specifications.

4.2 IN concepts

The term IN is used to indicate an architectural concept for structuring telecommunication networks in such a way, that rapid service deployment and provisioning in a multi-vendor environment will be possible. Therefore, a separation of switching and control is introduced in IN, the service logic is centralised.

NOTE: It is true that there is no such thing as an "IN-service" strictly speaking (a service may be implemented in an IN way or in another way equally well). Nevertheless, there are some services that are typically best realised in an IN fashion, such as freephone, virtual private networks, and UPT.

The list of services drawn in NA6 or CCITT XI/4 for IN CS-1 is a good example of IN services.

In the following subclauses, the IN architectural concepts and the IN modelling techniques are introduced and clarified.

4.2.1 The IN planes

In the IN studies, the IN Conceptual Model (INCM) (see CCITT Recommendation Q.1201 [14]) is used as a framework for the design and description of the IN architecture. It is intended to present an integrated, formal framework within which the various models and concepts used in the standardisation of IN are identified, characterised and related. Figure 2 visualises this INCM. It consists of four planes where each plane represents a different abstract view of the capabilities provided by an IN-structured network. These views address service aspects, global functionality, distributed functionality and physical aspects of an IN.

This figure is a slightly modified version of figure 3.1/a of CCITT Recommendation Q.1201 [14].

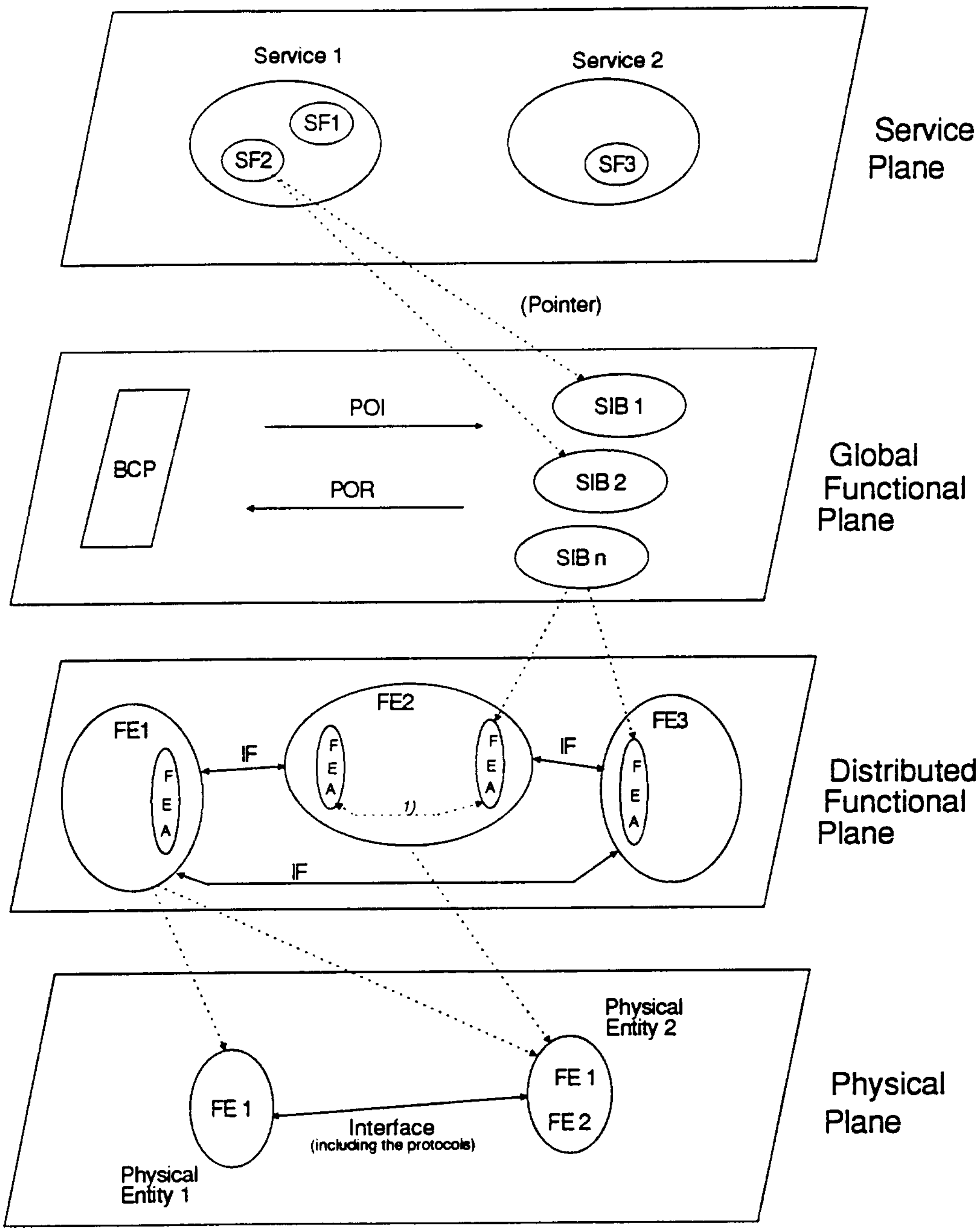

Figure 2: The Intelligent Network Conceptual Model (INCM)

- the Service Plane (SP) represents an exclusively service-oriented view (no implementation knowledge);
- the Global Functional Plane (GFP) models an IN-structured network as a single entity;
- the Distributed Functional Plane (DFP) models a distributed view of an IN-structured network;
- the Physical Plane (PP) models the physical aspects of IN structured networks.

Because each plane represents a different view of the same model, there is no interaction between planes, however, the entities in adjacent planes are related to each other. The exact mapping between the planes, and, therefore, the nature of the pointers in figure 2, is at the moment not extensively defined. This is for further study.

It should be underlined, that this INCM is "only" a modelling tool for the design and description of the IN architecture, indicating and relating abstract modelling concepts. Therefore, no implication on the way a IN network is structured is intended with the concept of these planes.

In the following subclauses, the characteristics of each of these planes are indicated.

4.2.1.1 The service plane

The SP is the uppermost plane in the INCM. It represents an exclusively service-oriented view. This view contains no information whatsoever regarding the implementation of the services in the network. All that is perceived is the networks' service-related behaviour: it contains the user view of the services offered to him/her. The network is only seen from a very high level, global perspective as a source of services. The SP illustrates that services can be described to the service user (or service subscriber/customer) by means of a set of generic blocks called Service Features (SFs). The items contained in this plane are:

- (management) services (a stand-alone commercial offer from a service provider to a subscriber who pays for the use of that service);

- (management) service features (a part of the whole service, which may or may not be mandatorily present in each of the different variations of the service offering).

4.2.1.2 The global functional plane

The GFP is the plane in the INCM immediately below the service plane. It models the network from a global, or network-wide, point of view. The network is still seen from a high level perspective, hiding the complexity of the distribution of functions. As such, the IN structured network is said to be viewed as a single entity in the GFP.

This plane was introduced in the INCM to take into account the concept of **service creation**. It contains the service designer view of the services which are to be offered to subscribers. Services and SFs are redefined in terms of the broad network functions required to support them. These functions are neither service nor service feature specific and are referred to as Service Independent Building blocks (SIBs). Each SIB is mapped onto one or more Functional Entities (FEs) in the DFP.

The items contained in this plane are:

- SIBs, which are the elementary "bricks" with which a service designer may construct a service, as a mason would build a wall. SIBs represent standard re-usable network-wide capabilities, and the control of those network capabilities used to realise services and service features. The Basic Call Process (BCP) SIB provides the basic call capabilities from which IN-provided services are launched and returned. The BCP is defined in CCITT Recommendation Q.1203 [14], § 4 and CCITT Recommendation Q.1213 [14], § 3. The SIBs are described in CCITT Recommendation Q.1213 [14], § 2 (stage 1 description) and CCITT Recommendation Q.1214 [14], § 5 (stage 2 description);

- Global Service Logic (GSL), which describes how SIBs are chained together to describe service features, and also describes interactions (including data) between the BCP and the SIB chains. The GSL is defined in CCITT Recommendation Q.1203 [14], § 5 and CCITT Recommendation Q.1213 [14], § 4[2)].

4.2.1.3 The distributed functional plane

The DFP is the plane in the INCM immediately below the DFP. It models a distributed view of an IN-structured network. It identifies the specific elements and the relationship between them that are necessary to support the objectives of IN. However, since it is a functional view, there is flexibility in the real allocation of each functionality to physical blocks. The items contained in this plane are:

- Functional Entities (FEs);

- Functional Entity Actions (FEAs);

- Information Flows (IFs) between FEs/FEAs;

- Elementary Functions (EFs)[3)].

A FE is defined in CCITT Recommendation Q.1204 [14] as:

"A unique group of functions in a single location and a subset of the total set of functions required to provide a service. One or more FEs can be located in the same Physical Entity (PE). Different FEs contain different functions, and may also contain one or more of the same functions. In addition, one FE cannot be split when mapped to PEs. Finally, duplicate instances of a FE can be mapped to different PEs, though not to the same PE".

Each FE may perform a variety of FEAs. Any given FEA may be performed within different FEs. However, a given FEA may not be distributed across FEs[4)].

SIBs are realised in the DFP by a sequence of particular FEAs performed by the FEs. Some of these FEAs result in information flows between FEs (see CCITT Recommendations Q.1201 and Q.1204 [14]). In subclause 4.2.4, the role of SIBs in IN is clarified.

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2) The mapping of GSL of the GFP onto the Distributed Service Logic (DSL) of the DFP is for further study within NA6.

3) The concept of EFs is for further study within NA6

4) The information exchange between FEAs within an FE is an internal processing matter.

4.2.1.4 The physical plane

The PP is the lowest plane in the INCM, immediately below the DFP. It models the physical aspects of IN-structured networks. It contains the real view of the physical network, with the real physical blocks (systems, nodes, links, etc.). It identifies different PEs, the allocation of functional entities to PEs, and the interfaces between the PEs (see CCITT Recommendation Q.1205 [14]).

The items contained in this plane are:

- PEs and links (physical interfaces);
- protocols across physical interfaces and procedures in the PEs.

CCITT Recommendation Q.1205 [14], § 3 and CCITT Recommendation Q.1215 [14], § 3 describe a selection of PEs. In CCITT Recommendation Q.1215 [14], possible scenarios for physical architectures are indicated.

4.2.2 The IN functional architecture

To summarise the IN network functions and their functional relationships, the IN functional architecture is given in figure 3.

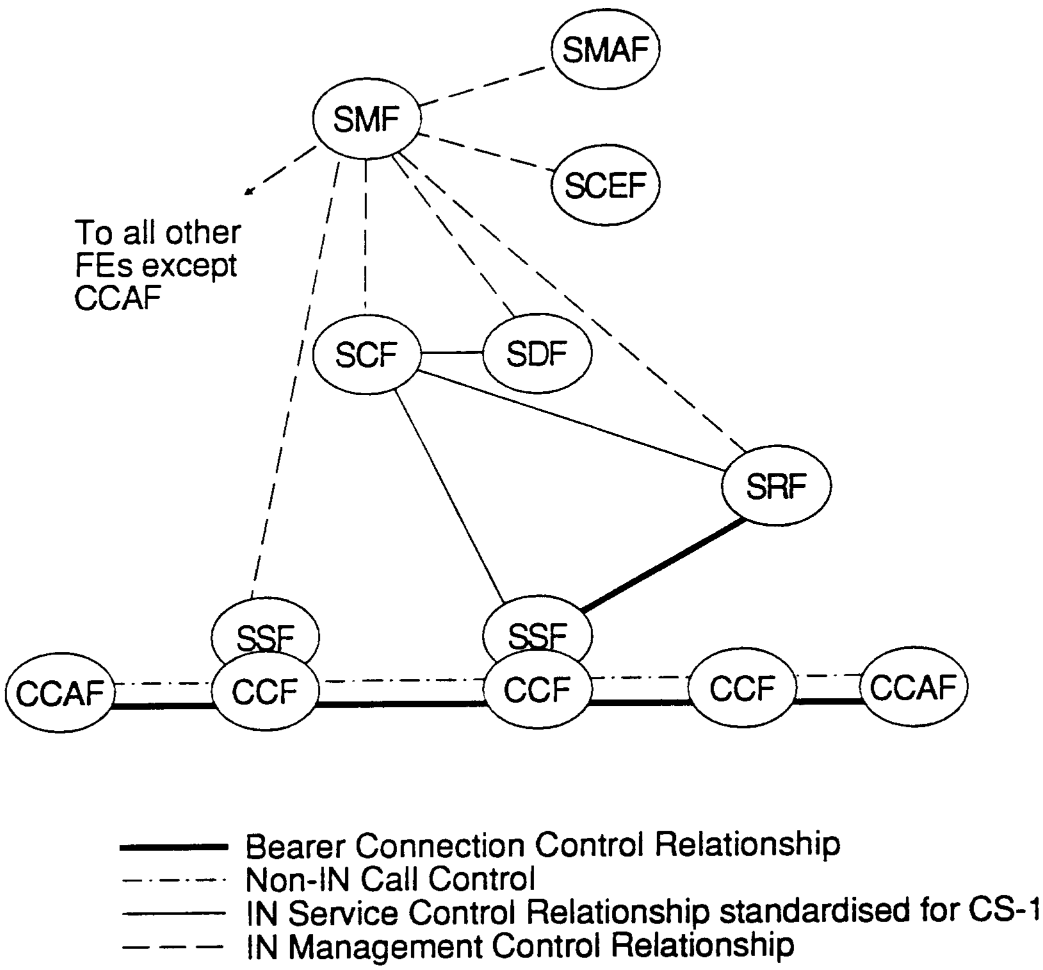

Figure 3: Functional Relationships for CS-1

The IN functional architecture contains FEs of different types and the relationship between them in order to describe the appropriate distribution of functionality to process, manage and create IN based services. The relationships indicated in this figure are to be seen as FE type relationships, where an FE type represents a grouping of functions in a single location and a subset of the total set of functions required to provide the service. Two or more FEs are said to be of the same type if they consist of the same grouping of functions. The FE type relationships as indicated in the functional architecture are identified to be standardised (when mapped to different PEs). All reasonable distributions of functions are considered, thus leaving the option open to an operator how to actually offer the service(s).

The functional architecture permits an FE type to be instantiated a number of times into FE instances (e.g. the IN Service Switching Function (SSF)). The IN functional architecture only contains those instances up to the point where no new combinations of external relationships to other FE instances are encountered. For example, the IN CS-1 functional architecture allows instances of Service Control Functions (SCFs) (e.g. specialised SCFs for different services, containing different service logic), but it does not describe the relation (information flows) between these SCF instances (this is in the scope of future CSs, see figure 6). An FE instance is mapped entirely within one physical entity (PE), and thus (the functions of an FE instance) cannot be split when mapped to two or more PEs. An SSF/Call Control Functional entity (CCF) instance should be mapped entirely within a PE, a CCF instance could also be mapped separately within a PE, but a separate SSF instance is considered as not appropriate. In order to indicate that an Specialised Resource Function (SRF) instance does not **require** a relationship with each CCF/SSF both possibilities are indicated.

An hierarchical relationship between the different FE types can be identified between the SCF functional entity and the other FEs identified. That is, the SCF can be seen as a "controlling" entity; the FEA in the SCF represents the control side of the network capability (it has the logical start and logical end characteristics that are described in the GFPs' stage-1 descriptions), whereas the FEAs in the "slave" entities (Service Data Function (SDF), SRF, SSF) represents the network capability itself.

In IN, the management relationship between two different domains is modelled via Service Management Function - Service Management Function (SMF-SMF) relationships (see figure 6 of CCITT Recommendation Q.1211 [14]).

4.2.3 IN information modelling

The IN modelling technique is based on the CCITT Recommendation I.130 [15] which defines the so-called 3-stage methodology. CCITT Recommendation I.130 [15] provides a method for the characterisation of telecommunication services (including supplementary services) and a definition of network capabilities in an ISDN to support the identified services. Since the methodology defined in CCITT Recommendation I.130 [15] does not support one of the objectives of IN, which states that IN is service independent, some enhancements were made.

The service independency of IN is, amongst others, obtained through the use of SIBs. These SIBs reflect network-wide capabilities used by a number of services and, therefore, are service independent, i.e. they provide functionality for more than one service. The SIB-concept is further clarified in subclause 4.2.4.

The 3-stage methodology is described in CCITT Recommendation I.130 [15]. Here, a brief description of the methodology enhanced for IN modelling is given.

The method is divided into three main stages of activity:

- service aspects (stage 1);
- functional network aspects (stage 2); and
- network implementation aspects (stage 3).

In principle the application of the method is sequential. Stage 1 gives the service description from the user point of view, resulting in descriptions of services and the identified SIBs. Stage 2 offers an intermediate view of what happens at the user-network interface and inside the network between different nodes, resulting in one or more implementation independent scenarios. Stage 3 gives the actual nodes descriptions, as well as protocols and formats to be adopted, resulting in a set of protocol and node recommendations needed to realise the targeted services. Each of these stages consist of several steps which are briefly described below.

- Stage 1.

  This stage is used to define services and service features (in the SP of the INCM) and to define SIBs (in the GFP of the INCM). The structured approach for analysing services and decomposing services into SIBs is illustrated in CCITT Recommendation Q.1203 [14].

  It should be noted, that "SIB creation" will mostly[5)] imply the creation of new network capabilities; in this case, changes in the network are required. This, however, is not the case for "service creation" [6)]. Here, the existing network capabilities (as represented by the SIB definitions) are merely used in a different way, therefore, apart from changes in the service control logic, no changes in the network are required in this case. Subclause 4.2.4 elaborates further on service creation and the role of SIBs in IN.

  Stages 2 and 3 identified below reflect the procedures for defining and/or updating the network capabilities. Therefore, these stages will only be relevant when new SIBs are identified in stage 1.

- Stage 2.

  This stage identifies the functional capabilities and the information flows needed to support the SIBs as identified and described in stage 1. It is used to define the realisation of SIBs (in the DFP of the INCM).

  - Step 2.1.

    A functional model, i.e. the IN functional architecture, is derived for all SIBs. This functional architecture is the aggregate of the functional entities (FEs, e.g. SSF and SCF) and relationships, (e.g. SSF-SCF).

  - Step 2.2.

    The distribution of the functions needed to provide the SIBs (and, therefore, the services) requires interactions between FEs. These interactions are referred to as information flows, (e.g. Call Information request). In this step, the IFs are identified.

  - Step 2.3.

    The functions performed within an FE are identified and presented in the form of an SDL diagram.

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5) This will only not be needed in the situation where the (control of) network capabilities of a newly identified SIB have already been identified for other SIBs. In this case, however, the SIBs appear to represent "overlapping" capabilities. SIBs should be defined in such a way, that these overlaps are avoided as much as possible.

6) The current (IN-) technology does not provide for a rapid creation of new network capabilities.

- Step 2.4.

  The actions performed within an FE are represented as a list of functional entity actions FEAs (e.g. ref.nr.9061: Initiate request). The relationship between FEAs and the EF is for further study.

- Step 2.5.

  All identified FEs and information flows are allocated to PEs, (e.g. Service Switching Point (SSP) and Service Control Point (SCP)). The relationship supported between two FEs located in different PEs must be realised with protocols.

- Stage 3.

  The information flows and SDL diagrams are used to define the protocols, (e.g. Transaction Capabilities Application Part (TCAP) and the ISDN basic access user-network interface), procedures and requirements for the nodes needed and applied (in the PP of the INCM).

Summarising, it may be stated that CCITT Recommendation I.130 [15] has been adjusted for IN modelling by removing the service dependent aspects by using SIBs instead of services (in the SP of the INCM). SIBs in the GFP are realised in PEs via stage 2 decomposition into FEAs and IFs in the DFP, and then mapped onto operations and procedures in the PP.

Although the enhanced 3-stage methodology, as described above, is accepted for IN CS-1, in the IN Long Term Architecture (LTA) group other modelling techniques are considered for adoption by IN to fulfil future IN needs. The O-O modelling technique is especially considered for its applicability for IN (see CCITT Recommendation Q.1201 [14], § 4.5.4).

The use of object modelling could satisfy the modelling needs of IN LTA by the use of abstract object modelling concepts. These concepts are utilised within, both, the TMN work and DAF work.

4.2.4 The role of SIBs in IN

To build new services in the network, IN has introduced the concept of the Service Creation Environment (SCE). In this SCE, a service program (logic and data) is written in terms of SIBs. The SIBs are used as standard reusable network-wide capabilities used to realise services (and service features) in an efficient and quick way. They are considered to be functional building blocks of services, defined independently from the underlying network. In the SIB-description the information flows between the relevant functional entities (FEs), and the actions to be taken there, are being described as a sequence of events (see e.g. CCITT Recommendation Q.1214 [14]).

Below, the role of SIBs in the different stages of IN modelling, IN service creation and IN service processing is identified.

4.2.4.1 SIBs during IN modelling

In the modelling phase of IN structured networks, SIBs reflect a reusable set of FEAs and IFs to provide service features in an IN. These SIBs reflect network-wide capabilities used (shared) by a number of services, and are, therefore, indicated as "service-independent". They provide functionality for more than one service. They are used to model the IN by decomposing/describing services in order to define the supporting network capabilities. SIBs are mapped onto IFs at/between FE(s) in order to model and standardise the IN (functions and interfaces).

4.2.4.2 SIBs during service creation

Once the IN is modelled and implemented, a set of SIBs is offered to the service creator. These SIBs provide the service creator with the possibility to create new services rapidly. The internal structure of the SIBs in e.g. the SCP is unknown to the service creator as this is provided by the SCP platform. The service creator builds its service by programming a Service Logic Program (SLP) by means of GSL which consist of invocations of the required SIBs and supporting data. This can be compared with programming using procedure calls. The resulting software (service logic program and data) is, after testing, deployed into the network.

The Service Creation Environment Function (SCEF) FE provides the new SLPs, new data templates and new data, that are needed for the service processing (execution) process. The SLPs, data templates and data are to be installed in or more SCPs or SDPs with the help of the Service Management Point (SMP).

4.2.4.3 SIBs during service processing

Once the created SLP (and its related data) has been deployed and provisioned "into" the SCP (and SDP), it can be invoked by service users. This service invocation generally corresponds to interactions between several IN-functional entities and FEAs.

The users access the call/service processing functions of the SSF/CCF via the Call Control Agent Functional entity (CCAF). The CCAF receives call setup/service requests from the users and passes them to the SSF/CCF for processing. In the course of processing these requests, the SSF/CCF may detect pre-defined events that can lead to the invocation of an instance of service logic. In case of a pre-defined event, the SSF/CCF reports the event to the SCF, along with some related data. The SCF invokes an instance of the appropriate SLP. This SLP Instance (SLPI) is a dynamic entity that actively controls the flow of service execution and invokes SCF functional routines. These functional routines are the functionality in the SCF that can be invoked by SLPIs to cause a sequence of FEAs to be performed in the network in support of service execution. During the IN modelling these FEAs related to the specific SIBs were already defined and distributed over the FEs (see subclause 4.2.3).

Hence, SIB invocations as part of a SLPI are mapped (via an Application Programming Interface (API)) onto the functional routines which cause the corresponding FEAs (see figure 4). This can be seen as a chain reaction of FEAs. An FEA in the SCF may result into an IF to another entity, e.g. an SDF. The receipt of this IF may/will result into an FEA which again may result into another IF, and so on. Thus, an SLPI consists of SIB invocations, where each SIB instance consists of functional routine invocations (leading to FEAs).

Examples of proposed functional routines are: functional routines to perform appropriate functions in response to asynchronous events (e.g. events reported by other FEs), functional routines to retrieve time and date, functional routines to facilitate SLPI initialisation and termination.

The following example will show how an SIB may be implemented and executed:

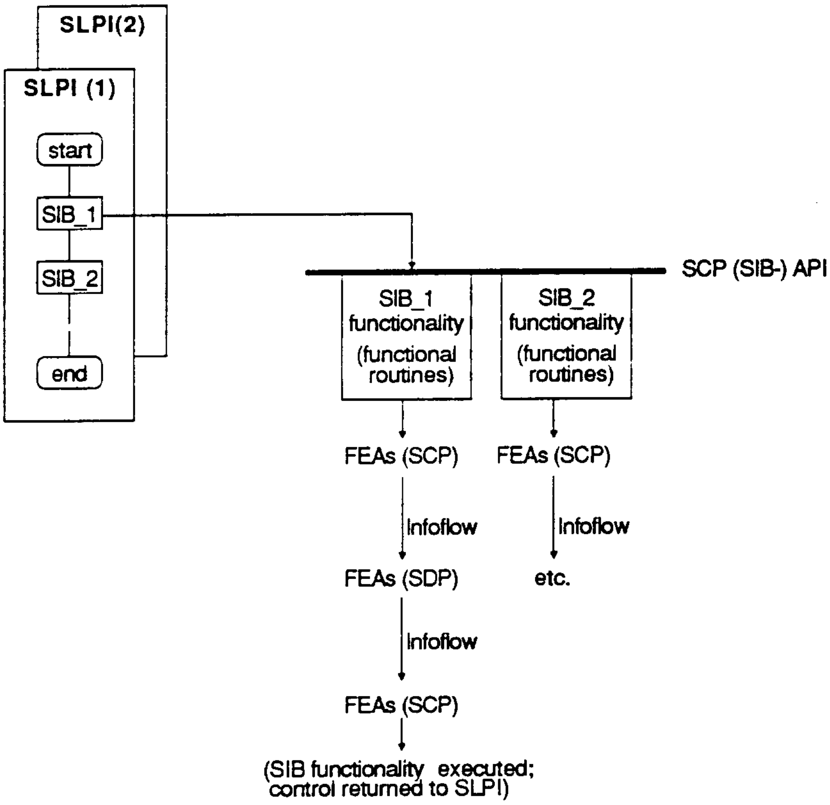

Figure 4: A representation of SIB invocations as part of an SLPI

The "Screen SIB" provides the capability for the SCF to perform a comparison of an identifier against a list located in the SDF (e.g. a credit card number as part of the service credit card calling). The credit card service SLPI invokes the SCREEN SIB, the service logic execution manager "recognises" this SIB invocation (possibly via an API) and the related functional routine is invoked and as such the required FEA. In this case FEA "9081" which processes the request from the service logic, and generates/sends a query request indication, i.e. an information flow to the SDF. In the SDF this information flow is handled by FEA "4081" of the SDF which receives and analyses the query request indication, screens data in the base, and generates/sends a query result response confirmation to the SCF. Finally, FEA "9083" of the SCF receives the query result response confirmation and returns response ("match" or "no match") to the service logic after which the SLPI processing continues (possibly with the invocation of another SIB).

4.2.4.4 Conclusion

In conclusion, a SIB as a modelling tool for the IN consists of all the required FEAs and IFs, whereas a SIB as part of the service creation process may consists of a "SIB identifier" indicating to the SCF (via an API) the SIB to be performed (and as such the functional routines and FEAs to be invoked). Service processing generally corresponds to interactions between several IN-functional entities and actions in functional entities (FEAs). However, when a service program is created in the service creation environment, no knowledge should be required of the structure of the underlying network.

4.2.5 IN CS-1 management requirements

The service scope of CS-1 is restricted to single-ended, single-point-of-control services. The management aspect primarily addresses the network operators' interaction with the SSF/CCF, SCF, SDF, and SRF. This interaction normally takes place outside the context of a particular call or service interaction. However, CS-1 neither excludes or constrains the capability of service customers to interact directly with customer-specific service management information (e.g. a personal service profile). The following points capture key principles for CS-1:

- the SMF, SCEF, and Service management Application Function (SMAF) may be used to add, change or delete CS-1 based service related information or resources in the SSF/CCF, SCF, SDF, and SRF. Such changes should not interfere with CS-1 based service invocations or calls that are already in progress;

- the network operator may, at its discretion, give the customer the ability to add, change, or delete appropriate customer-specific information. The mechanisms and safeguards that are put into place by the network operator for this interaction may take advantage of CS-1 functions and capabilities (see CCITT Recommendation Q.1211 [14], § 6.2).

The management-related functional relationships between the SMF and the other IN FEs remain to be specified in subsequent IN capability sets. For CS-1, it is expected that market forces will result in customer-responsive non-standard solutions for the associated interfaces, and that multi-vendor objectives of IN will be met in subsequent capability sets.

5 Integration of architectures

To identify the relation (and overlap) between IN and TMN identified functionality, in this Clause the IN and TMN architectural concepts are compared and related to each other. As both areas are (partly) covering the same field (management of networks and services), this Clause focuses on this area. For completeness, also the service processing and service creation aspects are covered.

As a result of the study to integration of the IN and TMN architectures, some proposed enhancements to the identified IN and TMN functional architectures have been identified. These will be argued and explained in this Clause and summarised in Clause 7.

5.1 IN planes versus TMN layers

While the planes of the INCM (see subclause 4.2.1) represent different abstract views of the capabilities of an IN, the layers of the TMN OS functional hierarchy (see subclause 4.1.1) represent a way of structuring the management functionality. So, although both models do have a different scope and aim, they have some commonalities (see figure 5).

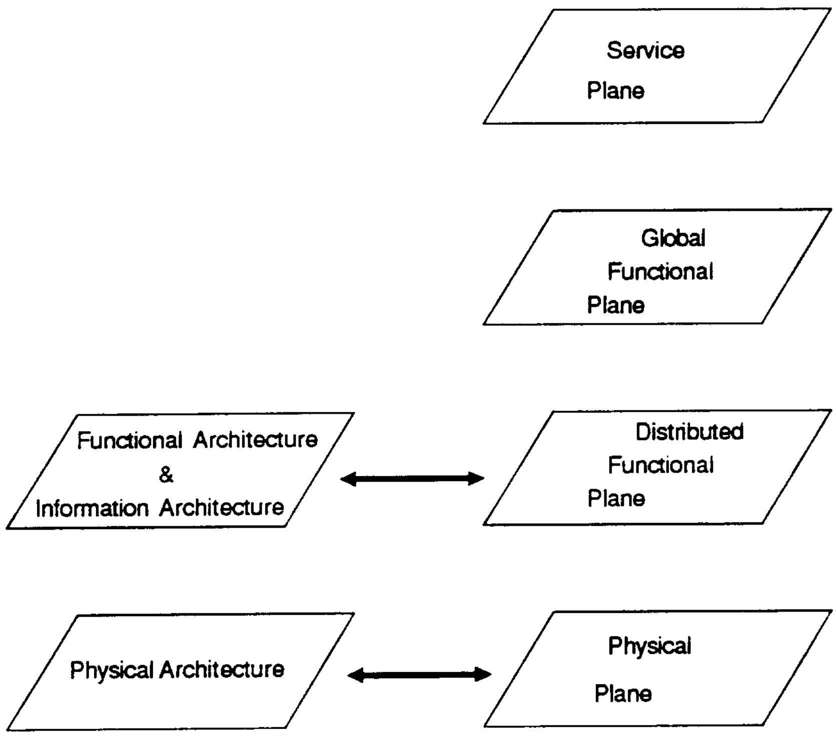

Figure 5: Correspondence of the TMN architectures and the planes of the INCM

The SP of the INCM represents an exclusively service-oriented view: it contains the user view of the services offered to him/her, and the network is only seen from a very high level global perspective, as a source of services. In TMN, no specific architectural concept is defined for presenting the same view. However, TMN implicitly covers this "service plane" concept: the manager view ("user view") on a function block is unambiguously described by the O-O information models. A description of corresponding management services can be found in CCITT Draft Recommendation M.3200 [9].

The GFP of the INCM represents a service designer view. In TMN, no specific architectural concept is defined for presenting the same view. However, TMN implicitly covers this "service designer view" concept: the view presented by the network management layer (see subclause 4.1.1) provides a view of the network capabilities to the service management layer. The concept of a service creation environment, however, has not been identified by TMN. A comparison of the information modelling aspects in IN and TMN is provided in Clause 6.

The DFP architecture of the INCM identifies the specific functions and the relationships between them that are necessary (to support the objectives of IN). This corresponds to the TMN functional architecture, where also the functions and reference points are defined (to support the objectives of TMN). Thus, in the DFP of the INCM and the TMN functional architecture the functions and the reference points are defined with regard to their own objectives. However, the DFP of the INCM also describes the information flows between the functional entities of the IN functional architecture. Within the TMN the (concept of) information exchange is defined in the TMN information architecture (see subclause 4.1.2). In conclusion we can say that the distributed functional plane of the INCM corresponds to the TMN functional architecture and the TMN information architecture.

The PP of the INCM identifies different PEs, the allocation of functional entities to PEs, and the interfaces between the PEs (to support the objectives of IN). This corresponds to the TMN physical architecture, where also the realisable interfaces and examples of physical components are identified (to support the objectives of TMN). So, in this respect, the IN PP and the TMN physical architecture correspond to each other.

5.2 Relation between the IN and TMN functional architectures

In this subclause the IN and TMN functional architectures are compared. It is indicated how they relate to each other.

As the scope of TMN is restricted to management activities, but in IN service processing and service creation are also considered, it can be useful to consider separate representations of the IN functional architecture for these three areas within IN:

- IN service processing;
- IN management[7]; and
- IN service creation[8].

In the following, the relation of IN and TMN functional architectures for these three distinguishable main processes in IN are considered.

5.2.1 IN service processing

In figure 7 the service processing part of the IN functional architecture (compare figure 3) is given. As TMN is not concerned with modelling service processing, there are no direct relations between TMN and IN in this area. However, it may be possible that in the future some relations may be identified, as also in IN standardisation bodies O-O modelling of service processing is considered. More on the comparison and possible integration of IN and TMN information modelling can be found in Clause 6.

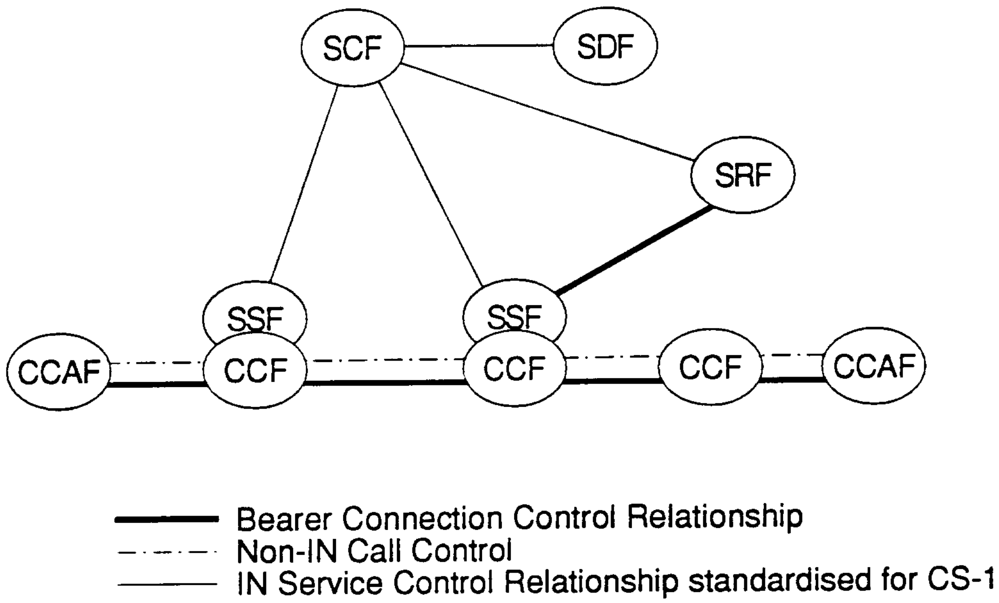

Figure 6: Management part of the IN functional architecture

5.2.2 IN management

In figure 6 the management part of the IN functional architecture is given. Both IN and TMN are concerned with modelling management. It is clear that conflicting developments on this area between both IN and TMN may cause some severe interworking problems (and waste of resources) in the future. Therefore, in this study it is indicated how IN and TMN concepts may be integrated to fulfil both the IN and TMN requirements. Since TMN is widely accepted as the concept to support the management requirements of administrations to plan, install, maintain, operate and administer telecommunications networks and services, in this study it is assumed that TMN concepts can be used to structure and model the management aspects of IN. In addition, considering the developments in ETSI NA4, it has been decided to adopt TMN layering principles for modelling the management of IN structured networks.

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7) To prevent mis-interpretation, in this ETR the IN term "Service Management" is denoted as "IN management", "management of IN (based services)", or just "management": in TMN, the term "Service Management" is used in a different meaning as it is in IN (see subclause 4.1.1).

8) In this context, service creation is not regarded as a subset of management.

Therefore, it is suggested that the modelling process of IN management aspects should be based on the TMN OS functional hierarchy, see figure 8.

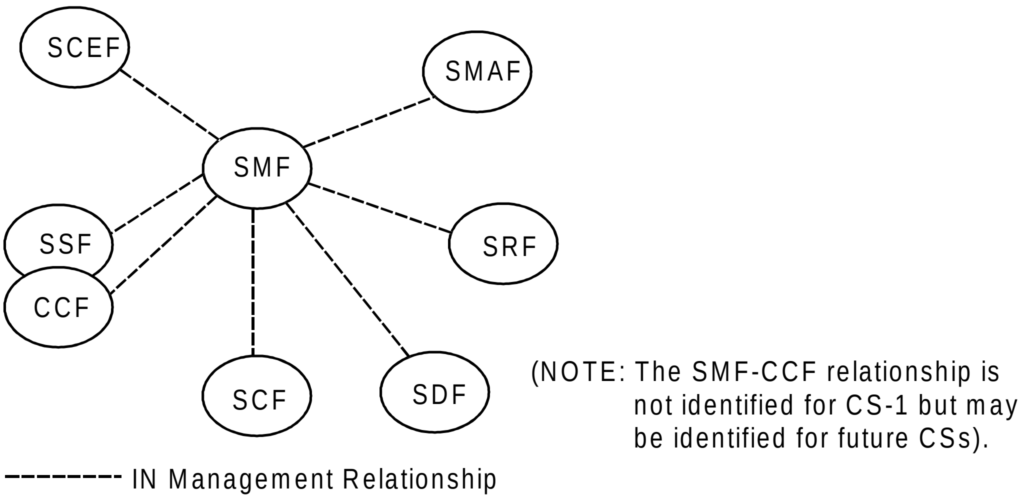

Figure 7: Service processing part of the IN functional architecture

Each of the functionalities identified in IN should be mapped onto this figure. In following subclauses this exercise has been performed for all IN functional entities, indicated in figure 6.

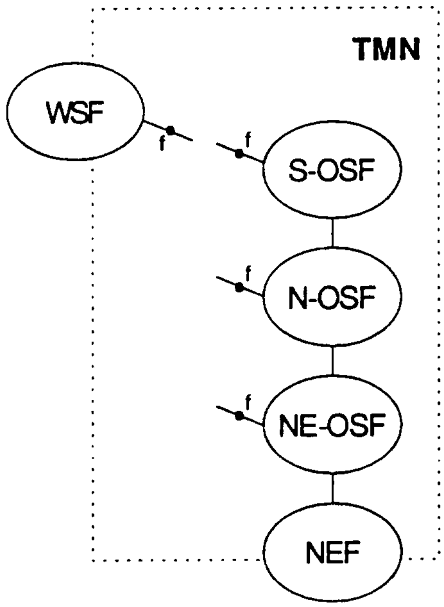

Figure 8: Example of a TMN OS functional hierarchy

5.2.2.1 Mapping of the IN service processing FEs to TMN

The IN FEs involved in the IN service processing are the CCAF, CCF, SSF, SRF, SCF, and SDF. In the TMN terminology, these functional entities can be referred to as NEFs: in TMN, the NEF is a functional block which provides the telecommunications and support functions which are involved in the telecommunications process. The NEF communicates with the TMN for the purpose of being monitored and/or controlled. The part of the NEF that provides the representation of these functions is part of the TMN itself, whilst the telecommunications functions themselves are outside.

Each IN service processing FE can be mapped onto a TMN NEF block. The fact that in IN some parts of these telecommunications functionality is re-allocated to other FEs ("unglued" from the switch) doesn't essentially alter the **type** of functionality (although it will probably get more "sophisticated" in the IN situation).

5.2.2.2 Mapping of the SMAF to TMN

In NA6 the SMAF functional entity is described. The following SMAF subfunctions are mentioned:

- Human Interface Functions (HIF); and
- Management Support Functions (MSF). These can be subdivided into:
    - Human Interface Management (HIM);
    - Service Management (SM);
    - Service Management Control Supports (SMCS).

In TMN, OSF and WSF functions have been identified for modelling access to management functions. To arrive at consistency in terminology and concepts, in figure 9 a mapping is given from the SMAF subfunctions onto the TMN WSF and OSF function blocks.

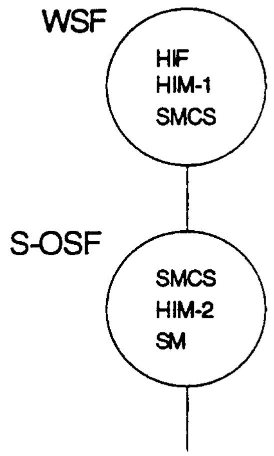

Figure 9: Mapping of the SMAF subfunctions to TMN function blocks

This figure is based on the following assumptions:

- the SMAF HIF can be mapped onto the TMN Presentation Function (PF) and should, therefore, be mapped onto the TMN WSF;

- the SMAF HIM function contains several types of functions like "display manipulation", "user profiles" and "filter definition". The first type of function (in the figure denoted as HIM-1) can be mapped onto the PF, whereas the other ones (HIM-2) could be functions for identification and authentication of the user, for which a mapping to the Human Machine Adaptation (HMA) function (and, therefore, to an OSF function block) of TMN could be made;

- the SMF of the SMAF contains "data back-up" and "user definition" and "authorisation" functions. This seems to refer to the definition of user access rights and relevant data needed to identify and authorise the user. Therefore, this function can be mapped on the HMA of a TMN OSF;

- the SMCS function seems to refer to functionality needed to exchange information with the IN SMF. This can be mapped onto the corresponding TMN S-OSF. More generally, such communication function exists in any OSF communicating with another TMN function block compare the TMN Message Communication Function (MCF) from CCITT Draft Recommendation M.3010 [7].

With the mapping as identified above, all IN management requirements are taken into account, while the TMN functional architecture is respected. Therefore, in this study it is decided to avoid the term SMAF and take - for the management function blocks - more TMN oriented names.

5.2.2.3 Mapping of the SMF to TMN

In NA6 the SMF functional entity is described.

It is out of the scope of this study to provide a detailed mapping of SMF activities to the TMN OSF layers. Instead, the purpose of this subclause is to indicate that the SMF activities should be mapped onto several layers in the TMN OS functional hierarchy.

For this reason, and as an example, only the "service (generic) data allocation" activity is mapped on the TMN functional layers:

Service management layer:

Service data allocation is performed after the service software has been created and tested successfully. The service data is passed onto a network deployment and provisioning function on the NM layer. This should be done in a co-ordinated way, so performed by one subfunction for all kinds of data.

Network management layer:

In the NM layer, it is determined for which part of the network the service data is relevant. The service data is passed on to the network element management functions on the NEM layer. This should be done in a co-ordinated way, so performed by one subfunction for all kinds of data.

Network element management layer:

Here, the individual IN network elements are managed: it is determined for which IN-NEs the service data is relevant. The service data is downloaded into the corresponding NEs.

In Annex A, an example of a more detailed mapping of the IN-SMF to TMN layers is provided.

The conclusion of the mapping of the SMF activities onto the TMN layers is that all TMN layers are involved. However, the **initiation** of the SMF identified activities will in many cases be done on the SM-layer (by the service provider or service subscriber). Resulting from this, the **effectuation** of these activities will in many cases be performed by generic, service independent functionality within the network, so in the NM layer and the NEM layer.

So, considering this mapping, it is found that the IN-SMF functionality will have to be mapped on the SM, NM and NEM layer of the TMN layered functional architecture. With this approach, all IN management requirements are taken into account, while the TMN functional architecture is respected. As for the mapping to physical architectures, this approach is more flexible and allows several physical configurations such as presented in figure 10. All scenarios identified by CCITT Recommendation Q.1205 [14] are taken into account.

Therefore, in this study it is decided to avoid the term SMF and take more TMN oriented names for the management function blocks. For listing the IN specific management aspects it is proposed to use the term "IN management aspects", in stead of SMF description/definition.

Furthermore, the SMF activities as identified by NA6 appear not to be specific for IN: many of these management functionalities have already been identified (and sometimes implemented) for non-IN networks. As a result, an integration of the TMN architecture and the (management part of the) IN architecture is essential for reasons of efficiency and to prevent conflicting modelling and architectural developments in the future.

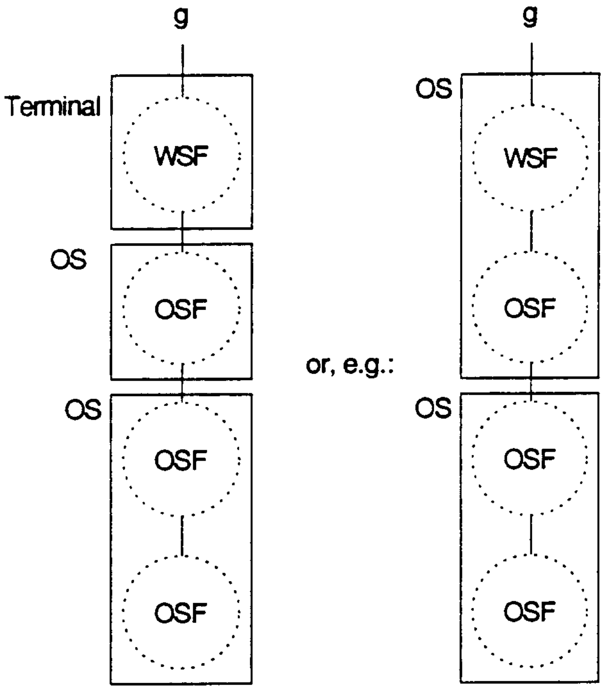

Figure 10: Examples of some physical scenarios for accessing OSFs

5.2.3 IN service creation

In IN, service creation is performed by the IN SCEF, while the resulting service logic and data is to be deployed into the network by the SMF. In figure 11, the service creation part of the IN functional architecture is given.

At the moment, in TMN no specific attention has been given to the concept of rapid creation of service (and/or management service) logic and data. Instead, the main attention in TMN has been given to operational management of existing services and networks. However, to be able to use TMN concepts for management of IN, more attention should be paid to the question on how TMN concepts can fulfil the IN management requirements of rapid service creation and deployment. Both a integration of IN and TMN architectures and an integration of the modelling techniques of both areas should be covered. In this subclause attention has been given to a possible way to integrate the architectures of IN and TMN. In Clause 6, the IN and TMN modelling techniques are compared, and possible ways of integration are indicated.

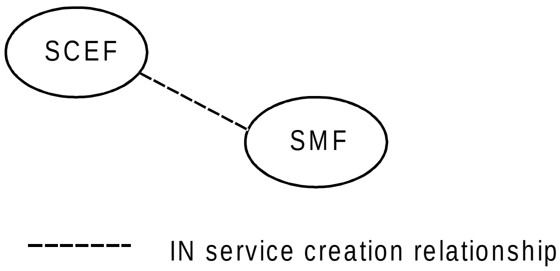

Figure 11: Service creation part of the IN functional architecture

5.2.3.1 The IN service creation process

In this subclause a short elaboration is provided on the IN SCE concept, that will be used in the following subsections for reference.

In the IN CCITT Recommendations Q.1200 series [14], the SCEF is described as a functional entity that allows services provided in an IN to be defined, developed, tested and input to the SMF. The service creation process is based on a high level service description. This information is provided by a "service preparation" process. This service preparation process uses results of market analysis (for a large group of subscribers, a generic service) and/or service negotiation (for a small specific group of subscribers, a tailored service) to provide a high level service description and a plan for development and implementation of the new services. Based on this information, also the tariff structure is defined. This tariff structure determines which part of a service is to be charged and for how much. The setting of the tariff structure is based on the planned impact on the network resources by that service and on the desired profit range and the amount of money that a service subscriber is willing to pay for services.

Based on the high level service description and the tariff structure, the service creation process produces verified service logic, service data and service trigger information. In this process, the following SCEF sub-functions can be identified:

- service specification:

  this is the first step in the service creation process. It includes activities as refinement of the high level service description, functional analysis, generation of a service specification and definition of a high level structured design;

- service development:

  this is the step which transforms the high level structured design into a detailed structured software design and subsequently develops the necessary software components, data definitions etc. required to realise the service design. For this it needs information about the network capabilities of the underlying IN structured network. The major output of this step is the developed service software and documentation which is ready for more rigorous service verification testing;

- service verification:

  this is the step in the service creation process where the developed software is tested to validate that the resulting service application completely satisfies the specification. The principal output of this step is the verified service software and supporting documentations required for deployment.

5.2.3.2 The IN service creation process as a pre operational TMN activity

The relation of the IN service creation concept to TMN is of dual nature. Firstly, the concept of service creation can be seen to be a special (pre-operational) TMN functionality: service creation is a process that precedes the deployment and provisioning of services. Secondly, the IN SCEF functional entity can be seen as an element to be managed by a TMN. In subclause 5.2.3.3, this last aspect is discussed. In this subclause a way to incorporate the IN service creation process into the TMN functional architecture is proposed. In Clause 6 information modelling implications of this integration are indicated.

To be able for TMN to fulfil the IN requirements of rapid service deployment, TMN should pay more attention to service creation as a pre-operational TMN functionality; the relation with other TMN functions should be identified. In this study, it is proposed to re-use TMN functions and concepts for the deployment and provisioning of service logic and data, (i.e. the output of the SCEF).

From the description of the IN service creation process in the previous subclause it can be seen that the activities of the SCEF function itself can be positioned completely on the service management layer of the TMN functional hierarchy. Furthermore, it can be concluded that the SCE has relations with other functions that would be allocated in the service management layer of the TMN functional hierarchy. Examples of these functions are the tariff management function and the service preparation function as identified in the previous subclause. Furthermore, it needs a view of the network capabilities to be able to realise the service design. No specific information of network topology and/or network resources is necessary for this. In TMN, it is envisaged that the mapping from the service logic and data to the network is performed by the network management layer (subclause 4.1.1). In IN, the network capabilities (and the ways to control them) are inferred by the set of SIBs known in the SCE: the SIBs provide the service designer a global view of the network capabilities. Therefore, no direct relation from the IN SCE to other layers than the service management layer is needed for this. However, if the service creation environment is also used for creation of the management functionality for the newly deployed service and/or for new management services, a (logical) view of the **management capabilities** of the network (including the OSFs) will be needed as well. This information is provided by the network management layer of TMN. Furthermore, in the service verification phase, a simulation tool should be available on the SCE for a first and exhaustive verification of the dynamic behaviour of the service program. Therefore, it needs a network reference model on which the simulation has to run. For these reasons, a direct relation between the IN SCE and the TMN NM layer will have to be identified in the TMN functional hierarchy.

The precise way to model this relation is dependent on whether the SCE should be seen as part of the TMN, or as a separate entity. In the first case, a "q3-like"[9] reference point could be identified, in the second, an x reference point would be more appropriate. In this study, it is decided to take the first approach. The view is taken that, to fully capture the advantages of network service programmability in a market-driven approach, the service creation will be a process internal to, and administered by the operating company. The resulting mapping of the SCEF as a pre-operational TMN function is presented in figure 12. Although the precise impact on the interfaces between the SCE and the OSs in the TMN service and network management layer have not been extensively identified in this study, the provisional view taken here is that a "Q3-like" interface would be the most likely candidate for the long term.

To enable IN and TMN the use of common platforms and SCEs for the creation and provisioning of both service and management functionality, it is necessary to use (similar) SCEF concepts for creation of both telecommunications services and management services. However, to be able to do this, it is to be clarified how the IN service creation concepts like SIBs can be translated to the TMN situation. This issue is tackled in Clause 6.

9) The nature of this "q3-like reference point" is for further study; it is not clear at the moment if the existing q3 reference point in appropriate for the SCEF - OSF relation.

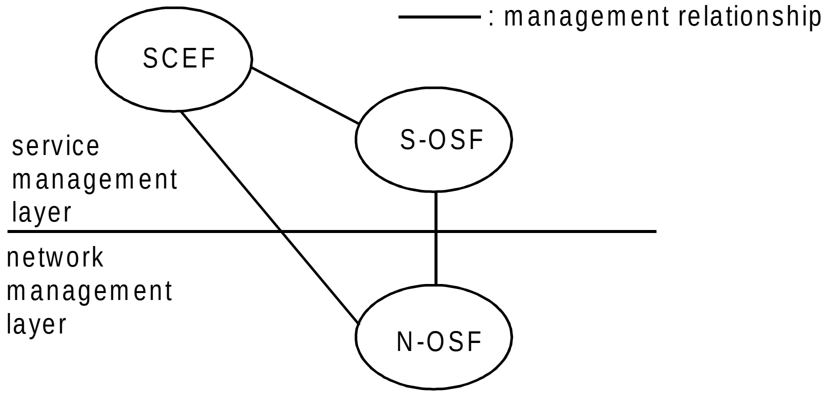

Figure 12: Mapping of the SCEF to TMN layers

5.2.3.3 The IN SCEF as a TMN NEF

The IN SCEF functional entity can be seen as an element to be managed by a TMN. In line with the preceding subclause, where the IN SCE was identified as a pre-operational TMN function, management of the SCEF by a TMN can be seen as a "TMN for TMN" issue. At the moment, this aspect, although identified in CCITT Draft Recommendation M.3010 [7], has not been given much attention in CCITT nor ETSI. Therefore, the management of the service creation environment by TMN functions is out of the scope of this ETR. When the SCE concept is adopted by TMN this issue may be further studied.

5.3 Reference configurations for management of IN

In subclause 5.2, the IN functional entities are mapped onto the TMN functional architecture of figure 8. As a result, figure 13 presents an overview of this mapping: all IN FEs are mapped onto the layers of the TMN OS functional hierarchy. According to the previous mapping exercises, in this figure, most of the IN functional entities are positioned in the lowest (NEF) layer of the TMN functional architecture. As indicated in subclauses 5.2.2.2 and 5.2.2.3, it has been decided to use TMN concepts for modelling the management function blocks and the access to these function blocks.

Between the FEs on the NEF-layer, **"service & connection control"** reference points" are defined by IN (see figure 7). These are used for "real-time service/connection control" related messages. The other reference points will be referred to as **management** (q3) reference points. The messages they convey will in general have less real-time constraints as these are only intended for management purposes.

In figure 14 the management architecture of figure 13 is applied to the situation of different network environments: it illustrates functions (OSFs) for management of basic telephony functions, functions for management of mobile functions and functions related to management of typical IN functions. For all these environments, TMN principles could be used in order to model facilities to optimise management, control and supervision of the managed resources (networks and services).

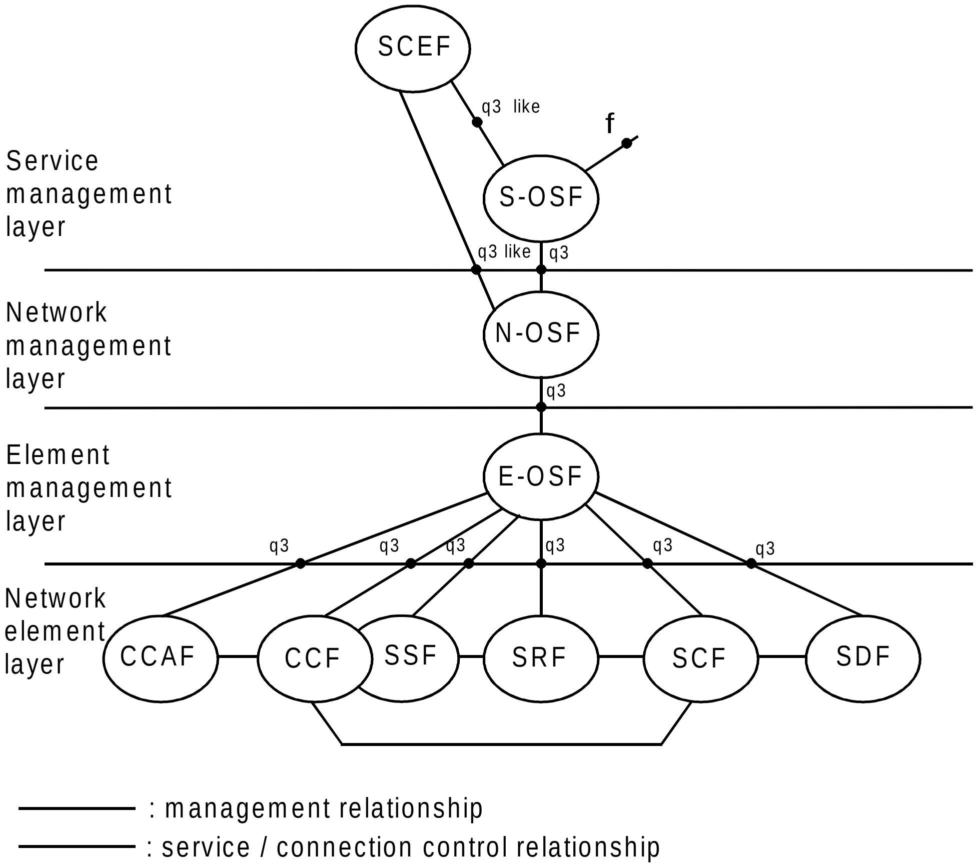

Figure 13: A possible mapping of the IN service processing functional entities onto the TMN functional architecture

The management functions in the different types of OSF may be different for these environments. Information transfer will generally take place on the service management layer, although also coordination between lower layer OSFs may be provided.

5.4 Customer access to management functions

In previous subclauses, the IN functional entities have been allocated to function blocks in the TMN functional architecture. As a result, an architectural integration of IN and TMN concepts has been provided. In this subclause, it is indicated how customer access to management functions can be modelled in this management architecture.

It is expected that customers of an IN have a growing demand for managing the service they use. An example can be found in the situation for a Virtual Private Network (VPN), where a subscriber wants to add or remove users from its VPN or wants to change the service-profile of a particular user. Therefore, the possibility to grant customers access to management functions is an important requirement of the identified management architecture; it should be possible to provide customers with a (service-)management service in a standardised way.

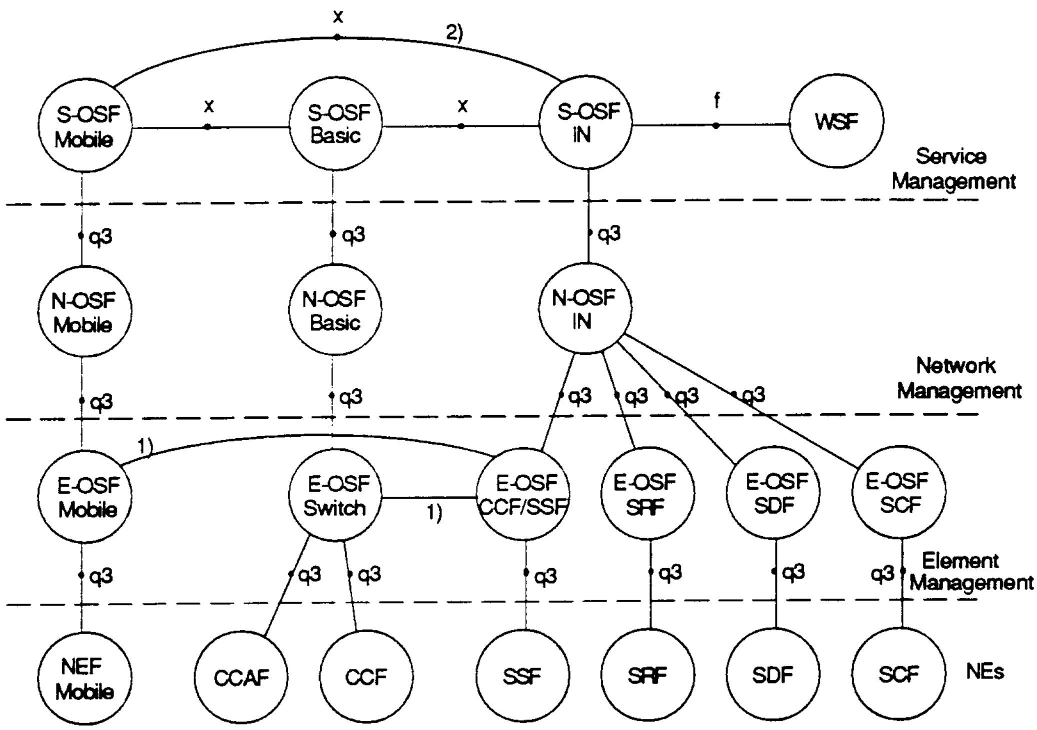

Figure 14: A possible integrated management infrastructure in different network environments

TMN provides guidelines on how to model access to TMN functions for customers: in CCITT Draft Recommendation M.3010 [7] it is stated that customer access to management functions "is required in order to allow the users to exercise a limited amount of control and get feed-back on their use of the network". When this management information is related to aspects of the user-access (e.g. a loop back request by the customer) this is generally modelled as part of the service(-logic). When, on the other hand, the management activities have impact on the network as a whole or on the services provided to other customers, the management information will be exchanged in a centralised way at an x-reference point, accessing functions on the service management layer [10]).

In figure 15, both ways of access have been indicated:

- when the management activity is modelled as part of the service, the invocation of this (management) service is done in the normal IN way, i.e. via the CCAF, CCF/SSF and SCF/SDF functional entities;

- when the management activity may have impact on other services, access - via an x reference point to a management OSF is provided. This customer access to management functions of an administration is regarded as external access to TMN functions. According to CCITT Draft Recommendation M.3010 [7], this is to be modelled as access to TMN functions at an x reference point 1[11]).

  The customer itself may have additional management functions, for which the administration has no responsibility. In this respect, the customer may be regarded to access the TMN (i.e. the administration domain) from its own "customer domain".

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10) Here, it is assumed that customers may only access management functions on the service management layer. It may be possible, © however, that also management functions on lower TMN layers may be accessed through x-reference points.

11) Other types of reference points seem to be excluded in CCITT Draft Recommendation M.3010 [7]. However, an x reference point implies the presence of an OSF in the user equipment. The need for this functionality in the user equipment is not quite clear in all situations. Therefore, it is possible that in the future, also other types of reference-points may be considered for modelling access to TMN management functionalities, (e.g. an f type reference point).

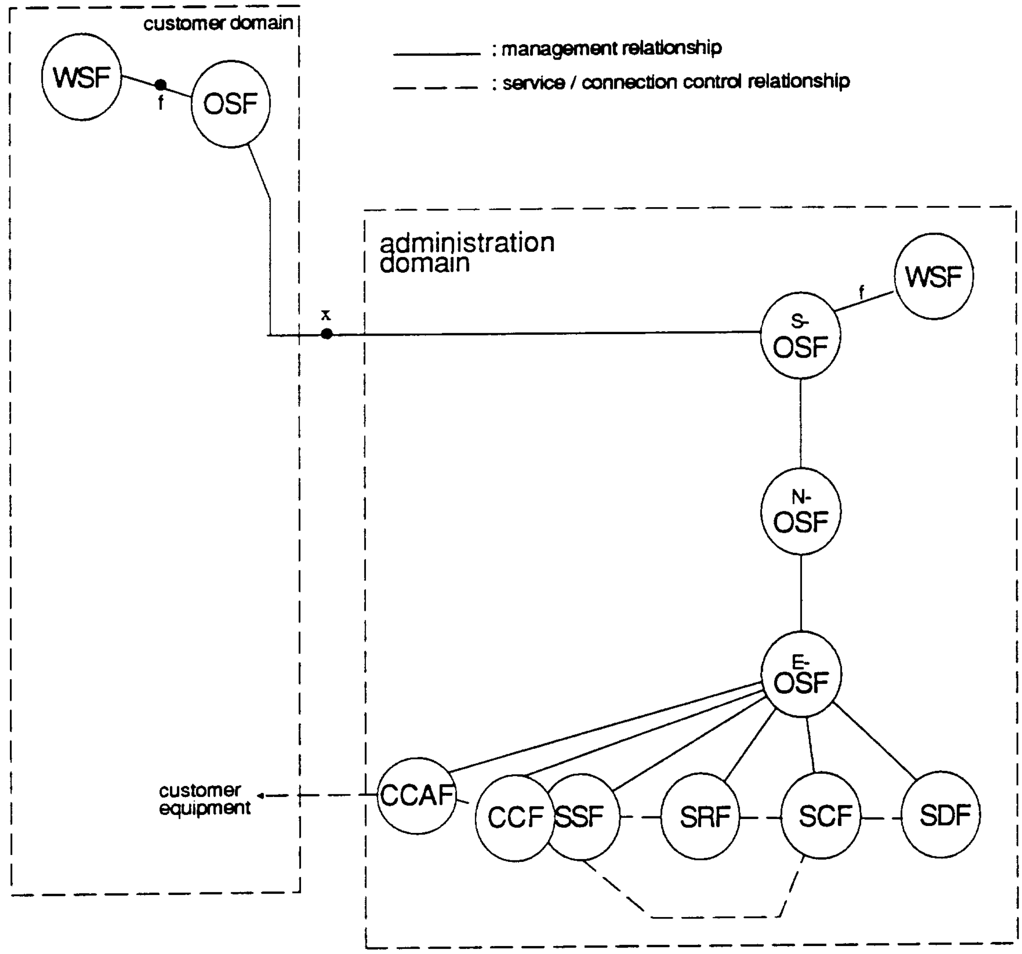

Figure 15: Customer access to TMN functions for IN

For clarification, in figure 16 a possible physical realisation of the previous figure is given. Here, the customers' facilities for accessing the service management layer on the one hand, and the "normal" call processing functions on the other, are jointly implemented in his terminal equipment. Of course, it is also very feasible, that separate devices are used for the call invocation and management activities, respectively. When accessing the service management functions (using the x-interface) a logical connection is set up between the customer and the SMP. In the physical sense, this logical connection may be set up using the PSTN network switching capabilities. In this figure, the SMP may provide capabilities related to the service management activities (e.g. charging, complaint handling and service control and observation) but it may also have the responsibility to maintain the consistency of the IN nodes and to perform data updates of a given SCP. So, in that case, the SMP covers network management and element management functions as well.

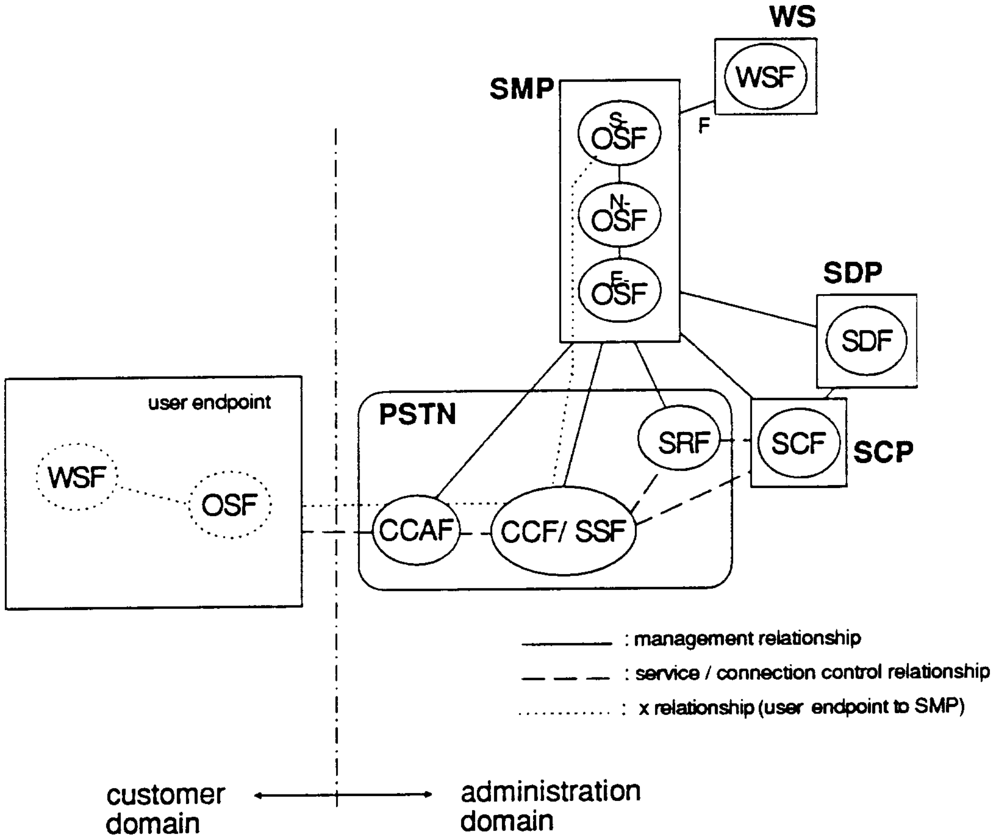

Figure 16: A possible physical realisation of figure 15

EXAMPLE: An example of possible customer required management functionality is the situation where an administration, in his role as service provider, provides a subscriber facilities to manage its own VPN on the public network infrastructure. In that case, the subscriber (e.g. a company) hires a VPN service from the administration. The administration has operational staff which will effectuate the provisioning of the VPN-service for this particular company (via the WSF in the administration domain). The company may want to customise its VPN for its own users, e.g. add a new user to the VPN. For this purpose, operational staff of the company can initiate service management activities in its own (customer-) domain, invoking management functionality of the administration.

6 Integration of IN and TMN information modelling

In Clause 5 reference configurations for management of IN specific elements are provided. In this Clause, the information modelling of IN and TMN are compared. The need and consequences of integration of both techniques are examined. In subclause 6.1, a high level comparison is made between the IN and TMN information modelling concepts. In subclause 6.2, the IN SIB concept is elaborated on, to provide a solid basis for comparison with O-O modelling techniques, which is described in subclause 6.3. Subclauses 6.4, 6.5 and 6.6 indicate how the IN SIB concept can be integrated with the O-O modelling technique of TMN, and what the benefits of this integration are.

As a result of the study to integration of the IN and TMN information modelling techniques, some proposed enhancements to the identified IN and TMN modelling concepts have been identified. These will be argued and explained in this Clause and summarised in Clause 7.

6.1 Comparison of IN and TMN information modelling concepts

In subclauses 4.1.2 and 4.2.3 an overview is given of the TMN and IN information modelling, respectively. For ease of reference, table 1 gives a high level overview of these concepts.

Table 1: Comparison of IN and TMN modelling techniques

	IN	TMN
Main focus	**Service processing**	**Management**
Grouping of functions	**Functional entities (SSF, SCF, etc.)**	**Function blocks (NEF, OSF, etc.)**
Interface descriptions	**Functional (information flows)**	**Object-oriented (managed objects)**
Service creation modelling concepts	**SIBs**	**-**
Protocols	**SS#7, INAP**	**OSI, CMIP**

Table 1 should only be seen as a way to globally indicate the main differences between the corresponding IN and TMN concepts. In the remainder of this subclause, this overview will be used as a reference for further detailing the possible relations between the IN and TMN concepts.

From this table, it appears that in TMN, no specific concept for service creation is identified (see also figure 5). Therefore, this subclause is mainly addressing this issue: can the TMN and IN concepts be integrated to be able to rapidly create new (management) services, and, if so, how? To be able to do this, it has to be studied how the concepts of SIBs, as identified by IN, relate to TMN.

Figure 17 is an attempt to indicate the correspondences between the IN and the TMN concepts.

NOTE: The relationships only indicate a rough correspondence.

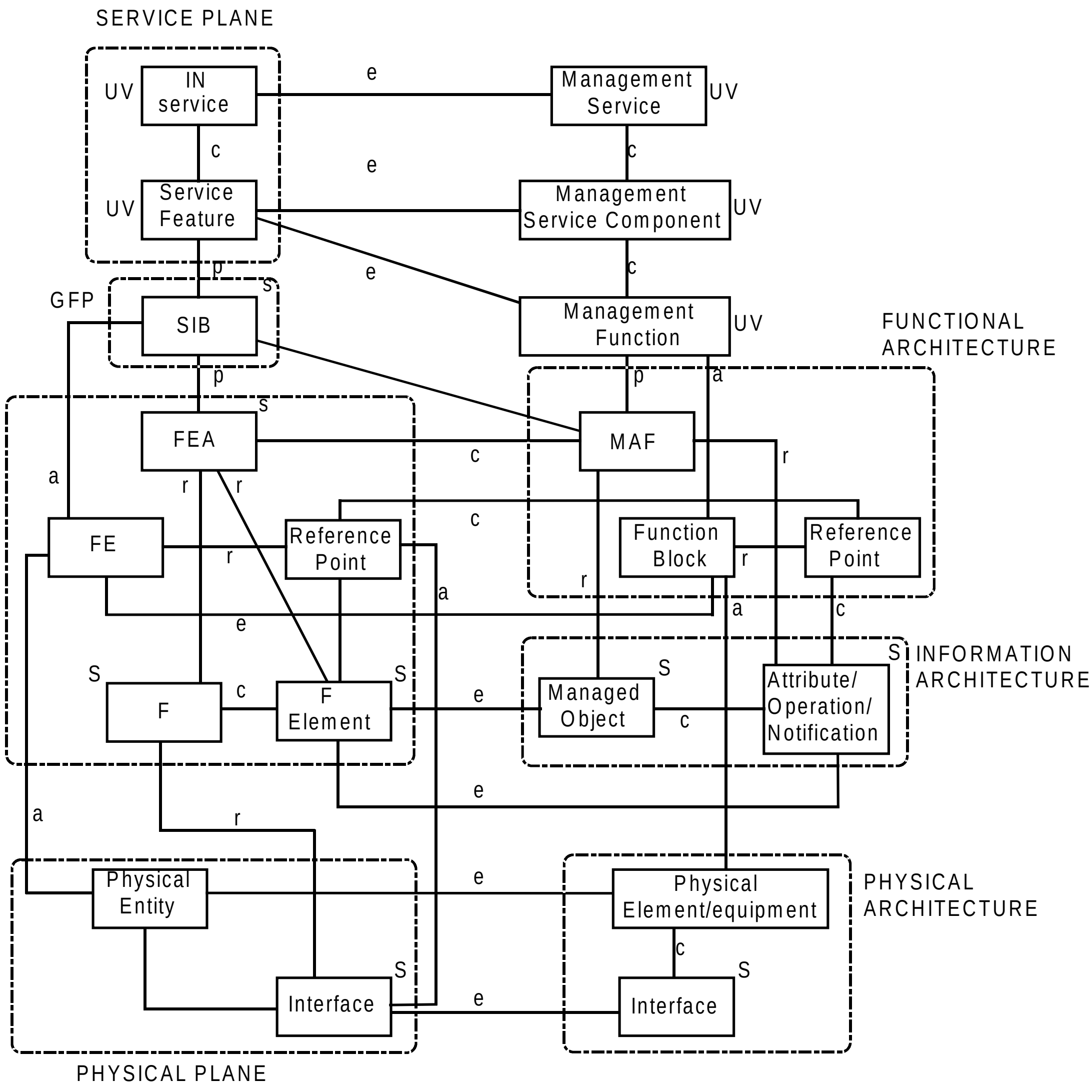

Figure 17: Correspondences between the IN and TMN concepts

A number of points should be noted. The IN planes are different modelling views of IN services. Therefore, identified relationship between the planes must be understood to mean that the concepts can be mapped in a modelling sense, the way indicated and not that a physical allocation is envisaged. The Management Application Function (MAF) is the management capability of the OSF that offers management services at the operator interfaces (described by the MSs, MSCs and management functions) and that consume the management services by referencing and processing the MOs, either remotely using the management communication services, or locally using database management services. Since the IN SIBs are intended to be standard, the question whether the TMN MAFs should also be standard has been raised.

The TMN concepts attribute, operation and notification have been represented as one box only for practical reasons since there is no counterpart for this structure in IN. The formal place for the IN Information Flow (IF) element is not fixed yet and presently no structure for this construct has been described in the literature. Hence the question whether it should be standard or not is an open question. In TMN the corresponding structural elements are standard. The IN concepts global service logic, distributed service logic and service logic programs have not been shown since this is described as part of behaviour of the various TMN constructs and not as separate constructs.

For a further comparison of the relation between SIBs and TMN concepts, in next subclause an elaboration is given of the IN SIB concept.

6.2 An elaboration on the IN CS-1 SIB concept

In subclause 4.2.4 the different roles of SIBs in IN have been identified. In this subclause a further elaboration is given of the CCITT CS-1 definition of SIBs. The reason for doing this here is, that this enables us to further identify the relation between the IN and TMN modelling concepts (see subclauses 6.3 and 6.4).

IN CCITT Recommendation Q.1290 [14], the following definition is provided of SIBs:

"A re-usable set of FEAs and IF used to provide a service feature as part of a service in an IN".

In this definition, it is not defined what the function of a SIB is (to provide a primitive network capability), but only how it is implemented (FEAs and IFs) and what characteristics is has (re-usable). In that sense, this definition only covers the DFP view of SIBs. The GFP view of SIBs could be stated as follows:

"SIBs reflect a primitive, network wide, network capability and the ability to control it. These capabilities are used (shared) by a number of services and are, therefore, indicated as "service-independent"; they provide functionality for more than one service. SIBs are used for specification and development of a service" (GFP view).

The difference between the "DFP view" and "GFP view" on SIBs can further be clarified by the following SIB "models".

The **model of a SIB in the GFP** is that of a single entity that has:

- a single logical start, representing the point where the capability can be "invoked";

- one or more logical ends, representing the point where the operation of the capability is completed.

The **model of a SIB in the DFP** is that of two categories of FEAs and the information flows between them. In this view, a SIB can be seen as:

- "controlling FEAs", representing the ability to control the network capability;

- "capability FEAs", representing the network capability itself; and

- the IFs between the controlling FEAs and capability FEAs.

A controlling FEA supports the logical start and logical end characteristics that are modelled in the GFP. A capability FEA is invoked as result of an IF from a controlling FEA. It may or may not return an IF to the controlling FEA during its processing.

This aspect of controlling the network capability is not explicitly mentioned in the CS-1 recommendation, but it is implied very strongly. Identification of this concept does not impact CS-1 at all, but it:

- defines more clearly what a SIB means and represents;

- makes a comparison with and mapping to an object-oriented specification approach more readily available (see subclause 6.3).

Based on this elaboration and clarification of the SIB concept, in next subclause, it is indicated in what way the IN function oriented approach can be combined/expanded with object oriented modelling concepts, and what the benefits of this integration may be.

6.3 Integration of the IN SIB concept and O-O techniques

Although the IN SIB concept proves to be useful for modelling IN information transfer, it does have a drawback. There is no method available to relate SIB activities to a specific network capability. The fact that different SIBs may reference the same network capability, is clarified by the following example of (SIB described) activities on a data network capability (an SDF database).

The following SIBs represent different functions on what can be seen as the same data network capability:

- screen SIB, checking whether or not a value is contained in a list in the database;
- service data management SIB, which actually supports 2 functions:
  - retrieving data elements from the database;
  - updating data elements in the database;
- translate SIB, retrieving data elements (numbers) from the database given a set of input data (numbers).

Other functions on this data network capability may be required for management of the service. Examples are:

- add a new set of data elements (record) to the database;
- remove a set of data elements (record) from the database;
- create a database (a new instance of the data network capability);
- etc.

IN does not have any method to describe this relationship between SIBs that operate in the same network capability. This is the point where O-O techniques may be helpful: we can represent a specific (instance of a) data network capability by an object (in the corresponding object class definition, the characteristics of the data network capability is described). The activities that are performed on an instance of the data network capability class are referred to as "actions". What happens as a result of an action performed on an object is referred to as the object behaviour. The entity that invokes the action on the object is referred to as the manager of that object.

The precise way of mapping of the OSI management concepts to the DFP IN terminology[12])is dependent on the views taken on the scope of manager, agent, FEA and Elementary Functions (EF). In this context, the following mapping is proposed:

- the controlling FEA can be compared to the manager (MIS-user in the manager role) that invokes the operation on the object(s);
- the capability FEA can be seen as the agent (MIS-user in the agent role): both concepts encompass the invocation of underlying activities as result of the invoked operations. The description of these activities is defined in the EFs cq. the behaviour of the corresponding object(s); the activities itself are realised by the underlying resources;

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12) The use of the O-O description method in the GFP is for further study.

- the information flows between the controlling and capability FEAs can be seen as a representation of the actions to be performed on the object(s) (or on attributes of the object) cq. the notifications emitted by the objects.

These relationships are clarified in figure 18.

As can be seen from this, the IN description method and the O-O description method are to a large extent complementary:

- the O-O description method supports a way to describe an IN network capability and the relationship between the activities that operate on it;

- the IN description method supports a way to describe a part of the manager entity as recognised by O-O description. To make this clear, in next subclause the relation between the IN service logic and the TMN management application function will be elaborated on.

6.4 Integration of IN service logic and the TMN management application function

Based on previous subclause, we can continue the integration of IN and O-O modelling, extending it beyond just SIBs.

In the GFP, SIBs can be linked together to form a GSL, which can represent a service (feature) as defined in the service plane. A set of these GSLs can be combined to form a SLP that represents a complete service in the service plane. This SLP and the supporting service data can be deployed in the network (in the SCF and any FE respectively) to support the actual invocation of the service by the service user.

In the DFP, the controlling FEAs of the SIBs are linked together to form a Distributed Service Logic (DSL). This DSL represents the control part of the GSL in the GFP. This control part is what actually makes up the SLP as identified in the GFP. In IN, this control part is deployed in the SCF.

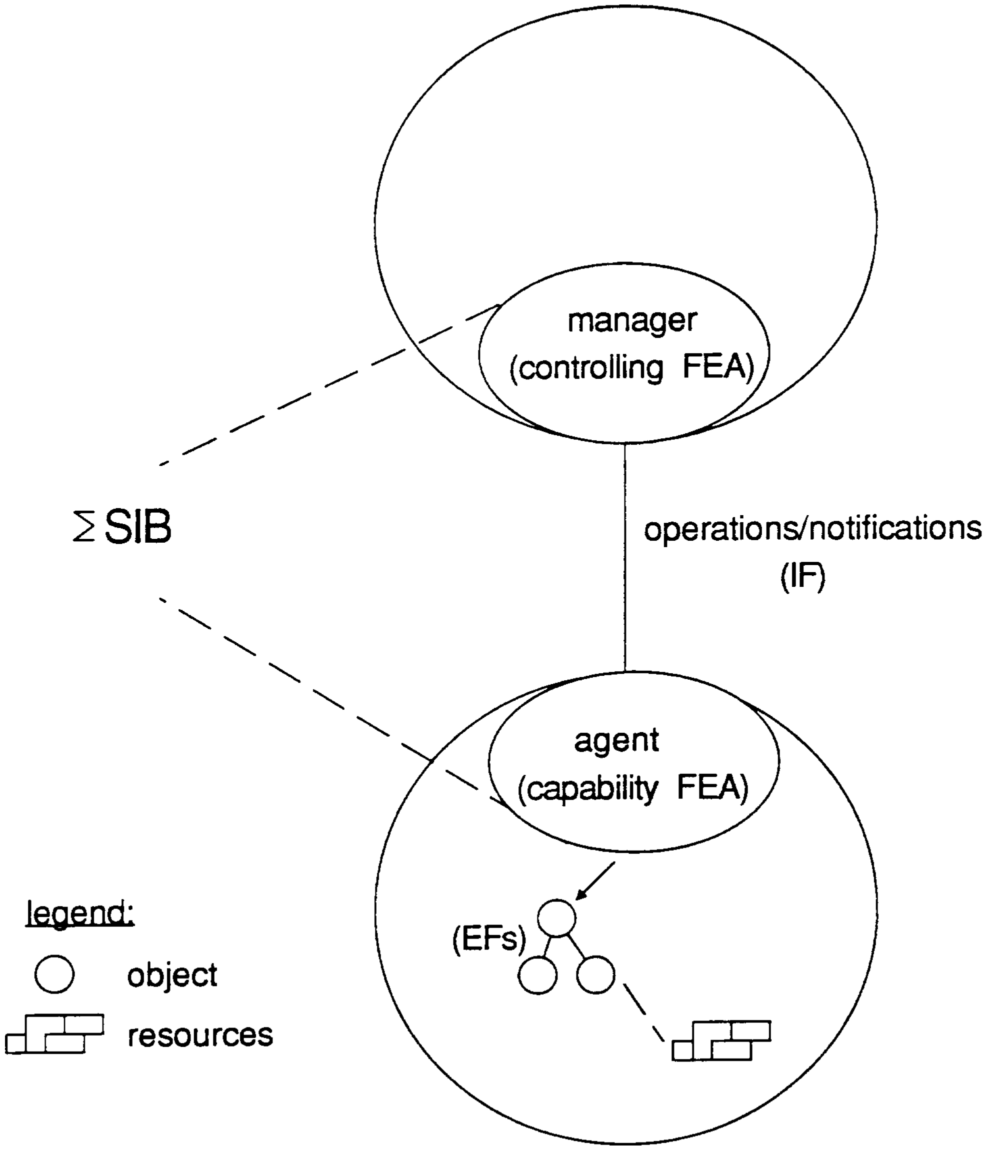


Figure 18: A possible mapping of IN concepts to O-O modelling

The capability FEAs of the SIBs are assumed to be resident in the FEs that support the network capabilities. The supporting service data represents the configuration and/or data that is required in the FEs that support the network capabilities required for the service.

Comparing this IN view to the O-O description method, it can be said that the DSL describes the manager process that controls the network capabilities (objects). The SIBs linked by this DSL represent the actions performed on the network capability object(s). The linking defines the order in which the different network capabilities are used to perform the service. To model this ordering mechanism, the principle of the logical start / logical end characteristics of a SIB can be used.

In this view, the SCF in which the SLP (the DSL) "runs" can be considered the manager of the network capability objects in the other FEs, being:

- the Service Data Function (SDF);
- the Service Switching Function (SSF);
- the Special Resource Function (SRF); and also
- the SCF, since it may support some network capabilities itself (e.g. queuing, limiting).

The supporting service data represent the (to be created) network capability objects (e.g. databases, announcements) and the data stored in the instances for use by the service (e.g. the data elements in the database and the "recorded" voice of an announcement).

The mapping of the IN service logic and network capabilities to the TMN concepts of manager, agent and objects, is clarified in figure 19.

6.5 The value of the O-O description method for IN

In subclauses 6.3 and 6.4, the value of the O-O technique for IN has been identified: the O-O description method supports a way to describe an IN network capability and the relationship between the activities that operate on it. The described way of integration of the IN SIB concept and IN service logic to O-O information techniques result in a concept that integrate the best of both worlds: the IN way of structuring and creation of service logic is integrated with the widely accepted benefits of the O-O approach (re-usability, encapsulation, extendibility and compatibility). Furthermore, with this approach it is possible for IN to re-use the information modelling techniques as defined by e.g. OSI management and/or ODP.

It is recommended that, at first instance, the current TMN modelling techniques should be adopted for modelling the management aspects of IN. Management requirements and managed object classes can be defined for this using the current TMN methodology. It is expected that migration to an enhanced TMN concept, adopting the IN modelling techniques for providing means for rapid creation of services and management services will be possible in the longer term. Next subclause elaborates on ways to arrive at this "enhanced TMN concept".

Furthermore, it may be considered to model the IN service processing activities in the same O-O way as well, as this would enable a common concept for IN and TMN in modelling all information transfers and supporting application functionality. This would enable the use of the same service creation and deployment platforms for IN and TMN. However, it is not expected to be implemented in a short time range, as this would influence the current IN CS-1 specifications extensively.

6.6 The value of the SIB concept for TMN

In subclauses 6.3 and 6.4, it has been indicated that TMN may benefit from IN modelling concepts: the IN description method supports a way to describe a part of the manager entity as recognised by O-O description. In this subclause the value of the SIB concept for TMN is investigated in a broader sense. It is identified whether the IN SIB concept can be useful in the TMN network modelling and/or for creation of management services.

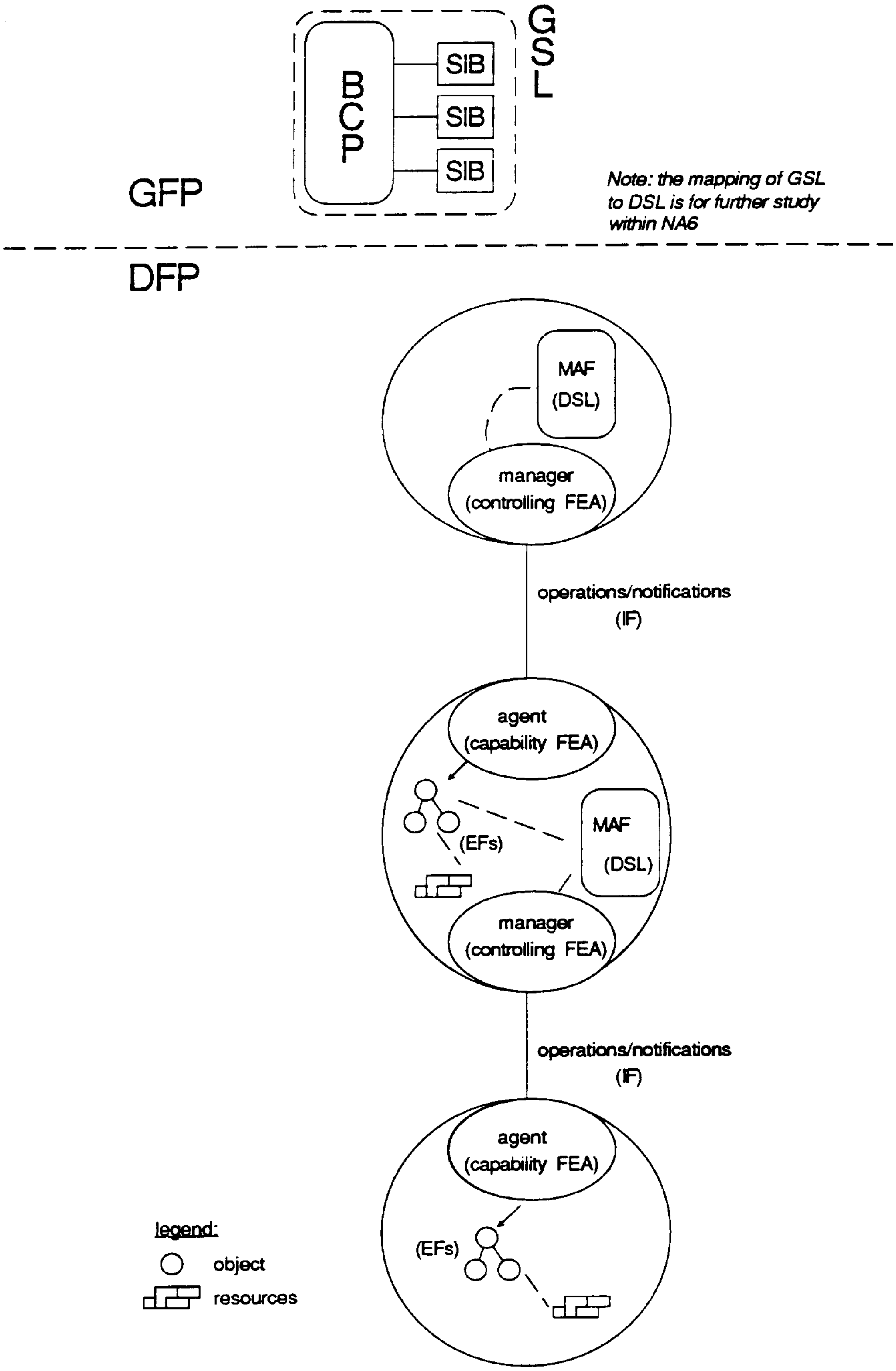


Figure 19: A possible mapping of IN concepts to O-O modelling in a layered architecture

6.6.1 TMN network modelling

In subclause 4.2.4 the different roles of SIBs in the IN phases of network modelling, service creation and service invocation have been identified.

We have seen, that in the DFP, SIBs reflect a reusable set of FEAs and IFs to provide service features in an IN. With this set of FEAs and IFs, all the required actions and information flows at/between FE(s) are identified in order to model and standardise possible ways to control the capabilities of an IN structured network, and the capabilities itself.

When we compare this with the way management activities are modelled in TMN, it seems that the "reusable set of IFs" can be compared with the SMI operations (GET, SET, CREATE, DELETE, ACTION etc.). Therefore, in this respect, there is no extra value in the SIB concept for TMN.

6.6.2 Creation of management services

In the IN service creation phase, SIBs are used as a set of functional building blocks (functions) on the basis of which the service creator builds its service by programming an SLP (by means of GSL). After the creation of the service logic, TMN management functions should be used for deployment and provisioning of the corresponding service logic & data in the network. In support of the (IN-provided) services, management processes - for example some service-specific management activities - are required (e.g. for monitoring the services). These activities in itself could be offered, as a management service, to customers.

An example can be found in the management activities which have to be performed by a subscriber of a VPN; here, the subscriber may add new members of his VPN service or may fetch some statistical information about the usage of his VPN service. In order to provide customers with these possibilities (service-) management services may be offered to the customers.

So, services can be divided into two categories:

- the "telecommunications service", provided to the end-user (generally related to a call);

- the "management service", enabling customers to exercise a limited amount of control and get feed-back on their use of the network. Examples can be found in management services for gathering of charging- or statistics-information or for providing customer control over its customer profile and service characteristics. To enable this service to be provided, limited and controlled access to management functions in the network has to be provided to the customer. Generally, the management services provided to an external customer will be a subset of the services available to the operator.

The IN concept of fast service creation (using the concepts of SIBs) would in itself be less powerful, if not the management of these newly created service-aspects is created in the same fast and efficient way. Therefore, it may be useful to consider adoption of the SIB-concept by TMN for creation of the management of the IN-provided services(-features), created in the IN-SCE. This would mean that, in the creation phase, both types of services may be "assembled" from "service independent building blocks". Generally, the term **SIBs** is used for telecommunications services. In this ETR, the building blocks for the management services are indicated with the term **"management-service independent building blocks": M-SIBs**[13], while the building blocks for telecommunications are referred to as Telecommunications SIBs (T-SIBs) from now on.

13) In some IN documents, (e.g. CCITT Recommendation Q.1201 [14]) for the latter, the term management (independent) building blocks (MBBs) is used; however, as this term may cause confusion with CCITT Recommendation M.30 [16] terminology the term M-SIBs is used in this paper instead.

It should be noted that this different denotation of terminology (T-SIBs versus Management SIBs (M-SIBs)) does not necessarily imply a difference in the way they should be modelled or implemented. At this stage the different names are only to indicate the different purposes of these building blocks (namely, building telecommunication services versus building management services).

So, we may divide SIBs into the following two categories:

- the "service processing SIBs" (T-SIBs), used to provide a (part of a) service feature of a telecommunications service;

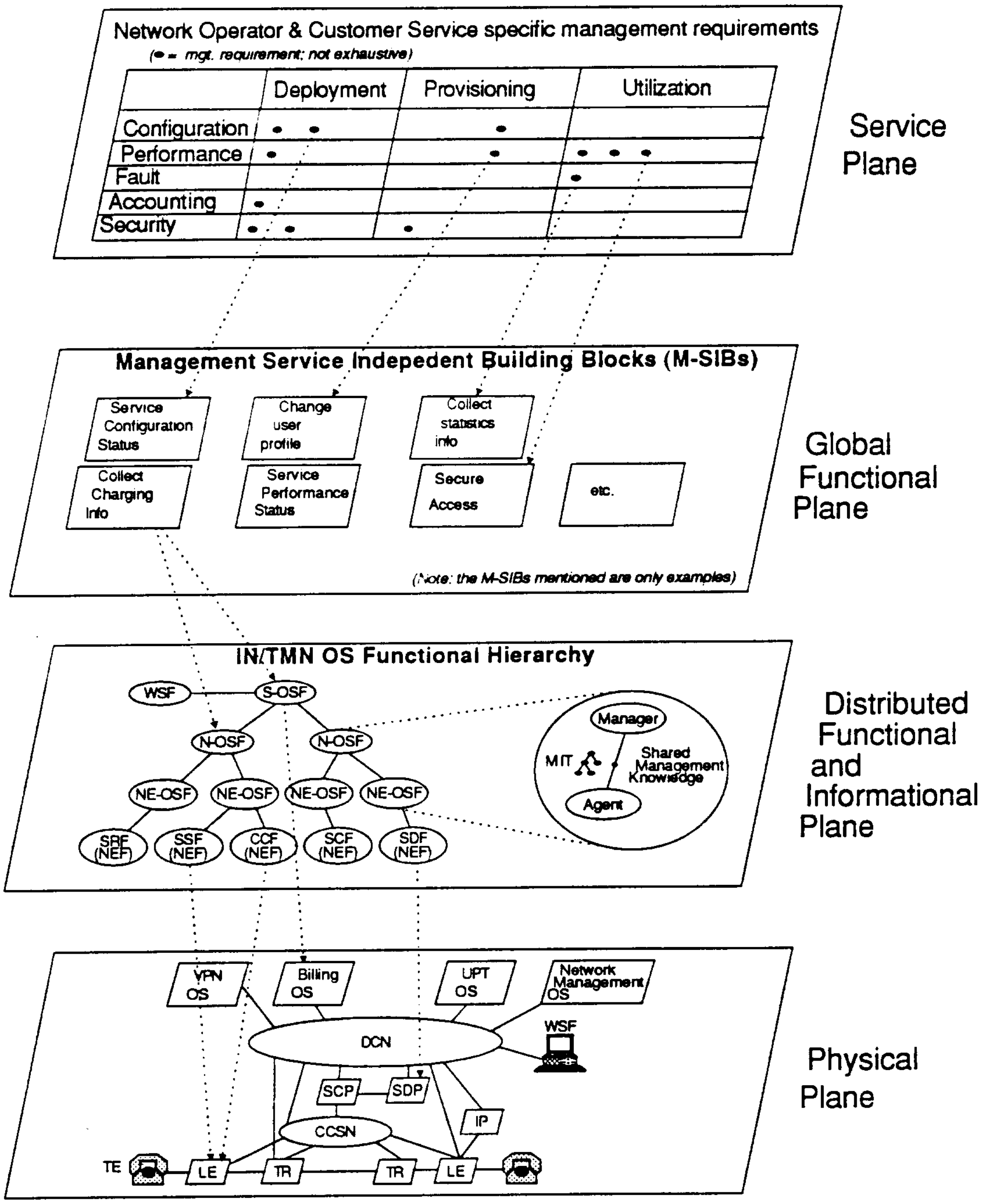
- the "Management SIBs" (M-SIBs), used to provide a (part of a) service feature of a management service.

This means that every new SLP can have one or more related "management programs". The management program may be created in parallel with the SLP on the SCE. Similarly as telecommunication services can be constructed from T-SIBs, the corresponding management services may be regarded to be constructed from M-SIBs. In this way, not only the service itself, but also the management of this service can be created in the same SCE, using the same concepts.

At the moment, the concept of M-SIBs is not covered for by IN CS-1. Similar to T-SIBs, that reflect capabilities of the underlying network providing telecommunication services, a similar statement can be made for M-SIBs: M-SIBs can be seen to represent network wide capabilities for management of the network and the services provided by it. The corresponding functionality can be compared with the TMN management functions as defined in CCITT Draft Recommendation M.3400 [10]. It should be noted, however, that this statement does not imply a equality between M-SIBs and TMN management functions. The TMN management functions only represent the corresponding functionality of the M-SIBs; they are not seen as building blocks that could be used in a service creation environment for creation of management functionality.

Figure 20 presents a global overview how the resulting IN/TMN framework for modelling creation of management could look like. In this figure, the management for service creation is depicted. This figure serves the same purpose as the INCM and is, therefore, called the Management INCM (M-INCM). The same remarks as for the INCM can be made for the M-INCM, i.e.:

"The IN management Conceptual Model should not be considered in itself as an architecture. It is a framework for the design and description of the IN/TMN-integration. Various "models" and "concepts" will be used in the standardisation of IN-management. The M-INCM is intended to represent an integrated, formal framework within which these concepts are identified, characterised and related. It should be possible to define clearly the purpose, value and limitation of any IN-management concept and its relationship to other such concepts. Existing concepts may need to be adapted for use within this framework. To achieve this, the M-INCM consists of four "planes" where each plane represent a different abstract view of the capabilities provided by an IN/TMN network. These views address (management) service aspects, global functionality, distributed functionality and information aspects and physical aspects of IN-management."



(Note: the pointers are not intended to be exhaustive; the mappings in this figure are only intended as examples).

Figure 20: M-INCM

The objective is to integrate the IN and TMN concepts to be able to create both telecommunication services and management services in the same service creation environment using T-SIBs and M-SIBs. Using this concept, the advantages of object-oriented specification techniques (e.g. re-usability of specifications) may be combined with the advantages of the SIB-concept (rapid deployment of new services).

However, at the moment it is not possible to provide a straightforward mapping of the IN service creation concepts to TMN. This can be seen as follows.

In IN, service creation is based on the fact that it is possible to construct service logic based on the knowledge of existing T-SIBs **and** on knowledge of a pre-defined functional distribution of the IN FEs in the IN DFP. From this, it can be derived, what kind of activities take place in each of the IN FEs and, therefore, what kind of information transfer can take place between a pair of FEs. From this "pre-described functional distribution" is it for example clear that the SCF is the only location where service logic programs are located and how this controlling entity relates to the other "supporting" ones. In TMN, however, the specific activities of the function blocks are **not** pre-described. The only guidance that can be derived here is a description of the responsibilities of the layers in the TMN OS functional hierarchy (although even this is not really standardised). Therefore, further elaboration is needed to provide a more detailed view on how this mapping could be performed, and how this could fulfil the requirement of rapid deployment of (management) services in combination with O-O interface specifications.

7 Conclusions and recommendations

7.1 Conclusions

From the study, different relations between IN and TMN have been identified.

First of all, it has been indicated how TMN can be used to model the operation and maintenance of IN structured networks. It appears to be feasible to map the IN functional architecture onto the TMN OS functional hierarchy and produce reference configurations for an integrated management infrastructure in different network environments. Based on identified reference configurations, new managed object classes can be defined and standardised to represent the IN related aspects to be managed by TMN. Corresponding interface description to the IN related network elements can be defined. This work can be done based on the current IN and TMN concepts. Using the OSI management and TMN concepts for representing the IN entities to be managed will be beneficial, as it can be based on existing methodology and already existing MO class definitions.

Secondly, it has been shown, that current TMN concepts can be used for provisioning IN services and management services to customers. It has been identified how customer access to TMN functions may be modelled.

Thirdly, ways to integrate IN and TMN concepts for rapid creation of both services and management services have been indicated. To be able to use TMN for rapid deployment of new (management) service logic and data is has been shown that it is necessary to have a structuring mechanism for the application logic cq. TMN management application function that is not currently available. A first approach for integration of IN and TMN modelling concepts to cover this has been provided. This approach may be beneficial for both IN modelling and TMN modelling; in this respect, the IN and TMN concepts appear to complement each other to a great extent. With this approach, TMN and IN can be considered to belong to a common concept "Intelligence in the network". Based on this, efficient introduction and operation of new services involving distributed intelligence in the network should be possible. Although this approach does have impact on TMN, the risk of neglecting the IN requirements of rapid service creation by TMN, might give cause to conflicting developments and interworking problems in the future.

7.2 Recommendations

IN is recommended to consider to base IN management modelling on the TMN functional hierarchy. This implies the usage of a Q3 interface wherever q3 reference points are to be implemented.

Furthermore, and related to this, IN is recommended to consider the TMN WSF and OSFs to replace the SMAF and SMF functional entities.

The use of object oriented techniques for modelling IN management should be considered for future IN studies. The possibility of using the same or a closely related approach as ETSI/CCITT TMN (and ISO OSI Management) should be urgently considered for this.

Furthermore, the use of O-O techniques for IN service creation and processing in stead of, or in addition to SIB modelling, is recommended as a study item for NA6. For example, the use of O-O techniques for modelling IN service data points should be considered.

IN and TMN should both consider ISO ODP (Open Distributed Processing)/CCITT DAF (Distributed Application Framework) for modelling the distribution of functionality in the longer term architecture. One benefit is that these are likely to be based on the OSI management approach.

TMN and IN should aim for a combination of efforts to develop the same implementation and service creation platforms.

TMN should consider the adoption of a service creation environment in its architecture and modelling concepts.

TMN should consider the IN SIB concept for modelling the manager process and for rapid creation of management services.

Annex A (informative): An example of mapping the SMF FE activities onto TMN logical layers

This Annex elaborates on the relation between the subfunctions of the IN SMF functional entity and the TMN layers of the TMN OS functional hierarchy. In addition to subclause 5.2.2.3 of this ETR, it provides a more detailed mapping of SMF activities onto these TMN logical layers. This text is based on the SMF subfunctions and makes use of the layering descriptions of subclause 4.1.1.

It is acknowledged that a more detailed mapping will be necessary to identify and specify management functions for all IN management requirements. Therefore, this text should only be seen as an example of how such a mapping may be performed.

For this mapping of the SMF functionality onto the SM, NM and the NEM layers of TMN, the following considerations have been taken into account:

- when mapping a function onto the TMN layers, all the necessary subfunctions per layer are identified;

- identified subfunctions are re-used in other functions as much as possible.

In table A.1 the mapping of the SMF-functionality onto the TMN layers is depicted. Below, the identified subfunctions are explained.

These subfunctions can be grouped into the TMN layers:

Service management SMF-functionality:

- **A1s:** after the service software has been tested successfully (by A6), this subfunction passes the service scripts, generic data, signalling routing data, trigger data and Special Resource data on to the NM layer (A1n). This should be done in a co-ordinated way, so performed by one subfunction for all kinds of software and data of the newly developed and tested service.

- **A6s:** this subfunction collects the service software from the Service Creation Environment Function to be loaded into a stand-alone IN-network, in order to test the newly developed service. This function passes the service software to the NM layer (A6n) and enters service and service subscriber specific data. Also, this function performs the SM-related part of the test itself, i.e. the SM-related test operations.

- **B1s:** this subfunction collects service subscriber specific data and administrates that in a subscriber database and contract database. Then it passes these data on to the NM layer (B1n).

- **C18s:** this subfunction monitors the service usage and controls the service performance. Service control operations can be performed by the service provider and some operations by the service subscriber. To check whether certain service control operations are granted for a service subscriber, B1s will be consulted. For the use of service control operations by the service subscriber this subfunction generates management detail records.

Table A.1: Mapping of SMF-functionality onto TMN layers

SMF-functions	**SM layer**	**NM layer**	**NEM layer**
A - Service deployment functions			
A1 - Service scripts allocation	A1s	A1n	A1e
A2 - Service generic data allocation	A1s	A1n	A1e
A3 - Signal. routing data intr. & alloc.	A1s	A1n,A3n	A3e
A4 - Trigger data introduction & alloc.	A1s	A1n,A4n	A4e
A5 - Special resource data intr. & alloc.	A1s	A1n	A1e
A6 - Service testing	A6s	A6n	A6e,A1e
B - Service provisioning functions			
B1 - Customer specific data intr. & alloc.	B1s	B1n	A1e
C - Service control functions			
C1 - Service maintenance			
C11 - Software maintenance	A1s	A1n	A1e
C12 - Updating service generic data	A1s	A1n	A1e
C13 - Updating customer specific data	B1s	B1n	A1e
C14 - Updating signalling routing data	A1s	A1n,A3n	A3e
C15 - Updating trigger data	A1s	A1n,A4n	A4e
C16 - Updating special resource data	A1s	A1n	A1e
C17 - Adjustment of the SMAF	B1s	A1n	A1e
C18 - Service reconfiguration	A1s,B1s,C18s	A1n,A3n,A4n,C18n	A1e,A3e, A4e
C19 - Service (de)activation	B1s,C18s	A1n,A3n,A4n,C18n	A1e
C1A - Service dismantlement	A1s,B1s,C18s	A1n,A3n,A4n,C18n	A1e,A3e, A4e
C2 - Security	B1s,C18s	A1n,C18n	A1e
D - Billing functions			
D1 - Generating & storing charging records	C18s		D1e
D2 - Collecting charging records	D2s		D1e
D3 - Modificating tariffs	D3s		
E - Service monitoring			
E1 - Initiating measurements and collecting measurement data	B1s,C18s	C18n,B1n	A1e,D1e
E2 - Analysis and reporting of measurement data	B1s,C18s		

- **D2s:** this subfunction collects the call records from D1e and the management detail records from the C18s. Then it uniforms and correlates them. Based on the tariffs from D3s the price per service per uniformed record is calculated. Then those records will be cumulated, so that one bill for each service subscriber can be produced for all services to which a service subscriber is subscribed, for a certain period.

- **D3s:** this subfunction determines the tariff structure and the tariff for a newly developed service or changes them for an existing one. This is based on the impact on the network resources by that service, and on the desired profit range and the amount of money that a service subscriber wants to pay for a service.

Network management SMF-functionality:

- **A1n:** this subfunction determines for which part of the network the service scripts, generic data, signalling routing data, trigger data and Special Resource data are relevant and passes these to the corresponding functions on the NM layer (A3n, A4n) or on the NEM layer (A1e). This should be done in a co-ordinated way, so performed by one subfunction for all kinds of software and data of the newly developed and tested service.

- **A3n:** this subfunction manages the SS#7-network. It downloads the signalling routing data from A1n into the SS#7-network (via A3e).

- **A4n:** this subfunction manages the PSTN. It downloads trigger data from A1n into the PSTN (via A4e).

  A6n: this subfunction determines for which part of the stand-alone IN-network the service scripts, generic data, signalling routing data, trigger data and Special Resource data are relevant and passes these to the corresponding functions on the NEM layer (A6e, A1e). Also, this function performs the NM-related part of the test itself, i.e. the NM-related test operations.

- **B1n:** this subfunction translates the service and subscriber specific data into network specific data and passes this on to the NEM layer (A1e).

- **C18n:** this subfunction monitors and controls the performance of the whole network. Therefore it needs measurement results from the underlying parts: the SS#7-network management function (A3n), the PSTN-network management function (A4n) and the IN-element management function (A1e).

Network element management SMF-functionality:

- **A1e:** this subfunction manages the IN-NEs. It determines for which IN-NEs the service scripts, service generic data, customer data and the Special Resource data are relevant and downloads them into the corresponding NEs.

- **A3e:** this subfunction manages SS#7-NEs. It determines to which SS#7-NEs the signalling routing data should be allocated and downloads the data into the corresponding NEs.

- **A4e:** this subfunction manages the PSTN-NEs. It determines to which PSTN-NEs the trigger data should be allocated and downloads the data into the corresponding NEs.

- **A6e:** this subfunction determines for which NEs the service scripts and data are relevant and downloads the scripts and data into the corresponding NEs. Also, this function performs the NEM-related part of the test itself, i.e. the NEM-related test operations.

- **D1e:** this subfunction logs the call records generated by the PSTN-switches (from A4e) and the IN-switches (from A1e).

Conclusion:

The SMF functions can be mapped onto all TMN layers. However, the **initiation** of the SMF identified activities will in many cases be done on the SM layer (by the service provider or service subscriber). And resulting from this, the **effectuation** of these activities will in many cases be performed by generic, service independent functionality within the network, so in the NM layer and the NEM layer.

History

Document history	
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