IN and TMN - Key Concepts for Future Telecom Networks

Thomas Magedanz

DETECON / Technical University of Berlin
Hardenbergplatz 2, 1000 Berlin 12, Germany

Abstract

A number of different concepts has been developed for the provision of future open service environments The most important concepts identified in this context are the Intelligent Network (IN) architecture, which allows for the flexible and uniform provision of a variety of future telecommunication services by the definition of functional network elements and a set of generic service building blocks, and CCITT´s Telecommunication Management Network (TMN) providing a range of management functions above a set of support systems, needed to operate, control and maintain future telecommunication networks and services. Based on the management related aspects of future IN-structured telecommunication networks, this paper examines the issues and relations of both concepts focussing on a possible integration of both concepts into a common telecommunication platform.

1. Motivation

Different concepts developed for the open provision of future services and the management of future service environments form the basis for bringing the telecommunications and computing together into an overall information networking architecture, which would be applicable in the mid 1990´s and beyond. Taking a look at the ongoing work for a future *Telecommunications Information Networking Architecture* the major influencing concepts identified are:

- Intelligent Networks (IN),
- Open Distributed Processing (ODP),
- OSI Systems Management,
- Telecommunications Management Network (TMN), and
- Open Network Provision (ONP).

INs [1] and ODP [2], [3] activities cope with the provision of open services programming platforms, where existing services or service components can be reused for the realisation of new services.

Focussing on the common ideas of providing a supporting environment for future services and distributed applications, IN services can be compared to distributed applications in ODP as done in [4]. This means the Intelligent Network can be considered as a short term case study for the longterm ODP concepts where IN could profit from the ODP concepts developed for distribution transparency (i.e. the use of Traders [5] for service provision).

In contrast to the early days of management standardization, where CCITT´s TMN [6] was quite different from ISO´s OSI Management [7], which focusses on the management of open systems and the hosted services and applications in the OSI environment, the concepts of both bodies have reached a convergence of views, where a coherent standards framework can be expected within the next two years. Management in future multi-service multi-vendor networks driven by the IN becomes a crucial task. This becomes even stronger in the light of the ongoing worldwide deregulation and liberalization of telecom environments by concepts like Open Network Provision (ONP) [8], which points towards openness, derregulation and growing competition among network and service providers, which will determine crucial conditions and restraints for this target environment [9].

Comparing the current developments of both the telecommunication and data processing worlds, it becomes obvious, that there is a convergence of views, where the network moves towards an open distributed operating system, connecting several intelligent computing systems with eachother and allowing public and private service providers to introduce and manage their own services on a common network and service infrastructure [10]. Note that management services can be considered itself as services running in that open service environment, which calls for

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an analysis of an integration of IN and TMN architectures and the related service models for the development of a common implementation platform based on common interfaces, protocols and objects, which allows the uniform creation and provision of future application (IN) and management (TMN) services. Taking a brief look at the properties of both concepts, there are significant commonalities, which are listed below:

- Modularization of network functions by means of generic network elements and functional interfaces provides network technology independence,
- Flexible allocation of network functions among physical entities allows for several implementation scenarios,
- Standardized communication between network functions via service independent interfaces,
- Integrated service creation and implementation by means of reusable standard network functions (e.g. service independent building blocks vs. management service components),
- Enhanced customer control and access to specific service attributes.

But besides these conceptual commonalities, there is a basic difference between these both concepts in the way of information modelling, where TMN uses an object-oriented approach, which is up to now outside the scope of IN, since the IN uses a more function-oriented approach of modelling the data required for service provisioning. But there are good chances for introducing this approach also in the IN concept, since there will be an additional object modelling of information required for management purposes (managed objects), which will be based on the TMN modelling approach.

2. Integration Aspects of IN and TMN

Based on the briefly discussed issues and commonalities of both concepts, this paragraph contains a first analysis of aspects for the integration of both concepts for the development of a common implementation platform and a common set of objects and components. An integration of both concepts comprises several aspects, namely an:

1.) Integration of the functional architectures (common interfaces),

2.) Integration of data (information modelling), and

3.) Integration of applications (service execution logic & service management logic).

The following sections provide more information to the listed items.

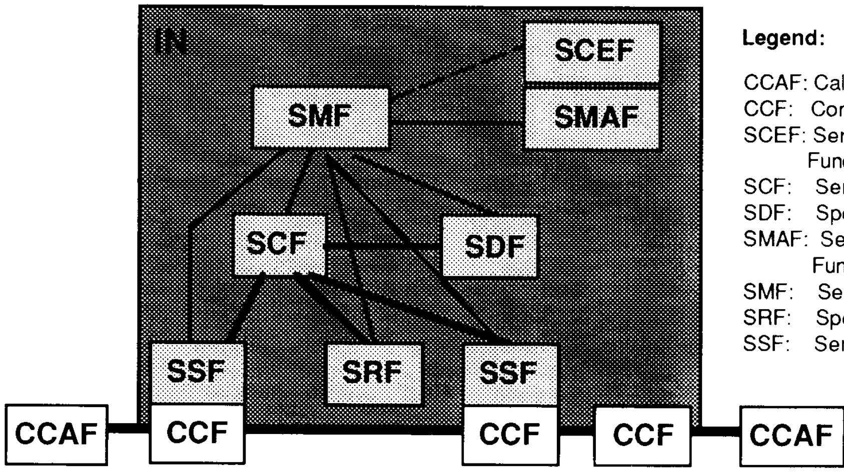
2.1 Integration of IN and TMN Architectures

An integration of IN and TMN architectures requires an analysis of the commonalities and possible mapping and interconnection of the defined elements within both architectures. This section contains a brief introduction of the basic aspects of both archtectures.

Within the international standardization of INs CCITT Study Group XI and XVIII [1] developed an *Intelligent Network Conceptual Model (INCM)*, which represents a modelling tool for IN architectures and consists of four planes addressing service aspects, global and distributed functionality and physical aspects of an IN.

The *Service Plane (SP)* represents an exclusively service-oriented view, where the service implementation and the underlying network technology is transparent to the users. Each service consists out of one or more *Service Features (SFs)*, where each SF contains one or more *Service Independent Building Blocks (SIBs)* and could also be a complete service. The *Global Functional Plane (GFP)* contains the SIBs, which will be used for service realization. Note that this plane provides distribution transparency to the service programmer and models the network as a single programable entity. That means the possible distribution of the functional entities involved in service provision is not visible at this plane. The *Distributed Functional Plane (DFP)* models the IN in terms of a set of *Functional Entities (FEs)* related to basic call handling, service execution and service management is defined where this plane provides transparency to the physical network elements SIBs are realized in a distributed way by means of special protocols between the corresponding entities. That means different FEs have to cooperate for the provision of SIBs. The *Physical Plane (PP)* models the physical aspects of an IN and defines different *Physical entities (PEs)* where the relevant FEs from the DFP are located.

Focussing on the Distributed Functional Plane the following IN Functional Entities are defined for connection control, service execution and service management (see figure 1). The *Connection Control Function (CCF)* provides call processing for basic telephony services and also advanced, switch-based services and is accessed by the *Call Control Agent Function (CCAF)* representing the user terminal function. A *Service Switching Function (SSF)* represents additional functionality for controlling switch resources and provides a well-defined, service-independent interface to the *Service Control Function (SCF)* which controls resources in a switch or peripheral based on the own service logic.



Legend:

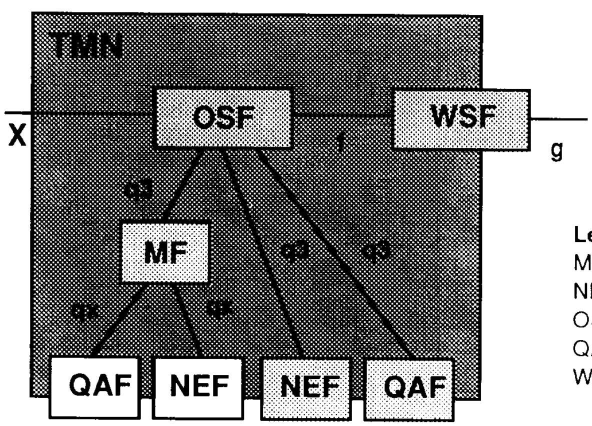
CCAF: Call Control Agent Function
CCF: Connection Control Function
SCEF: Service Creation Environment Function
SCF: Service Control Function
SDF: Specialized Data Function
SMAF: Service Management Agent Function
SMF: Service Management Function
SRF: Specialized Recource Function
SSF: Service Switching Function

Figure 1: IN Distributed Functional Plane

A *Specialized Data Function (SDF)* contains specialized data (customer and network related data) and provides standardized real time access for SCFs to service data. Additional functions for controlling (intelligent) peripheral resources for instance voice prompts and digit collection are represented by a *Specialized Resource Function (SRF)*.

The *System Management Function (SMF)* controls service management, provision and deployment and is accessed by a *Service Management Agent Function (SMAF)* which provides the man-machine interface to the SMF. An additional *Service Creation Environment Function (SCEF)* provides software engineering tools for service logic and data template creation.

Focussing on the TMN architecture one has to look at the functional TMN architecture and the TMN functional hierarchy. The *Functional TMN Architecture* describes the appropriate distribution of functionality within the TMN to allow for the creation of building blocks from which a TMN of any complexibility can be implemented. The model defines the exchange of management information by means of functional blocks and a set of reference points as illustrated in figure 2. In this architecture an *Operations System Function (OSF)*, accesed by a *Workstation Function (WSF)*, embodies the principal functions of management and communicates with the *Network Element Functions (NEFs)* being managed.



Legend
MF: Mediation Function Block
NEF: Network Element Function Block
OSF: Operations System Fucntion Block
QAF: Q Interface Adaptor Function Block
WSF: Workstation Function Block

Figure 2: Functional TMN Architecture

The interface between OSF and NEFs is called the TMN-Q3 interface, which is based on OSI´s Common Management Information Protocol (CMIP). Sometimes specific functionality is required to permit this communication, which is located in a *Mediation Function (MF)*. A *Q-Interface Adaptor Function (QAF)* connect to TMN those NEFs which do not support standard TMN interfaces.

Additionaly TMN defines a *functional TMN hierarchy*, where for operational purposes the complexity of management is partitioned into four management layers. Each layer restricts management activities within the boundary of the layer to a clearly defined rank, namely *business, service, network and element management.*. The element management layer manages each network element on an individual basis, whereas the network management layer has the responsibility for the management of all network elements, both individually and as a set. The network management layer provides the functionality to manage a network by coordinating activity across the network and supports the "network demands" made by the service management layer, which is concerned with and responsible for contractual aspects of services that are being provided to customers. The business management layer has the responsibility for the total enterprise and is the layer at which agreements between operators are made. Each layer is represented by a corresponding OSF which can use the functionality of the OSFs of lower layers in the same TMN via a Q3 interface, where in same instances it may be possible to bypass layers of communication within the functional hierarchy.

Putting the pieces together one has to look at the functional architectures of the IN and TMN and try to map the functional entities defined in the IN DFP to the TMN functional architecture building blocks. The IN DFP seems to be the most important plane in the context of management, since here are the worlds of service management (e.g. service installation, configuration, etc) and (functional) network management (e.g. network configuration and maintenance) will meet. Here exists an obvious similarity between the IN Service Management Function and the TMN Operations System Function for Service Management. In principle both functions have the same functionality, namely customer interfacing, providing the point of contact with customers (applications) for transactions related to all the services, and interaction with other SMF/OSF in the same or other TMN domains for the provision of global services together with related management services.

As mentioned above service and network management can be realized in the TMN context through corresponding OSFs (OSF-S, OSF-N), which use the same interfaces, namely the Q3 interface. Looking at the IN SMF, which represents some kind of TMN Service Management OSF (OSF-S), the SMF has to communicate with the relevant IN functional entities, containing parts (data) of a service and representing network element functions (NEFs) in the TMN terminology, via a Q3 interface as shown in figure 3. This means in general all IN functional entities have to provide a Q3-Interface which additionally supports the access for IN network management purposes, e.g. from a TMN network management OSF (OSF-N) and for subscriber management (figure 4).

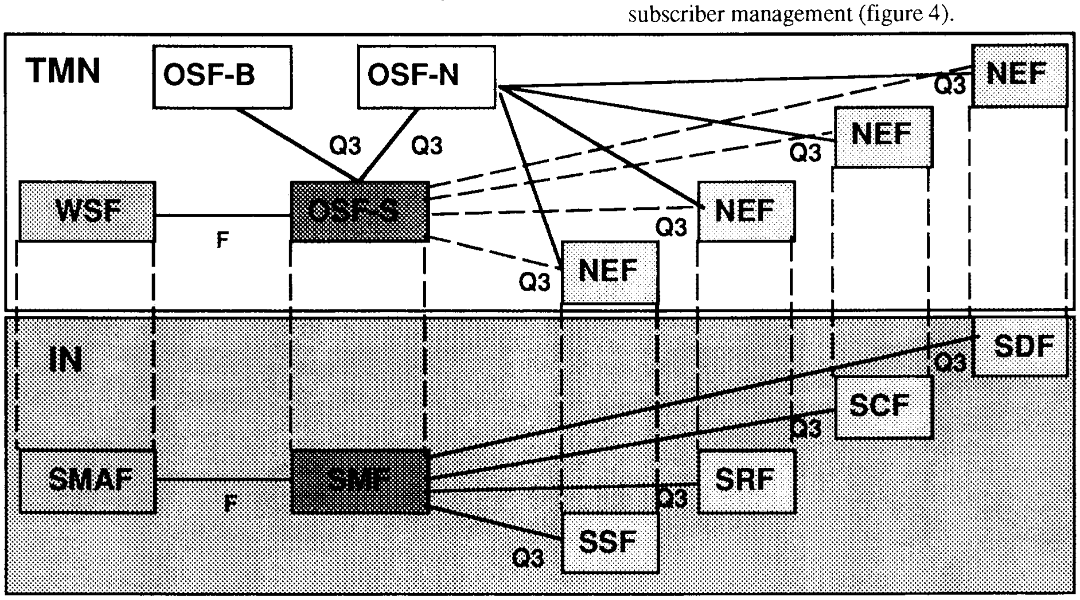


Figure 3: Relations between IN DFP and TMN Functional Architecture

Note that the relevant management informations (MIB) of the IN network elements and the provided IN services will be physically distributed across the functional entities of the IN architecture. Since the IN concept allows various different network technologies (like PSTN, ISDN, B-ISDN) in the IN Physical Plane this Q3-Interface is also required in the physical entities of the INCM Physical Plane for allowing a unified physical network management.

Note that the CCAF and CCF functional entities in figure 4 are subject to basic network management since they are part of the basic network infrastructure common to many traditional telecom services. The CCF and SSF relationship is up to now still subject to discussions where in some opinions the CCF belongs to the IN and should be managed by an integrated SSF/CCF OSF for network element management. Note that the interrelationships between IN service management and basic service management are not further considered in this paper. Adopting the separation of OSFs for the management of basic services provided by public service operators (OSF-S-BS) and the management of liberalized services (comprising IN services) provided in competition by private and public service providers (OSF-S-LS), the integration scenario becomes more complex and has to be studied in the future.

In conclusion one can say that the IN DFP of the INCM corresponds to the TMN Functional Architecture (including the Functional TMN Hierarchy) and the TMN Information Architecture, where a lot of work has to done for analysing the relationships between network and service management.

2.2 Integration of IN and TMN Data

The integration of IN and TMN data means to allow all applications from IN and TMN to use the same data functionaly by means of an appropriate data modelling. Up to now IN and TMN use different ways of information modelling. For using TMN concepts in INs and especially the usage of the Q3 interface for an integrated IN management, requires the definition of corresponding management information in the TMN way of information modelling, which should be accessed across this Q3 interface. For an integrated management of both the IN network elements (functional entities) and the services runing on that infrastructure, using the same interfaces and protocols, a common information model has to be applied for both domains. Since TMN adopts the object-oriented approach for structuring management information by means of managed objects [11] appropriate MO classes have to be developed for the IN services and IN funtional enties.

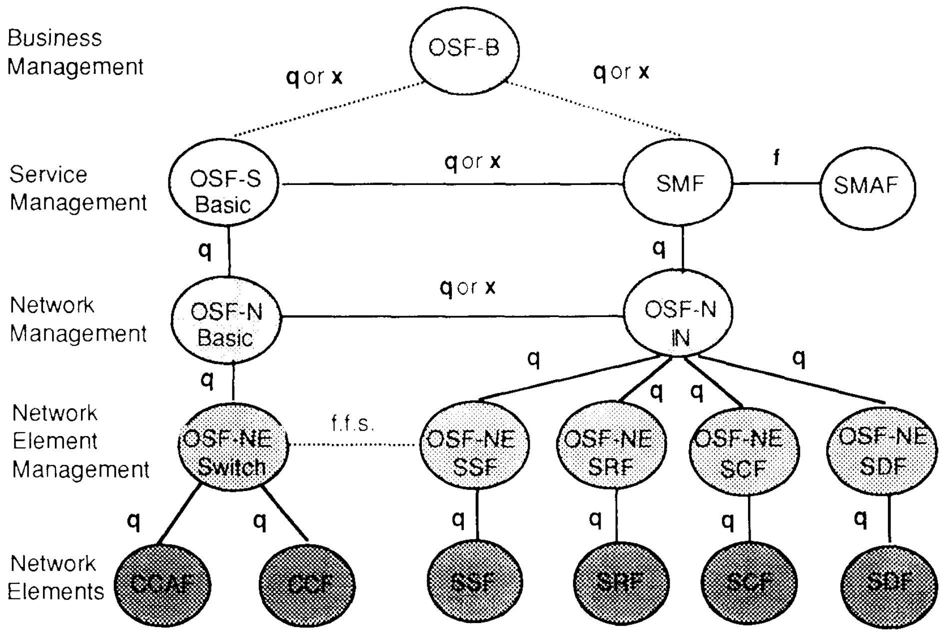


Figure 4: Integrating functional IN and TMN Architectures

2.3 Integration of IN and TMN Applications

The integration of IN and TMN applications means to integrate the creation and execution of service execution logic and service management logic from IN and TMN so that both kinds of programs could be supported by a common execution platform, e.g. the IN service execution environment. This is straight forward since management services are also services, which have to be provided in an efficient and uniform way, where these management services should use the same network resources as the networks and services they manage. Focussing on the way of IN service creation, management services should be constructed in the same uniform way as IN services, namely by the use of *Management SIBs (MSIBs)* provided by a *Management Application Programming Interface (MAPI)*. This should be the case for all kinds of management services like network and service management applications. Since the IN provides a means for fast service introduction there is the need to create the corresponding management service in the same range of time. Otherwise the bottleneck in the service introduction process will be shifted into the management domain and the time advantage to traditional service provision environments gets lost.

Therefore the definition of TMN management service components has to be analysed for their suitability for the provision of an appropriate MAPI in the IN Global Functional Plane according to the management requirements of the different planes in the INCM, where the already defined set of TMN management service components has to be complemented if necessary.

3. Conclusions

This paper focuses on the key concepts for future telecommunication networks and services, namely the IN architecture and TMN, which will play an important role in a future telecommunication environment of derregulated monopolies and liberalized markets. The Management of services and the network itself is a crucial task in INs, where standard management concepts like TMN should be applied as described in /[10]. Concluding the issues raised in the preceeding sections there are a number of aspects, which call for an integration of both concepts for the provision of a common implementation platform for future application and management services, which is now also subject of work within ETSI [12]. Important aspects for this integration are due to the ongoing deregulation of telecommunication environments the relationships between network and service management and the development of a common modelling techniques (object-oriented) for IN/TMN based on an analysis of existing object catalogues for their suitability to model the data relevant to IN/TMN.

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