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Introduction to intelligent networks

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Abstract

The development of telecommunications techniques and the need for more advanced services has created projects on standardization of international Intelligent Networks (*IN*). The standards of Intelligent Networks define IN in an abstract point of view, so it leaves the service providers the decisions on their own implementations. The first standard sets of IN are Bellcore's AIN release 1 and the CCITT's Capability Set 1 (*CS1*). They define the basic services of IN, additional features such as rapid service introduction and a flexible architecture that provides future expansion to further IN Capability Sets. The standardization organisations, such as CCITT and ETSI, work hard to help the service providers to implement their IN architecture in order to be able to provide international IN services. This kind of architecture is better known as global Intelligent Network architecture and it should be taken into consideration already in the early implementations of IN. This paper presents some history of telecommunications technology, an overview of IN and its services.

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1. TURNING-POINTS IN TELECOMMUNICATIONS

Several turning-points can be found in the history of telecommunications technology (marked as circles in the figure) (Figure 1).

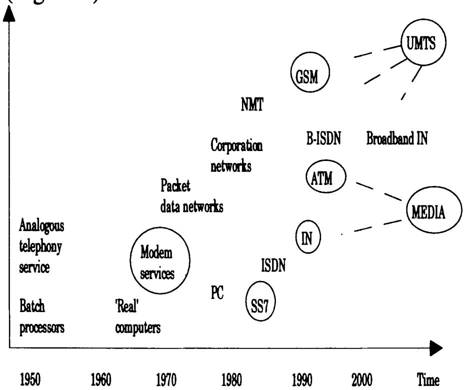


Figure 1. The development of telecommunications.

First, the beginning of data transfer by the use of analogous telephony service was an important stage in the history. This service was not good for use in corporations because of its low data transfer speed. Then, there was a need for a data transfer service that used billing by data amount while the expences of the analogous telephony service consisted mainly of the data transfer time. The packet switched data networks were developed especially for corporations use. Second, CCITT (*Consultative Committee for International Telephone and Telegraphy*) introduced its SS7 protocol stack to replace the analogous signalling system. This was the corner-stone for the digital telecommunications technology that is used, for instance, in ISDN (*Integrated Services Digital Network*). In the late 1980's radio signalling technology was advanced enough to provide digital telephony service. The GSM (*Global System for Mobile communications*) mobile phone technology, introduced into use 1991, is also suitable for low-speed data transfer. The Intelligent Network is an architecture capable to integrate all the telecommunications services mentioned in a flexible way.

The telecommunications networks and wide area networks used PDH (*Plesiochronous Digital Hierarchy*) technology in the physical data transfer. At the introduction of CCITT's SDH (*Synchronous Digital Hierarchy*) technology the physical data transfer rates increased remarkably. A new technology, ATM (*Asynchronous Transfer Mode*), was introduced to use the available bandwidth efficiently in the 1992. By the introduction of ATM it was possible to imagine of such concepts as B-ISDN (*Broadband Integrated Services Digital Network*), broadband mobility and broadband IN. Broadband infrastructure will make it possible to introduce advanced value added, mobile and media services (Figure 2).

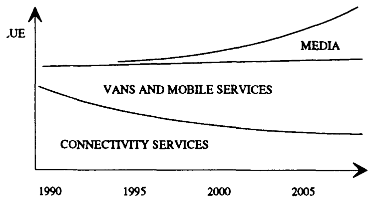


Figure 2. Turnover Value of Service Types

In modern telecommunications deeply influential changes are taking place, caused by the emerging competitive media services market and the new technological breakthroughs. The market changes are due to the integration of telecommunications and information technology, which brings interactive real time video and multimedia services available to users. Examples of these services are digital interactive TV, video on demand services for banking, shopping and leisure, electronic press and publishing. The technological requirements for these services are cost effective broadband transmission and access technologies, flexible computer based management and control of networks, switching and service applications and the support of mobility.

1.1 UMTS

UMTS (*Universal Mobile Telecommunications System*) is intended to be an international standard for global telecommunication system. It is a third generation mobile telecommunications system which integrates several second generation mobile systems like cordless telephones (CT2 (*Cordless Telephone* 2) and DECT (*Digital European Cordless Telecommunications*)), mobile telecommunications systems (GSM and PCN) and radio message systems (ERMES (*European Radio Message System*)).

UMTS is researched in RACE and financed by EC (*European Community*) and ETSI's group SGM5. UMTS defines a mobile communications system where a mobile phone could be used at home, office and elsewhere. UMTS is an open system which is based on TMN and IN concepts. The system supports ISDN services and could be at some degree compatible with B-ISDN with ATM-switching and possible broadband mobile access. This system is a very advanced telecommunications system that supports global mobility and Intelligent Network services and is not expected to be introduced before the year 2000.

2. COMPUTER CONTROLLED TELECOMMUNICATIONS

2.1 CCITT Signalling System No. 7

With the introduction of electronic processors in switching systems came the possibility of providing Common Channel Signalling (*CCS*). This is an out-of-band signalling method in which a common data channel is used to convey signalling information related to a number of trunks. CCITT published this new signalling protocol stack SS7 (*Signalling System No. 7*) based on CCITT OSI (*Open Systems Interconnection*) Reference Model (*OSIRM*) in 1980.

SS7 is fully digital and SS7 protocol stack corresponds to the seven layers of the OSIRM and includes the Application Services and User Parts *(UP)* (Figure 3). The signalling network structure component of SS7 is the Network Service Part (*NSP*), and it consists of the Message Transfer Part (*MTP*) and the Signalling Connection Control Part (*SCCP*). The OSIRM layers 4 - 6 are provided by Intermediate Service Part *(ISP)* and each User Part.

SS7 is quite an advanced protocol stack. It includes capabilities for congestion control and overload control. It also includes features for avoiding congestion by alternative routing or capacity expansion when heavy load is detected. With congestion is ment, generally, shortage of resources, which is caused by an excessive amount of load, or a failure that reduces the installed capacity of a network element. SS7 also includes capabilities for sending congestion and overload indications to the adjacent exchanges or traffic sources. [Lehti93]

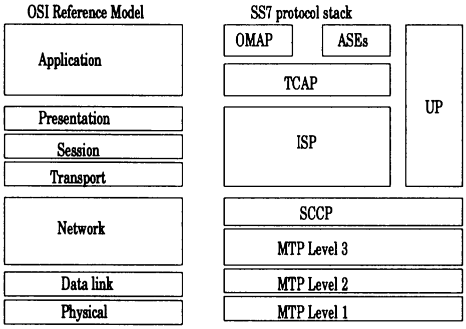


Figure 3. SS7 protocol architecture.

2.1.1 Network Services Part

MTP consists of levels 1-3 of the SS7 protocol stack and it provides a connectionless message transfer system that enables signalling information to be transferred across the network to its desired destination. Functions are included in MTP that allow system failures to occur in the network without adversely affecting the transfer of signalling information. So the overall purpose of MTP is to provide a reliable transfer and delivery of signalling information across the signalling network and to have the ability to react and take necessary actions in response to system and network failures to ensure that reliable transfer is maintained. The first level of MTP presents the signalling data link functions. A signalling data link functon is a bidirectional transmission path for signalling, consisting of two data channel operating together in opposite directions at the same data rate. It fully complies with the OSI's definition of the physical layer. Level 2 of MTP presents the signalling link functions. The signalling link functions correspond to the OSI's data link layer. Together with a signalling data link, the signalling link functions provide a signalling link for the reliable transfer of signalling messages between two directly connected signalling points. The third level of MTP presents the signalling network functions. They correspond to the lower half of the OSI's network layer, and they provide the functions and procedures for the transfer of messages between signalling points, which are the nodes of the signalling network. [Modar90]

SCCP provides additional functions to MTP for both connectionless and connection-oriented network services. SCCP enhances the services of the MTP to provide the functional equivalent of OSI's network layer. The addressing capability of MTP is limited to delivering a message to a node and using a four-bit service indicator to distribute messages within the node. SCCP supplements this capability by providing an addressing capability that uses DPCs (*Destination Point Code*) plus Subsystem Numbers (*SSN*). The SSN is local addressing information used by SCCP to identify each of the SCCP users at a node.

2.1.2 User Part

The User Part forms the most upper layer of the SS7 protocol stack that use the services provided by the lower layers SCCP and MTP. User Part functions are ISDN-UP, TCAP (*Transaction Capabilities Application Part*) and OMAP (*Operations, Maintenance, and Administration Part*). The ISDN-UP is not discussed in this paper. TCAP refers to the set of protocols and functions used by a set of widely distributed applications in a network to communicate with each other. TCAP directly uses the service of SCCP. Essentially, TCAP provides a set of tools in a connectionless environment that can be used by an application at a node to invoke execution of a procedure at another node and exchange the results of such invocation. As such, it includes protocols and services to perform remote operations. It is closely related to the OSI Remote Operations Service Element (*ROSE*). The OMAP of the SS7 protocol stack provides the applications protocols and procedures to monitor, coordinate, and control all the network resource that make communications based on SS7 possible.

2.1.3 Signalling network structure

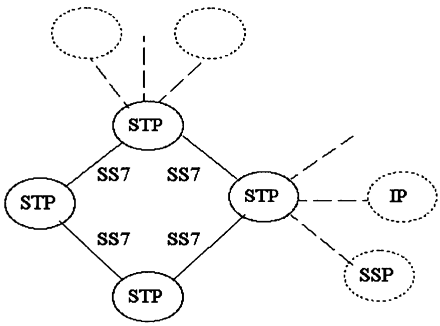


Figure 4. CCITT SS7 network structure.

Signalling networks consist of signalling points and signalling links connecting the signalling points together. (Figure 4) As alluded to earlier, a signalling point that transfers messages from one signalling link to another at level 3 is said to be a STP (*Signalling Transfer Point*). Signalling points that are STP's can also provide functions higher than level 3, such as SCCP and other level 4 functions like ISDN-UP. When signalling point has an STP capability and also provides level 4 functions, it is commonly said to have an integrated STP functionality. When the signalling point provides only STP capability, or STP and SCCP capabilities, it is commonly called a stand-alone STP. Signalling links, STP's (stand-alone and integrated), and signalling points with level 4 protocol functionality can be combined in many different ways to form a signalling network. The SS7 Network Services Part protocol is specified independent of the underlying signalling network structure. However, to meet the stringent availability requirements given below (e.g., signalling route set unavailability must not exceed ten minutes per year), it is clear that any network structure must provide redundancies for the signalling links, which have unavailabilities measured in many hours per year. In most cases the STP's must also have backups.

The worldwide signalling network is intended to be structured into two functionally independent levels: the national and international levels. This allows numbering plans network management of the international and the different national network to be independent of one another. A signalling point can be a national signalling point, an international signalling point, or both. If it serves both, it is identified by a specific signalling point code in each of the signalling networks.

2.2 Intelligent Network

2.2.1 The need for IN

In the past few years the development of telecommunications networks has been rapid. Earlier, the telecommunications network functions before were controlled mainly by operators. The desire to share data and distribute application processing among network elements, the need for standard interfaces between them and user demands for more sophisticated telecommunications services has changed the controlling of network elements notably. The telecommunications network elements today are controlled by the network operator, the service provider or the customer himself. To integrate the control and management of different services inside the operator, or to be able to provide third party control and management services, control and management interfaces with software support are needed.

The development of IN architecture was initiated by Bellcore in USA almost ten years ago in order to help the Regional Bell Operating Companies to become more competitive in the deregulated telecommunications environment. The original goal was to provide network operators with the ability to introduce, control and manage services more effectively by using a centralized database in a Service Control Point (*SCP*) for controlling and managing the various network services. [Lauta93]

The objective of IN is to allow the inclusion of additional capabilities to facilitate provisioning of service, independent of the service or network implementation in a multi-vendor environment. Service implementation independence allows service providers to define their own services independent of service specific developments by equipment vendors [Q1201].

Network implementation independence allows network and service operators to allocate functionality and resources within their networks and to efficiently manage their networks independent of network implementation specific developments by equipment vendors.

The network architectures, so far, have developed almost independently of each other. This point of view, of course, causes the network operators and service providers to provide independently implemented service to customers. The basic idea of IN has been that it facilitates the provisioning of services independently from the telecommunications networks and equipment vendors. So, the IN acts as a distributing and centralizing framework of the telecommunications services. With this framework, it is possible to introduce advanced customer oriented services rapidly and cost effectively.

2.2.2 Definition of Intelligent Network

Intelligent Network (IN) is an architectural concept for the operation and provision of new services which is characterized by [Q1201]:

- extensive use of information processing techniques;
- efficient use of network resources;
- modularization and reusability of network functions;
- integrated service creations and implementation by means of the modularized reusable network functions;
- flexible allocation of network functions to physical entities;
- portability of network functions among physical entities;
- standardized communication between network functions via service independent interfaces;
- service subscriber 1) control of some subscriber-specific service attributes;
- service user 2) control of some user-specific service attributes;
- standardized management of service logic.

IN is applicable to a wide variety of networks, including but not limited to: public switched telephone network (PSTN) mobile, packet switched public data network (PSPDN) and integrated services digital network (ISDN) - both narrowband-ISDN (N-ISDN) and broadband-ISDN (B-ISDN).

IN supports a wide variety of services, including supplementary services, and utilizes existing and future bearer services (e.g. as those defined in N-ISDN and B-ISDN contexts).

3. INTELLIGENT NETWORK ARCHITECTURE

3.1 Origins of IN

The Intelligent Networks is a telecommunications network services control and management architecture. In February 1985, Regional Bell Operating Companies (*RBOC*) submitted a Request For Information (*RFI*) for a Feature Node concept with the following objectives:

- support the rapid introduction of new services in the network,
- help establish equipment and interface standards to give the RBOCs the widest possible choice of vendor products and
- create opportunities for non-RBOC service vendors to offer services that stimulate network usage.

As with the past telecommunications technology, it was not desirable to introduce short term services, because of the long implementation and development period. Now, with IN technology it is possible to introduce new services rapidly without affecting the available services. IN defines a large set of standards that describe the interfaces between different network control points. With only specifying the interfaces IN makes it possible for vendor systems to provide with different products and, of course, for operators to use any of these products in their network configuration. IN includes also capabilities for other than operators to introduce new services into the telecommunications network.

The IN's main advantage is the ability to orchestrate exchange service execution from a small set of Intelligent Network nodes known as Service Control Points (*SCP*). SCPs are connected to the network exchanges (known as Service Switching Points) via a standardized interface; CCITT Signalling System No. 7. The SS7 will facilitate a multi-vendor SCP and SSP marketplace, and the standardization of application interfaces allows a multi-vendor software marketplace for SCP applications (that is, the service control logic and its related data) (Figure 5).

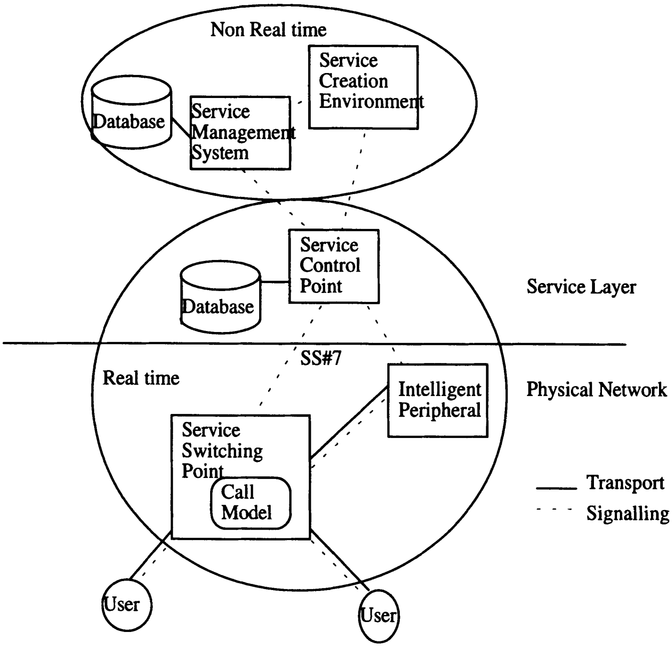


Figure 5. Intelligent Network overview.

The IN's long term goal is the ability to introduce new services, or change existing services quickly, without having to adapt SSP software (only parameters or trigger updates). The adaptation will be confined to the SCP where parameters or stimuli are updated. This goal was first planned by Bellcore to be achieved in two stages: IN/1 and IN/2. IN/1 definitions introduced the term Intelligent Network in 1986 and in 1987 IN/2 definitions were introduced. In 1988 IN/2 was delayed and IN/1+ was introduced instead. In 1989 Bellcore abandoned IN/1+ for several reasons, some being problems in the technology and lack of multivendor involvement. Instead a MultiVendor Initiative (MVI) was started in 1989 to define Advanced Intelligent Network (AIN). At the same time CCITT and ETSI started work on IN. The IN basic concepts for a service independent architecture were introduced already in IN/1. The AIN concepts were essentially those of IN/2 defining a fully service independent architecture with total separation of service logic from the underlying seitching system. These principles were accepted also by CCITT and ETSI work. The AIN Release 1 and CCITT CS1 were published in 1993.

Table 1: IN/1 outlines

IN/1 requires updates in the SSP and SCP in order to support a new service. A typical IN/1 service is the Green Number Service (*GNS*) with which a subscriber can call a number free of charge. The SSPs contain triggers (such as the value of the dialed digits) that tell the SSP to send a message to an SCP in order to get information about the destination to which the call should be routed. Migration from IN/1 to IN/2 implies significant changes in the SSPs to accomodate new services.

Table 2: IN/2 outlines

Once IN/2 is in place, no updates need be made to the SSPs software when new services are introduced. The IN/2 triggers advise the SSP whether to complete execution locally. All SSPs and SCPs contain set of basic service elements (for example, connect two lines, disconnect a line). The SCP also contains service relevant data. These basic service elements are knows as Functional Components (*FC*) from which each service can be contructed. A customer could conceptualize a new service and the network operator, via the SMS/SCP, could construct it quite rapidly. Any successful and widely-used service may be downloaded (via the service logic) to, but transparent to, the SSPs (if this is more economic or provides a desired higher grade of service). This facilitates complete rapid service creation. Rapid service creation and user programmability will take place in the SCP and the SMS.

An Intelligent Network is able to separate the specification, creation, and control of telephony services from physical switching networks. The key benefit of this capability is that exchange carriers will be able to rapidly engineer new revenue-producing services, in response to market opportunities, without having to rely on lenghty cycles for implementing them entirely on switching fabric. Ultimately, service creation, or at least service customization, can be extended to subscribers [Homa92]

The original IN concepts IN/1 and IN/2 were not considered sufficient to support vendor independence and open interfaces, and extensive standardization activities were started in 1989's. The first available publications were the Advanced Intelligent Network (AIN), and after that CCITT and ETSI provided their first draft recommendations. Our presentation here is mainly based on the CCITT, presently ITU-T, recommendations.

3.2 IN standardization

3.2.1. IN standards bodies

The IN standards are defined by ETSI and CCITT. Also, in the USA, the work is being done by Bellcore, which is not a standards body but provides the major input to the American National Standards Institute committee TS.1. [Roger90]

ETSI

ETSI was created in 1988 and its members are the European Telcos (*Telecommunications Operating Company*), manufacturers, user representatives and research bodies. ETSI has two purposes. IN belongs to the latter category.

- ETSI is to achieve workable versions of international standards for the European environment.
- ETSI is to define European standards in areas where quick response is required for technical development.

CCITT

Work on international standards for IN began at CCITT in 1989. Study Group XI.4 is responsible of the standartization. CCITT expects that the specification and deployment of IN will continue over a number of study periods. CCITT name has changed to ITU (*International Telecommunications Union*) and there the Special Interest Group (*SIG*) is T (ITU-T). Its approach to the development of IN standards assumes that it is necessary to start with a minimum set of criteria which are sufficiently open that they can evolve to meet the needs of the long-term concept as this becomes a practical reality.

Both ETSI and ANSI are keen to ensure that CCITT recommendations agree substantially with their own activities, and collaboration between all three bodies is likely to be an important determinant in the rapid development of realistic IN standards.

3.2.2. Phased standardization

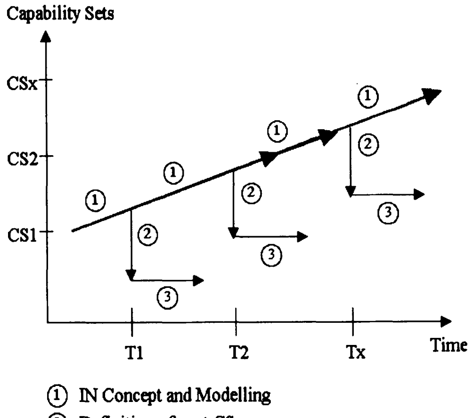


Figure 6. Phased standardization of IN.

To meet the goals and objectives, CCITT has embarked on a phased standardation process toward the target IN architecture (INA) [Q1201]. CCITT works on defining a set of capabilities for each phase and simultaneously on evolving the view of the target IN architecture called the long-term capability set (LTCS) (Figure 6) The IN subjects of standardization are called Capability Sets (*CS*). The Capability Sets involve service creation, management and interaction and also network management, service processing and network internetworking.

3.2.3. Structure of CCITT IN standards

The basic standard that defines the framework of other IN standards is Q.1200 - Q-Series Intelligent Network Recommendations Structure. The standards have been numbered so that every new CSx will have a number that begins with 12x and the description of the CSx recommendation part y will be numbered also systematically such as 12xy. (Table 3) So, the principles introduction for IN CS2 will be recommendation number Q.1221.

Table 3: IN recommendations structure.

0X - General	
1X - CS1	1 - Principles Introduction
2X - CS2	2 - Service Plane (not included for CS1)
3X - CS3	3 - Global Functional Plane
4X - CS4	4 - Distributed Functional Plane
5X - CS5	5 - Physical Plane
6X - CS6	6 - For future use
7X - CS7	7 - For future use
8X - CS8	8 - Interface Recommendations
9X - Vocabulary	9 - Intelligent Network Users Guide

3.2.4. Capability Set 1

It has been an international and european wide aim to define the first step of INA. These recommendations are gathered into a set called IN Capability Set 1 (CS1). There are two standardation organisations working on CS1: CCITT and ETSI. CCITT has gathered these recommendations into the Q.121y -series. (Table 4) CCITT's and ETSI's standards do not substantially differ from each other.

CCITT Study Group XI, Working Party XI/4 includes representatives from most of the important telecommunications network operators and equipment vendors in the world. Study Group XVIII also is involved in the initial set of IN standards, and is sharing responsibility for the Introductory Recommendations. At these meetings, there is an obvious willingness to strongly focus on achieving a realistic initial set of IN capability, which is both technically implementable and commercially deployable.

Table 4: IN CS1 recommendations.

Recommendation Q.1200	Q-Series Intelligent Network Recommendations Structure
Recommendation Q.1201	Principles of Intelligent Network Architecture

Recommendation Q.1202	Intelligent Network - Service Plane Architecture
Recommendation Q.1203	Intelligent Network - Global Functional Plane Architecture
Recommendation Q.1204	Intelligent Network - Distributed Functional Plane Architecture
Recommendation Q.1205	Intelligent Network - Physical Plane Architecture
Recommendation Q.1208	Intelligent Network - Application Protocol General Aspects
Recommendation Q.1211	Intelligent Network - Introduction to Intelligent Network Capability Set 1
Recommendation Q.1213	Intelligent Network - Global Functional Plane for CS1
Recommendation Q.1214	Intelligent Network - Distributed Functional Plane for CS1
Recommendation Q.1215	Intelligent Network - Physical Plane for CS1
Recommendation Q.1218	Intelligent Network - Intelligent Network Interface Specifications
Recommendations Q.1219	Intelligent Network Users guide for Capability Set 1

In defining IN CS1, CCITT applied the INCM (*Intelligent Network Conceptual Model*) using both "bottom-up" and "top-down" approaches. The former approach focused on modelling the capabilities of existing networks in terms of functional and physical architectures that could evolve the target IN architecture, given CCITT's objective of evolving IN from existing networks. The latter approach was service-driven and it focused on identifying a set of IN CS1 services and Service Features.

IN CS1 defines capabilities of direct use to both manufactures and network operators in support of circuit-switched voice/data services either defined or in the process of being defined by CCITT. The primary characteristic of the target set of IN CS1 services is that they apply during the setup phase of a call or during the release phase of a call. CCITT chose this *single-ended* service characteristic to limit the operational, implementation, and control complexity for IN CS1. Even with this limitation, it may be expected that equipment suppliers will support interworking of IN CS1 capabilities with existing switch-based services, including more complex services such as those that apply during the active phase of a call. For example, IN CS1 routing, charging, and user interaction capabilities may be used to customize or improve existing switch-based services to better satisfy market needs.

It is anticipated that CS1 recommendations of CCITT and ETSI will be adopted world-wide. This can help to develop open interfaces between the SSP (*Service Switching Point*) and SCP (*Service Control Point*), thus putting into effect one of the important goals of the IN, namely vendor independence. [Lauta93]

3.2.5 IN CS1 Services

Although, by nature, the IN is a service independent architecture, it is relevant to describe the general CS-1 service capabilities. The services and Service Features that are to be supported by CS-1 are fundamental to the CS-1 Service Building Blocks, call processing model and service control principles.

The target set of CS-1 defines several services (Table 5) and service features. A service is a stand-alone commercial offering, characterized by one or more core Service Features, and can be optionally enhanced by other Service Features. A Service Feature is 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. [Q1211]

Table 5: Target set of IN CS1 services.

Automatic Alternative Billing (*ABB*)	Mass Calling (*MAS*)
Abbreviated Dialling (*ABD*)	Malicious Call Identification (*MCI*)
Account Card Calling (*ACC*)	Premium Rate (*PRM*)
Credit Card Calling (*CCC*)	Security Screening (*SEC*)
Call Distribution (*CD*)	Selective Call Forward on Busy/Don't Answer (*SCF*)
Call Forwarding (*CF*)	Split Charging (*SPL*)
* Completion of Call to Busy Subsrciber (*CCBS*)	Televoting (*VOT*)
* Conference Calling (*CON*)	Terminating Call Screening (*TCS*)
Call Rerouting Distribution (*CRD*)	User-Defined Routing (*UDR*)
Destination Call Routing (*DCR*)	Universal Access Number (*UAN*)
Follow-Me-Diversion (*FMD*)	Universal Personal Telecommunications (*UPT*)
Freephone (*FPH*)	Virtual Private Network (*VPN*)

Note: The service indicated with a * may only be partially supported in CS1, because they require capabilities beyond those of type A services.

3.3 IN Functional Requirements

IN functional requirements arise as a result of the need to provide network capabilities for both customer needs (service requirements) and network operator needs (network requirements) [Q1201].

A service user is an entity external to the network that uses its services. A service is that which is offered by an administration to its customers in order to satisfy a telecommunications requirement. Part of the service used by customers may be provided/managed by other customers of the network. These are often called as third party services and their providers as 3rd party service providers.

Service requirements will assist in identifying specific services that are offered to the customer. These service capabilities are also referred to as (telecommunication) services. Network requirements span the ability to create, deploy, operate and maintain network capabilities to provide services.

Service and network requirements can be identified for the following areas of service/network capabilities: service creation, service management, network management, service processing and network interworking.

- **Service creation**: An activity whereby supplementary services are brought into being through specification phase, development phase and verification phase.
- **Service management**: An activity to support the proper operation of a service and the administration of information relating to the user/customer and/or the network operator, Service management can support the following processes: service development, service provisioning, service control, billing and service monitoring.
- **Network management**: An activity to support the proper operation of an IN-structured network.
- **Service processing** consists of basic call and supplementary service processing which are the serial and/or parallel executions of network functions in a coordinated way, such that basic and supplementary services are provided to the customers.
- **Network interworking**: A process through which several networks (IN to IN or IN to non-IN) cooperate to provide a service.

3.3.1 Service Requirements

The goal of work for IN is to define a new architectural concept that meets the needs of telecommunication service providers to rapidly, cost effectively, and vendor-independently satisfy their existing and potential market needs for services, and to improve the quality and reduce the cost of network service operations and management. In [Q1201] the following overall service requirements are given when defining the IN architecture:

- it should be possible to access services by the usual user network interface (e.g. POTS, ISDN);
- it should be possible to access services that span multiple networks;
- it should be possible to invoke a service on a call-by-call basis or for a period of time, in the latter case the service may be deactivated at the end of the period;
- it should be possible to perform some access control to a service;
- it should be easy to define and introduce services;
- it should be possible to support services involving calls between two or more parties;
- it should be possible to record service usage in the network (service supervision, tests, performance information, charging);
- it should be possible to provide services that imply the use of functions in several networks;
- it should be possible to control the interactions between different invocations of the same service.

Service requirements for service creation refer to the network capabilities that are used by network operators for the provision of service creation services to customers.

Service requirements for service management refer to the network capabilities that are necessary for the provision of service management services to customers.

Service requirements for service processing refer to the network capabilities that are necessary for the provision, from a customer's point of view, of basic and supplementary services by an IN-structured network. The IN is primarily a network concept that aims for efficient creation, deployment and management of supplementary services that enhance basic services. Hence, from a customers point of view the provision of services is transparent, the customer is unaware whether the service is provided in an IN way. Service processing requirements can be identified for service and access capabilities. The service capabilities of IN can be applied to the support of supplementary services for the following basic services [Q1201]:

- bearer services including speech, audio and data,
- teleservices as telephony, telefax and videotex,
- broadband interactive services and
- broadband distribution services.

The access capabilities of IN should be applicable to all telecommunications networks, such as Public Switched Telecommunications Networks (*PSTN*), including Integrated Services Digital Networks (*ISDN*), both narrowband and broadband, packet-switched public data networks, and mobile networks. Although, IN CS1 enables only the use of PSTN, PLMN (*Public Land Mobile Network*) and ISDN, IN should enable service providers to define their own services, independent of service-specific developments by equipment suppliers.

CS1 is intended to address services with high commercial value, focusing at addressing flexible routing, charging, and user interaction services. The list of benchmark services and features will be listed later on. Standardization of these services, however, is not CCITT's role. An important characteristic is that the services will be technologically feasible and understandable, but do not significantly impact existing deployed technology. In this context, services have been categorized by CCITT as specified in tables 6 and 7.

Table 6: CCITT Type A service features.

All type A services are invoked on behalf of and directly affect a single user. Most type A services can be invoked only during call setup or tear down and fall in the category of "single-user, single-ended (no requirements for representing end-to-end messaging or control), single point-of-control (no requirement for representing interaction points between multiple service logic programs), and single-bearer capability (one media profile)". Type A services may be used in conjunction with other services, switch-based or not, of any type, to form a more complete service package.

Table 7: CCITT Type B service features

Type B services can be invoked at any point during the call. These services may be invoked on behalf of and directly impact one or more users. Feature interaction and arbitration, and topology manipulation are capabilities that need to be addressed to deploy these services. Note that it is possible to use type A capabilities to enhance some existing type B services.

The services addressed by CS1 fall under type A services. The type A category lead to a series of advantages in the context of CS1 standardization. First, they represent a wide range of services of proven value. Second, these services depend on well-understood control relationships between network components and this represents an achievable target within required time frame of IN CS1 product deployment in 1993. Finally, complexity in the transition to rapid service delivery process is minimized both for service provider and for the equipment manufacturer.

3.3.2 Network Requirements

Overall network requirements of IN are stated in [Q1201] as follows:

- it should be possible to move cost-effectively from existing network bases to target network bases in a practical and flexible manner,
- it should be possible to reduce redundancies among network functions in physical entities,
- it should be possible to allow for the flexible allocation of network functions to physical entities,
- there is a need for communication protocols that allow flexibility in the allocation of functions,
- it should be possible to create new services from network functions in a cost and time efficient manner,
- it should be possible to quarantee the integrity of the network when new service is being introduced and
- it should be possible to manage network elements and network resources such that quality of service and network performance can be quaranteed.

Network requirements for service creation refer to the network capabilities that are necessary from a network operator point of view for the creation of new supplementary services. The service creation process consists of specification, development and verification steps.

Network requirements for service management refer to the network capabilities that are necessary from a network operator point of view to support the proper operation of services.

Network requirements for service processing refer to the network capabilities that are necessary for the provision, from a network operator point of view, of basic and supplementary services by an IN-structured network. The main network requirements for service processing stem from the inability of network operators of traditional "non-IN" networks to rapidly create and deploy new supplementary services. To overcome this inability the IN aims for:

- rapid service implementations by means of reusable network functions;
- modularization of network functions;
- standardized communication between network functions via service independent interfaces.

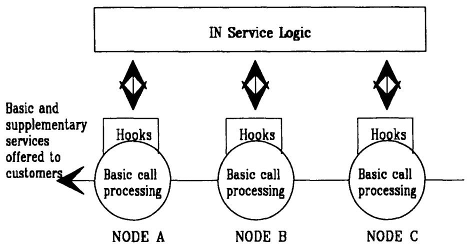


Figure 7. IN Service Processing Model.

To achieve the goal of fast service implementation, the IN Service Processing Model is introduced (Figure 7).

The three main elements of this model are: the basic call processes, the "hooks" that allow the basic call processes to interact with IN service logic, and IN service logic that can be "programmed" to implement new supplementary services. For these elements the main principles are described below:

- The basic call process should be available all over the network and is designed to support, with optimal performance, services that do not require special features. In order to achieve flexibility in service processing, the basic call process needs to be modularized into service-independent sub-processes such that these can be executed autonomously (without interference from the outside during execution).
- "Hooks" are to be added to the basic call process forming the links between the individual basic call sub-processes and the service logic. The "hooks" are able to start an interaction session with the IN service logic. For this it should continuously check the basic call process for the occurrence of conditions on which an interaction session with IN service logic should be started. During an interaction session the basic call process can be temporarily suspended.
- IN service logic uses a programmable software environment that needs to be developed to allow fast implementation of new supplementary services. New supplementary services can be created by means of "programs" containing IN service logic. The IN service logic is able, via the "hooks" functionality, to interact with the basic call process. In this way IN service logic can control the sub-processes in the basic call process and the sequencing of these sub-processes.

Thus, by changing logic at the service control point and modifying network data, a new service that uses existing network capabilities can readily be implemented.

In addition IN service logic can decide to terminate an interaction session with the basic call process. The basic call process will then resume its execution as specified by the IN service logic. In order to allow fast service implementation, the IN service logic should have a logical view of the network resources that constitute the basic call process and additional (specialised) network functions. For proper service processing, the following principles apply:

- it should be possible to distribute resources between services in a well balanced way;
- it should be possible for IN supported services to share resources with non-IN supported services;
- it should be possible to provide a different method of resource data management from the current embedded method;
- it should be possible to introduce IN supported services specific resources.

To define an IN architecture including the network elements within this architecture, there is a need for a **call model** that describes the real-time behaviour of call control capabilities for the provision of basic and supplementary services. In order to be consistent with the principles of the above-described IN service processing model, the IN call model should cover the following aspects:

- it should specify which basic services can be supported by the model;
- it should model the basic call processes (each individual basic service may require its own IN basic call process);

- it should describe **trigger mechanisms** ("hooks") that allow the IN basic call process to interact with service logic;
- it should provide a logical view (from the service logic point of view) of call processing functions and network resources, which as a consequence allows fast service implementation;
- it should specify the mechanisms according to which an IN-basic call process may interact with the service logic (e.g. single-ended interactions, simultaneous interactions, service logic initiated interactions, etc.);
- it should be evolvable from the existing technology base.

3.4 IN Conceptual Model

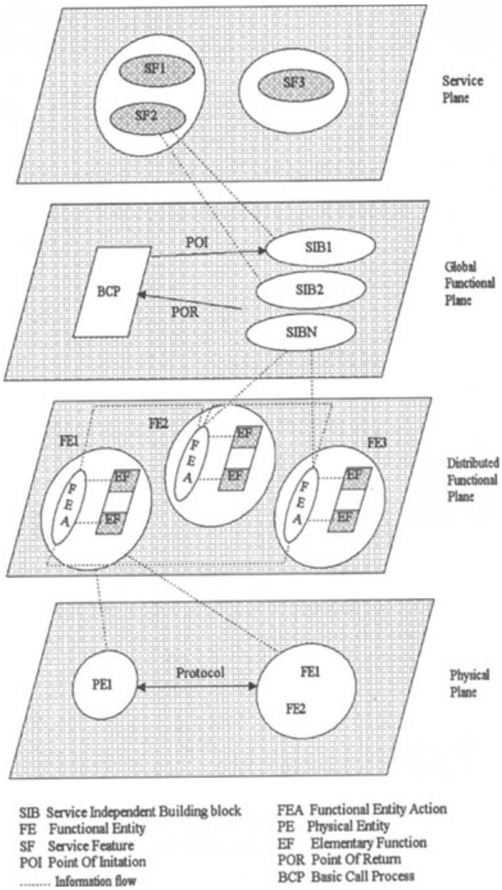


Figure 8. IN Conceptual Model

The IN Conceptual Model *(INCM)* is defined in the CCITT Recommendation Q.1201. The conceptual model is divided into four planes and it forms the basis for the standardization work. The IN conceptual Model was designed to serve as a modelling tool for the Intelligent Network. It is also a tool that can be used to design the IN architecture to meet the following main objectives [Q1201]:

- service implementation independence,
- network implementation independence and
- vendor and technology independence.

Each INCM plane represents a different abstract view of the capabilities provided by an IN-structured network. These views address service aspects, global functionality, distributes functionality and physical aspects of an IN (Figure 8).

The **Service Plane** represents an exclusively service-oriented view. This view contains no information whatsoever regarding the implementation of the services in the network, e.g. an "IN-type" implementation is not visible. All that is perceived is the network's service-related behaviour as seen, for example, by a service user. Services are composed of one or more Service Features (SFs), which are the "lowest level" of services.

The **Global Functional Plane** (GFP) models an IN-structured network as a single entity. Contained in this view is a global (network-wide) basic call processing *(BCP)* SIB, the service independent building blocks *(SIBs)*, and point of initiation *(POI)* and point of return *(POR)* between the BCP and a chain of SIBs.

The **Distributed Functional Plane** (DFP) models a distributed view of an IN-structured network. Each functional entity *(FE)* may perform a variety of functional entire actions *(FEAs)*. Any given FEA may be performed within different functional entities. However, a given FEA may not be distributed across functional entities.

Within each functional entity, various FEAs may be performed by one or more elementary functions. The manner in which elementary functions result in FEAs is for further study.

Service-independent building blocks (SIBs) are realised in the distributed functional plane (DFP) by a sequence of particular FESs performed in the functional entities. Some of these FEAs result in information flows between functional entities. The information flows consist of messages which exhance information between functional entities. The messages comply with OSI structures and principles.

The **Physical Plane** models the physical aspects of IN-structured networks. The model identifies the different physical entities and protocols that may exist in real IN-structured networks. It also indicates which functional entities are implemented in which physical entities.

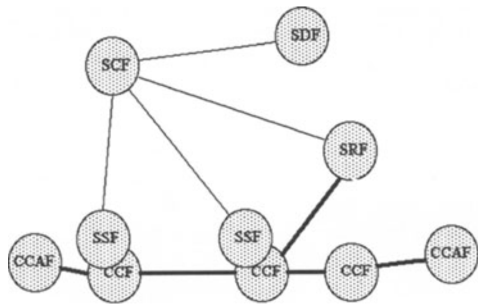
The entities contained in adjacent planes of the INCM are related to each other. The nature of the relationship is as follows (Q1201):

- Service plane to GF plane: Service features within the service plane are realised in the GF plane by a combination of global service logic and SIBs including the basic call process SIBs. This mapping is related to the service creation process.
- GF plane to distributed functional (DF) plane: Each SIB identified in the GF plane must be present in at least one FE in the DF plane. A SIB may be realised in more than one FE. Thus, cooperation of several FEs may be needed. The service logic in the GF plane maps onto one or more DSLs in the DF plane. This mapping is related to the service creation process.

- DF plane to physical plane: FEs identified in the DF plane determine the behaviour of the physical entities (PEs) onto which they are mapped. Each FE must be mapped onto one physical entity, but, each PE contains one or more FEs. Relationships between FEs, identified in the DF plane, are specified as protocols in the physical plane. DSLs may be dynamically loaded into physical entities and this mapping is related to the service management process.

3.5 Distributed Functional Plane

The global Distributed Functional Plane (*DFP*) is of primary interest to network designers and providers. It describes the functional architecture of an IN-structured network in terms of units of network functionality (Figure 9). These functionalities are referred to as Functional Entities (*FE*). The information that flows between Functional Entities are referred to as relationships. The functional entities are described independently of how the functionality is physically implemented or deployed in the network. SIB's on the global functional plane are realized on the Distributed Functional Plane by a sequence of Functional Entity Actions (*FEA*) and resulting information flows. [Q1214]



CCAF Call Control Agent Function SCF Service Control Function
CCF Call Control Function SRF Special Resource Function
SSF Service Switching Function SDF Service Data Function

Figure 9. Distributed functional plane architecture.

The DFP architecture provides flexibility to support a large variety of services and facilitates the evolution of IN by organizing the functional capabilities in an open-ended and modular strtucture to achieve service independence. The DFP architecture is vendor/implementation independent, thereby providing the flexibility for multiple physical networking configuration and placing no constraints on national network architecture beyond the network and interface standards which will be developed for IN structured networks. The definition of the DFP architecture initially accomodates service execution capabilities and will accomodate service creation and service and network management capabilities when they become available.

A Functional Entity is 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 Functional Entities can be located in the same Physical Entity. Different Functional Entities contain different functions, and may also contain one or more of the same functions. In addition, one Functional Entity cannot be split between two Physical Entities; the Functional Entity is mapped entirely within a single Physical Entity. Finally, duplicate instances of a FE can be mapped to different PEs, though not the same PE.

3.5.1 Definition of FEs

This section gives a description of the Functional Entities at the Distributed Functional Plane related to IN service execution and how they are mapped to the Physical Plane architecture.

CCAF

The CCAF is the Call Control Agent Function that provides access for users. It is the interface between user and network call control functions. It has the following characteristics: It

a) provides for user access, interacting with the user to establish, maintain, modify and release, as required, a call or instance of service;
b) accesses the service-providing capabilities of the Call Control Function, using service requests (e.g. setup, transfer, hold, etc.) for the establishment, manipulation and release of a call or instance of service;
c) receives indications relating to the call or service from the CCF and relays them to the user as required and
d) maintains call/service state information as perceived by this functional entity.

CCF

The CCF is the Call Control Function in the network that provides call/connection processing and control. It

a) establishes, manipulates and releases call/connection instances as "requested" by the CCAF;
b) provides the capability to associate and relate CCAF functional entities that are involved in a particular call and/or connection instance (that may be on SSF requests);
c) manages the relationship between CCAF functional entities involved in a call (e.g. supervises the overall perspective of the call and/or connection instance);
d) provides trigger mechanism to access IN functionality (e.g. passes events to the SSF) and
e) is managed, updated and/or otherwise administred for its IN-related functions (i.e. trigger mechanisms) by a Service Management Function.

SSF

The SSF is the Service Switching Function, which, associated with the CCF, provides the set of functions required for interaction between the CCF and Service Control Function. It

a) extends the logic of the CCF to include recognition of service control triggers and to interact with the SCF;
b) manages signalling between the CCF and the SCF;
c) modifies call/connection processing functions (in the CCF) as required to process requests for IN provided service usage under the control of the SCF and
d) is managed, updated and/or otherwise administred by an SMF.

SSF/CCF Model

The SSF/CCF model described below include the Basic Call Manager *(BCM),* the IN-Switching Manager *(IN-SM),* the Feature Interactions Manager *(FIM)*/Call Manager *(CM),* the relationship of the BCM to the IN-SM, the relationship of the BCM and IN-SM to the FIM/CM, and the functional separation provided in the SSF/CCF (Figure 4-7). [Q1214]

a) BCM - The entity in the CCF that provides basic call and connection control to establish communication paths for users and interconnects such communication paths, that detects basic call and connection control events that can lead to the invocation of IN service logic instances or should be reported to active IN service logic instances, and that manages CCF resources required to support basic call and connection control. The BCM interacts with the FIM/CM as described in the FIM/CM description below.

b) IN-SM - The entity in the SSF that interacts with the SCF in the course of providing IN service features to users. It provides the SCF with an observable view of SSF/CCF call/connection processing activities, and provides the SCF with access to SSF/CCF capabilities and resources. It also detects IN call/connection processing events that should be reported to active IN service logic instances, and manages SSF resources required to support IN service logic instances. The IN-SM interacts with the FIM/CM as described below.

c) FIM/CM - The entity in the SSF that provides mechanisms to support multiple concurrent instances of IN service logic instances on a single call. In particular, the FIM/CM can prevent multiple instances of IN an non-IN service logic instances from being invoked. The ability of the FIM/CM to arbitrate between multiple instances of IN and non-IN service logic instances is for further study. The FIM/CM integrates these interactions mechanisms with the BCM and IN-FM to provide the SSF with a unified view of call/service processing internal to the SSF for a single call.

d) BCM Relationship to IN-SM - The relationship that encompasses the interaction between the BCM and the IN-SM, through the FIM/CM. The information flow related to this interaction is not externally visible and is not standardized for CS-1. However, an understanding of this subject is required to identify how basic call and connection processing and IN call/connection processing may interact.

e) BCM and IN-SM Relationships to FIM/CM - The relationships that encompass the interaction between the BCM and FIM/CM, and the IN-SM and the FIM/CM. The information flows related to these interactions are not externally visible and are not standardized for CS-1. However, an understanding of this subject is required in order to unify the BCM, IN-SM and FIM/CM.

f) Functional Separation in the SSF/CCF. The functional separation of processes and resources in the SSF/CCF that provides a means of handling service logic instance interactions for CS-1. This functional separation services to isolate single-ended service logic instances related to the calling party from single-ended service logic instances related to the called party for the same call. Within the scope of CS-1, there is no functionality in the SSF for handling service feature interactions between the separate SSF calling party processes and SSF called party processes.

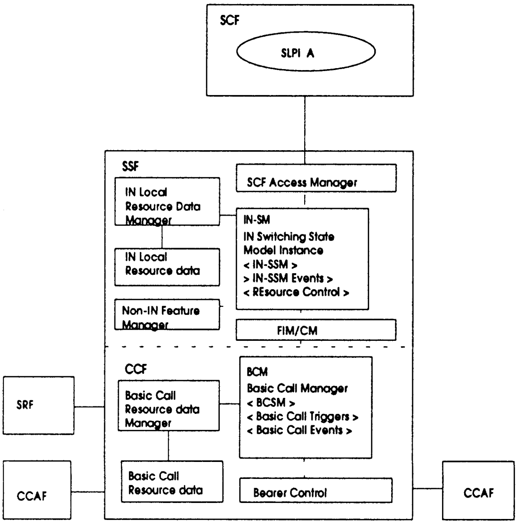


Figure 10. SSF/CCF Model

BCSM

The BCSM (Basic Call State Model) is a high-level finite state machine description of CCF activities required to establish and maintain communication paths for users. As such, it identifies a set of basic call and connection activities in a CCF and shows how these activities are joined together to process a basic call and connection (i.e., establish and maintain a communication path for a user). [Q1214]

Many aspects of the BCSM are not externally visible to IN service logic instances. However, aspects of BCSM will be the subject of standardization. As such, the BCSM is primarily an explanatory tool for providing a representation of CCF activities that can be analysed to determine which aspects of the BCSM will be visible to IN service logic instances, if any, and what level of abstraction and granularity is appropriate for this visibility.

The BCSM identifies points in basic call and connection processing when IN service logic instances are permitted to interact with basic call and connection control capabilities. In particular, it provides a framework for describing basic call and connection events that can lead to the invocation of IN service logic instances or should be reported to active IN service logic instances, for describing those points in call and connection processing at which these events are detected, and for describing those points in call and connection processing when the transfer of control can occur.

Figure 10 shows the key components that have been identified to describe a BCSM, to include: Points in Call *(PICs),* Detection Points *(DPs)*, transitions, and events. PICs identify CCF activities required to complete on or more basic call/connection states of interest to IN service logic instances. DPs indicate points in basic call and connection processing at which transfer of control can occur. Transitions indicate the normal flow of basic call/connection processing from one PIC to another. Events cause transitions into and out of PICs. Information Flows [Q1214] (e.g. between SSF/CCF and SCF) corresponding to Events and PICs are represented by Operations [Q1218] and modelled as Application Service Elements (ASEs).

The BCSM for CS-1 should model existing switch processing of basic two-party calls, and should reflect the functional separation between the originating and terminating portions of calls. In addition, though CCAF functionality is not explicitly modelled in the BCSM, a mapping is required between access signalling events and BCSM events, for each access arrangement supported by CS-1.

Since the BSCM is generic, it may describe events that do not apply to certain access arrangements. It is important to understand and describe how each access arrangement applies to the BCSM.

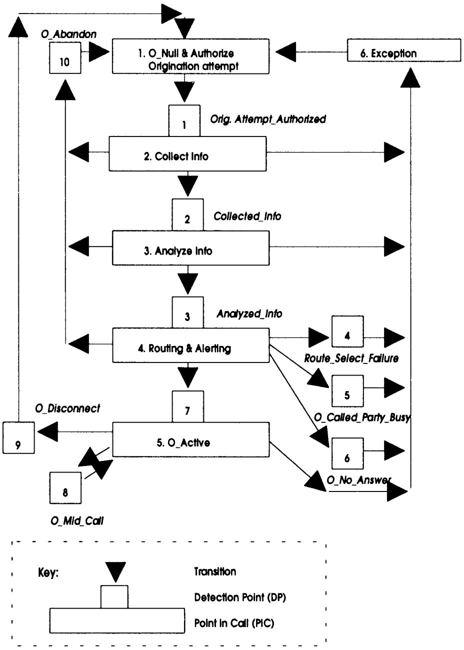


Figure 11. Originating BCSM for CS1

SCF

The SCF is a function that commands call control functions in the processing of IN provided and/or custom service requests. The SCF may interact with other functional entities to access additional logic or obtain information (service or user data) required to process a call/service logic instance. It

a) interfaces and interacts with SSF/CCF, SRF and SDF functional entities;
b) contains the logic and processing capability required to handle IN provided service attempts;
c) interfaces and interacts with other SCFs, if necessary;
d) is managed, updated and/or otherwise administered by an SMF.

SDF

The SDF contains customer and network data for real time access by the SCF in the execution of an IN provided service. It

a) interfaces and interacts with SCF as required;
b) interfaces and interacts with other SDFs, if necessary;
c) is managed, updated and/or otherwise administered by an SMF.

SRF

The SRF provides the specialized resources required for the execution of IN provided services (e.g. digit receivers, announcements, conference bridges, etc.). It

a) interfaces and interacts with SCF and SSF (and with the CCF);
b) is managed, updated and/or otherwise administered by an SMF;
c) may contain the logic and processing capability to receive/send and convert information received from users;
d) may contain functionality similar to the CCF to manage bearer connections to the specialized resources.

3.6. Global Functional Plane

The Global Functional Plane (*GFP*) is of primary interest to service designers. [Wyatt91] The Global Functional Plane models network functionality from a global, or network-wide, point of view. As such, the IN structured network is said to be viewed as a single entity in the GFP. In this plane, services and Service Features 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 SIB's (*Service-Independent building Block*). [Q1203]

Services identified in the service plane are decomposed into their service features, then mapped onto one or more SIBs in the GFP. Each SIB is similarly mapped onto one or more FEs in the Distributed Functional Plane [Q1203] (Figure 12).

3.6.1 SIB

IN CS1 contains 14 SIBs that include algorithm, charge, compare, translate, basic call process, among others. In principle many other services described in CCITT Recommendations Q.1211 could be specified. [Raat93] SIBs are standard reusable networkwide capabilities residing in the Global Functional Plane, used to create services. As such they are global in nature and their locations need not to be considered as the entire network is regarded as a single entity. A Service Feature is provided by a combination of one or more SIBs. SIBs have the following characteristics:

- SIBs are defined completely independent from any physical architecture considerations.
- Each SIB has a unified and stable interface, with one or more inputs an one or more outputs.
- SIBs are reusable, monolithic, building blocks, describing a single complete activity, and used by the service designer to create services.

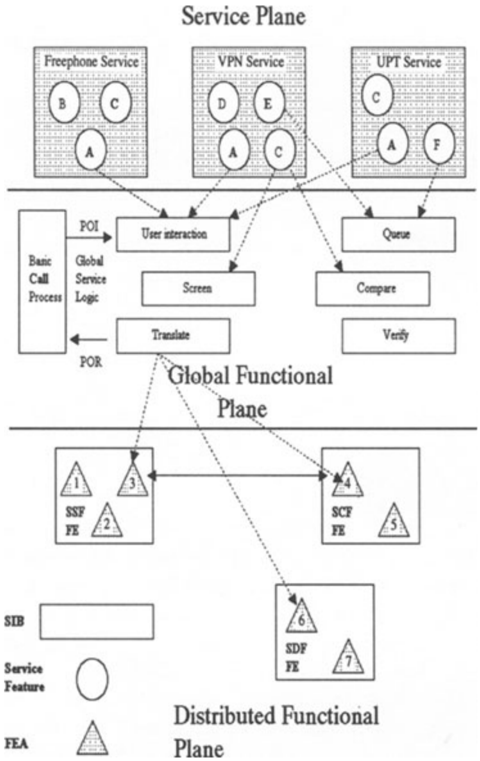


Figure 12. Service decomposition.

A SIB can exist independently, or it can coexist with other SIBs in the same network element. IN-based services can be distinguished from one another by the sequence of SIB functions and by the specific parameters within each SIB. IN CS1 describes 13 SIBs plus a specialized SIB called Basic Call Process (Table 8).

Table 8: The CS1 SIBs

Algorithm	Screen
Charge	Service Data Management
Compare	Status Notification
Distribution	Translate
Limit	User Interaction
Log Call Information	Verify
Queue	

Basic Call Process (*BCP*) identifies the normal call process from which IN services are launched, including Points Of Initiation (*POI*) and Points Of Return (*POR*) which provide the interface from the BCP to Global Service Logic (*GSL*). The GSL describes how SIBs are chained together to describe Service Features. The GSL also describes interaction between the BCP and the SIB chains. [Q1203] (Figure 13) By definition, SIBs, including the BCP, are service independent and cannot contain knowledge of subsequent SIBs. Therefore, GSL is the only element in the GFP which is specifically service dependent.

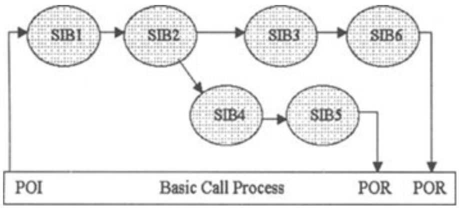


Figure 13. Modelling of Global Functional Plane.

In order to chain SIBs together, knowledge of the connection pattern, decision options, and data required by SIBs must be available. Therefore, the pattern of how SIB are chained together must be maintained within the GFP, and described in the GSL. The GSL describes subsequential SIB chaining, potential branching, and where branches rejoin. When an IN supported service is to be invoked, its GSL is laucnhed at the POI by a triggering mechanism from the BCP. At the end of chain of SIBs, the GSL also describes returning point to the BCP by indicating the specific POR. For a given service or Service Feature at least one POI is required. However, depending upon the logic required to support the service or Service Feature, multiple PORs may be defined. [Q1203]

In order to describe Service Features with these generic SIBs, some elements of service dependency is needed. Service dependency can be described using data parameters which enable a SIB to be tailored to perform the desired functionality. Data parameters are specified independently for each SIB and are made available to the SIB through GSL. Two types of data parameters are required for each SIB, dynamic parameters called Call Instance Data (*CID*) and static parameters called Service Support Data (*SSD*). [Q1203]

3.6.2 Basic Call Process

The Basic Call Process is responsible for providing basic call connectivity between parties in the network. The BCP can be viewed as a specialized SIB which then provides basic call capabilities including connecting call with appropriate disposition; disconnecting calls, with appropriate disposition; and retaining CID for further processing of that call instance [Q1203]

The need for specific POI/POR functionality is that the same chain of SIBs may represent a different service if launched from a different point in the BCP. Similarly, the same chain of SIBs launched from the same point may represent a different service if returned to the BCP at a different point. [Q1203]

3.6.3 Global Service Logic

The Global Service Logic can be defined as the "glue" that defines the order in which SIBs will be chained together to accomplish services. Each instance of global service logic is (potentially) unique to each individual call, but uses common elements, comprising specifically: BCP interaction point (POI and POR); SIBs; logical connections between SIBs, and between SIBs and BCP interaction points; input and output data parameters, service support data and call instance data defined for each SIB. [Q1203] The GSL will then chain together these elements (SIBs) to provide a specific service.

3.7. The IN-structured network

The IN concept is an extension of, rather than a replacement for, traditional service control. Since an IN primarily affects only the internal service processing of switching systems, it should have little influence on the signalling procedures of a traditional network. Therefore, we can place intelligent nodes in existing networks without affectting traditional network operations or capabilities. [Wyatt91]

The Intelligent Network consists of integrated hardware and software distributed throughout the service providers' network. Thanks to the new technologies, service providers will be able to create their own services. [Nerys91] Compared to the convenient telecommunications network architecture, IN forms an excellent and fast way of introducing services.

IN promises to change the way vendors, telephone companies, and customers run their businesses and work with one another. Today, vendors develop a product that delivers a certain service, then sell it to telecommunications operators. With IN, vendors will develop software "building blocks" [Nerys91], then deliver these to telephone companies who assemble them to create new services.

3.7.1. SCE

The Service Creation Environment capability of IN enables effective service creation. Service Creation Environments enable network and service providers to create new revenue-generating services that are independent of equipment vendor's deployment schedules. Many administrations are asking vendors of IN equipment to provide them with Service Creation Environment capabilities. This is also true of large service subscribers, who prefer to control the operation of their IN-based services. In the current Service Creation Environment, service subscribers can control services using existing capabilities or modifying parameters within these capabilities. Current Service Creation Environments are user friendly and support updates of service control points. The next generation of Service Creation Environment will also support updates of intelligent peripherals and Adjuncts. Because SIBs are being defined for the IN, it is now possible to develop a Service Creation Environment platform to support new services and direct them to appropriate Physical Entities. In addition, new SCEs must provide extensive validations for new IN-based services so they do not have an adverse effect on the overall operation of the network or the subscribers services. [Wyatt91]

The service designers are staff members of the provider's company. They have to create new services by definite and unambiguous descriptions. Such descriptions are called Service Logic Programs (*SLP*). After deployment of a new service in the network, one can buy or subscribe to such a service. [Abram92]

The services are determined by single Service Features. Following the ETSI framework this should be reflected in the service representation: each SLP should be composed from SIBs. The interface for composition of new services may differ. The interface might be an advanced specification language for the construction of SIBs and their interfaces/(inputs and outputs). However, it is possible to build a Graphical User Interface (*GUI*) on the top of the specification language and by so ease and speed up the introduction of new IN services.

3.7.2. IN Application Protocol

The IN Application Protocol (*INAP*) is intended to be used between the following four functions: SSF, SCF, SDF and SRF. The INAP in CS1 is ment to be using the SS7 protocol stack, but it does not imply that only this signalling protocol should be used. [Q1218]

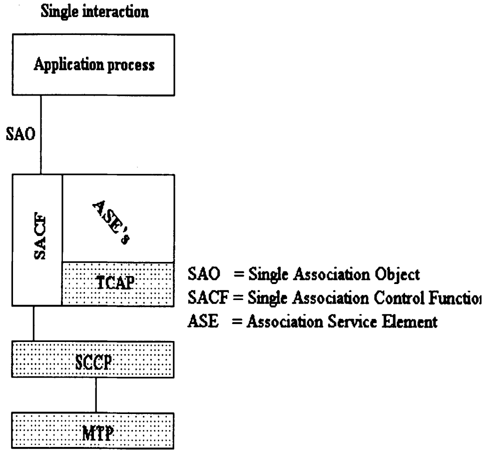


Figure 14. INAP Protocol Architecture.

The INAP protocol architecture is based on the OSI Application Layer Structure (Figure 14). A physical entity has either single interactions or multiple co-ordinated (not discussed here) interactions with other physical entities. The Single Asociation Control Function provides a co-ordination function using Application Service Elements *(ASEs)*, which includes the ordering of operations supported by ASEs (based on the order of received primitives) [Q1218]. The SAO represent the SACF plus a set of ASE's to be used over a single interaction between a pair of Physical Entities. If there were need for multiple interactions, the use of MACF (*Multiple Association Control Function*) would be acceptable. In this case, MACF would provide a co-ordinating function among several SAOs, each of which interacts with an SAO in a remote PE.

Each ASE supports one or more operations. Information flows of [Q1214] are in principle mapped one to one with operations. For example, the operations corresponding to the information flows of the Originating BCSM for CS1 (Figure 11) are the following:

- Origination Attempt Authorized
- Collect Information
- Collected Information
- Analyze Information
- Analyzed Information
- Route Select Failure
- OCalled party Busy

- O_No Answer
- ODisconnect
- OAnswer
- O_Mid Call

In the CCITT New Recommendation Q.1218 the INAP and TCAP messages are specified using the Abstract Syntax Notation One (*ASN.1*). The encoding rules which are applicable to the defined abstract syntax are the Basic Encoding Rules (*BER*).

3.8. Integration of TMN and IN

IN is a generic, service-oriented architecture, intended to be used for all kinds of services (real-time or management) on top of call-control type services. TMN is a generic, management-oriented architecture, intended to be used for all kinds of management services. Obviously, the IN and TMN architectures overlap. For instance, one TMN application such as billing and one IN application such as Freephone must be tightly related because Freephone billing should be handled in a consistent way with TMN billing. This shows that, unless both IN and TMN architectures are made more consistent, the interconnection of IN and TMN applications would be difficult. It is not possible to support two independent architectures while applications on both architectures must interoperate. Also, IN is just one part of the whole network, and as such should be managed with TMN. The integration of TMN and IN can be considered as an evolution path to TINA [Appel93].

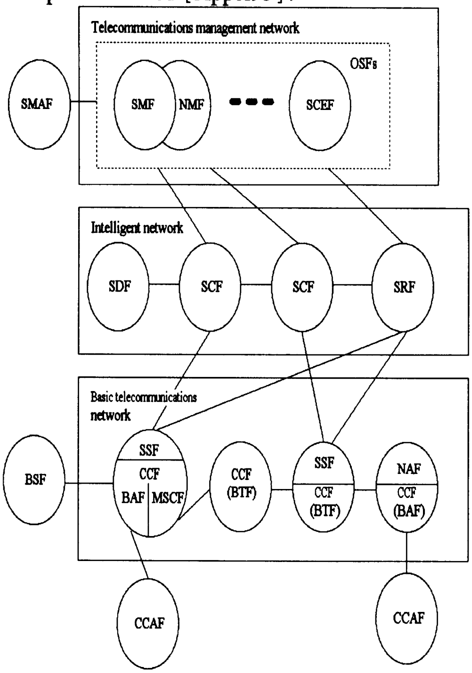


Figure 15. The TMN and IN concept. [Wyatt91]

Figure 15 shows network-related functions required for IN architecture: the Basic telecommunications network, Intelligent Network, and the Telecommunications Management Network.

The Basic telecommunications network is commonly known as the Public-Switched Telephone Network (*PSTN*), this network controls basic telecommunications services (for example, local and transit/toll switching, voice and data calls) offered to a user. It detects whether control of a call should be transferred to the IN. The Intelligent Network manages intelligent telecommunications services offered to a user. It includes specialized telecommunications functions, such as customized announcements, voice regognition, encryption, and network reource assignments. At present, TMN controls telecommunications support for basic telecommunications network and IN functions. In the future, TMN will include functions such as service creation, service provisioning, service deployment, and service management.

Both in TMN and IN, the challenge is to ensure a global consistency of all interconnected applications, while allowing for evolution of some applications. This shows that while IN and TMN architecture are to be integrated, they both must evolve towards a unified target architecture to be more flexible. [Appel93]

3.8.1. Comparison of IN planes to TMN planes

The IN Conceptual Model represents different points of view to the users, customers and operators. The TMN planes describe, however, different management-related aspects. The correspondence of these architectures is shown in this section.

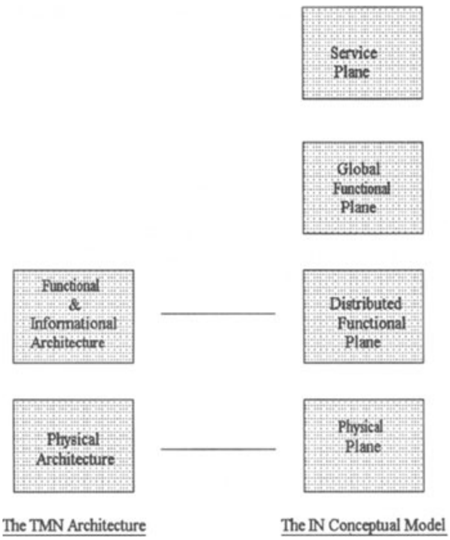


Figure 16. Correspondence of IN planes and TMN architecture planes.

The Service Plane represents the service from the user's point of view. The TMN architecture does not directly provide with this kind of aspects. The Global Functional Plane represents with the service designer's point of view of the services. The TMN architecture does not directly provide with aspects of Global Functional Plane. Distributed Functional Plane represents the fucntional parts of the IN architecture and the relations between them. This is quite the same as the TMN architectures Functional Architecture. The relations between DFP parts corresponds to the TMN Informational Architecture. The lowest layer of IN architecture corresponds straight to the Physical Plane architecture of INCM (Figure 16).

In order to avoid multiple definitions of management it is possible that IN will be managed through TMN concept. This is very well stated, because TMN has been widely accepted as a telecommunications management concept.

3.9. Future IN Capability Sets

The main CS1 capabilities support flexible routing, flexible charging and flexible user interaction [Q1211]. Only limited mid-call interruption facilities are supported. It is not expected that significant capability will be provided within CS1 for services occurring during the active phase of call, for multiparty or multimedia services, for services requiring the direct manipulation of call topology such as mobility or conference calling or non call associated signalling as needed in mobility. Such capabilities, as well as standards for SMF and SCEF capabilities, are expected to be provided in CSs beyond CS1, starting with CS2, on which work began in 1992. Refinements of CS1 will continue during 1994. The CS2 with non-call associated signalling, SDF and management interfaces will be available in 1995. CS3 providing terminal mobility is to be completed in 1997.

Thus, the work beyond CS1 will provide support of mobility, multimedia calling; support of services affecting a call in the active phases where several subscribers may be affected (Type B Services); standards for feature interaction mechanisms; standards for creation, deployment, and management of service logic; and support for complex call topology management. However, it seems to be so that CS2 will continue to address only Type A services.

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