Introduction

Communication methods are essential to enable the continual expansion of the technological society in which we live. They enable people to exchange ideas, opinions and synchronise all interactions between themselves and others. Telephony is still the predominant method of communication although new techniques, such as electronic mail and mobile communications are becoming more and more popular. Network users are requesting increasingly complex services which cannot be effectively supported by existing network architectures. Also, there is a desire to share data, distribute application processing among network elements and an increasing demand for more sophisticated telecommunications services. All of these factors have led to the evolution of new networking architectures.

A particular architecture which has evolved is the **Intelligent Network (IN),** in which services are provided independently of the bearer networks or equipment vendors. The IN is essentially an architecture which separates the service logic from the telephone exchanges, enabling the establishment of an open platform for uniform service creation, implementation and management. It enables advanced customer orientated services to be rapidly and cost effectively introduced.

The Existing Telecommunications System

In the traditional Plain Old Telephone Service (POTS), the switching systems (known as 'switches') perform the basic call processing. Each supplementary service is a non-reusable software entity that modifies this basic process in the switches. The switching network typically consists of a hierarchy of switches, e.g. a local exchange level, an intermediate exchange level and a transit exchange level, as shown in figure 1.

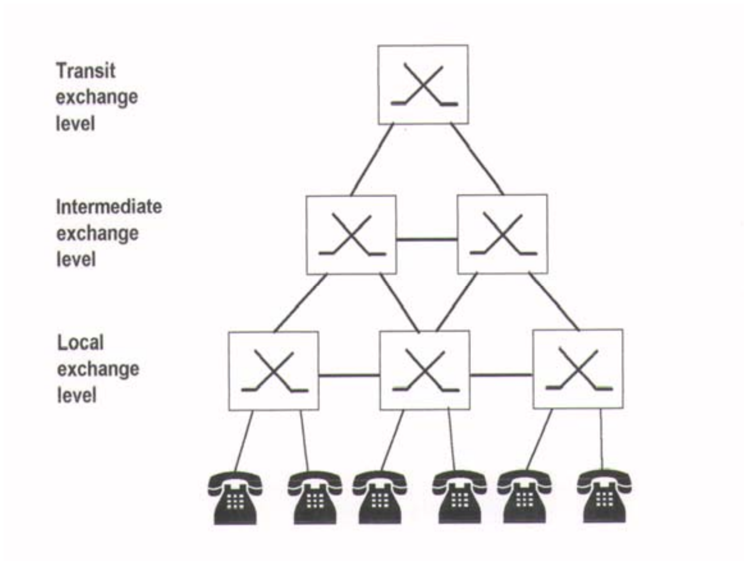

Figure 1 - Levels of a switching hierarchy.

In these systems, if the switch based services are situated at the transient (top) level, there is a large overhead for their use. This is because of the number of switches and related trunks that need to be accessed in order to use a service. For this reason, services have been 'migrating' to lower levels of the hierarchy, reducing the overhead for service use. In the extreme case, each local exchange level switch contains the service data, meaning that every service must be loaded into every switch's software before it can be used (see figure 2).

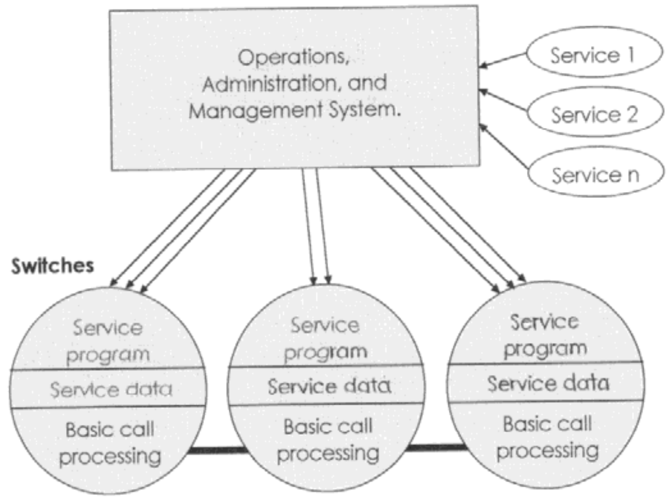

Figure 2 - Provision of services in the POTS environment.

Having the services located in the switches complicates service maintenance and addition, especially as the number of services contained in each switch increases. Consequently, the addition of new services occurs very rarely.

There are also a number of economic implications to a network structured in this way.

- A single company is traditionally responsible for running an exchange and all of the services it offers. This means that there is not a competitive market for service provision since the company running the exchange is the only service provider.
- Lack of competition leads to lack of innovation, and so service provision does not progress and the standards of services are not forced to improve as they would be in a competitive market.
- As previously mentioned, service addition is complicated so it is not feasible for customers to request specific services to suit their business

needs. Services are rarely introduced and so when they are, they need to benefit as many network users as possible.

There are various problems with the traditional system other than those identified here. Collectively, they have highlighted the need for a new telecommunications architectures, and in response to this, the **Intelligent Network** has evolved.

Intelligent Network Basics

Having identified the inadequacies with the traditional system, it was possible to outline the various changes which needed to be made:

1. Increase Service Velocity: enable the rapid introduction of new services with direct responsiveness to customer needs.
2. Broaden The Range of Services: go beyond traditional voice and data bearer services to include information services, broadband and multimedia.
3. Enable a Multivendor Competitive Environment: ensure services will work correctly and consistently on any vendor's equipment.
4. Evolve from Existing Networks: must interwork with and evolve from existing networks since completely replacing existing networks would be far to disruptive and time consuming..

The first step in realising these changes was to remove the service data from the switching network, and locate it in a centralised database, which is accessible to all the switching nodes. The next step was to separate the service logic from the switch and put it into an independent node, called an 'intelligent node'. A single new service can be added to this node, which then becomes available throughout the whole network.

A real time connection is needed between the network nodes, known as 'service switching points' (SSPs), and the intelligent node, known as the 'service control points' (SCPs). This fast and standardised interconnection forms the basis of the IN architecture. Figure 3 shows the relationship between these network elements.

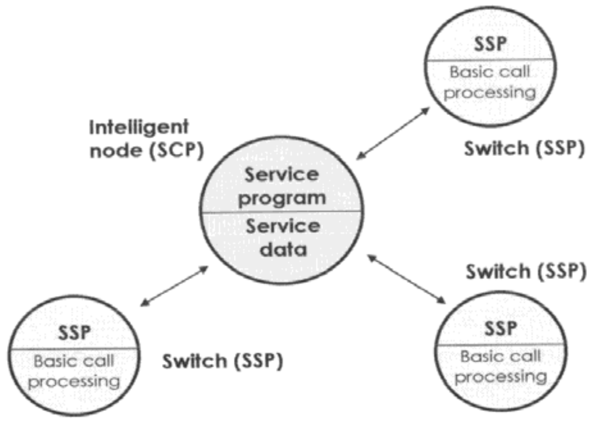

Figure 3 - Intelligent Network approach.

This networking structure enables the IN architecture to provides a complete framework for the uniform creation, provision and management of advanced telecommunication services. It also enables the set of services to be extended, giving users a wider choice i.e. it defines an open set of services. Other advantages created by the IN structure can be identified:

1. extensive use of information processing techniques;
2. efficient use of network resources;
3. modularization of network functions;
4. integrated service creation and implementation by means of reusable standard network functions;
5. flexible allocation of network functions to physical entities;
6. portability of network functions among physical entities;
7. standardised communication between network functions via service independent interfaces;

8. customer control over their specific service attributes;
9. standardised management of service logic.

IN has been intensively researched by all the major organisations in the telecommunications industry, yet a finalised system has still not been established. There are a number of key reasons for this. Firstly, the task of restructuring existing telephone exchanges to provide a well-defined control interface is one of enormous complexity. At the same time, there is increasing competitive pressure for new network features to be provided quickly, and the only way this can be achieved at present is by using embedded service solutions. As a result, the implementation of INs becomes even more complicated. Also, network operators may be cautious about investing in a set of standards which is new and still evolving. Another area suspending the implementation of INs is the inability of the various authorities involved to agree on any one set of standard recommendations. Despite this, various recommendations for the international standardisation of intelligent networks have been produced, which will be introduced in the following section.

Standards For Intelligent Networks

In 1989, the International Standardisation Union (ITU) and the European Telecommunications Standardisation Institute (ETSI) began work on international IN standards. A phase structured development process was started, which aimed to completely define the target IN architecture. Each phase of development intended to define a particular set of IN capabilities, known as a capability set (CS). This refers to a set of services and service features that can be constructed, given the available functionality at that particular evolution phase of the IN. Each CS defines the requirements for one or more of the following areas:

- service creation
- service management
- service interaction
- service processing
- network management
- network interworking

In addition to this, each CS is intended to be compatible with the previous CS and is enhanced to ensure that it is one stage closer to the final IN target.

In March 1992 the first capability set (CS-1) was approved, but a revised version was released several years later in 1995, known as CS-1R. Work on CS-2 was started in 1994 which addressed basic aspects that were excluded from CS-1, such as IN management. Furthermore, work on CS-3 was started in 1995. Figure 4 shows the time scale for the expected release of the various capability sets. It can be seen that the release date for CS-2 turned out to be slightly ambitious, as it has not yet been finalised.

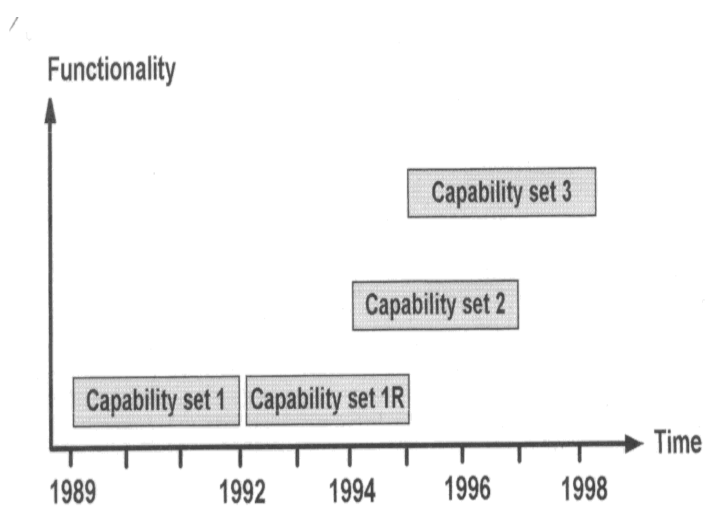

Figure 4 - IN standards development schedule (ITU/ETSI).

The recommendations for the definition of IN capability sets is show in Appendix A. CS-1 represents the first actual standardised stage of the IN, and supports a first set of IN services. Both ITU and ETSI have produced technical reports and documents for CS-1 recommendations. Before considering CS-1 in detail, a general framework for developing international standards for INs will be considered, which is known as the IN conceptual model (INCM**).**

The IN Conceptual Model (INCM)

The INCM was developed to provide a framework for the design and description of each capability set and the target IN architecture. As a contained model, it completely captures the whole engineering process of the IN. The INCM is structured into four planes as follows:

1. service plane
2. global functional plane
3. distributed functional plane
4. physical plane

The upper two planes focus on service creation and implementation, whereas the lower two planes addressing the physical IN architecture.

Service Plane (SP)

This plane is of primary interest to service users and providers. It describes services and service features from a user perspective, and is not concerned with how the services are implemented within the network.

Global Functional Plane (GFP)

The GFP is of primary interest to the service designer. It describes units of functionality, known as service independent building blocks (SIBs) and it is not concerned with how the functionality is distributed in the network. Services and service features can be realised in the service plane by combining SIBs in the GFP.

Distributed Functional Plane (DFP)

This plane is of primary interest to network providers and designers. It defines the functional architecture of an IN-structured network in terms of network functionality, known as functional entities (FEs). SIBs in the GFP are realised in the DFP by a sequence of functional entity actions (FEAs) and their resulting information flows.

Physical Plane (PP)

The PP is of primary interest to equipment providers. It describes the physical architecture for an IN-structured network in terms of physical entities (PEs) and the interfaces between them. The functional entities from the DFP are realised by physical entities in the physical plane.

The four planes of the model are portrayed in figure 5. This model forms the framework for the evolution of intelligent networks, and when defining a capability set, all planes of the INCM should be considered. The next sections will take a detailed look into CS-1, by following the four planes of the INCM, in order to get a feel of how an IN may be implemented.

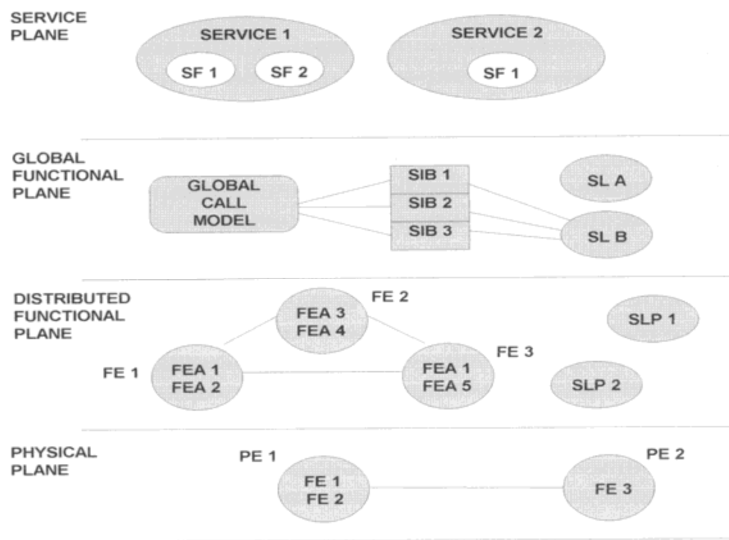

Figure 5 - The IN conceptual model (INCM).

Key:

SF Service feature

SIB Service independent building block

SL Service logic

SLP Service logic program

FE Functional entity

FEA Functional entity action

PE Physical entity

CS-1 Service Plane

CS-1 service capabilities are defined by the upper two planes of the INCM, namely the service plane (SP) and the global functional plane (GFP), as shown in figure 6. It should be realised that the IN aims to define a platform for service execution where the type of service is not fixed, i.e. an open set is supported.

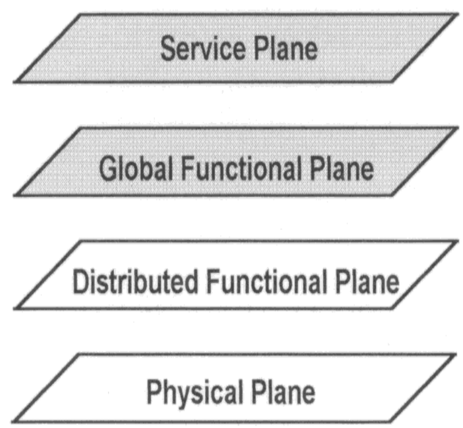

Figure 6 - CS-1 service capabilities are defined by the upper two INCM planes.

IN services can be categorised into two groups, as follows:

1. Single-ended and single-point-of-control services, known as 'type A' services. Single-ended means that the service applies to one and only one party in a call, and is independent of any other parties participating in the call. Single-point-of-control defines a control relationship in which a given call is influenced by one and only one service logic program. The service logic is located in the service control points (SCPs), and hence there are no interactions between SCPs when providing a 'type A' service.
2. All other services are know as 'type B' services. Such services allow several IN subscribers to be associated with a single call, and also enable several call parties to be added or removed dynamically during the call. In order to provide 'type B' services, the SCPs may be required to interact.

CS-1 is targeted to support 'type A' service only, thus reducing implementation complexity. Many different types of services exist in an IN, a few of which are listed below. For a more complete listing of the CS-1 services.

- Abbreviated dialling enables the use of short numbers for outgoing calls.
- Account card calling allows calls from any telephone by charging a credit card.
- Televoting enables voting via the network.
- Malicious call identification enables logging of incoming calls.

Service Features

A service feature is a part of a telecommunications service, which can be used in conjunction with other services/service features. A service feature is either a core part of a telecommunication service, i.e. a fundamental component, or an optional part offered as an enhancement to the service. Service features are combined to achieve new services in the service plane. Many different types of service features exist, a few of which are listed below.

- One number allows two or more destination lines to be reached via one number.
- Reverse charging allows call charges to be allocated to the called party.
- Automatic call back allows a call to be set up after a line becomes free.

CS-1 Global Functional Plane

Defined by CS-1 is a high-level logical programming interface. This programming interface consists of a set of service independent building

blocks (SIBs) in the global functional plane (GFP). This is used by the service designer for the definition of service logic programs (software programs that contain the service logic that runs in an SCP). Hence, service features in the service plane are defined by one or more SIBs in the GFP.
Some of the SIBs defined by the CS-1 standards are shown below:

- **Algorithm:** applies a mathematical algorithm to data in order to produce a result.
- **Verify:** provides confirmation that the information received is syntactically consistent with the expected form.
- **Basic Call Process:** a dedicated SIB responsible for providing basic call connectivity between parties in the network.

In order to build intelligent network service logic, the SIBs must be chained together. IN service logic built using a SIB chain, is referred to as global service logic (GSL). At specific points in the call processing the SIB chain must interact with the initial basic call at in order to correctly handle the service request.

Hence, a dedicated SIB, known as the basic call process (BCP) is used to model the real-time behaviour of the network. It is the BCP which allows the passing of call control temporarily to the IN service logic, and hence the SIB provides two specific interaction points:

- **Points of initiation** (POI) allow the transfer of control from the switch hosting the basic call process to a service switching point which contains the global service logic.
- **Points of return** (POR) allow the transfer of control from the SCP back to the basic call process.

This whole process is captured in figure 7 below.

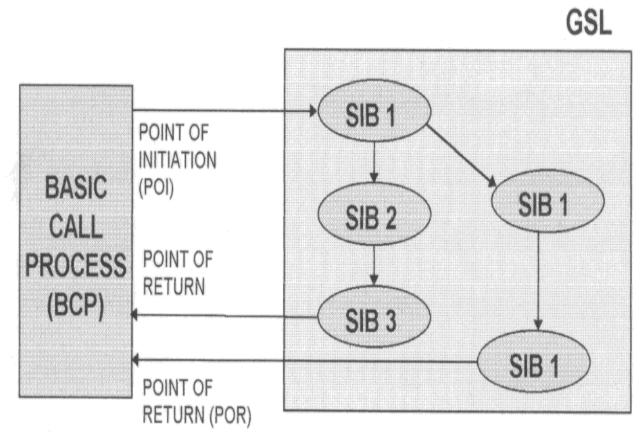

Figure 7- Global Functional Plane Model.

To summarise, SIBs are combined into SIB chains in order to construct new services. The IN services can only be implemented within the capabilities of the available set of SIBs. Also, the service creation environment is fundamental, providing the service designer with an appropriate interface for constructing new services/service features.

CS-1 Distributed Functional Plane

The lower two planes of the INCM , namely the distributed functional plane (DFP) and the physical plane (PP) define the actual IN architecture. This is shown in figure 8 below.

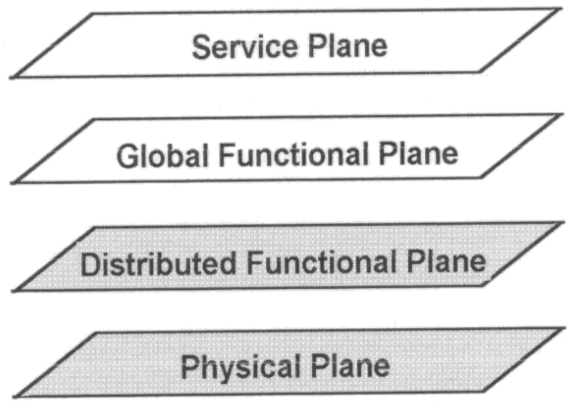

Figure 8 - CS-1 IN architecture is defined by the lower two INCM planes.

The actual functional IN architecture for CS-1 is defined in the DFP. Architectural functions represented in this plane enable IN services to be supported. Each SIB which is defined in the GFP must be implemented by functional entities (FEs) in the DFP. The three categories of functions that can be identified in CS-1 are listed below.

1. Basic call-handling functions e.g. the connection control function (CCF) which provides the functionality for the basic call processing.
2. Service execution functions e.g. the service switching function (SSF) contains the logic for controlling switch resources. It also provides a service-independent interface to the service control function (SCF), which is used for controlling network resources. Also, the service data function (SDF) contains both customer-related and network-related data and provides standardised access methods, enabling the SCFs to use this data.
3. Service management functions e.g. the system management function (SMF) which supports the introduction, provision and maintenance of IN services.

Modelling IN services in the DFP

IN services/service features are composed of SIBs in the GFP. In order to realise services in the service plane, each SIB must be decomposed into an interacting set of FEs in the DFP. The FEs must exchange messages in order to perform a desired SIB functionality and these information exchanges are known as information flows (IFs).

This whole process is captured in figure 9.

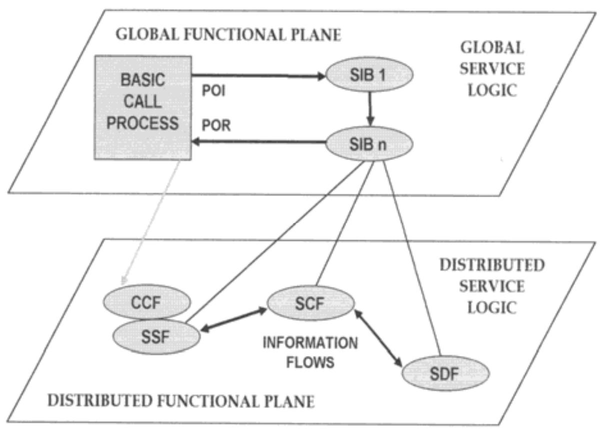

Figure 9 - Realisation of SIBs by information flows in the DFP.

Basic Call Model

New service logic is needed in order to realise any additional telecommunication services. The starting point for the execution of IN service logic is represented by the basic call model (BCM). The BCM identifies all possible points in the basic call processing from which IN services can be invoked. Hence, it is a fundamental component in the IN architecture, and enables control to be passed from the switch to external IN logic.

To summarise, each SIB in the GFP must be decomposed into a set of interacting functional entities in the DFP. The functionality of each SIB is achieved by information flows between the functional entities. Hence, the implementation of SIBs by FEs in the DFP allows services in the service plane to be realised.

CS-1 Physical Plane

This plane defines the real physical IN architecture. Each of the FEs in the DFP are mapped to a physical entity (PE) of the IN-structured network. Some of the typical physical entities that you would find in an IN-structured network are:

- **A service switching point** (SSP) which provides the service switching function (SSF) and the connection control function (CCF).
- **A service control point** (SCP) which contains a service control function (SCF) and a service data function (SDF). Hence, the SCP contains the service logic programs and the data that are used to provide IN services.
- **A service data point** (SDP) which provides the platform for a service data function (SDF), and thus contains customer and network data, which is accessed during the execution of a service.

In addition to the call-related PEs, other PEs exist for management and service creation. Also, in order to achieve an IN service, the physical entities need to be able to communicate. These information flows are implemented through a protocol known as the IN application protocol (INAP).

To summarise, each FE in the DFP must be mapped to a physical entity in the physical plane. The INAP enables the implementation of IN CS-1 services and service features by supporting the necessary interactions between the PEs.

IN Capability Set 2 (CS-2)

CS-2 is the second standardised stage of the intelligent network evolution, addressing the limitations of CS-1. Some of the enhancements that it intends to make are identified below:

- Enhanced IN services should be supported, such as mobility and broadband services.
- IN interworking should be supported. This enables national IN hardware platforms to be interconnected, allowing IN services to be available world-wide. The interworking of IN architectures is intended to support data, multiparty , video and multimedia services for all of ISDN, packet, mobile and B-ISDN technologies.
- Both IN service management and network management should be fully supported.

Like CS-1, the development of CS-2 standards has been based on the INCM. Since the enhanced architecture envisions new services in the service plane, this results in additional changes in the lower planes of the INCM. In the GFP, new SIBS must be defined and the basic call process SIB has to be enhanced. In the GFP, new functional entities may have to be defined, as well as existing entities enhanced, thus resulting in new information flows. In view of this, the INAP in the physical plane will need to be modified, in order to handle the new information flows in the DFP. Also, new physical entities may have to be defined.

From the service users point of view, instead of concrete services being defined (as was the case for CS-1), the following service categories have been defined:

1. Internet working services, such as Internet Televoting, based on interconnected INs.
2. call party handling services allowing several parties to participate in a particular call.
3. mobility services required for personal mobility, terminal mobility (e.g. support of cordless terminal mobility in an IN structured network) and mobile communication systems.
4. broadband services and bearer services, including connectionless and connection-oriented bearer services.
5. other service features, such as conference calling, which are outside the range of 'single ended' and 'single point of control' service features (see CS-1 service plane) and which were not fully addressed in CS-1.

One of the fundamental differences between CS-1 and CS-2 is the separation of the management-related functional entities from all other FEs in the DFP. CS-1 only defined a service management function, and considered the specification of common management interfaces to be outside the scope of standardisation. This approach greatly hinders the concept of vendor independence, as each vendor will develop its own management interface. This also makes the interworking of different IN platforms a particularly complex issue. This is because different IN management systems with different interfaces have to be interconnected. An IN management functional model has therefore been developed to standardise IN management interfaces. This model is based on standardised management architectures, such as the telecommunications management network (TMN).

Advanced Intelligent Network (AIN)

The majority of work on capability sets has been carried out by ITU and ETSI. However, INs have been studied by other organisations world-wide. Bellcore in the US have also been involved with IN standardisation, undergoing work on the advanced intelligent network (AIN). The AIN program was developed to address IN evolution in the local exchange carrier networks of the Bellcore client companies in the US. Thus, Bellcore specifications do not represent real international standards, but are considered to be standards in North America.

Like the ITU approach, AIN is developed in evolutionary steps, known as releases. These can be compared with CSs, although the contents and timing of releases do not necessarily coincide. Each release represents a set of marketable and maintainable AIN capabilities. To date, AIN release 0.1 and AIN release 0.2 have been produced.

Bellcore's work has focused primarily on the IN architecture contained in the lowest two planes of the INCM, namely the DFP and the physical plane. However, it should be stressed that there is no mention of the INCM within the AIN specifications.

Services and Capabilities

AIN 0.1 and 0.2 are closely aligned with CS-1, in that they support circuit-switched voice/data services, with an emphasis on flexible routing, flexible charging and flexible user interaction for two-party calls. AIN 0.1

and 0.2 services are considered to be single-ended but it is hoped that later AIN releases will support multiparty calls.

Architectures and Interfaces

AIN 0.1 focuses on service processing requirements and the network interworking required for the specific AIN 0.1 services. Also, as with CS-1, call modelling is used in AIN and is the foundation for the distributed architecture. However, AIN 0.1 goes beyond the CS-1 specifications by addressing service and network management requirements.

AIN release 0.2 can be compared with the revised version of capability set one (CS-1R). The basic difference between the two standards is the use of slightly differing call models, resulting in minor differences in the information flows. However, AIN releases and ITU capability sets are functionally converging with increasing speed, to define a single international IN standard.

BENEFITS OF INTELLIGENT NETWORKS

The main benefit of IN is the ability to improve existing services and develop new sources of revenue. To meet these objectives, providers require the ability to accomplish the following:

- **Introduce new services rapidely-** IN provides the capability to provision new services or modify existing services throughout the network with physical intervention.
- **Provide service customization**- service providers require the ability to change the service logic rapidly and efficiently. Customers are also demanding control of their own services to meet their individual needs.
- **Establish vendor independence-** A major criterion for service providers is that the software must be developed quickly and inexpensively. To accomplish this, suppliers must integrate commercially available software to create the applications required by service providers.
- **Create open interfaces-** Open interfaces allow service providers to introduce network elements quickly for individualized customer services. The software must interface with other vendor's products while still maintaining stringent network operations standards.

AIN technology uses the embedded base of stored program-controlled switching systems. The AIN technology also allows for the separation of service-specific functions and data from other network resources. This feature reduces the dependency on switching system vendors for software development and delivery Schedules. Service providers have more freedom to create and customize services.

Conclusions

This report has presented a simple overview of intelligent networks as defined by the international standard bodies. Some of the drawbacks of the traditional telephone system were identified along with the solutions provided by the intelligent network concept. This concept outlines a networking architecture in which the data and logic required for a particular service are removed from the telephone switching network, and put it into intelligent nodes, thus enabling additional network services to be easily introduced.

The IN conceptual model (INCM) and its role as a general framework for IN development has been described. Also, the international IN standards which provide the foundation for current IN implementation have been presented. Additionally, the relationships betweeen IN and other emerging concepts, such as TMN and mobile communication systems were addressed. To conclude, the future evolution of INs was considered by focusing on the telecommunications networking architecture (TINA), which is rapidly gaining momentum.

Only a very basic description of the IN concept has been introduced in this report. However, the field of INs is much more complex and furthur technical documents should be consulted in order to gain a deeper understanding of the IN architecture. Today INs are in use in various parts of the world. There are however still some problems in actual implementations which are methodically being resolved, and given time it is beleived that the IN will become a global networking infrastructure, interconnecting many national and regional installations around the world.

References

BOOKS:

- **Intelligent Networks**; Thomas Magendanz and Radu Popescu-Zeletin (International Thopmson Computer Press, 1996)
- **Intelligent Networks**; J.Harju, T.Karttunen and O.Martikainen (Chapmen & Hall, 1994)
- **Worldwide intelligent systems : approaches to telecommunications and network management**; J.Liebowitz and D.S.Prerau.(1995)

JOURNALS:

- **IEEE Communications Magazine**, March 1993
- **BT Technology Journal, Volume 13**, April 1995
- **British Telecommunications Engineering Magazine**, Vol. 15, April 1996

WWW SITES:

- **http://www.geocities.com/SiliconValley/2121/papers96.html**
- **http://www.fokus.gmd.de/ovma/Tangram/pub/aachen-abstract.html**

CONTENTS

ABSTRACT

An Intelligent Network (IN) is a service-independent telecommunications network.That is,intelligence is taken out of switches and placed in computer nodes that are distributed throughout the network.This provides the network operator with the means to develop and control services more efficiently. In IN the services are provided independently of the bearer networks or equipment vendors. The IN is essentially an architecture which separates the service logic from the telephone exchanges, enabling the establishment of an open platform for uniform service creation, implementation and management. It enables advanced customer orientated services to be rapidly and cost effectively introduced.

ACKNOWLEDGEMENT

I thank God Almighty for the successful completion of my seminar.

I express my sincere gratitude to **Dr. M N Agnisharman Namboothiri**, Head of the Department, Information Technology.

I am deeply indebted to Staff-in-charge, **Miss. Sangeetha Jose** and **Mr. Biju,** for their valuable advice and guidance. I am also grateful to all other members of the faculty of Information Technology department for their cooperation.

Finally, I wish to thank all my dear friends, for their whole-hearted cooperation, support and encouragement.