1.Intelligent Network (IN)

Intelligent Network (IN) is a telephone network architecture originated by Bell Communications Research (Bellcore) in which the service logic for a call is located separately from the switching facilities, allowing services to be added or changed without having to redesign switching equipment. According to Bell Atlantic, IN is a "service-specific" architecture. That is, a certain portion of a dialed phone number, such as 800 or 900, triggers a request for a specific service. A later version of IN called Advanced Intelligent Network (AIN) introduces the idea of a "service-independent" architecture in which a given part of a telephone number can interpreted differently by different services depending on factors such as time of day, caller identity, and type of call. AIN makes it easy to add new services without having to install new phone equipment. An **intelligent network** (IN) is a service-independent telecommunications **network**. That is, **intelligence** is taken out of the switch 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

It allows operators to differentiate themselves by providing value-added services in addition to the standard telecom services such as PSTN, ISDN on fixed networks, and GSM services on mobile phones or other mobile devices.

Examples of Value-Added Services

- Live streaming
- Location-based services
- Missed call alerts and voicemail box
- Mobile advertising
- Mobile money and M-commerce based services
- Mobile TV and OTT services
- Ring tones
- Online gaming
- Ringback tone (RBT and RRBT)
- SMS chatting and dating premium services

- Infotainment services
- Stickering
- WAP content downloads

The intelligence is provided by network nodes on the service layer, distinct from the switching layer of the core network, as opposed to solutions based on intelligence in the core switches or equipment. The IN nodes are typically owned by telecommunications service providers such as a telephone company or mobile phone operator.

IN is supported by the Signaling System #7 (SS7) protocol between network switching centers and other network nodes owned by network operators.

2.Services of IN

- Televoting
- Call screening
- Local number portability
- Toll-free calls/Freephone
- Prepaid calling
- Account card calling
- Virtual private networks (such as family group calling)
- Centrex service (Virtual PBX)
- Private-number plans (with numbers remaining unpublished in directories)
- Universal Personal Telecommunications service (a universal personal telephone number)
- Mass-calling service
- Prefix free dialing from cellphones abroad
- Seamless MMS message access from abroad
- Reverse charging
- Home Area Discount
- Premium Rate calls
- Call distribution based on various criteria associated with the call
    - Location-based routing
    - Time-based routing
    - Proportional call distribution (such as between two or more call centres or offices)
- Call queueing

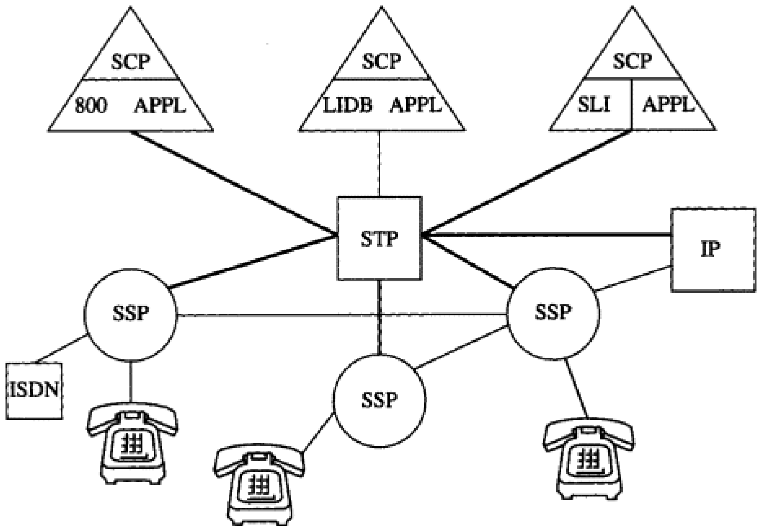
- Call transfer

3.Intelligent Network *Architecture* (INA)

The *Intelligent Network Architecture* (INA) is a model for organizing the programmable network elements and the communication between those elements. The objectives of that model are in part the same as those of the OSI reference model for computer networks: decomposition and standardization. INA is more complex in that it involves not only communication protocols and data elements as OSI does, but other network resources, including hardware elements. On the other hand, the OSI model is quite abstract, whereas the INA architecture is specifically designed for telephone networks.

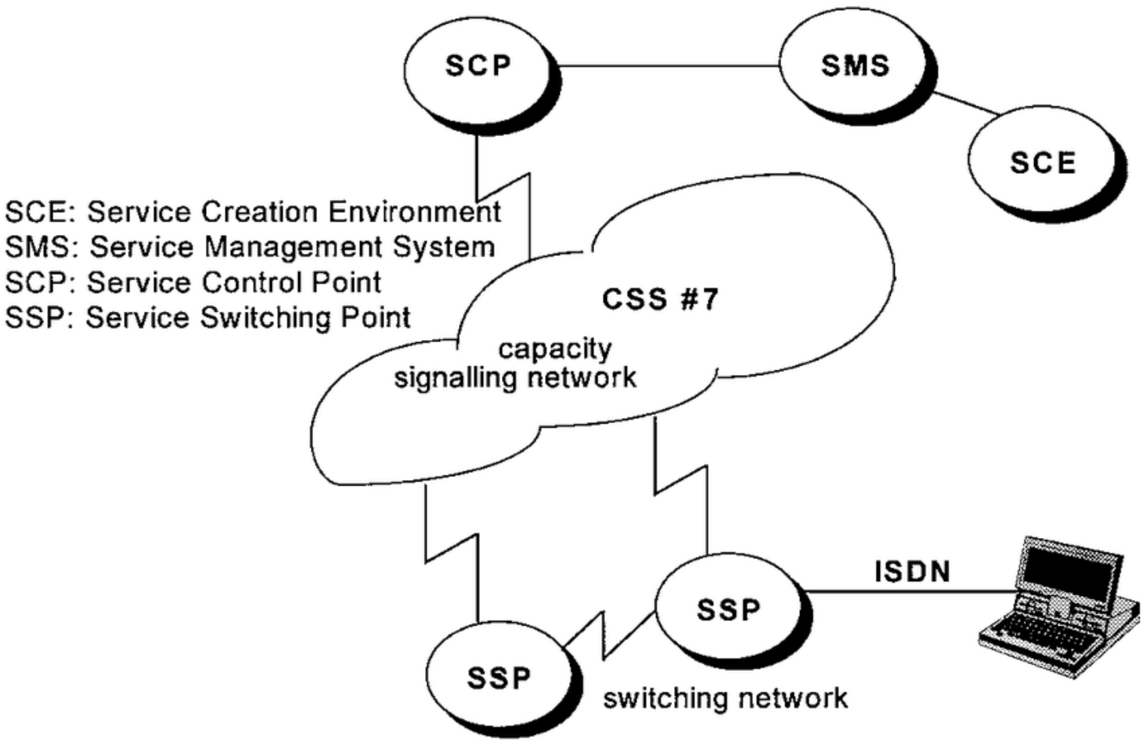
As we discussed above, the main feature of an intelligent network is that the *control functions* and the *network resources* are separated. The network has transmission and other resources, including subscriber lines, trunk lines, switch ports, databases, and voice recorders. The control functions are call-control functions and resource-control functions. Examples of these functions include connecting three network users in a conference call, playing a recording, and collecting digits dialed by a user. To implement a control function, the network executes a sequence of atomic operations called *functional components.*

INA classifies the network elements into three types: *service switching points* (SSPs), *service control points* (SCPs), and *intelligent peripherals* (IPs). (See Figure 5.29.) These elements exchange information over the *common channel signaling* (CCS) packet-switched network, using the *signaling system* 7 (SS7) protocol. INA calls the CCS network switches *signal transfer points* (STPs).



The figure shows three telephone sets and one IP attached to the network of SSPs. Regular lines denote the links used by the voice signals. The bold lines represent links of the CCS network. The SCPs contain databases and instructions for special applications.

The network elements are capable of performing different functions. The SSP can detect the need for IN service based on an originating line trigger such as off-hook, triggers applying to all calls such as for 800 or 911 calls, and terminating line triggers such as for call forwarding users. When such a trigger is activated, the SSP sends a request to the SCP for instructions. The SSP can identify, monitor, and allocate transmission resources (legs) connected to it. An IP can identify, monitor, and allocate nontransmission resources connected to it. The SCP detects IN service requests forwarded by the SSP. It then interprets the request according to a *service logic program* (SLP). A *service logic interpreter* (SLI) executes the SLP. A given SLI can execute multiple SLPs concurrently. The execution of the SLP involves invoking functional components and monitoring resources. Finally, at completion of the execution, the SLI notifies the SSP.



The Intelligent Networks (IN) architecture

The introduction of the IN architecture as an extension of the classic telephony service aimed to move the service control from the local node (the exchange) to a centralised service control point (SCP). Although the main task of the SCP in the early intelligent networks was to set up simple telephony services in the network, this separation of the service control from the call processing facilitated the enhancement of more complicated services on the existing network infrastructure.

The "conceptual model" of the IN architecture makes a clear distinction between the different views that a service may exhibit to the different stakeholders involved in the provision of services. The user's view of the service is called "service plane", while the modelling of the service independent building blocks (SIB) is described within the "global functional plane". The "distributed functional plane" provides a decomposition of the service building blocks to functional entities, and the "physical plane" refers to the deployment of the computational entities to the physical system. It is worthwhile noting that IN provides a particular SIB that processes the calls (basic call process) and also a charge SIB which allows specific charging for IN services. This latter can log a usage record, apply a specific charging policy to a call, or monitor accounting events.

The key advantages of intelligent networks, in service provision, are:

- The ability to offer new and advanced facilities.
- All staff within an organisation can have access to equal services, irrespective of the branch in which they are located.
- It enables operational services to be more easily sub-contracted.

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.

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.

Benefits Of IN:

The main benefit of intelligent networks 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 rapidly**—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 vendors' products while still maintaining stringent network operations standards. Service providers are no longer relying on one or two vendors to provide equipment and software to meet customer requirements.

4.Advanced Intelligent Network (AIN)

Advanced Intelligent Network is a particular kind of network which is evolving from the Intelligent Network (IN). In fact, an advanced intelligent network has got an independent architecture. This independent architecture allows telecommunication service operators to create and modify services very quickly according to network performance and a customer's requirements. In the intelligent network concept, the service providers require more control to offer new services. Further, the intelligent network is able to separate various specifications, creation, and control of telecommunication services from the physical switching network such that the Home Location Register (HLR) and the Visitor Location Register (VLR) are no longer integrated in the Mobile Telephone Switching Office (MTSO).

The essence of the AIN is that, the current PSTN is evolving into what is known as the Advanced Intelligent Network (AIN). In the old PSTN, the control functions for telephone services (service logic) are implemented in software that runs in telephone switches. In the AIN, service logic is implemented by Service Logic Programs (SLPs) that run in Service Control Points (SCPs). SCPs are, in most cases, ordinary commercially available microprocessor-based workstations or servers, running the same insecure operating systems that are used on most Internet hosts. SCPs communicate with switches through the SS7 network. In addition, SCPs will have connections (sometimes via other machines) to the telephone companies' corporate data networks to support such functions as customer service and billing. There are also plans to offer customers an Internet interface for changing their service parameters—such as the number to which their calls should be forwarded.

Network Characteristics of Advanced Intelligent Network (AIN)

AIN is evolving from IN. The various characteristics of AIN can be listed as under:

- It is a programmable network operable by either user or carrier provider, or both.
- Capable of rapid introduction of new services.
- AIN is service independent.
- Supplier transparent i.e. o en system architecture (OSA).
- Accessible for other service providers as well.
- Common channel signaling (CCS) makes out of band signaling.
- AIN makes use of CCS to deliver the call set-up signaling and the network information.
- Service logic- invokes AIN service logic programs (SLPs).
- The use of CCS can increase the speed of process for call process and information delivery

Elements of AIN and Interfaces of AIN

Elements of AIN An AIN consists of the following elements:

1) Service Switching Point The Service Switching Point (SSP) is a telephone switch. In order to participate in the AIN, a switch must be upgraded to run a version of software that conforms to the AIN call model and has triggers at specified points in

the call setup sequence. If a trigger is enabled, the SSP will, at that point in call setup, send a request to the SCP asking for instructions about how to proceed with the call setup.

2) Service Control Point The Service Control Point (SCP) is the brain of the AIN. The SCP invokes service logic programs. The common channel signalling network allows the SCP to fully interconnect with AIN switching systems via a signalling transport (STP). The switch (SSP) will consult the SCP at various points in the call setup sequence. The SCP will run its Service Logic Programs, consult its (customer-specific) databases, and return instructions to the switch. There is a requirement that the instructions be returned very quickly since the switch is in the middle of a call setup and the customer is waiting for the ringing tone to start. An SCP can provide service to multiple switches. The switch and SCP communicate over the SS7 network.

3) Service Data Point The Service Data Point (SDP) is a database server for the SCPs. It implements the Service Data Function (SDF). It contains the customer-specific databases that are queried by SLPs during call setup.

4) Intelligent Peripheral The Intelligent Peripheral (IP) serves a switch (or perhaps several switches), to which it is connected by an ISDN link. It provides such services as recorded announcements, voice recognition, and the collection of DTMF tones for later transmittal, when a customer, for example, is entering a PIN number. The Adjunct Processor (ADJ) provides the adjacent SSP (to which it is connected by an Ethernet link) with SCP-like services requiring faster response than can be obtained over the SS7 network from remote SCPs. Both the ADJ and the IP can run some SLPs.

5) Service Creation Environment The Service Creation Environment (SCE) is a development environment for Service Logic Programs (SLPs). The Service Management System (SMS) provides an interface between the SCE and the SCP for deploying new SLPs. It also provides other management functions such as the provisioning (initial setup) of services for customers, and the updating of individual customers' call processing options.

6) AIN Switch Routs a call to an IP to ask for a function. When the IP completes the function, it also collects the user’s information and sends it to AIN service logic(resides in SCP)via the AIN switch.

7) Operational System (OS) Provides memory administration, surveillance, network testing and network traffic management, maintenance and operation.

8) Signal Transfer Point (STP) The Signal Transfer Point (STP) is an SS7 packet switch. These, too, are part of the existing network. This is a point that interconnects the SCP and AIN switching systems.

9) Service Management Systems (SMS) It provides three functions as under:

(i) Provision-creates service order, validation, load record;

(ii) Maintenance-resolves record inconsistency, tests call processing logic, performs special studies;

(iii) administration- creates service logic, maintains service data.

Interfaces of AIN

The interfaces between AIN network elements are as under:

a) Between the switching system and SCPs or adjunct systems using SS7 signaling.

b) Between the switching system and IPs or service nodes using ISDN.

c) In AIN, between SCP and SMS using the X.25 protocol.

d) Between end users AIN services; may be either conventional analog or ISDN interface.

General Architecture of AIN

The AIN general architecture with the indicated AIN interfaces has been shown in figure 1 . In cellular systems, the channel link between the mobile switching system and the user does not make use of ISDN. Because, a 64 kbps ISDN channel needs a bandwidth of 64 kHz for radio transmission. In cellular systems, the data rate of a channel is 16 kbps or less, and needs only a bandwidth of 25 kHz or less. Using less channel bandwidth increases more spectrum efficiency.

The AIN system uses a Service Creation Environment (SCE) to created advanced applications. The SCE is a development tool kit that allows the creation of services for an AIN that is used as part of the SS7 network. A service management system (SMS) is the interface between applications and the SS7 telephone network. The

SMS is a computer system that administers service between service developers and signal control point databases in the SS7 network. The SMS system supports the development of intelligent database services. The system contains routing instructions and other call processing information. To enable SCPs to become more interactive, intelligent peripherals (IPs) may be connected to them. IPs are a type of hardware device that can be programmed to perform a intelligent network processing for the SCP database. IPs perform processing services such as interactive voice response (IVR), selected digit capture, feature selection, and account management for prepaid services. To help reduce the processing requirements of SCP databases in the SS7 network, adjunct processors (APs) may be used. APs provide some of the database processing services to local switching systems (SSPs).

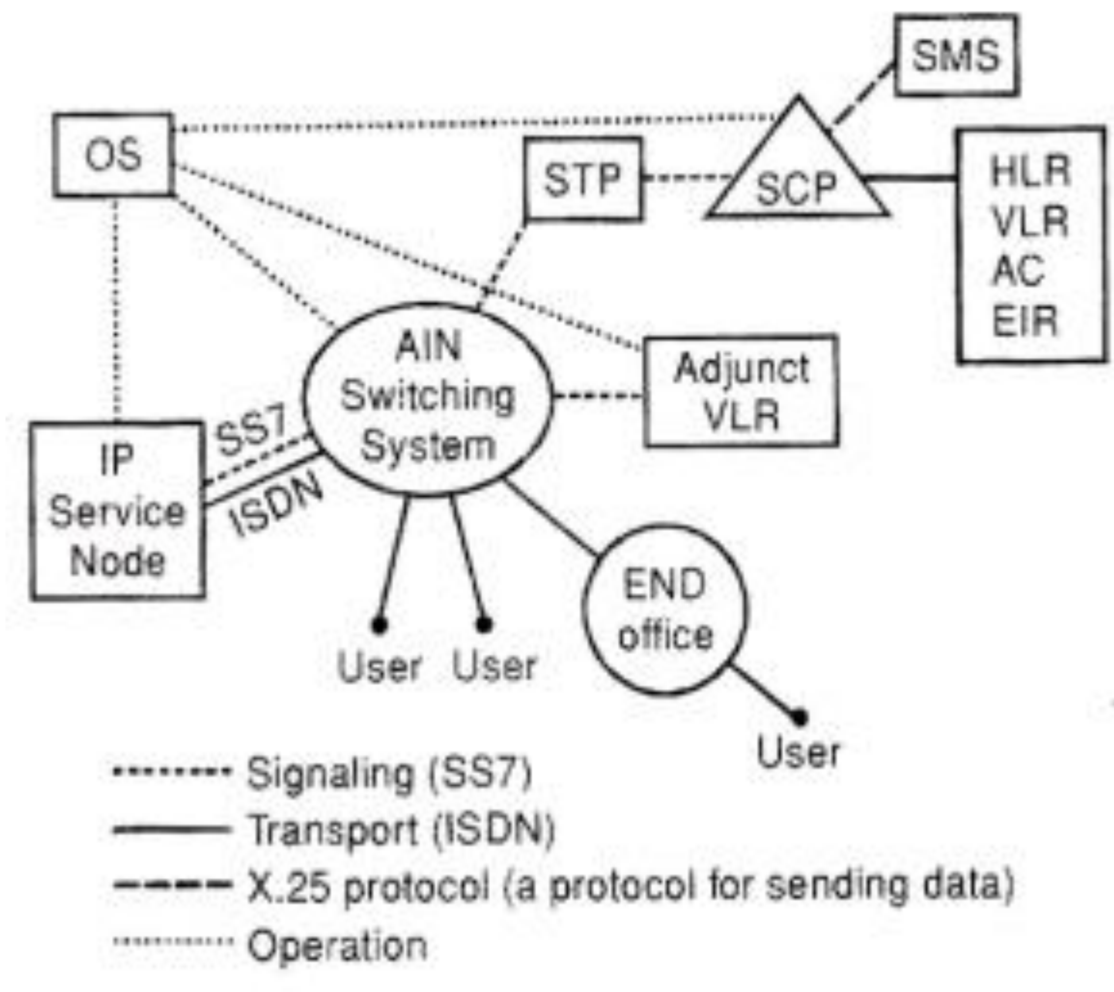


Fig.1 Illustration of AIN system architecture

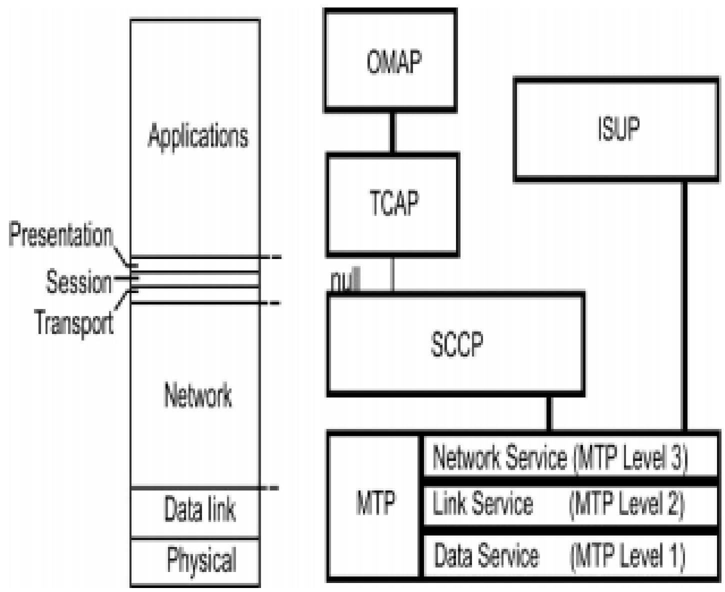
5.SS7 Network and ISDN for AIN

In this section, we discuss SS7 network and various related issues.

5.1 Evolution of SS7 Network This is an out-of-band signalling method in which a common data channel is used to convey signalling information related to a large number of trunks (voice and data). Signaling has traditionally supported. (1) Supervisory function , e.g., on hook-/off-hook to indicate idle or busy status; (2) Addressing function, e.g., called number; and (3) Calling information, e.g., dial tone and busy signals.

5.2 Common Channel Signaling The introduction of electronic processors in switching systems made it possible to provide common channel signalling. In 1976, Common Channel Interoffice Signaling (CCIS) was introduced. CCIS is based on the International Consultative Committee on Telegraphy and Telephony (CCITT) Signaling System No.6 recommendations and called CCS6. The CC6 protocol structure was not layered. It was a monolithic structure. The signalling efficiency was high. In 1980, CCITT first recommended SS7 a signalling system for digital trunks. The layered approach to designing SS7 protocols was being developed for Open System Interconnection (OSI) data transport. Also, the High-level Data Link Control (HDLC) bit-oriented protocols had an influence on the development of SS7 system.

5.3 Protocol Model for SS7 The inefficiencies of layered protocols are far outweighed by their flexibility in realization and management of complex functions. The protocol becomes more aligned with the seven –layer OSI reference model as shown in figure 2(a). The seven layers are physical, data link, network, transport, session, and presentation and application layer. The SS7 protocol model has been shown in figure 2(b) for comparison with the OSI model. In SS7 the Message Transfer Part (MTP) provides the OSI layered protocol model as level 1 data service, level 2 link services and level 3 network services. The full level 3 service is provided by the Signalling Connection Control Part (SCCP). SCCP provides an enhanced addressing capability that may be considered as level 3+ or a level close to level 4.Layers 4 to 6 in the OSI model do not exist in the SS7 protocol model. The Transaction Capabilities Application Part (TCAP) levels are considered the same as the application part (level 7) in OSI. IJCEM International Journal of Computational Engineering & Management, Vol. 11, January 2011 ISSN (Online): 2230-7893 www.IJCEM.org IJCEM www.ijcem.org 9 The Application Service Element (ASE) is at the same level as OMAP. TCAP includes protocols and services to perform remote operations. The primary use of TCAP in these networks is for invoking remote procedures in supporting IN services like 800 service



(a) (b)
Fig.2 (a) OSI Model (b) SS7 Protocol Model

OMAP provides the application protocols and procedures to monitor, coordinate, and control all the network resources which make communication based SS7 possible. ASE is for the MTP routing verification test (MRVT), which uses the connection less services of TCAP, MRVT is an important function of OMAP. 5.4 SS7 Network Link Deployment for AIN The SS7 links can provide high-speed service because of the common channel signaling. Based on the connection among the entire resource element, there are six links from A to E.

A link	STP ↔ SCP
	STP ↔ SP/SSP
B/D and C links	STP ↔ STP
E link	STP ↔ SP/SSP
F link	SP/SSP ↔ SP/ SSP

The SS7 network link deployment chart is shown in figure 3. The interfaces between any two entities are indicated by the letters from A to F.

5.5 ISDN Signaling has evolved with the technology of the telephone. The Integrated Service Digital Network(ISDN) is used to integrate all – digital networks in which the same digital exchange and digital transmission paths are used for provision of all voice and data services. Signaling in ISDN has two distinct components. a) Signaling between the user and the network node to which the user is connected (access signaling). The SS7 signaling is not used between the mobile user and the network node. b) Signaling between the network nodes (network signaling). The current set of protocol standards for ISDN signaling is Signaling System No. 7(SS7).

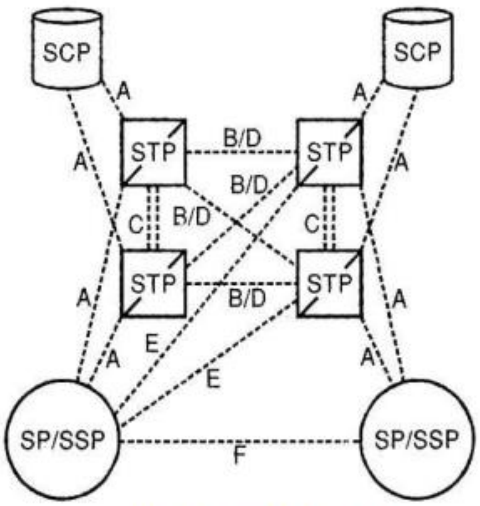


Fig3. SS7 Network Link Deployment

5.5.1 ISDN-UP In the SS7 protocol model, functions not covered by the SS7 levels will be provided by the ISDN-UP protocol, such as the signaling functions that are needed t support the basic bearer service and supplementary services for switched voice and data applications in an ISDN environment.

5.5.2 B-ISDN The broadband ISDN will support a range of voice, video, data , image and multimedia services using available resources. These resources include transmission, switching and buffer capaci5ty, and control intelligence. The target is to provide switched services over Synchronous Optical Network/Asynchronous Transfer Mode (SONET/ATM) transport using signaling based n the extended ISDN protocol.