LESSON 34:
DATA COMMUNICATION ARCHITECTURE

Objective

To provide a detailed understanding of the concepts of data transmission in PSTN's

Introduction

Computer Communication Architecture

Data communication among computers involves a number of functions such as:

1. Physical Transmission of bits
2. Error Control
3. Routing and session establishment

For implementing above functions efficiently, vendors of computer Systems evolved their own architectures.

Examples of vendor specific architectures are:

- System Network Architecture (SNA) of IBM
- Digital Network Architecture (DNA) of Digital Equipment Corporation (DEC).

These architectures permit interconnection of computers from the same vendor but not from different vendors. Systems or networks, which are not open to other vendor systems for networking, are known as 'Closed' systems or networks.

In order that heterogeneous computer systems from different vendors be interconnected as a network, an architecture which is used as a standard by all the vendors is required.

Heterogeneity of systems covers the following aspects:

1. Systems of different vendors
2. Systems under different managements
3. Systems of different complexities
4. Systems of different technologies.

The example of interconnecting heterogeneous Systems is the ARPANET. It is the network project supported by Advanced Research Project Agency of Department of Defence, U.S.A. The efforts put in and the experience gained in the project has significantly contributed to the emergence of world standards architecture for computer communication. The world standards architecture for computer communication is largely pursued and set out by International Standardisation Organisation (ISO). These Standards now well known as ISO-Open System Inter connection (ISO-OSI) Standards. These standards are widely accepted. These standards are based on a reference architecture which is described in the ISO standard is 7498. CCITT has also adopted this standard under its own number X·200. The architecture is considered 'open' as any vendor's system conforming this reference model is capable of organising information transfer with any other vendor's system which also conforms to the same architecture.

ISO-OSI Reference Model

In the discussion of this model, we use following definitions:

1. System
2. Subsystem
3. Layer
4. Entity

System:

A system is one or more autonomous computers and their associated software, peripherals and users, which are capable 6f information processing and/or transfer.

Subsystem

A logically independent smaller unit of a system. A succession of subsystems make up a system. It is shown in Fig. 34.1.

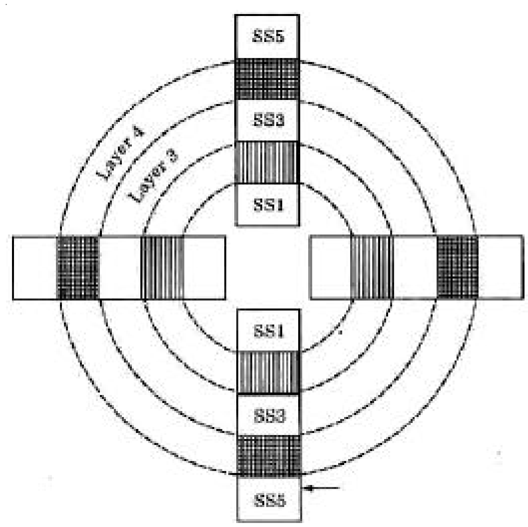


Fig. 34.1 Systems, subsystems and various layers in IS0-0SI model.

Layer:

A layer is composed of subsystems of the same rank of all the interconnected systems. The concept of a layer is shown in Fig.34.1. This figure shows a 5-layer network. The subsystems and the layers are numbered starting with one at the bottom.

Entity

The functions in a layer are performed by hardware subsystems and/or software packages. These are known as entities.

ISO·OSI architecture is a layered one. Layering is a natural choice for communication architectures.

It is well understood by an example. Consider the activities that are involved when executives A and B of two companies in different cities want to converse over a trunk telephone connection. Here, we assume that there is no STD facility between the two cities. Let executive A be the calling party. As the first step, executive A requests his secretary to connect him to executive B.

His secretary in turn calls up the trunk operator and communicates the calling number, called number, nature of the call, the name of the particular person called etc. Then, the local trunk operator calls up the other trunk operator in the other city and communicates the details. Remote trunk operator now calls up the secretary of executive E, who in turn confirms with executive E that he would like to receive the call and requests the operator that the call be put through.

This whole process of conversation between executives A and B without STD facility is depicted in Fig. 34.2.

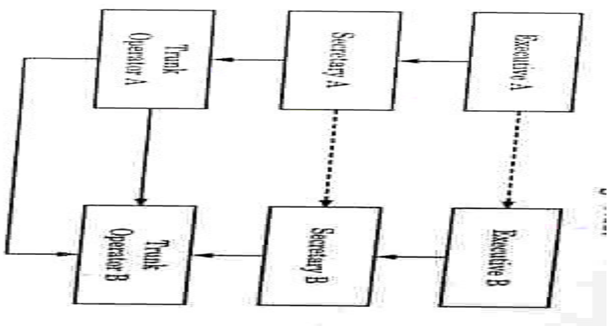


Fig.34.2 Illustration of a three layer structure for a trunk call connection

Some interesting observations about this whole process are:

1. A three-layer structure is used in this communication process.
2. The conversation between an upper and lower layer is strictly business like.
3. There is generally a little private conversation between the trunk operators and the two secretaries on account of their familiarity. In other words, entities in the same level or layer exchange information using their own private protocols.
4. A layer obtains services from its immediate lower layer and provides services to its immediate upper layer. In other words, we can say that a layer acts both as user as well as a service provider.
5. There are fairly well defined functions to be performed by each layer.
6. It is not so important that how the functions of each layer are implemented. For example, the secretary may ask his assistant to book the call and as far as the executive is concerned it' is immaterial who books the call as long as the call is booked.

ISO-OSI reference model (IS-7498) recommends standard reference conventions when discussing layers and their functions. Some of the important reference conventions are given as follows:

1. A layer is referred to as the (N) layer, *N* is the layer number
2. The layer immediately below *(N)* layer is called *(N* - 1) layer
3. The layer immediately above (N) layer is called *(N* + 1) later
4. Services offered by the (N) layer are termed (N) services
5. The entities of (N) layer are referred to as (N) entities.
6. Entities in the same layer, but not in the same subsystem, are caned peer entities.
7. Peer entities communicate using what are known as peer protocols
8. Data exchange between peer entities is in the form of protocol data units (PDUs)
9. Data exchange between entities of adjacent layers is in the form of Interface Data Units (IDUs)
10. IDUs exchanged between (N) and (N + 1) layers are referred to as (N) IDUs

The structures of protocol data units (PDUs) and interface data units (IDUs) ate shown in Fig. 34.3 *(a)* and Fig. 34.3 *(b),* respectively. Both PDUs and IDUs have two parts each. Control information and data.

Normally (N*)* PDU becomes (N - 1) interface data. It is illustrated in Fig. 34.3 (c).

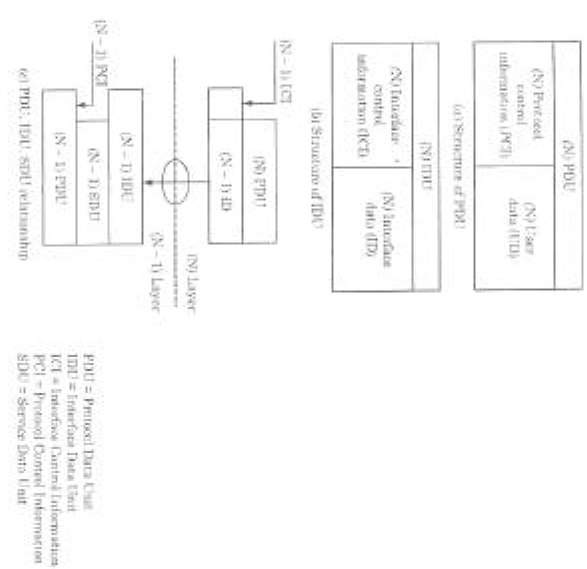


Fig.34.3 Illustration of structure of PDU and IDU

Depending upon the complexity of implementation only a part of (N) interface data may be sent to the receiving end of a connection, in which case this part is called (N) service data unit (SDU).

In simple implementation, (N) PDU, (N - 1) interface data and (N - 1) SDU are all the same.

Entities of a layer interact with entities of adjacent layers via service access points (SAPs). SAPs at the interface of (N) layer and (N + 1) layers are called (N) SAPs.

There are certain restrictions with regard to the use of SAPs.

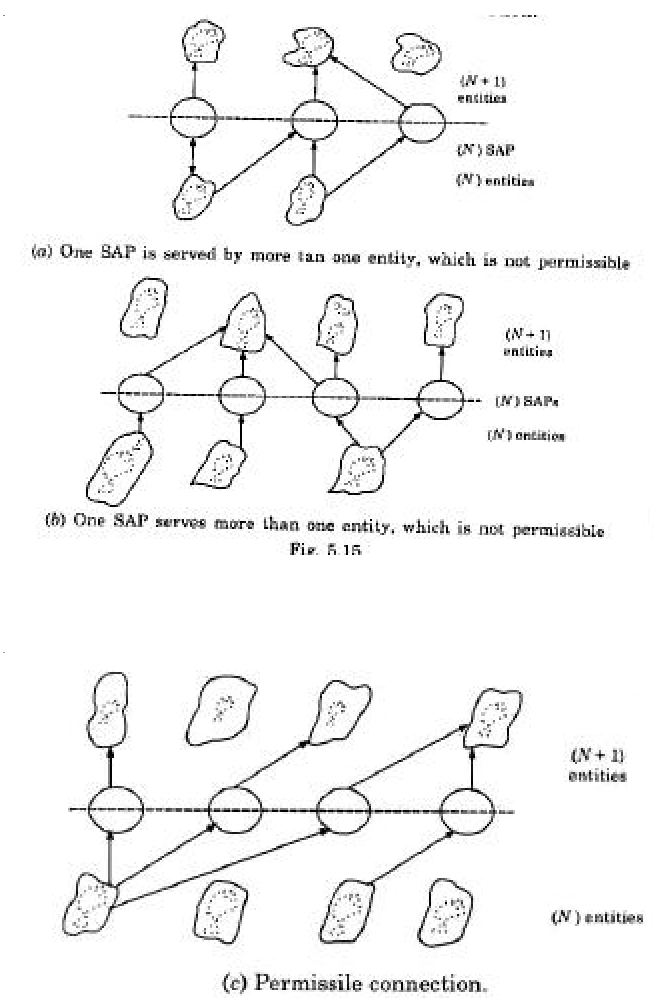
1. An (N + 1) entity may obtain services via one or more (N) SAPs.

2. An (N) entity may serve one more (N) SAPs.
3. An (N) SAP may be served by only one (N) entity and may serve only one (N + 1) entity.

These restrictions are shown in Fig. 34.4.

The connection shown in Fig. 34.4 (a) is not permissible because the (N) SAP in the middle is being serviced by two (N) entities.

Similarly, the connection shown in Fig. 34.4 (b) is also wrong because one of the (N) SAPs is serving more than one (N + 1) entity. The connection of Fig. 34.4 (c) is a valid connection.



(a) One SAP is served by more tan one entity, which is not permissible

(b) One SAP serves more than one entity, which is not permissible
Fig. 5.15

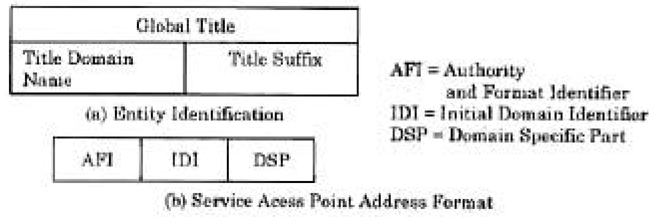
(c) Permissile connection.

Fig. 34.4 Address structure of entities and SAPs.

Entities in the OSI environment are identified by unique global titles. These global titles are valid regardless of the location and the movement of the entities. The global title is a structured address. It has two parts:

1. Time-domain name
2. Title suffix

Global title structure is shown in Fig.34.5



(a) Entity Identification

(b) Service Acess Point Address Format

Fig.34.5 Address structure of entities and SAPs.

The two-part structure facilitates delegation of authority to assign new global titles. There is also a provision to .use local titles within a limited context as specified by the title domain. The scheme of local and global titles is very similar to the scheme of local and global variables in structured programming languages such as Pascal or ALGOL. Entity addressing is functional from the point of view of users. Thus Entity addressing is location independent. But the actual access to an entity demands the knowledge of location of the entity. This is achieved by attaching an entity to SAP. This attachment is dynamic in nature. The SAP is detected as soon as the entity is released by the process. Entity and SAP addressing is similar to virtual and physical addressing schemes in a virtual memory computer system or logical and physical addressing of peripherals in computer.

Obviously, SAP addressing is location independent. The format of the SAP address is given in Fig. 34.5 (b)

The authority and format identifier (AFI) field can take on values from 10 to 99, AFI currently specifies three major authorities:

1. CCITT
2. ISO member bodies
3. ISO international organisations.

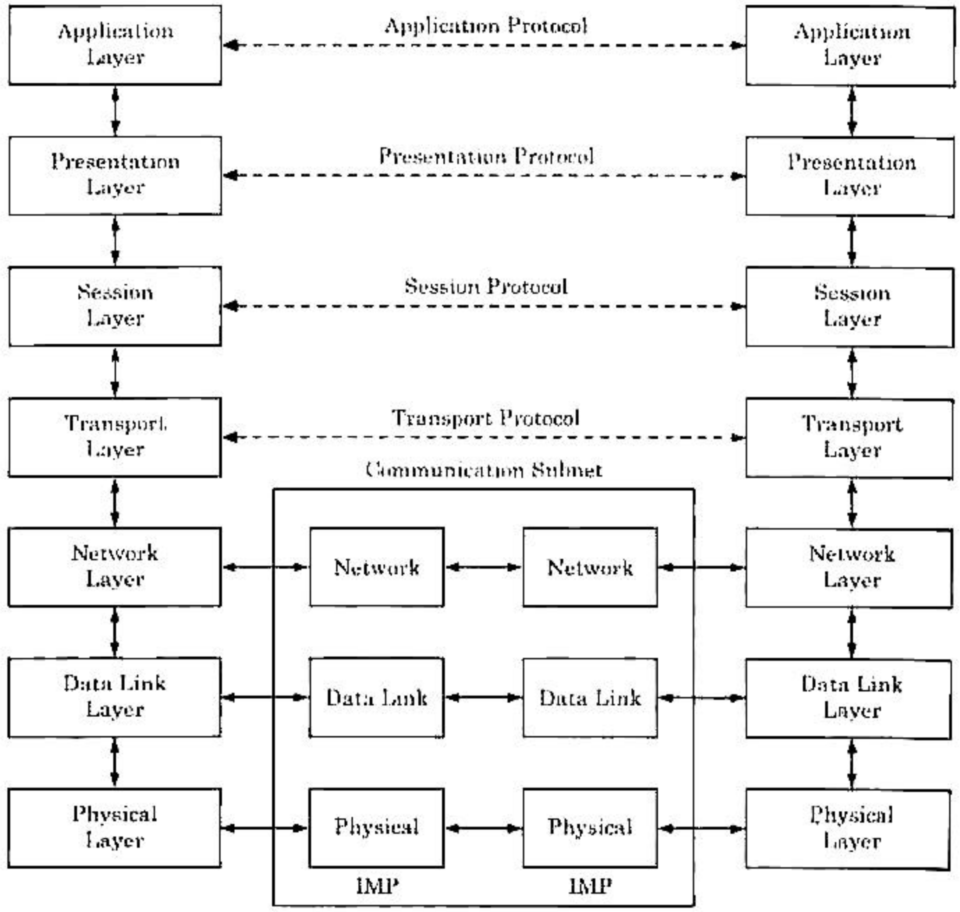
AFI also identifies the format and type of address present in the initial domain identifier (IDI) field and the domain specific port (DSP).

Binary and packed decimal formats are generally supported. IDI and DSP types may include PSTN numbering, Packet switched network numbering, ISDN numbering. Telex numbering and other similar numbering schemes. The full SAP address is of variable length (up to 40 decimal digits Of 20 bytes). An important objective of SAP addressing format is to enable convenient Internet working.

OSI reference model proposes a general layered concept. The OSI reference model has the provision for adding or deleting layers as demanded by factors like service complexity, technology options etc. A 7-1ayer ISO-OSI model is shown in Fig. 34.6.

In this figure, two end systems that communicate with each other *via* two intermediate systems are shown. Only the first three layer functions come into action is an intermediate node.

Entities in these layers always communicate with peer entities in the adjacent system. In other words, in the first three layers, the communication proceeds on link-by-link basis. Layers 4 to 7 communicate with peer entities in the end systems. There is no communication with the entities in the intermediate systems. Therefore, layers 4 to 7 are often called End-to-End layers. The seven-layer architecture has been arrived at after a careful



Notes

application of a broad set up layering principles.

We have following important principles:

1. Create layers to handle functions which are manifestly different in the process performed or technology involved.
2. Collect similar functions into the same layer and create a boundary at a point where the number of interactions across the boundary are minimised.
3. Create a layer of easily localised functions so that the layer could be totally redesigned and its protocols changed in a major way to take advantages of new advances in architectures hardware and software technology without changing the services offered or the interfaces with the adjacent layers.