CRITERIA FOR THE DESIGN OF TELECOMMUNICATION SYSTEMS

The design for telephone switching center or equipment requirement in a telecommunication system is determined on the basis of the traffic intensity of the busy hour. The traffic intersity is defined as the product of the calling rate and the average holding time. The busy hour is defined as that continuous sixty-minute period during which the traffic intensity is highest.

Otherwise the average holding time is the average duration of occupancy of traffic path by a call.

Grade of Service: In telephone field, the so called busy hour traffic is used for planning purposes. Once the statistical properties of the traffic are known, the objective for the performance of a switching system should be stated.

GOS is a measure of congestion expressed as the probability that a call will be blocked or delayed. Thus when dealing with GOS in traffic engineering, the clear understanding .of blocking criteria, delay criteria and congestion are essential.

Blocking criteria: If the design of a system is based on the fraction of calls blocked (the blocking probability), then the system is said to be engineered on a blocking basis or call loss basis. Blocking can occur if all devices are occupied when a demand of service is initiated.

Delay criteria: If the design of a system is based on the fraction of calls delayed longer than a specified length of time (the delay probability), the system is said to be a waiting system or engineered on a delay basis. Delay criteria are used in telephone systems for the dimensioning of registers. In waiting system, a GOS objective could be either the percentage of calls which are delayed or the percentage, which is delayed more than a certain length of time.

Congestion: It is the condition in a switching center when a subscriber cannot obtain a connection to the wanted subscriber immediately. In a circuit switching system, there will be a period of congestion during which no new calls can be accepted. There are two ways of specifying congestion.

1. **Time congestion:** It is the probability that all servers are busy. It is also called the probability of blocking.

2. **Call congestion:**It is the proportion of calls arising that do not find a free server. Call congestion is a loss system and also known as the probability of loss while in a delay system it is referred to as the probability of waiting.

Measure of GOS:GOS is expressed as a probability. The GOS of 2% (0.02) mean that 98% of the calls will reach a called instrument if it is free. Generally, GOS is quoted as P.02 or simply P02 to represent a network busy probability of 0.02. GOS is applied to a terminal-to-terminal connection. For the system connection many switching centers, the system is generally broken into following components.

(*i*) An internal call (calling subscriber to switching office)

(*ii*) An outgoing call to the trunk network (switching office to trunk)

(*iii*) The trunk network (trunk to trunk)

(*iv*) A terminating call (switching office to called subscriber)

The GOS of each component is called component GOS. The GOS for internal calls is 3 to 5%, for trunk calls 1-3%, for outgoing calls 2% and for terminating calls 2%. The overall GOS of a system is approximately the sum of the component grade of service. In practice, in order to ensure that the GOS does not deteriorate disastrously if the actual busy hour traffic exceeds the mean; GOS are specified 10% or 20% more of the mean.

FUNDAMENTALS FOR THE DESIGN OF TELECOMMUNICATION NETWORK:

A telephone network is composed of a variety of all processing equipment, interstate switching links and inters office trunks. Because of the random nature of the call request, the design ofequipment switching links and trunks are quite difficult. Thus, the traffic analysis is thefundamental request for the design of cost effective, efficient and effective configuration ofnetworks. The effectiveness of a network can be evaluated interms of how much traffic itcarries under normal or average loads and how often the traffic volume exceeds the capacity ofthe network.Fundamental problem in the design of telecommunication networks concerns thedimensioning of a route. To dimension the route, volume of traffic required grade of serviceand capacity (in bits per sec) must be known.

Traffic: In telecommunication system, traffic is defined as the occupancy of the serverin the network. There are two types of traffic viz. voice traffic and data traffic. For voice traffic,the calling rate is defined as the number of calls per traffic path during the busy hour. In a day,the 60 minutes interval in which the traffic is highest is called busy hour (BH).

Average occupancy: If the average number of calls to and from a terminal during aperiod T second is '*n*' and the average holding time is '*h*' seconds, the average occupancy of theterminal is given by

$$A = \frac{nh}{T}$$

The average occupancy is also referred as traffic flow of traffic intensity. The internationalunit of telephone traffic is the Erlang.

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DISTRIBUTED&CENTRALIZED SWITCHING SYSTEM

Distributed Model

A simplest way of structuring the telecommunication switching is the terminal-toterminalconnection. This kind of switching is called distributed switching and applied only to small telephone system. Some examples of distributed switching are shown here. Fig. 1.3 shows the full interconnection of five terminals.

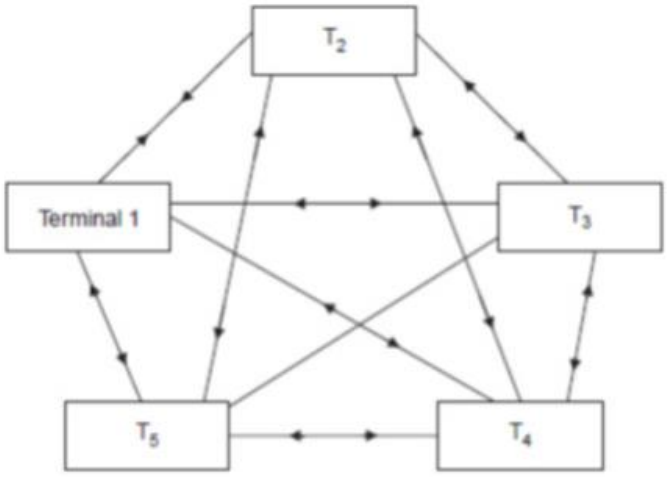

Fig 1.3 Distributed model[4]

Each terminal has two kinds of switches, one to make required link and other to connect a link to receive a call. By this method, for N terminals, the numbers of links required are 1 2 N (N – 1) Fig. 1.4 shows the interconnection of four terminals but only with 4(N) links. Here each terminal is connected permanently to one channel and all other terminals may be accessed by operating a switch. Also it removes the need to connect a terminal to a link for an incoming cal.

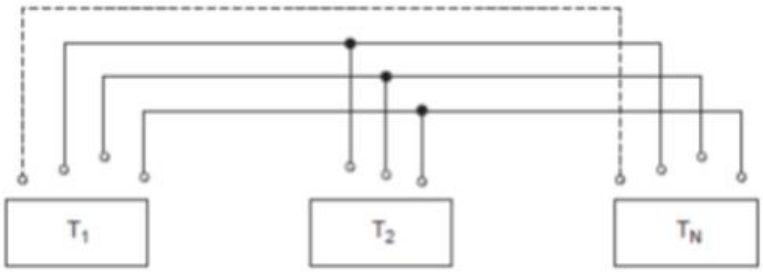

Fig 1.4 Centralized model with (N-1) links [5]

In this arrangement, a calling terminal sends a calling signal to indicate the called terminal to which the terminal should be switched in order to receive the call. The recognition of an incoming call and switching operation may be performed automatically in system using coded signals.

Centralized Model:

The distributed system cannot be extended to large terminal cases and the increased geographical separation of terminals. A simple centralized system, which reduces the average length of transmission link, and hence the transmission cost is shown in Fig. 1.8. But this system increases the total switching costs. Introducing more local centers instead of one national center switching machine can further reduce the transmission cost. Two local centers are connected by links called trunk. A trunk in telephone system is a communication path that contains shared circuits that are used to interconnect central offices. Fig. 1.5 shows the telecommunication system for short distances, with two exchanges (switching offices).

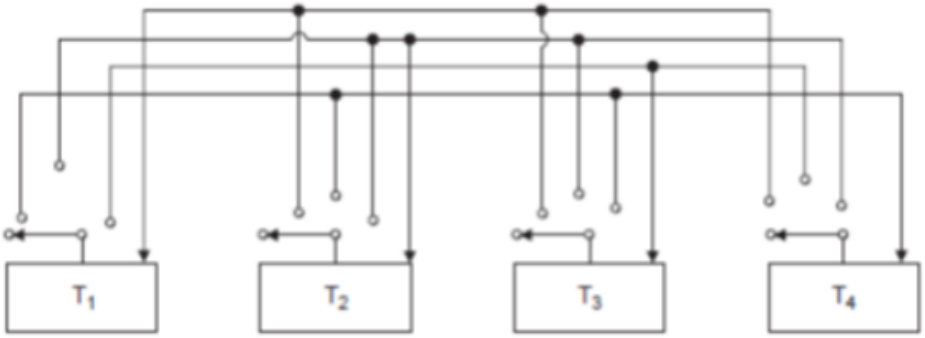

Fig 1.5 Type of centralized model [5]

Classification of Switching System:

In early days, the human exchange provided switching facilities. In manual exchanges, a humanoperator and the elements like switches, plugs and sacks were used to connect two subscribers.Around 1890's many electromechanical switching devices were introduced. Till 1940, differentelectromechanical switching system were invented, of which strowger switching system andcross bar switching system were still popular. The later invention of electronic switching system(ESS) which uses stored program control (SPC) and computer controlled switching systemsare presently dominating the worldwide exchanges. Fig. 2 below shows the classification of switchingsystem.

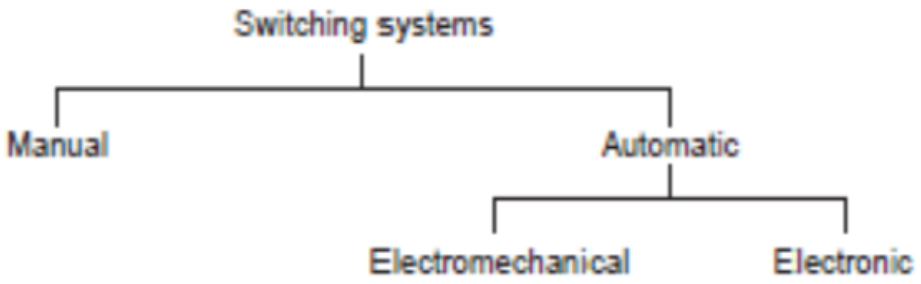

Figure 2. Classification of the switching system [1]

NUMBERING AND ADDRESSING:

In telephone and data networks, the end equipment are more often single units than multiple device units like PABX or LAN. Primarily a telephone, a computer, or a terminal has been the predominant end equipment. The numbering system is generally required single equipment end points.

But, in ISDN multiple device at the end points are more of the normal than single units. so it requires specific equipment end points. Specific equipment is a two level process; first the end point is identified as in the case of telephone or data network and then equipment at the end point. The component of the ISDN address which is used to identify the end point is known as the **ISDN number,** and the component for identifying the specific equipment at the end point is called as **ISDN sub address.**

The numbering plan for ISDN is as follows:

1. It is based on, and it is attachment of, the telephone numbering plan. In particular the country code is evolved for the telephone numbering is defined as CCITT standard E.163 is adopted in to for ISDN.
2. It is dependent of nature of the service (e.g. voice facsimile data) or the performance characteristics of the connection.
3. It is dependent of routing, i.e. the numbering or addressing does not specify the immediate exchanges through which the service is to be put through. Some addressing schemes in data network demand that the complete route from source to destination be specified as a part of address. E.g. UNIX.
4. It is the sequence of decimal digits. No alphabet or other characters are permitted as part of the address.
5. Its design is such that interworking between ISDNs require only the use of ISDN number and no other additional digits or addressing signals.

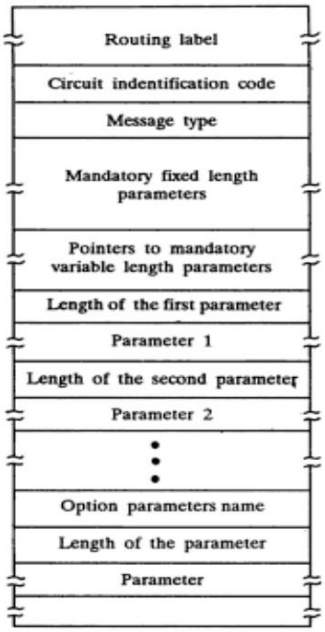

Fig.63: Message format for ISDN user part [1]

Address Structure

In ISDN address the number part is maximum of 15 digits and the ISDN sub address part a maximum of 40 digits.

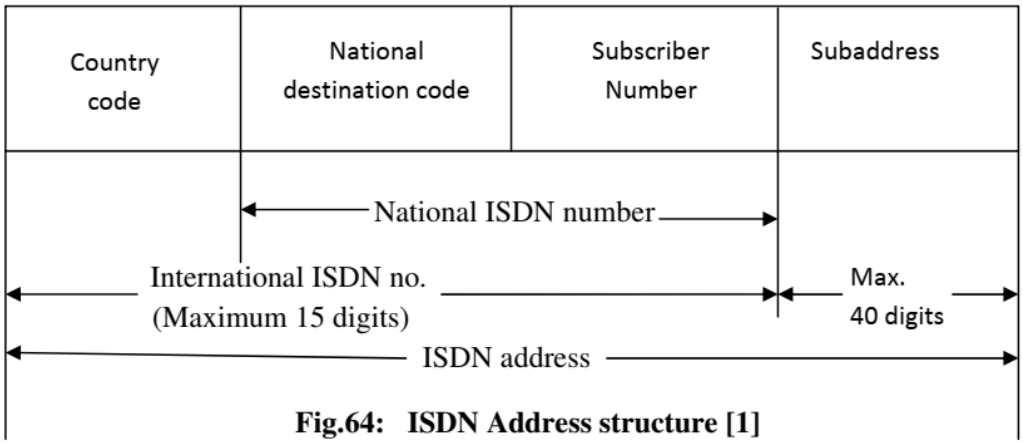

Fig.64: ISDN Address structure [1]

National destination code is like an area code in telephony network and is of variable length. ISDN subscriber number is the only normally listed in the directories. An ISDN number is a unique worldwide address and unambiguously identified an end point connection. The end point may be

1. Single S or T reference point
2. One of many T reference points at the same site
3. One of many S reference points using direct inward dialing feature.

A single S or T reference points may also be addressed by multiple ISDN numbers. This feature generally used in internetworking.

A sub address is a part of ISDN address, is carried in separate field in the user network interface message. The typical address using both ISDN number and the sub address as shown figure below.

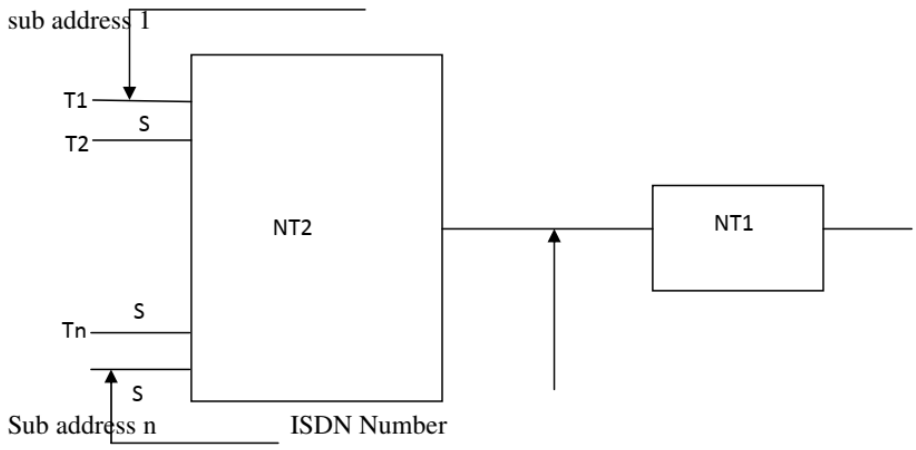

Fig.65: Example of ISDN addressing [1]

SERVICE CHARACTERISATION

ISDN services placed under two categories:

- ➔ Bearer service
- ➔ Teleservices

Bearer services are accessible at T and S reference points for ISDN compatible equipment. For non ISDN terminals the bearer service is accessible at R reference points of the user network interface. A packet data transmission is an example of bearer service, whereas telephony,teletex,videotext and facsimile are under class of teleservices.

Figure 62 shows the ISDN service possibilities.

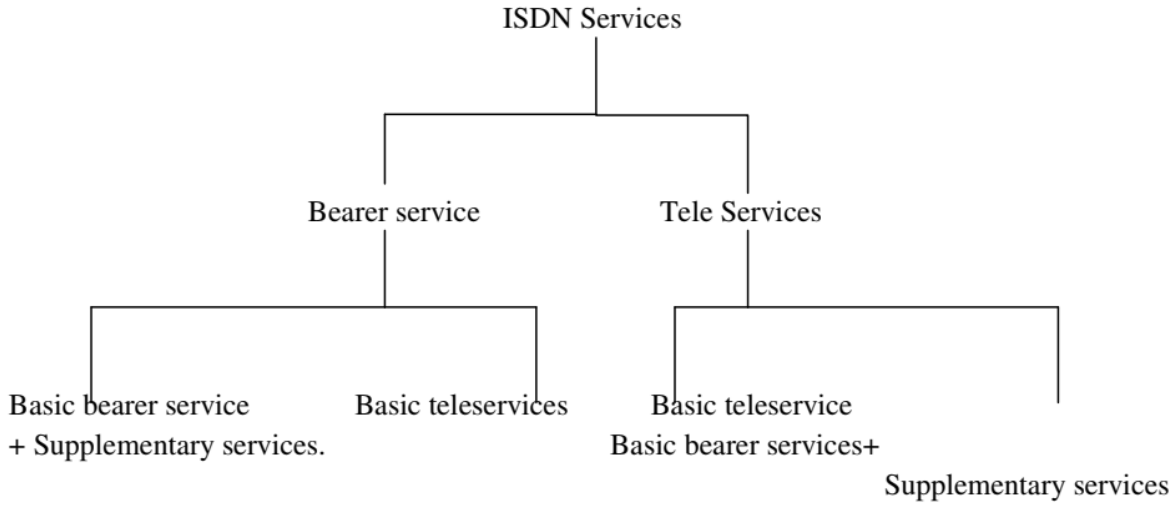

Fig.66: ISDN service categories [1]

Supplementary services call for additional functionalities both in lower and upper layers, depending on whether they supplement a basic bearer service or a basic teleservice.
Bearer service or lower level service attributes are under three categories:

1. Information transfer attributes
2. Access attributes
3. General attributes

Information transfer attributes describe the network capabilities for digital information transfer from S/T reference point of one customer to one or more S/T reference points of other customers. The attributes used for the purpose

1. Transfer mode- circuit switched mode or packet switched mode
2. Transfer rate- one of many standard rates
3. Structure-This type of transmission implies that the integrity of data is maintained by conveying timing information along with the data transmitted.
4. Transfer capability- It specifies the ability of network to carry structured data or unstructured data, restricted or unrestricted data, speech,audio and so on.

Some typical examples of transfer capabilities are:

➔ 8KHZ structured unrestricted
➔ 8KHZ structured speech
➔ 8KHZ structured ,3.1KHZ audio

The information transfer attributes 1-4 are referred to as **dominant attributes**.

5. Establishment communication-It can take three values demand, reserved, or permanent connection. In demand communication, a set communication is setup and released on demand. In reserve mode setup and release time is fixed in advance by the customer. In permanent a connection is pre-established.
6. Establishment of connection-It may take three values: switch, semi-permanent, permanent. Semi-permanent connection is a switched connection but provided for an indefinite period. Permanent connection is non switched connection, like a leased line bypassing the ISDN exchange.
7. Communication configuration-The configuration of communication may be point-to-point, multipoint or broadcast.
8. Connection configuration-The attribute connection configuration is of three sub attributes:
   → Topology
   → Uniformity

→ Dynamics

Topology may be simple with one connection element or tandem with two or more connections being formed with two or more elements put in parallel. **Uniformity** specifies the homogeneity of elements involved in connection. The **dynamics** connection deals with temporal aspect of establishing or releasing connections.

Symmetry deals with the information flow characteristics. Information flow may be unidirectional or bidirectional symmetric or bidirectional asymmetric. The information transfer attributes 5-9 are referred to as **secondary attributes.**

The third category of bearer service attributes, i.e.**general attributes** including the followings.

1. Supplementary services
2. Quality of services
3. Connection performance
4. Interworking
5. Commercial or operational attributes

A List of supplementary services in ISDN

Abbreviated dialing	closed user group
Do not disturb	reverse charging
Call waiting display	call forwarding
Call bearing	conference calls
Three party services	directdialing
City wide Centrex	credit card calling

A number of parameters are associated with quality of services:-

Flexibility-Ability to choose different services or terminal equipment and to interwork services
Cost/Charging-Ability to give correct billing and appropriate billing/ charging information desired by the user.
User friendliness- Provision of prompts and voice announcements
Ergonomicity-Aesthetic and ergonomic aspects of terminal equipment
Waiting time- Waiting time for the user to obtain service or terminal equipment
Enhance ability-Progressive introduction of new facility and technology upgrades.
Reliability-Mean time between failures, mean time to repair.
Promptness- Delay in establishment /release in connection
Fidelity-quality of production
Backup assistance-User training, maintenance
Transfer speed-End to end information transfer time or through put
Universality-ability to interwork other private or public network

The attributes characterizing teleservices are also placed under three broad categories.:

1. Low layer attributes
2. High layer attributes
3. General attributes

Low layer attributes is same as the attributes for bearer services and in particular the information transfer and the access attributes. High layer attributes deal with different communication aspects such as voice, audio, text, facsimile and picture transmission. They are defined in the forms of protocol confirming the OSI model.

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