Lecture – 9 (Dt. 13th April 2020)

Electronic Switching (EC- 8th Sem)

Telephone Network Organization

References :

1) S. Agrawal : Lecture Notes (VSSUT)

2) Telecommunication Switching Systems & Networks, Thiagrajan

3) Telecommunication System Engineering, R.L. Freeman

4) Telecommunication Switching and Networks, By, P. Gnanasivam

5) Internet sources

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TELEPHONE NETWORK ORGANIZATION

A telecommunication network contains a large number of links joining different locations, which are known as the nodes of the network. These nodes may be end instruments (subscriber nodes), switching centres (switching nodes), networks providing just a link between nodes (transmission nodes) or service nodes (which provides service on demand such a voice mail boxes, stock market price announcement, sports results etc.). To provide efficient communication, a telephone network should include various transmission system (for example, terestial, microwave, optical satellite communications), switching system (to identity and connect calling and called subscriber) and to exchange information between subscriber and switching systems or between interexchange, a good signalling system required. The calling and called subscriber should be connected almost instantly. So, as an identification, a numbering system is introduced and it varies region to region and country to country. Telephone networks require certain form of procedure to route a particular call to the destination for effective and cost effective communication. So, the telephone network should

be implemented with a good routing plan. An establishment of an exchange includes heavy expenses on switching equipment, establishing trunks and links, buildings, infrastructure, human resources to handle the exchange etc. These capital lost and the day-to-day expenses must be met by the exchanges through its subscribers. So, the billing and charging the subscriber calls or data transfer is a vital part of the network. Also, introducing a new exchange, extension of the existing exchanges, upgradation of the facilities and speed up the switching, changing the sales strategy based on the competition, addition of new services, management of maintenance, providing employment to the skilled peoples etc., are based on the government policies or the telephone company's business strategies. Thus, the functions of telecommunication networks is limit less and network management is an important part of any telecommunication network organization.

NETWORK MANAGEMENT

The basic goal of the network management is to maintain efficient operations during equipment failures and traffic overloads. Also controlling the flow of call requests during network overload is a vital function of network management. For the effective network management the study of various services provided by the network, offered load of the network, classification of the network based on services offered, interconnection of different types of networks and network planning is important. Based on the data available for the above factors, the network management has become updated.

Network Planning

The planning of telecommunication system comprising a network of switching centres includes various plans. From initiating the network to the extension of the network based on the increased load, network planning plays a vital role.

Network services: The capabilities often collectively referred to "as intelligence" within the network are listed below. Depending upon the applications the network is to handle the interconnectivity with other networks. The following functions and its essential parts are included in the network. Various services are:

1. **Switching.** The process of interconnecting incoming calls or data to the appropriate outgoing channel called destination is referred switching.

2. **Routing.** The ability of the network to select a path to connect calling and called subscriber for telephone conversations or providing path for data transfer between source and destination is referred as routing. The network generally choses a path and sometimes user may specify it.

3. **Flow control.** It is the ability of a network to reject traffic. Managing the rate at which traffic enters a network is referred to as flow control. A network without effective flow control procedures becomes very inefficient.

4. **Security.** There are two ways of providing security of the network. First, to increase the security of operation in presence of faults. To provide adequate security, the complete network may be duplicated or triplicated. Second, preventing unauthorized access to the network and the data it carries. This may be achieved by pass words, data encryption and providing limiting factors in accessing the network.

5. **Signalling.** A signalling system link the variety of switching system, transmission system and subscriber equipment in a telecommunication network to enable the network to function as a whole.

6. **Traffic management.** The ability of the network to keep track of traffic levels is referred as traffic management. Traffic management is useful both in short term and long term bases. On a short term basis, it can be used to support dynamic routing and flow control. Over a long term it can be used in network design to identify parts of the network where capacity may be productively increased or decreased.

7. **Accountability.** This includes charging, billing, accounting and inventory control. This is the ability of the network to track the users of the network.

8. **Administration.** It is related to the ability of the network to identify the load of a network and providing corresponding upgradation of parts, extension of networks facility. It also identities the sales strategy, investment planning etc.

9. **Inter-networking.** It is the ability of the network to perform the functions needed to communicate with and across other networks. This includes providing routes for traffic crossing through, into and out of the network, and allocating resources such as buffers and link capacity to traffic originating other networks.

Network levels: All the above functions and some other service related functions are usually classified or grouped into different levels. This grouping ease the network and the concerned

network engineers to carry out the functions efficiently. The grouping differs from network to network or divisions to divisions or between telephone companies. The ability of the network to provide these functions has a profound effect on the type of network. In particular, the nodes of the network become more complex and more expensive as their functionality increases. Fig. shows the different levels of the network management.

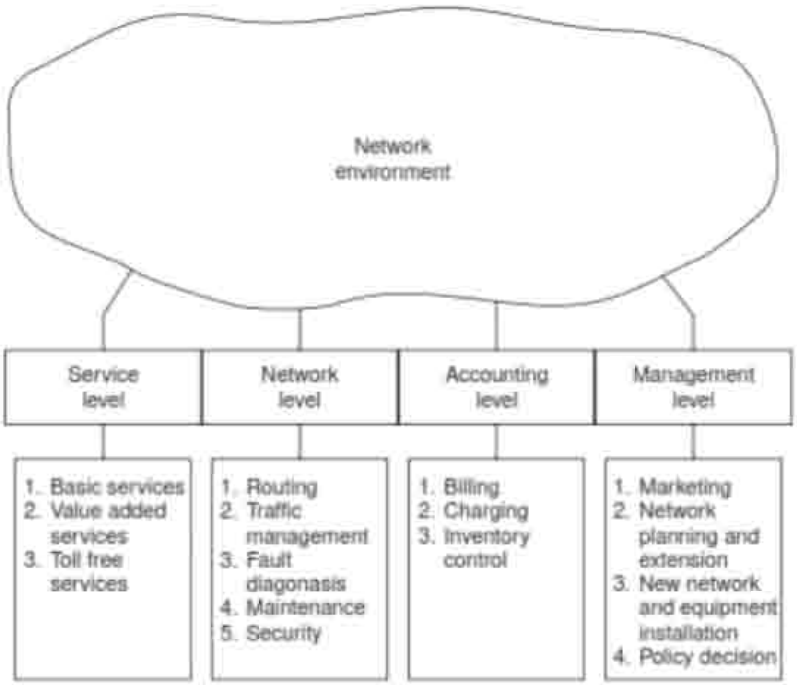


Fig. Different levels of network management.

Various networking plans: A national telecommunication network is large and complex. Therefore certain plans are needed to govern the design of network. The plans are independent and are affected by the predicted (or planned) growth rate of the telecommunication system. More specific network planning are :

1. Routing plans

2. Numbering plans

3. Charging plan

4. Transmission plan

5. Signalling plan

6. Grade of service

7. Network control and network administration.

The choice of a plan for a telecommunication system generally involves comparison of the economics of various possible plans. It also involves comparison of the economy of various possible plans and involves a certain amount of human judgement.

Types of Networks

There are in general three networks which can be used for any services (voice or data transfer).

They are:

(*a*) **Public switched network.** It allows access to the end office, connects through the long-distance network, and delivers to the end point. There are many hierarchies depends on the wish of network provider. But, the goal of the network hierarchies is to complete the call in the least amount of time and the shortest route possible.

(*b*) **Private networks.** Many companies, depending on their size and need, create or build their own networks. If their networks are underutilised, they may give their network for hire or lease. These networks employ mixture of technologies.

(*c*) **Hybrid networks.** To provide a service, if an organisation uses both private and public networks, the network is referred as hybrid network. Normally, the high-end usage services are connected via private facilities, the lower volume locations use the switched network.

This usually works out better financially for the organisation because the costs can be fully justified on a location by location basis. As the private line networks are designed to suit integration of voice, data, video graphics and facsimile transmission, pressure is more on it.

The customers are generally in need of variety of services. Even though certain networks are used to perform many services, they are more effective for a particular one or two services.

Hence, based on the services, the networks are classified as

1. The Public Switched telephone Network (PSTN)—for telephony.

2. The public switched telegraph network—for telex

3. Data networks—for voice and data

4. Cellular radio network—for mobile communication

5. Special service networks—to meet specialised demands.

As the above networks may be used to perform mixture of services, many authors categorised the networks into only three classes. They are generally considered as major telecommunication networks.

1. PSTN or POTS

2. Data networks

3. ISDN.

ROUTING PLAN

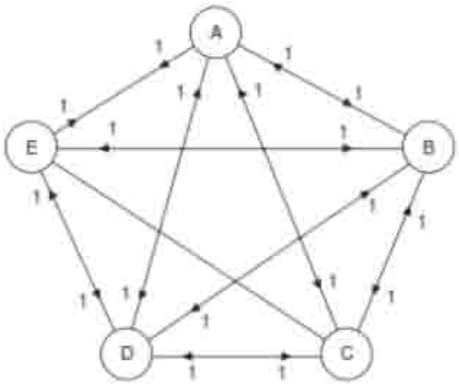
Routing planning refers to the procedures that determine which path in a network are assigned to particular connections. The switching centres may use fixed routes to each destination. Adaptive routing may be employed in which each exchange may use different routes for the same destination, depending upon traffic conditions. For effective routing of a call, some form of interconnection of switching exchanges are required. In the following paragraph various forms of networking and its related routing are discussed.

9.3.1. Basic Topologies

Three basic topologies are adopted for interconnecting exchanges. Exchanges are interconnected by group of trunk lines referred as trunk groups. Two trunk groups are required between any two exchanges. Mesh, star and mixed or hierarchical are the three basic topologies.

Determination at the total number of trunk circuits in any network is necessarily a function of the amount of traffic between each pair of stations or exchanges.

Mesh-connected network. This is also called fully connected topology. The advantage of mesh network is that each station has a dedicated connection to other stations. Therefore, this topology offers the highest reliability and security. If one link in the mesh topology breaks, the network remains active. A major or disadvantage of this topology is that it uses too many connections and therefore requires great deal of wiring, especially when the number of station increases. The mesh topology requires $N (N - 1)/2$ connections. For 100 stations, 4950 links required. Fig. depicts a full connected mesh structure.

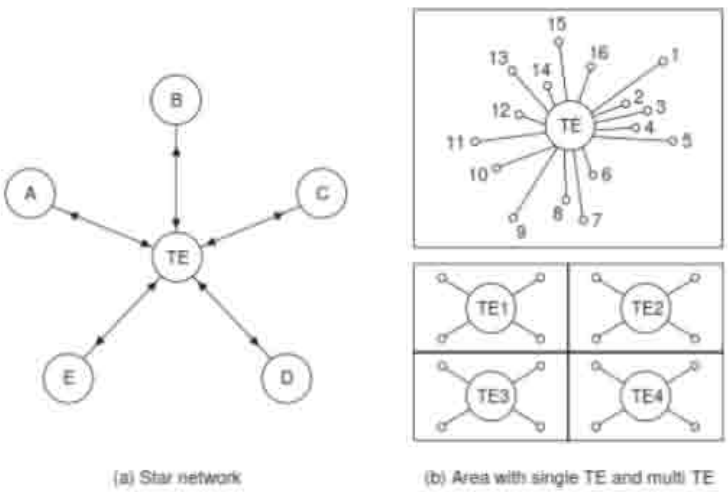


Mesh connected network.

For high traffic networks, the cost of network increases. As a compromise, generally, the circuits are divided into three groups. Two groups are used for one way trunks and third group is for both way trunks. An exchange first finds its outgoing trunk before trying one in common group.

This arrangement is practicable if number of exchanges in the network are limited and placed nearby (*i.e.* the lines are short). As the telephone network users are increasing at rapid rate, the concept of mesh network is uneconomical and the technological growth of transmission of signal by multiplexing made this technique to become completely obsolete.

Star topology. It is an alternative to the mesh arrangement. The network configuration shown in Fig. (*a*) is called star network. In star network, the number of lines is equal to the number of stations. As shown, a star connection utilises an intermediate exchange called a tandom exchange. Through the tandom exchange (TE) all other exchanges communicate.



(a) Star network (b) Area with single TE and multi TE

If the number of stations served by a TE increases, they are divided into smaller network, each served by its TE. Fig. (*b*) shows the star network with splitted setup. This configuration reduces the line cost but increases the exchange costs. With the star arrangement the outer centres

require fewer trunk terminations, but the trunk centre has greatly increased number of terminations. So, the star arrangement reduces the design requirements on all but one of the switching centres. It needs larger, and more powerful trunk centre. As only one larger centre is required, star arrangement preferable. Note that the exchange area indicates that all the calls in that area are considered to be local calls.

Hierarchical networks. Many star networks may be inter connected by using an additional tandom exchange, leading to two level star network. An orderly construction of multilevel star networks leads to hierarchical networks. Fig. shows the two types of hierarchical structures of AT & T and ITU–T. Hierarchical networks are capable of handling heavy traffic with minimal number of trunk groups. The hierarchical network requires more switching nodes, but achieves significant savings in the number of trunks. Determination of the total number of trunk circuits in entire network is necessarily a function of the amount of traffic between each pair of switching nodes. The efficiency of circuit utilization is the basic motivation for hierarchical switching structures. In Fig. it is shown that, if there is a high traffic intensity between any pair of exchanges, direct trunk groups may be established between any pair of exchanges (dotted lines or trunks of AT & T hierarchical network). These direct routes are known as high usage routes or trunks. In a strictly hierarchical network, traffic from subscriber A to B and vice versa flows through the highest level of hierarchy. A traffic route via the highest level of hierarchy is known as the final route. Whenever high usage route exists, route is primarily routed through them. The overflow traffic is routed through hierarchical network. Traffic is always routed through the lowest available level of the network. In addition to the high usage trunks, the tandom switches which is employed at the lowest level (not part of toll network) is augmented. The term tandom refers specifically to intermediate switching within the exchange area. The exchange area is an area within which all calls are considered to be local calls. The basic function of a tandom office is to interconnect those central offices (or class 5 or local exchanges) within an exchange area having insufficient interoffice traffic volumes to justify direct trunks. Tandom exchanges also provide alternate routes for exchange area call get blocked on direct routes between end offices.