TRAFFIC ENGINEERING:

Due to the non-availability of switching paths blocking of a subscriber call will occur. For this we have calculated blocking probabilities as discussed . These problems can be avoided by the help of traffic engineering. Traffic engineering analysis enables one to determine the ability of a telecommunication network to carry a given traffic at a particular loss probability

Network traffic load and parameters:

In a telephone network the traffic load on a typical working day during 24 hours is as shown in figure;

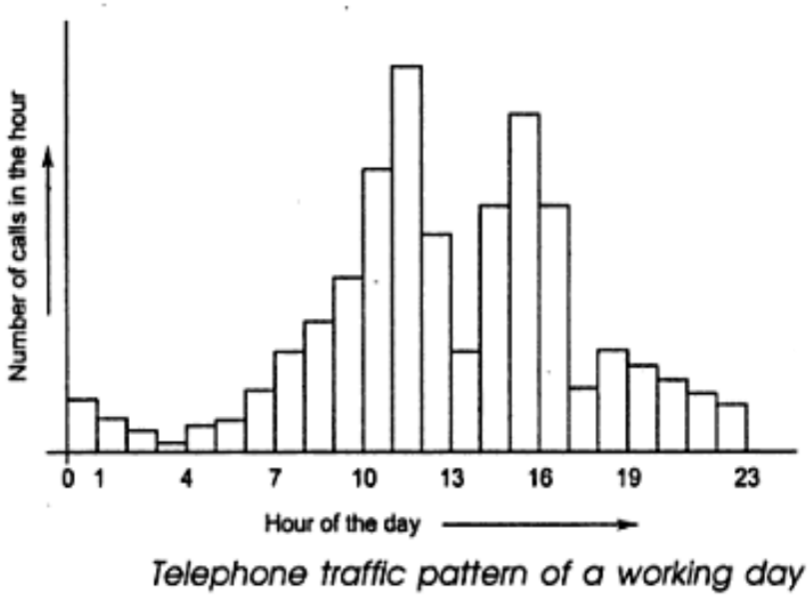

Fig19: Telephone traffic pattern statistics of a working day.

From this statistics:

i) There is a little use of network during 0 and 6 hours when most of the population is asleep.
ii) There is a large peak around mid-forenoon and mid-afternoon, which shows busy office activities.
iii) The afternoon peak is however slightly smaller.
iv) The load is low during the lunch hour period i.e. 12:00-14:00 hours.
v) During the period 17:00-18:00 hours shows low traffic because the people are move from office to their residences.

vi) The peak of domestic calls occurs after 18:00 hours when person reach home and reduces tariff applies.
vii) During holidays and festival days the traffic pattern is different.

Generally there is a peak of calls occurs around 10:00 hours just before people leave their homes on outings and another peak occur in the evening when people returns to their home.

There are 3 types of busy hours are defined by CCITT:

1) **BUSY HOUR:** In a day the 60 minute interval in which the traffic is the highest is called the busy hour.
2) **PEAK BUSY HOUR:** The busy hour on each day is called peak busy hour; It varies from day to day or over a number of days.
3) **TIME CONSISTENT BUSY HOUR:** The one hour period starting at the same time each day for which the number of call attempts is greatest over the days.

Again all the call attempts are not materialize into actual conversations for variety of reasons: Those are due to called line busy, no answers from called lines, and blocking in the trunk groups or the switching centers [1].

A call attempt is said to be successful or completed if the party answers, successful call attempts is again categorized into three types: [1]

1. **CCR (call completion rate):** It is defined as the number of successful calls to the number of call attempts.
2. **BHCA (busy hour call attempts):** The number of call attempts in the busy hour is called busy hour call attempts.

GRADE OF SERVICE AND BLOCKING PROBABILITY:

1. The amount of traffic rejected by the network is an quality of service offered by the network, This is known as **grade of service**.[2]
2. Grade of service is defined as the ratio of lost traffic to offered traffic.

$$GOS = \frac{\text{Blocked Busy Hour calls}}{\text{Offered Busy Hour calls}}$$

$$GOS = \frac{A - A_0}{A}$$

where A_0 = carried traffic
A = offered traffic
$A - A_n$ = lost traffic.

3. The smaller is the value of grade of service, the better is the service.

4. The blocking probability P_B is defined as the probability that all the servers in a system are busy.
5. When all the servers are busy no further traffic can be carried by the system and the arriving subscriber traffic is blocked.

DIFFERENCE BETWEEN GOS AND P_B

1. Grade of service is also known as call congestion or loss probability where as blocking probability is otherwise known as time congestion.
2. GOS is a measure from the subscriber point of view i.e. the GOS is zero as there is always a server available to a subscriber where as blocking probability is a measure from the network or switching system point of view i.e. the blocking probability is non zero as there is a definite probability that all the servers are busy at a given instant.
3. GOS is arrived by observing the number of rejected subscriber calls where as P_B is arrived by observing the busy servers in the switching system.

DELAY PROBABILITY:

If the offered load or the input rate of traffic far exceeds the network capacity, then the queue lengths become very large and the calls have undesirably long delay. The probability that the call experiences a delay termed as delay probability . In this case the delay systems are said to be unstable as they would never be able to clear the load.

The technique of queued up traffic cleared to an acceptable limit to maintain a stable operation is called **flow control.**

MODELLING SWITCHING SYSTEMS:

In a telecommunication network the call generation by the subscribers and the behavior of the network or the switching system are random process . A random process or a stochastic process is one in which one or more quantities vary with time such that the instantaneous variables predictable with certain probability.

We have four different types of stochastic process namely

i. Continuous time continuous state
ii. Continuous time discrete state
iii. Discrete time continuous state
iv. Discrete time discrete state

A discrete state stochastic process is called **chain.**

Random processes whose statistical parameters do not change with time are known as **stationary process**

The random processes which have identical time and ensemble averages are known as **ergodic process** .

In random process if the mean and variance alone are stationary and other higher order moments may vary with time are known as **wide sense stationary process** .

MARKOV PROCESS:

Markov process is an important class of random processes that have some special properties. The properties were defined by A.A Markov in1907.This property is used for modeling of our switching system

A discrete time markov chain i.e. discrete time discrete state Markov process is defined as

$$P\,[\{X(t_{n+1}) = x_{n+1}\}/\{X(t_n) = x_n, X(t_{n-1}) = x_{n-1}, \ldots\ldots X(t_1) = x_1\}]$$
$$= P\,[\{X(t_{n+1}) = x_{n+1}\}/\{X(t_n) = x_n\}]$$

where $t_1 < t_2 \ldots\ldots < t_n < t_{n+1}$ and x_i is the ith discrete state space value.

The above equation states that the entire past history (n-1,n-2,n-3) is summarized in its current status (n),hence the next state (n+1) is determined only by the current state

The interstate transition time in a discrete time markov process is **geometrically distributed** and in a continuous time markov process it is **exponentially distributed**

BIRTH-DEATH PROCESS:

The birth and death process is a special case of the discrete state continuous time Markov process, which is often called a continuous-time Markov chain. The number of calls in progress is always between 0 and N. It thus has N + 1 state. If the Markov chain can occur only to adjacent states (i.e. probability change from each state to the one above and one below it) the process is known as birth-death (B–D) process

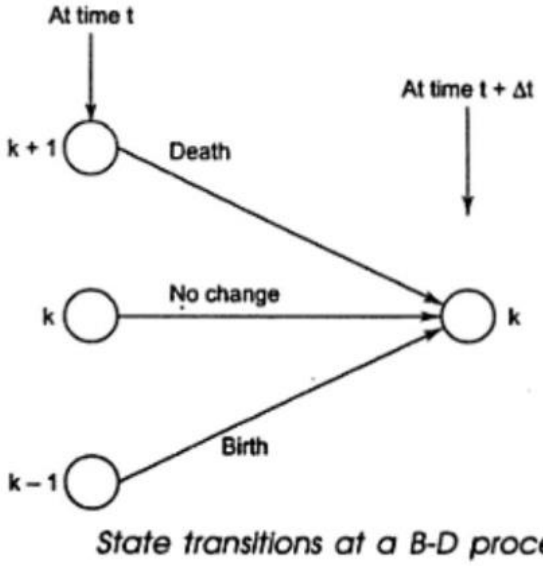

Fig20: State probability transition diagram in a birth death process.

The basic feature of the method of Markov chains is the Kolmogorov differential-difference equation, for the limiting case, can provide a solution to the state probability distribution for the Erlang systems and Engset systems.

Let N (t) be a random variable specifying the size of the population at time t. For a complete description of a birth and death process, we assume that N (t) is in state k at time t and has the following properties:

1. P (k) is the probability of state k and P (k + 1) is the probability of state k + 1.

2. The probability of transition from state k to state k + 1 in short duration Δt is $\lambda_k \Delta t$,

Whereλ_k is called the birth rate in state k.

3. The probability of transition from state k to state k – 1 in the time interval Δt is $\mu_k \Delta t$,

Whereμ_k is called the death rate in state k.

4. The probability of no change of state in the time interval Δt is equal to $1 - (\lambda_k + \mu_k) \Delta t$.

5. The probability in Δt, from state k to a state other than k + 1 or k – 1 is zero.

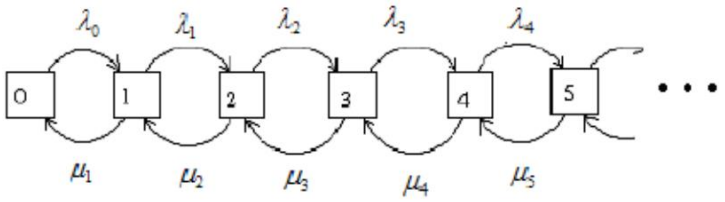

Fig21: State transition diagram in a birth death process with mean arrival and service rate.

Rate transition matrix for Birth-Death process:

$$Q = \begin{bmatrix} -\lambda_0 & \lambda_0 & 0 & 0 & 0\cdots \\ \mu_1 & -(\mu_1+\lambda_1) & \lambda_1 & 0 & 0\cdots \\ 0 & \mu_2 & -(\mu_2+\lambda_2) & \lambda_2 & 0\cdots \\ 0 & 0 & \mu_3 & -(\mu_3+\lambda_3) & \lambda_3\cdots \\ .... & \cdots & \cdots & \cdots & \cdots \end{bmatrix}$$

The stationary **probability state** (steady state) vector $\vec{p} = (p_0, p_1, p_2, p_3, \ldots)$ we get from the equation $\vec{p}Q = \vec{0}$.

This equation gives the system

$-\lambda_0 p_0 + \mu_1 p_1 = 0$, (eq1)

$\lambda_0 p_0 - (\mu_1 + \lambda_1) p_1 + \mu_2 p_2 = 0$, (eq2)

$\lambda_1 p_1 - (\mu_2 + \lambda_2) p_2 + \mu_3 p_3 = 0$ (eq3)

$\lambda_2 p_2 - (\mu_3 + \lambda_3) p_3 + \mu_4 p_4 = 0$ (eq4)

Equations eq1, eq2,… are called the **balance equations** because they show the balance between the average rates of entering and leaving each state, so called **rate-in =rate out principle**.

The system is equivalent with the following system:

$-\lambda_0 p_0 + \mu_1 p_1 - 0$, eqA (−eq1)

$-\lambda_1 p_1 + \mu_2 p_2 = 0$, eqB (= eqA+eq2)

$-\lambda_2 p_2 + \mu_3 p_3 = 0$ eqC (= eqB+eq3)

$-\lambda_3 p_3 + \mu_4 p_4 = 0$ eqD (= eqC+eq3)

We use this system to express the steady state probabilities p_k, k=1, 2, 3… as the functions of

From equation A, B, C, D… we have

$$p_1 = \frac{\lambda_0}{\mu_1} p_0,$$

$$p_2 = \frac{\lambda_1}{\mu_2} p_1 = \frac{\lambda_0 \lambda_1}{\mu_1 \mu_2} p_0,$$

$$p_3 = \frac{\lambda_2}{\mu_3} p_2 = \frac{\lambda_0 \lambda_1 \lambda_2}{\mu_1 \mu_2 \mu_3} p_0$$

….

$$p_n = \frac{\lambda_{n-1}}{\mu_n} p_{n-1} = \frac{\lambda_0 \lambda_1 \lambda_2 \cdots \lambda_{(n-1)}}{\mu_1 \mu_2 \mu_3 \cdots \mu_n} p_0$$

Substituting p_n, n=0, 1, 2, 3…in the equation

$$p_0 + p_1 + p_2 + p_3 + \cdots = 1,$$

we find p_0.

INTEGRATED SERVICE DIGITAL NETWORK (ISDN)

INTRODUCTION

ISDN has been most important development to emerge in the field of computer communications. ISDN is a well-conceived and planned area of development in the field of telecommunication.ISDN –An integrated digital network in which the same digital switches and digital paths are used to establish different services for e.g. telephony, data.

Six conceptual concepts on which ISDN standards laid are:

1. ISDN will evolve from telephony IDN by incorporating additional functions and network feature including other dedicated network to provide for existing and new services.

2. New services should be compatible with 64kbps switched digital connections.

3. The transition from existing network to comprehensive ISDN may require one or two decades.

4. Arrangement must be made for internetworking of services and services on other networks during transition period.

5. ISDN contains the intelligent of providing service features,maintenance and network management functions.

6. Various access arrangements to ISDN require layered functional set of protocols.

So ISDN can be defined as an ISDN is network evolving from telephony IDN that provides end to end digital connectivity to support wide range of services including voice and non-voice services, to which users have access by a limited set of standard multipurpose user network interface.

NEW SERVICES:

ISDN will support variety of services including the existing voice and data services and host of new services. Short lists of some important new services are:

1. Videotext
2. Electronic Mail
3. Digital Facsimile
4. Teletext
5. Database access
6. Electronic Fund Transfer
7. Image and graphics exchange
8. Document storage and transfer
9. Automatic alarm services, e.g., smoke,fire,police,medical
10. Audio and video conferencing

VIDEOTEX

Videotex is a generic term for systems that provide easy to use, low cost computer based services via communication facilities. Three forms of videotext exist:

1. View data
2. Teletext
3. Open Channel teletext

View data is fully interactive videotex. This means that request for information and service from a user are actually sent to, received by, and acted on by a centralized computer.

Teletex is broadcast or pseudo-interactive videotext service. Teletext users may select the information to be seen, the pace at which the information to be displayed and, often sequence of display. The information cast in the form of frames and set of frames which is called a magazine is recycled continuously. Teletext is a one way communication system and there is no real interaction between the user and the computer.

Open channel teletext is totally non-interactive one way videotext. With this form of videotext, the user receives pre-selected information in predetermined order. There is no interaction either real or apparent. The user has no control over the pace or sequence of display. Open channel text may classify into three categories according to the way of preselected information displayed and the way of display channel is used:

1. Dedicated open channel
2. Open captioning
3. Closed captioning

In dedicated open channel text, a separate transmission channel is dedicated for the display of preselected information. Open captioning shares a normal display channel and teletext display appears at fixed intervals along with other programs of channel.

ELECTRONIC MAIL

Electronic Mail is popularly known as email, may be defined as the communication of textual messages via electronics means. Even the telex communication is electronic in nature but the differences are telex communication is terminal to terminal, electronic mail communication is user-to-user. In telex message destined to no. of users are sent to the same terminal form where it is distributed by an operator or messenger. On the other hand electronic mail delivered to the mail boxes of individuals. Telex works on a circuit switched mode, where electronic mail is store and forward(S&F) services. Electronic mail is computer based message system where telex is generally not.Advantage of Electronic mail is first of all security then its ability to reduce the consumption of paper in the office. Being a computer based messaging system, files are prepared like automation packages like word, spreadsheet etc. easily interchanged as electronic mail. This facility improves efficiency for office work.

Early electronic mail systems were organized around the single time sharing or multiuser computer system,where electronic mail was exchanged among the user of the system.The typical configuration of electronic mail is given below which was established in 1970s.

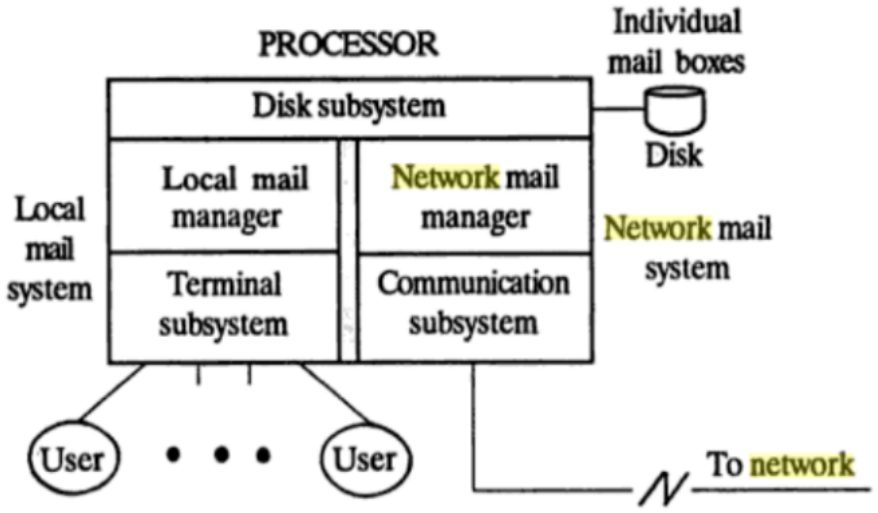

Figure.50: A typical configuration of electronic mail system

Component of the system are: one to handle within the system another to handle mail over the network. Both share common disk storage where mail boxes are maintained. Thus, real time exchanges of messages are possible in an electronic mail system, if the two concerned parties are logged onto the same machine at the same time. Electronic mail being S&F on a network, real time exchange may not possible. Some are the well-knownnetwork who is providing the electronic mail services are UUNET,BITNET,CSNET, and JANET.

DIGITAL FACSIMILE

Digital Facsimile which is process that digitally encoded the picture signal, i.e. encodes the baseband signal resulting from scanning the object. The facsimile equipment output may be either analog, as defined by CCITT group 3 protocol, or digital defined by CCITT group 4 , STANAG 5000 type I and STANAG 5000 Type II protocols.

Two types of facsimile systems are exists:

- ➔ Photographic facsimile
- ➔ Document facsimile

In photographic facsimile, the gray level information is transmitted and printed in addition to black and whitei.e. Typically 8 or 16 gray levels that can be recognized by the system.Document facsimile system handles only black and white levels, i.e. only two gray levels. Document facsimile system is more popular than the photographic system. The receiver / transmitter functions are applicable to both type of facsimile systems are shown in the figure below

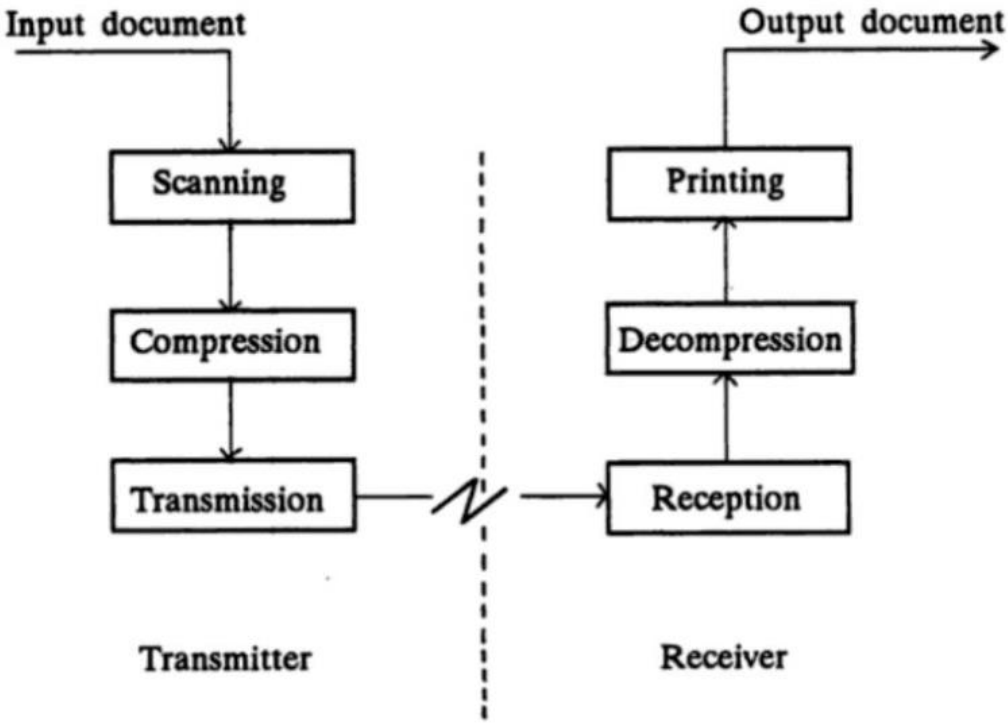

Fig.55: Function of facsimile system

Facsimile inputs or scanned data are required to compress before it transmitting. This is the second step in facsimile transmission. There are two types of compression techniques

- ➔ Information preserving techniques
- ➔ Approximate techniques

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