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Internal Assessment Test 1 – March 2017

Sub:	Digital Switching Systems							Code:	10EC82
Date:	28 / 03 / 2017	Duration:	ECE	Max Marks:	50	Sem:	8	Branch:	ECE
Answer Any FIVE FULL Questions									

		Marks	OBE CO	OBE RBT
1 a)	Explain the operation of a four wire circuit connected to a two wire circuit through a hybrid transformer.	6	CO1	L4
b)	Calculate the following power levels in dBm and dBW (i) 2mW (ii)100mW (iii) 1mW (iv) 1W	4	CO1	L3
2a)	Explain with a neat diagram, the 30 channel PCM frame format with all calculations included.	5	CO1	L4
b)	A four wire system has an overall loss(two wire to two wire)of 1 dB and the balance return loss at each end is 6dB.Find i) The singing point ii) The stability margin iii) the attenuation of talker and listener echo.	5	CO1	L3
3a)	Explain the working of Distribution frames in Strowger step by step switching System	5	CO2	L4
b)	Explain cross bar system with a neat diagram and write the significance of marker.	5	CO2	L2
4	Explain in detail Intra LM and Inter LM call processing through digital switching system.	10	C02	L4
5.	Derive an expression for iterative form of Erlang's LOST CALL FORMULA with the assumptions considered.	10	CO3	L4
6a)	In an average, during the busy hour, a company makes 180 outgoing calls of average duration of 3 minutes. It receives 400 incoming calls of average duration 6 minutes. Find the outgoing traffic, Incoming traffic and Total traffic. 3	5	CO3	L2
b)	A group of 20 trunks provides a grade of service of 0.01 when offered 12 E of traffic.a) How much is the grade of service improved if one extra trunk is added to the group?b) How much does the grade of service deteriorate if one trunk is out of service?	5	CO3	L1,L3
7a)	With a neat diagram, explain subscriber line interface circuit for digital switch	5	CO2	L2
b)	Explain any one type of PDH with a suitable diagram	5	CO2	L3

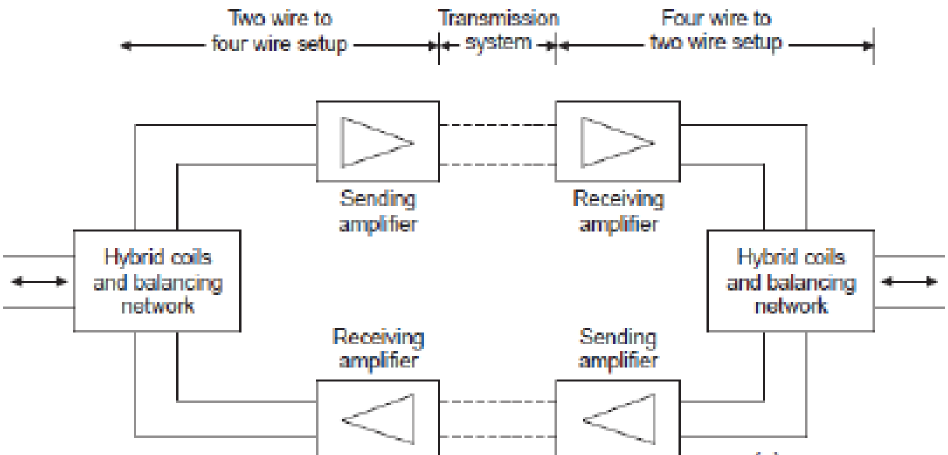
Course Outcomes		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1:	To examine the network structures and network services and describe the basic four wire circuits in telecommunication transmission	-	1	1	1	-	2	1	2	1	2	-	1
CO2:	To describe the different switching techniques and cross bar syStems	-	1	-	-	-	1	1	1	1	2	-	1
CO3:	Apply knowledge of science and probability theory to arrive at models and analyze lost call systems and queuing systems in telecommunication traffic.	2	2	2	1	-	1	-	1	1	1	-	1
CO4:	Analyze the design solutions for switching networks for given number of incoming and outgoing trunks, analyze the time switching networks.	3	3	2	2	-	1	1	1	1	1	-	1
CO5:	Assess the hypothetical model and maintenance of digital switching systems with support of computer organization concepts.	1	2	2	2	-	1	-	1	1	1	-	3
CO6:	Analyze the impact of digital switching systems through reliability analysis	1	-	-	1	-	1	-	1	1	1	1	1

Cognitive level	KEYWORDS
L1	List, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.
L2	summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend
L3	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover.
L4	Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, infer.
L5	Assess, decide, rank, grade, test, measure, recommend, convince, select, judge, discriminate, support, conclude, compare, summarize.

PO1 - *Engineering knowledge*; PO2 - *Problem analysis*; PO3 - *Design/development of solutions*; PO4 - *Conduct investigations of complex problems*; PO5 - *Modern tool usage*; PO6 - *The Engineer and society*; PO7- *Environment and sustainability*; PO8 – *Ethics*; PO9 - *Individual and team work*; PO10 - *Communication*; PO11 - *Project management and finance*; PO12 - *Life-long learning*

1 a)	Explain the operation of a four wire circuit connected to a two wire circuit through a hybrid transformer.	6
b)	Calculate the following power levels in dBm and dBW (i) 2mW (ii)100mW (iii) 1mW (iv) 1W	4

The term four wire implies that there are two wires carrying the signals in one direction and two wires carrying them in opposite direction. In normal telephone service, the local loops are two wire circuits, on which a single telephone call can be transmitted in both directions. If the distance between the subscribers is substantial, the amplifiers (repeaters) are necessary to compensate the attenuation. *As the amplifiers are unidirectional,* for two-way communication,four-wire transmission is necessary. The switching equipment in the local exchange and the line from subscriber to local office (local loops) are two wire operation. The local exchange will switch the subscriber loop to a toll connecting trunk. This is also a two-wire transmission. Telephone and Transmission Systems **35** The toll offices are interconnected with inter tool trunks (which connects towns and cities). These trunks are of four-wire transmission. Fig. 3.10 shows the simple arrangement of the two wire and four wire transmission.



(a)

A four-wire circuit has amplifiers in its repeaters for each direction of transmission. Thefour wire circuits may be physical four wire or equivalent four wire. For short distances, actual four wires used for transmission is referred as physical four wire circuits. But for long distance trunks physical four wire is undesirable and usually equivalent four wire transmission is used,needing one pair of wires only. The two directions of transmission use different frequency bands so that they do not interfere with each other. The two directions are separated in frequency rather than space. At the toll office, the two wires are converted into four wire for long transmission. A hybrid coil accomplishes this conversion.

b)

i) 2mW = 3dBm = - 27dBW

ii) 100mW = 20dBm = -10dBW

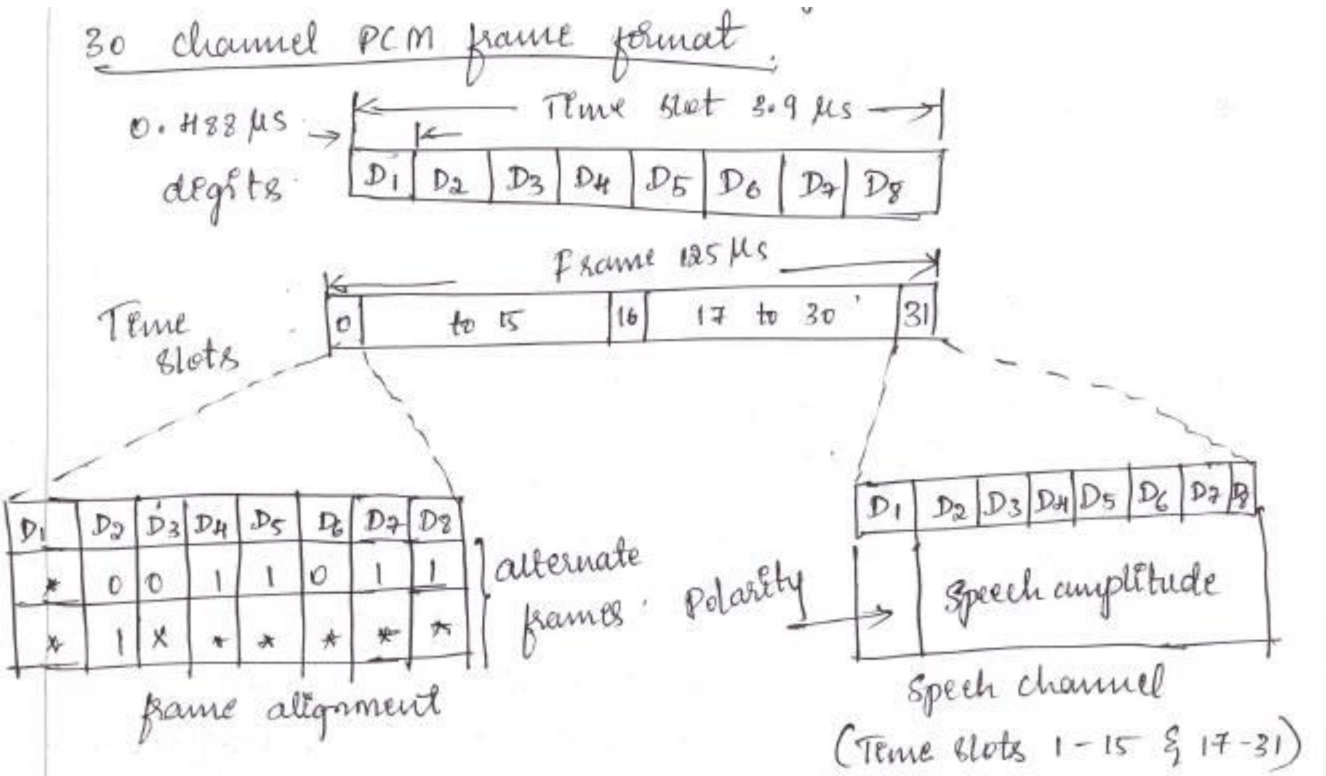
iii) 1mW = 0dBm = -30dBW

iv) 1W = 30dBm = 0dBW

2a)	Explain with a neat diagram, the 30 channel PCM frame format with all calculations included.	5
b)	A four wire system has an overall loss(two wire to two wire)of 1 dB and the balance return loss at each end is 6dB.Find i) The singing point ii) The stability margin iii) the attenuation of talker and listener echo.	5

2a)
Solution :

* PCM Systems were first developed for telephone transmission over cable originally designed for audio frequency transmission
* It was found that these satisfactory using suitable bipolar coding for transmitting upto 2M bit/sec
* Telephone channels are combined by TDM to from an assembly of 24 or 30 channels. This is known as primary multiplex group
  - The operation of a primary multiplexer explained with the help of fig.
- The length of the frame is 125 μ sec, corresponding to the sampling intervals.
- It contains one speech sample from each channel together with additional digits are used for synchronization and signaling.
- Two frame structures are widely used the European 30 channel system and the DS1 24 channel system. used in North America and Japan


30 channel PCM frame format
0.488 µs
digits
Time slot 3.9 µs
D1 D2 D3 D4 D5 D6 D7 D8
Frame 125 µs
Time slots
0 to 15 16 17 to 30 31
D1 D2 D3 D4 D5 D6 D7 D8
* 0 0 1 1 0 1 1
* 1 X * * * * *
alternate frames
frame alignment
Polarity
D1 D2 D3 D4 D5 D6 D7 D8
Speech amplitude
Speech channel
(Time slots 1-15 & 17-31)

* The frame of the 30 channel system is divided into 32 time slots each of 8 digits.
* The total bit rate is 8KHz × 8 × 32 = 2.048 Mb/sec
* Time slots 1 to 15 and 17 to 31 are each allotted to a speech channel.
* Time slot 0 is used for frame alignment.
* Time slot 16 is used for signaling
* The basic frame consists of 193 bits thus the bit rate 193 × 8K bit /sec = 1.544 M bits /sec.
* The first bit is used for framing and is called the F bit the others form 24, 8bit time slots for speech channels.
* on frames 6 and 12 of the multiframe bit D8 each channel time slot is used, for signaling for that channel.
* This process degradation in quantizing distortion which is none the less considered acceptable.

... explain basic central

2b)

i) Singing point $L_s = 2(B + L_2)$ dB

When $L_2 = -B, L_s = 0$

So singing point is +6dB

ii) Stability margin:

$M = B + L_2 = 6+1$ dB $= 7$dB

iii) Attenuation of talker echo $L_t = 2L_2 + B = 2+6$ B = 8dB

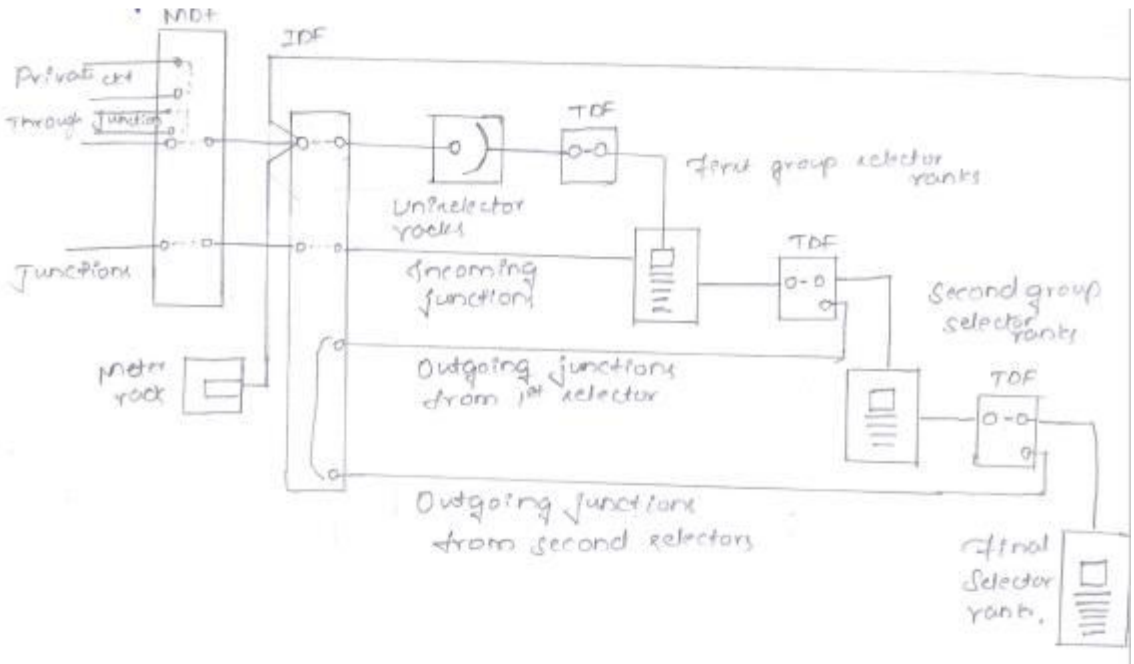
Attenuation of listener echo $L_1 = 2L_2 + 2B = 2+12$dB=14dB.

3a)	Explain the working of Distribution frames in Strowger step by step switching System	5
b)	Explain cross bar system with a neat diagram and write the significance of marker.	5

3a)

Solution:

→ Many changes occur during the life of telephone exchange. New customers join and old ones leave. Customers move from one part of exchange area to another and those with PBXs may increase their no of exchange lines. The total no of lines may increase over the years, say from an initialization of 2000 lines to an ultimate 10,000 lines. Growth of traffic
→ may require additional switches in the exchange and more junction to other exchanges. Great flexibility is therefore required in the permanent exchange cabling.
→ MDF corresponds to the street cabling so reflects the geography of the area. The no of line is changed by moving the jumper. protectors and fuses are mounted on the MDF also provides a convenient point of access for testing lines.
→ The intermediate distribution frame (IDF) is used to distribute incoming traffic evenly over the groups of first selectors.
→ The terminals on this side of the IDF can be said to correspond to equipment no (EN) of the lines.



3b)

- Strowger switches require regular maintenance. The banks need cleaning, mechanisms need lubrication and adjustments and wiper and cards wearout. This disadvantage led to the development of several other forms of switch. One idea was to replace the manually operated switch by a matrix of telephone relays with their contacts multiplied together horizontally and vertically as shown in Fig. 1.5.1.
- The crossbar switch retains a set of contacts at each crosspoint, but these are operated through horizontal and vertical bar magnets at the sides of the switch. Thus, a switch with N inlets and N outlets only needs 2N operating magnets.
- In case of Strowger system various function performed by the group selectors while in crossbar system various functions are performed by the marker.

Working

- Let us consider 3×3 crossbar schematic shown in Fig. 1.5.1 The schematic shows 3 subscribers with the horizontal bars representing the inlets and the vertical bar the outlets.

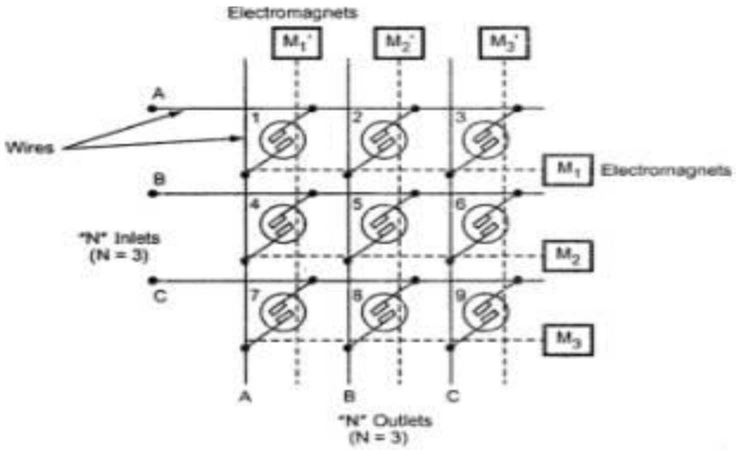


Fig.1.5.1 3 × 3 crossbar switching

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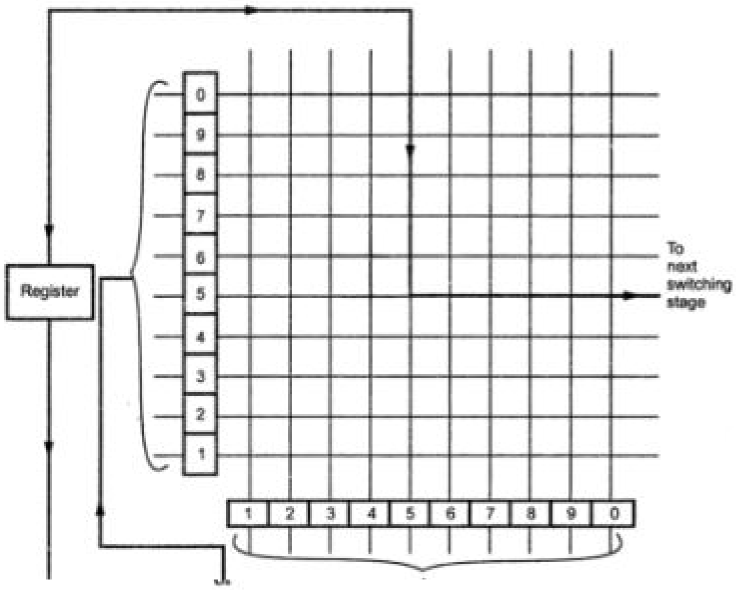
- Now consider the establishment of the following sequence A to C and C to B. First the horizontal bar A is energised, than the vertical bar C is energised. The crosspoint AC is latched and conversation between A and C can now proceed.
- Suppose we now energise the horizontal bar of C to establish the connection CB.
- Thus the procedure for establishing a connection in a crossbar switch may be summarised as

1. Energise horizontal bar
2. Energise vertical bar
3. De-energise horizontal bar



4. Energise vertical bar
5. Energise horizontal bar
6. De-energise vertical bar

Functions of marker

a) It decides which magnet to move.
b) It also controls many switches and has many registers in it.
c) It can make more than one connection at a time.
d) For a larger switching system marker makes use of linked frame switching system.

4	Explain in detail Intra LM and Inter LM call processing through digital switching system.	10

This section describes some *basic* types of calls that are usually processed through a digital switching system:

- Intra-LM calls
- Inter-LM calls
- Incoming calls
- Outgoing calls

As emphasized before, these are basic call classifications and do not reflect any enhanced features or call types. Basic call processing can be easily outlined by a simple digital switching system model, as shown in Fig. *1.5d*. Knowledge of how calls flow through a digital switching system will make clear the advantages of reliability modeling.

Intra-LM Calls. When a customer dials from a telephone that is connected to a specific line module and calls another customer who is also connected to the same line module, this type of call is classified as an intra-LM call. A call path for this type of call is shown in Fig. 1.6a. The off-hook (line origination request) condition is detected by the line module, and service circuits are attached to supply a dial tone to the calling customer. Many other functions are performed before a dial tone is given to a calling customer; these are discussed in later chapters. The line module's request for a path through the switching fabric is processed by the interface controller, which in turn works with the network control processor to make a path assignment. Consequently, a path is established through the switching fabric for the called line, and a service circuit is attached to ring the line. Again, many other functions are performed before ringing is applied to the called customer; these are also discussed later. Since this is an intra-LM call, the same line module will be involved in controlling the origination and termination of a call. This very simplified explanation is offered here for introductory purposes only. Later chapters go into far greater detail in explaining various functions such as digit reception, digit translation, and tests that are performed before a call is completed.

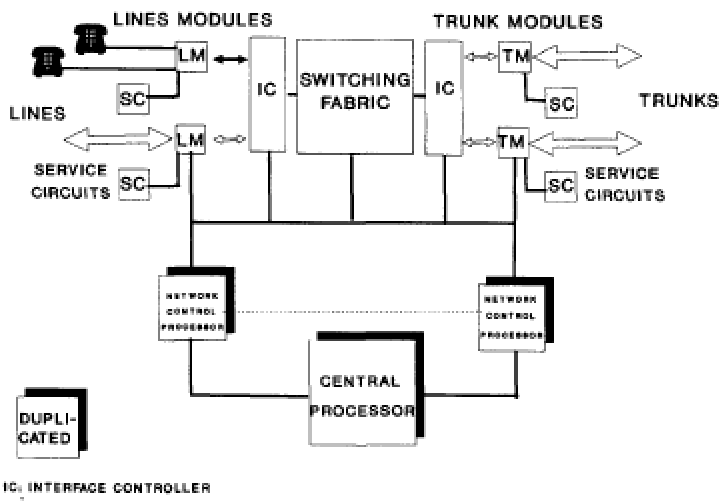


Figure 1.6a. Calls within a line module

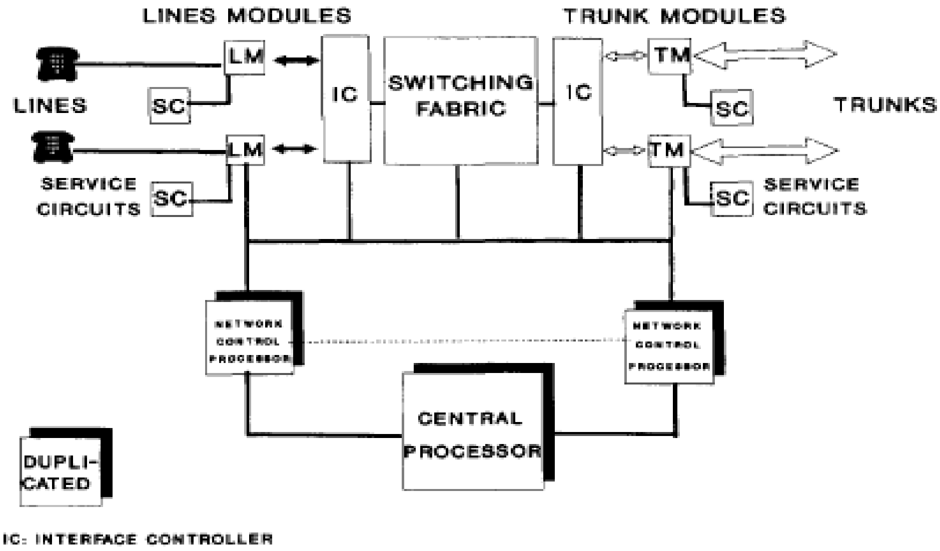


Figure 1.6b. Calls outside a line module

5.	Derive an expression for iterative form of Erlang's LOST CALL FORMULA with the assumptions considered.	10

Lost call systems:

Our aim is to find the GOS (B) of a lost call system that is offered traffic of A erlangs and has N outgoing trunks. Erlang worked out a solution to this problem based on the following assumptions:

i. Pure chance traffic – implies call arrivals and call terminations are independent random events.
ii. Statistical equilibrium - implies probabilities remain unchanged for the period being considered.
iii. Full availability – all incoming calls can be connected to any outgoing trunk that is free.
iv. Calls that encounter congestion are lost which is the basis on which lost call systems are classified.

If there are x calls in progress, then from equation 8,

$$P(x) = (A^x/x!)\, P(0) \qquad (10)$$

Where $0<x<N$, where N is the total number of trunks

$$\sum_{x=0}^{N} P(x) = 1 \quad \Rightarrow \quad \sum_{x=0}^{N} (A^x)/x!\,P(0) = 1$$

$$P(0) = 1/\left(\sum_{x=0}^{N} (A^x)/x!\right)$$

Substituting the value of P (0) in equation 10, we get

$$P(x) = (Ax/x!) \div \sum_{k=0}^{N} A^k/k!$$

This is called the first erlang distribution. When x=N, P(N) is the probability that a call encounters congestion i.e. the GOS of the network. It is represented by $E_{1,N}$

$$B = E\,1,N = (A^N/N!) \div \sum_{k=0}^{N} A^k/k! \qquad (12)$$

This formula is also called erlang's lost call formula. $E_{1,N}$ can also be calculated by an iterative formula given by

$$E_{1,N}(A) = (A\,E_{1,N-1}(A)) \div (N + A\,E_{1,N-1}(A))$$

very large. Since call arrivals are independent random events, the occurrence of calls is not affected by previous calls, therefore traffic is sometimes called memoryless traffic.

The number of call arrivals in a given time T has a poissonian distribution given by,

$P(n) = \mu^x/x!.e^{-\mu}$ (3)

where x is the number arrivals in time T

μ is the mean number of call arrivals in time T

i. The intervals Ŧ between calls arrivals are intervals between independent random events and these intervals have a negative exponential distribution,

$P(x>=t) = e^{-t/Ŧ}$ (4)

where Ŧ is the mean interval between call arrivals

ii. The call durations, T are intervals between independent random events (call termination). Therefore the call durations also have a negative exponential distribution.

$P(T>=t) = e^{-t/h}$ (5)

where h is the average holding time

b) Statistical equilibrium means that the generation of traffic is a stationary random process i.e. the probabilities do not change for the period being considered. Consequently the mean number of calls in progress remains constant.

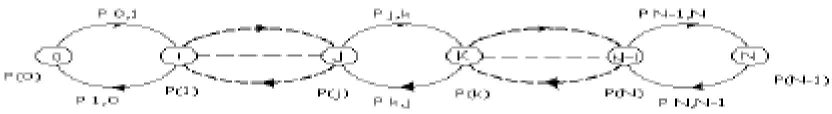


fig 3. State transition diagram for N trunks

The state transition diagram is shown for a group of N trunks. The total number of states that N trunks can have is N+1. The number of calls in progress varies randomly and lies between 0 and N. the state transition diagram shown is called a simple Markov chain. The probabilities P(0), P(1), …. are called the state probabilities and the $P_{j,k}$, $P_{k,j}$ are called transition probabilities of the Markov chain. In case of statistical equilibrium these probabilities will have a fixed value and they will not change.

Using Markov chains we can proceed to prove that if call arrivals has a Poissonian distribution, then the calls in progress will also have a Poissonian distribution:

Proof:

Consider a small interval of time δt such that the probability of two or more things happening in this interval is very small. The events that could occur in δt are,

a) one call arrives with probability P(a)
b) one call ends with probability P(e)
c) no change occurs with probability 1-P(a)-P(e)

6a)	In an average, during the busy hour, a company makes 180 outgoing calls of average duration of 3 minutes. It receives 400 incoming calls of average duration 6 minutes. Find the outgoing traffic, Incoming traffic and Total traffic. 3
b)	A group of 20 trunks provides a grade of service of 0.01 when offered 12 E of traffic.a) How much is the grade of service improved if one extra trunk is added to the group?b) How much does the grade of service deteriorate if one trunk is out of service?

Solution :

6a)

Outgoing traffic is $180 \times \frac{3}{60} = 9E$

Incoming traffic is $400 \times \frac{6}{60} = 40E$

Total TRAFFIC is 9+40 =49E

6b)

6) A group of 20 trunks provide a GOS of 0.01 when offered 12E of traffic. How much is the GOS when

a. 1 trunk is added to the group
b. 1 trunk is out of service

Solution:

From the recursive formula for $E_{1,N}(A)$

$$E_{1,N}(A) = (A\, E_{1,N-1}(A))/(N + A\, E_{1,N-1}(A))$$

a. $E_{1,21}(12) = (12E_{1,20}(12))/(21 + 12\, E_{1,20}(12))$
$= 12*0.01/(21+12*0.01)$
$= 0.0057$

b. $E_{1,20}(12) = (12\, E_{1,19}(12))/(20 + 12\, E_{1,19}(12))$
$= 0.017$

7a)	With a neat diagram, explain subscriber line interface circuit for digital switch	5
b)	Explain any one type of PDH with a suitable diagram	5

7a)

BORSCHT is an acronym for the set of functions performed by a subscriber line interface circuit (SLIC) in the line card of a telecommunication system. The letters represent the following functions: battery feed (B), over-voltage protection (O), ringing (R), signaling (S), coding (C), hybrid (H), and test (T).[1]

An earlier or alternate version of the acronym is **BORSHT**, lacking the letter *C* for the coding function.[2]

Functions

Battery feed

The central office provides a DC voltage level of nominally 48 V between the tip and ring conductors for talk and signaling current. The available DC current may range from 20 mA to 120 mA.

Over-voltage protection

Aerial lines may be struck by lightning or falling power lines, consequently arrestors such as gas tubes and carbon blocks are used in the central office to reduce the voltage. However the line card must typically be able to withstand 1000 volt spikes.

Ringing

The ringing voltage is typically 86 V (RMS) at a frequency of 20 Hz, 2 seconds ON, 4 seconds OFF. Some selective frequency systems used frequencies as low as 16 Hz and as high as 66 Hz for station selection.

Signaling

Signaling is often referred to as *supervision*. The circuit detects the on-hook and off-hook conditions by monitoring the loop current. In rotary dial systems, it decodes dial pulses. It includes decoding of dual-tone multi-frequency (DTMF) dialing, hook flash, and other signals.

Coding

Coding includes μ-Law coding in North America and A-Law coding in Europe. This includes the A/D and D/A conversion, companding and framing for time-division multiplexing.

Hybrid

The hybrid function involves two-wire to four-wire circuit conversions. This was originally performed by a hybrid transformer (induction coil) but has largely been superseded by DSP devices.

Test

External tests allow the local loop and handset to be directly connected to test equipment in the central office. Loop-in tests could measure the input return loss (IRL). Loop-around tests measure the hybrid and codec performance.

7b)

In a transmission network which has not been designed for synchronous operation, the tributaries entering a digital multiplex will not generally be exactly synchronous. Although they have the same nominal bit rate, they commonly originate from different crystal oscillators and can vary within the clock tolerance. They are said to be *plesiochronous*. The first generation of higher-order digital multiplex systems was designed for this situation. It forms

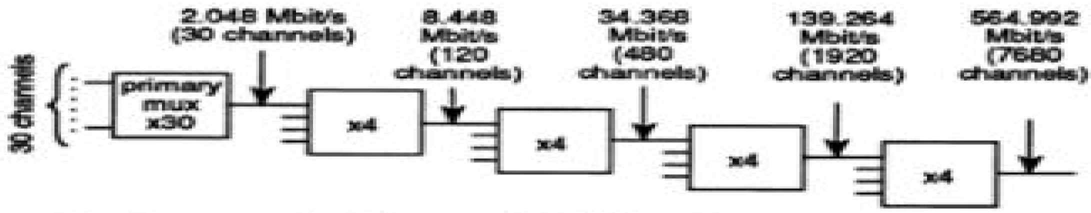


Figure 4.6 European plesiochronous digital hierarchy

the plesiochronous hierarchy (PDH) [12].

There are three incompatible sets of standards for plesiochronous digital multiplexing, centred on Europe, North America and Japan. The European standards are based on the 30-channel primary multiplex and the north American and Japanese standards on the 24-channel primary multiplex. The European and North American hierarchies are shown in Figures 4.6 and 4.7 and they are summarised in Table 4.3. Transoceanic digital transmission has led to the introduction of further muldexes to bridge between the different standards of the three 'islands'. These are also included in Table 4.3. The corresponding CCITT recommendations are listed in Table 4.4

These systems all use bit interleaving. The frame length is the same as for the primary multiplex, i.e. 125 μs, since this is determined by the basic channel sampling rate of 8 kHz. However, as shown in Figures 4.6 and 4.7, when N tributaries are combined, the digit rate of the higher-order frame is more than N times the digit rate of the tributary frames. This is because it is

The first reason is frame alignment. A higher-order demultiplexer must recognise the start of each frame in order to route subsequent received digits to the correct outgoing tributaries, just as a primary demultiplexer must route received digits to the correct outgoing channels. The same tehcnique is employed. A unique code is sent as a frame-alignment word (FAW), which is recognised by the demultiplexer and used to maintain its operation in synchronism with the incoming signal. The European hierarchy uses a bunched FAW at the start of each frame, but the other hierarchies use distributed FAWs.

The second reason for adding extra digits to the frame is to perform the process known as *justification* [12]. This process is to enable the multiplexer and demultiplexer to maintain correct operation, although the input signals of the tributaries entering the multiplexer may drift relative to each other. In *positive justification*, the transmitted digit rate per tributary is slightly higher than the nominal input rate. If an input tributary is slower, a dummy digit (i.e. a *justification digit*) is added to maintain the correct output digit rate. If the input tributary speeds up, no justification digit is added. These justification digits must be removed by the demultiplexer, in order to send the correct sequence of signal digits to the output tributary. Consequently, further additional digits, called *justification service digits*, must be added to the frame for the multiplexer to signal to the demultiplexer whether a justification digit has been used for each tributary. In *negative justification*, instead of dummy digits being inserted when the digit rate of a tributary is too slow, a data digit is occasionally removed when a tributary is too fast and is transmitted in a spare time slot. Another option is to use both positive and negative justification in the same multiplexer. This is called *positive/zero/negative justification*. The European PDH uses only positive justification.

The term 'justification' originated in the printing trade. Since different lines of print on a page contain unequal numbers of letters, the printer inserts additional spaces to ensure that all the lines on a page are of equal length. Word processors can also perform justification.

When bit interleaving is used, bits for a particular channel occur in different bytes of a higher-order frame. To separate one channel from the aggregate bit stream, a total demultiplexing process is required. This results in the 'multiplexing mountain' shown in Figure 4.8. The new synchronous digital hierarchy, described in Section 4.4.3, employs byte interleaving. This enables *drop and insert* or *add/drop muldexes* to insert or remove lower-order assemblies, down to a primary group, with relative ease.