Dar es Salaam Institute of Technology

Department of Electronics and Telecommunication Engineering

Communication Switching Systems

Course Code: ETU 07420

Answers & Solutions to Tutorial Questions

Prepared and Compiled By

Florent Morice Mtuka,

June 21, 2020

Table of Contents

1. LECTURE 01: Telephone and Transmission system

1.1. Introduction to Communication Switching System

1) List the five end instruments and its use

Answer

Laptop, Ipad, Smartphone, computer, etc.

2) What are the primary functions of transmission systems?

Answer

purpose of telecommunication switching system is to provide the means to pass information from one terminal (calling subscriber) to another terminal (called subscriber) somewhere.

3) Define a) local loop and b) trunks.

Answer

a) Local Loop: the wiring from the subscriber premises to the local exchange

b) Trunk: The guided and unguided media used between the local exchanges and local exchanges and primary.

4) What is the use of multiplexing? List the various multiplexing techniques.

Answer

a) multiplexing is a technique of combining multiple channels of information over a single circuit of transmission path.

b) The most important ones are Space Division Multiplexing (SDM). Frequency Division Multiplexing (FDM) and Time Division Multiplexing (TDM)

5) List various impairments which affects the signals.

Answer

Static impairments (Signal attenuation, Distortion), Transient impairments (Echoes and singing, noise, Cross talk, Fading and phase Jitter

6) Define noise related to telecommunication.

Answer

Noise is an unwanted electrical energy.

7) What are called cross talk?

Answer

The large current flow causes electromagnetic fields and thus creates signal distortions in adjoining wires

8) Explain briefly NEXT and FEXT.

Answer

a) *NEXT occurs near the transmitter and creates distortions that affect the signal on adjacent receive pairs Explain the various types of distortion.*

b) *FEXT is a measure of the cross talk that exists at the receiver end of the cable.*

9) Give the standard telephone battery voltage with respect to ground.

Answer: *-48 volts*

10) If the minimum current required for carbon microphone is 23 mA, battery voltage is 50 V, the battery resistance is 400 ohm and the telephone set resistance is 200 ohms, calculate the loop resistance limit.

Answer

$R_M = V_B/I_C$

where R_m *= maximum allowable resistance of subscriber loop.*

V_B *= Battery voltage*

I_c *= minimum current required for proper operation of carbon microphone*

The loop resistance limit is $R_L = R_m - (R_B + R_T)$

R_T *= Telephone set resistance.*

R_m *=50v/0.023A= 2173.913043Ω approx. 2.2kΩ*

R_L *= 2200 – (400 + 200) = 1600 Ω*

11) An exchange uses – 48 V battery, a resistance of 300ohm is placed in series with the battery. If the telephone set resistance is 50ohm, calculate the loop resistance limit for the minimum current requirement of 23 mA for carbon microphone.

Answer

Refer to Qn 9 for formulae

R_m *=48v/0.023A == 2087Ω*

RL = 2087 – (300 + 50) == 1737Ω.

12) Calculate dc loop resistance, if the loop resistance limit is 1250ohm for the loop length of 10km.

Answer

$R_{dc} = 21.96/d^2$

$L = R_L/R_{dc}$, $R_{dc} = R_L/L = 1250\ \Omega/10km = 125\Omega/km$

13) Consider a subscriber loop of 12km long. The loop resistance is 1600 ohm. Calculate the d.c. loop resistance and determine the cable gauge for the loop

Answer

From formulae in Qn 10&11

$R_{dc} = 1600/12 = 133.33\Omega/km$ from table wire Gauge is 26

14) What are the two limiting performance factors in the design of a subscriber loop that constrain length?

Answer

The maximum loop resistance and the maximum loss or attenuation on the loop

15) For a 24-gauge loop and a 1250-ohm loop resistance find the loop length.

Answer/Solution

From the given below, for 24gauge cable, the Rdc is 84.22 Ω/km. Hence, the length of the cable

$$L = \frac{R_L}{R_{dc}} = \frac{1250}{84.22} = 14.84\ km$$

16) For 24-gauge loop and a 6 dB loss, find the maximum loop length.

Answer/solution

For 24-gauge cable, the loss per km is 1.05 dB/km

$$L_m \frac{Attenuation\ limit}{loss\ per\ km} = \frac{6dB}{1.05dB/km} = 5.71\ km$$

17) If we assume that a modern local exchange is designed for a maximum of 2000Ω of loop resistance, not including the resistance of the end instrument (i.e., the telephone subset), find the maximum loop length of 26-gauge copper wire that can be used?

Answer/Solution

From the given below, for 26gauge cable, the Rdc is 133.90Ω/km. Hence, the length of the cable

$$L = \frac{R_L}{R_{dc}} = \frac{2000\Omega}{133.90\Omega/km} = 14.936\ km$$

18) The National Transmission Plan allows a 7-dB maximum subscriber loop loss. Assume a find the maximum subscriber loop length considering only loss?

Answer/solution

For 24-gauge cable, the loss per km is 1.05 dB/km

$$L_m \frac{Attenuation\ limit}{loss\ per\ km} = \frac{7dB}{0.69dB/km} = 10.14km$$

GAUGE NO (AWG)	diameter 'd' (mm)	R_{dc} (Ω/kM)	Attenuation or loss per km (dB/km)
19	0.91	26.39	1.68
22	0.64	52.95	1.35
24	0.51	84.22	1.05
26	0.41	133.90	0.69

19) What is the use of modem?

Answer

A MODEM (modulator/demodulator) converts digital data to analog signals and analog signals to digital information

1.2. Evaluation of a Switching System

20) Describe the telecommunication systems.

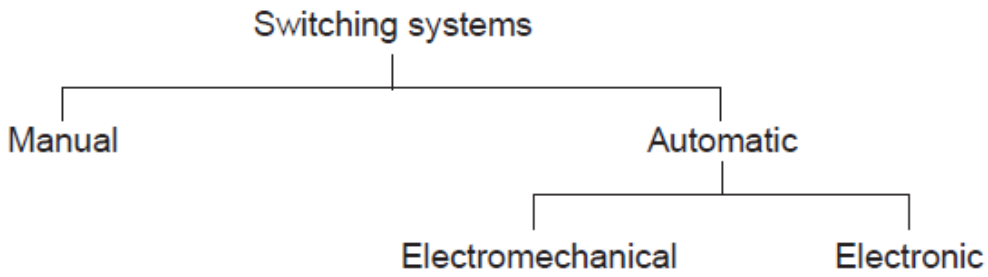
Answer

Telecommunication system is a set of system/equipment arranged transmit of voice or data over long distances. it consists of transmission, switching and facilities for maintaining equipment, and billing systems

.

21) How the switching systems can be classified?

Answer



22) Define a Switch/exchange as applied to telecommunication systems

Answer

A switch sets up a communication path on demand and takes it down when the path is no longer needed.

23) List at least four user requirements with regard to switching.

Answer

1. *capability of communicating with any other user.*
2. *connection time should be relatively small*
3. *Higher grade of service the goal at BH should be 99%*
4. *Privacy during conversation*
5. *The primary mode of communication for most users will be voice*

24) What are the two basic functions of a local switch?

Answer

Local Switch provide means to

1. *connect each subscriber line to any other in the same exchange*
2. *incoming trunk to connect to subscriber line and subscriber to outgoing trunk.*

25) There are eight basic functions that a conventional generic switch carries out. Name at least six.

Answer

1. Interconnection
2. Control
3. Alerting
4. Attending
5. Information receiving
6. Information transmitting
7. Busy testing
8. Supervisory

26) Explain the functions of a switching system with signal exchange diagram.

Answer

c) ***Identity****. The local switching center must react to a calling signal from calling subscriber and must be able to receive information to identify the required destination terminal seize.*

d) *Addressing. The switching system must be able to identify the called subscriber from the input information*

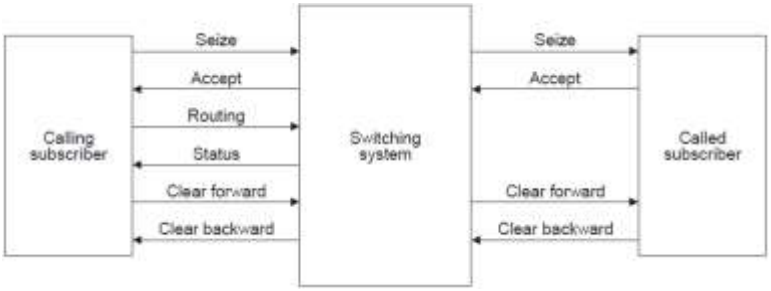
e) *Finding and path setup*

f) ***Busy testing***. *If number dialed by the calling subscriber is wrong or the called subscriber is busy*

g) ***Supervision.*** *Once the path is setup between calling and called subscriber, it should be supervised in order to detect answer and clear down conditions and recording billing information.*

h) ***Clear down***. *When the established call is completed, the path setup should be disconnected.*

i) ***Billing*** *switching system should be able to account for service/s used*



27) What is on hook and off hook? When a subscriber subset (the telephone) goes "off hook," what occurs at the serving switch? List two items.

Answer

a) *on hook is the condition that exists when a telephone or other user instrument is not in use,*

b) *A condition that exists when a telephone receiver or handset is lifted or removed from its cradle, thereby completing a circuit and placing the telephone in use.*

c) *When a subscriber subset (the telephone) goes "off hook," the following occurs to the serving switch*

1. *current flows in the line called seize signal indicates the call request*
2. *an exchange sends a dial tone to the calling subscriber to dial the numbers.*

28) Define availability.

Answer

Availability A = MTBF/(MTBF + MTTR)

Where MTBF = Mean time between failures & MTTR = Mean time to repair

29) List the requirements of an effective switching system.

Answer

a) *High availability*

b) *High speed*

c) *Low down time*

d) *Good facilities*

e) *High security*

30) What are the limitations of manual exchanges?

Answer

a) *Language dependent*

b) *Lack of privacy*

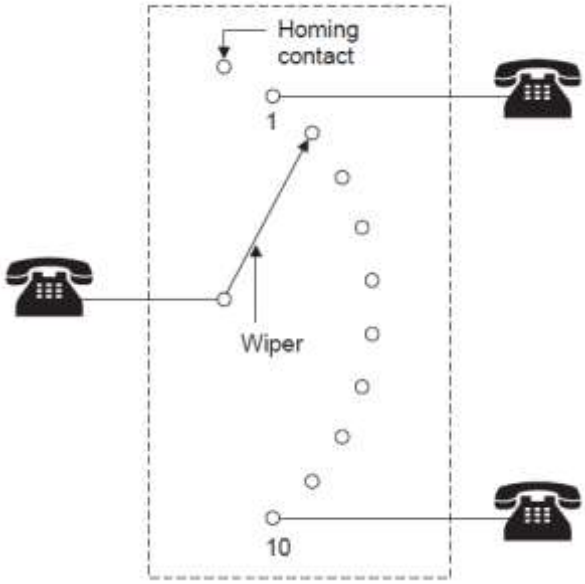
c) *Switching delay*

d) *Limited service*

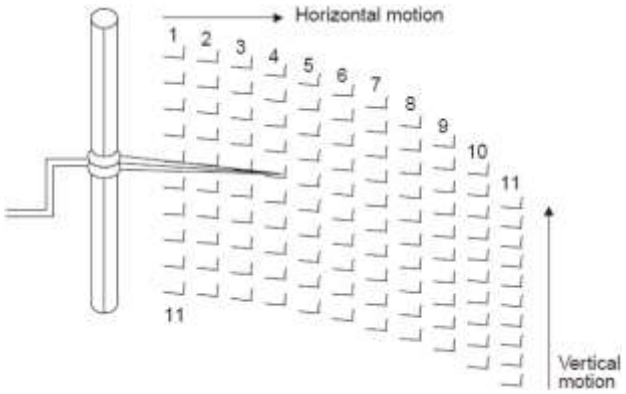
31) Write short notes on (a) uniselector and (b) two motion selector.

Answer

a) *Uniselectors. One which has a single rotary switch with a bank of contacts. Depending upon the number of switching contacts, they are identified as 10 or 24 outlets uniselectors.*



b) *Two motion selectors. A two-motion selector is a selector in which a set of wipers is moved in two different planes by mean s of separate mechanisms.*



32) Mention one advantage and three disadvantages of Strowger switching system.

Answer

Advantage

inexpensive for small system and highly reliable due to the distributed nature of equipment

Disadvantage

a) *Involves heavy mechanical displacements, regular maintenance by the skilled technicians are necessary.*
b) *It is not feasible to select an alternate route for interoffice calls, if all the trunks are busy as the switching is by step through various selectors.*
c) *Step by step switching is limited to dial pulses.*
d) *Low life time for high calling rate*
e) *The last two digits of the called line numbers are specifically determined by their location on the connector. Congestion could arise when the switching system is heavily loaded.*
f) *Accept only 7 to 9 pulses in 1 second. Hence if we dial fast, the system cannot give correct performance.*

33) What are the features of Stored Program Control (SPC)?

Answer

a) *Abbreviated dialing,*
b) *Call forwarding,*
c) *Call waiting,*
d) *Enables easier number changes,*
e) *Automated call tracing message unit accounting (for billing)*

34) Explain various Operation modes SPC and compare their availability.

Answer

1. *Standby mode*
    a) *All processors have the same capability to control the switching procedure.*
    b) *One processor is active and the other is on standby, both hardware and software wise.*
    c) *The standby processor is brought into operation when the active processor fails.*
    d) *State of the exchange system should be clear to the standby processor as its starting point.*
        i. *Which of the subscribers are busy or free?*
        ii. *Which of the trunks are busy or free?*
        iii. *Which of the paths are connected through the switching network?*
        iv. *Reconstitution of the state*
2. *Synchronous duplex mode*
    a) *Both two processors execute the same set of instructions.*
    b) *One of the processors actually controls the exchange.*
    c) *The results from two processors are compared continuously by a comparator.*
    d) *If the results match, the system works normally. Otherwise, a fault occurs, a checkout*
    e) *Program is run independently in both two processors to determine which one is faulty.*
    f) *The faulty processor is taken out of service, and the other one works independently*
3. *Load sharing mode*
    a) *Both two processors have access to entire exchange environment. Each of them has independent memories for redundancy purpose.*
    b) *Both two processors are active simultaneously and share the load and the resources dynamically.*
    c) *An incoming call is assigned randomly or in a predefined order to one of the processors which then handles the call right through completion.*
    d) *Inter-processor links are configured for processors to exchange information needed for mutual coordination and verifying the 'state of health' of the other.*

    Load sharing increases the effective traffic capacity by 30 percent compared with synchronous duplex

35) Differentiate between limited availability and full availability.

Answer

*When a switch has full availability, **each inlet has access to any outlet**. When **not all the free outlets in a switching system can be reached by inlets**, the switching system is referred to as one with "limited availability."*

36) Given that MTBF = 2200hrs and MTTR = 6 hrs. Calculate the unavailability of (a) single processor and (b) dual processor for 12 years and 24 years.

Answer

a) *Single processor*

Unavailability of single processor = (MTTR/ MTBF) = (6hrs/22000hrs) =0.2727273 X 10^{-3}

For 12year = 24hrs X 365 X 12 X 0.2727273 X 10^{-3} = 286.69Hrs

For 24year = 24hrs X 365 X 24 X 0.2727273 X 10^{-3} = 573.38Hrs

b) *Dual processor*

Unavailability of single processor = $2*(MTTR)/ MTBF)^2$ = $2*(6hrs/22000hrs)^2$ =$1.488*10^{-5}$

For 12year = 24hrs X 365 X 12 X $1.488X10^{-5}$= 1.56Hrs

For 24year = 24hrs X 365 X 24 X $1.488*10^{-5}$= 3.13Hrs

37) Compare the centralized SPC and distributed SPC.

Answer

The distributed SPC offers better availability and reliability than the centralized SPC.

38) Explain briefly the basic concepts of message and circuit switching.

Answer

a) *Message switching: the messages are stored and relayed from secondary storage.*
b) *Circuit switching: A dedicated end-to-end connection is established for the duration of the connection*

***Packet Switching:** Messages are divided into small packets; each packet is separately routed to the destination; Different packets can take different paths and times. Packets are reassembled into messages at the destination*

39) Tabulate the difference between circuit and message switching.

Answer

Message Switching	**Circuit switching**
The source and destination do not interact in real time	*The source and destination are connected temporally during data transfer.*
message deliver is delayed basis if destination node busy or otherwise unable to accept traffic	*Before path setup delay, may be there due to busy destination node. One the connection is made; the data transfer takes place with negligible propagation time.*
Destination node status is not required before sending message	*Destination node status is necessary before setting a path for data transfer.*
Network normally accept all traffic but provides longer delivery time because of increase queue length.	*Network rejects excess traffic if all the lines are busy.*
the transmission links are never idle	*After path setup, if the users denied services, the line will be idle. Thus, the transmission capacity be less, if the lines are idle*

1.3. Digital Switching Systems

40) Explain the process of digitization with neat diagram.

Answer

Process of converting analog signal into digital signals. It involves four steps

a) ***Filtering****: Frequencies below 300 Hz and above 3400 Hz (voice frequency range) are filtered from the analog Voice signal.*

b) ***Sampling.*** *The analog voice signal is sampled to ensure it carry sufficient information so that it is received at the receiver with minimum distortion.*

c) ***Quantization:*** *The signal is quantized using PCM technique to produce a series of binary code which represents the approximate amplitude of the signal sample at that instant*

d) ***Encoding****: quantized samples are encoded into a digital bit stream (series of electrical pulses).*

41) List the advantages of digital transmission.

Answer

a) *Satisfactory and quality transmission even in the presence of crosstalk and noise*

b) *It is possible to use regenerative repeaters instead of analog amplifiers*

c) *Lower Signal to line noise ratio*

d) *Ease of multiplexing*

42) List the disadvantages of digital transmission.

Answer

a) *Greater bandwidth*

b) *Need of synchronization*

c) *Multiplexing difficulties*

43) What are the different modes of digital transmission?

Answer

a) ***Asynchronous Transmission****: involves separate transmission of groups of bits or characters*

b) ***Synchronous Transmission****: the digital signals are sent continuously at constant rate*

44) List out the disadvantage of Asynchronous transmission.

Answer

Since the sample time for each information bit is derived from a single start bit, ***asynchronous system does not perform well in high noise environments***

45) Explain the principle of time division switching.

Answer

Time division switching involves the sharing of crosspoints for shorter periods of time. This paves way for the reassign of crosspoints and its associated circuits for other needed connections. Therefore, in time division switching, greater savings in crosspoints can be achieved. Hence, by using a dynamic control mechanism, a switching element can be assigned to many inlet-outlet pairs for few microseconds.

46) Local networks can be defined in a number of ways. Give the definition of a local network as applied in Communications Switching systems.

Answer

The local network links telephones in residences and businesses to a central office serving a particular geographical area. The size of the area may vary from 11.5 sq mi (30 km2) in cities to 123.5 sq mi (320 km2) in rural. The telephone lines connecting a subscriber to the central office are called local lines or loops.

47) Define subscribe local loop

Answer

The pair of wires connecting the subscriber to the local serving switch

48) SPC simply means that a switch is _____controlled.

Answer: *Computer*

49) What is the meaning of holding time and delay with regard to SPC systems?

Answer

i. *holding time is the time taken to serve a circuit*
ii. *delay is the time each circuit must wait to be served*

2. LECTURE 02: Computer controlled switching systems

1) List the basic steps to process a call.

Answer

1. *Idle state: the subscriber handset is in 'on-hook' condition*
2. *Call request identification*
3. *Providing dial tone*
4. *Address analysis*
5. *Called line identification*
6. *Status of called subscriber*
7. *Ringing*
8. *Path setup*
9. *Supervision.*
10. *Clear signal*

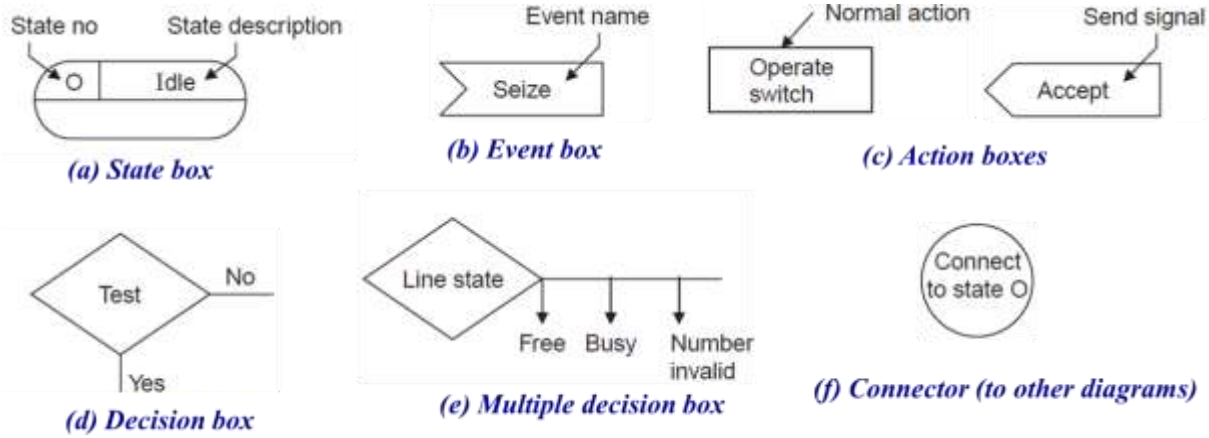
2) What is state transition diagram?

Answer

Specifies the response of a control unit to any sequence of events in a Switching System.

3) Draw the basic symbols of S.T.D.

Answer

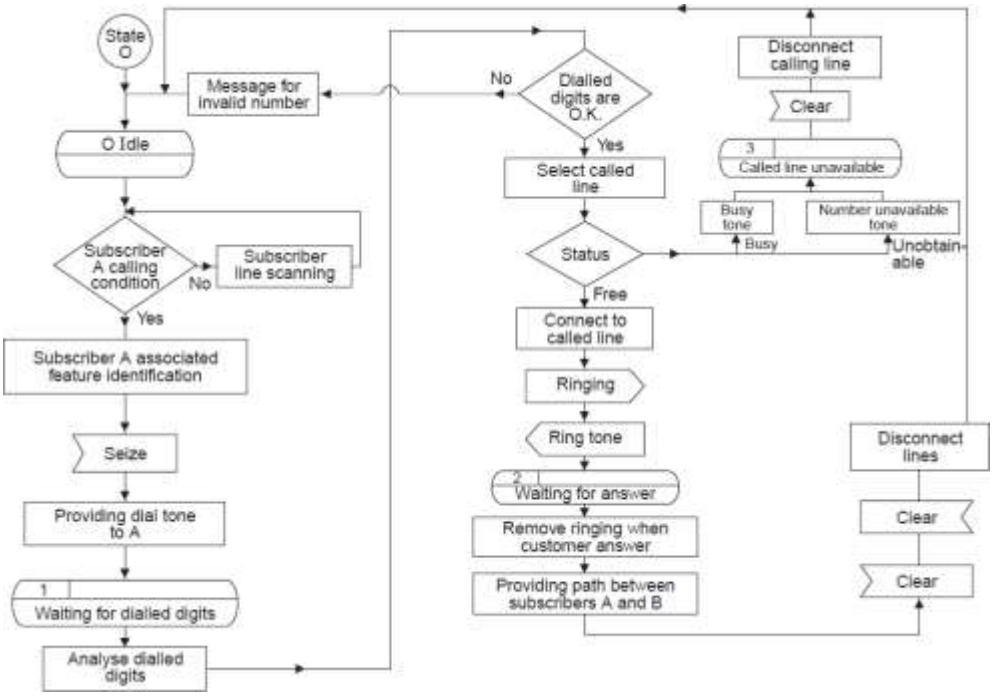


(a) State box *(b) Event box* *(c) Action boxes*

(d) Decision box *(e) Multiple decision box* *(f) Connector (to other diagrams)*

4) Draw and explain the S.T.D. flow chart for a typical local call.

Answer



5) What is the need for software in switching?

1. *Basic Functions*
    a) *Call processing*
    b) *Network control*
    c) *Signaling control*
    d) *Maintenance and administration*
    e) *Traffic recording*
2. *Customer care services*
    a) *Different modes of bill payment*
    b) *CTD websites*
    c) *Changed number enquiry services*
    d) *Telephone reconnection service*
    e) *Telephone address correction*
3. *Support of new technologies*
    a) *STM rings*
    b) *Intelligent networks*
    c) *Local network management*
    d) *Systems Microtunnelling*

e) *Centrex*

4. *Additional Services*
   a) *Answering machine services*
   b) *Direct internet Access services*
   c) *Voice over IP (VoIP)*
   d) *Account less internet*
   e) *Internet telephone*

6) How the software systems are classified?

Answer

Software systems are classified as:

a) *Maintenance software*
b) *Call processing software*
c) *Database/Administration software*
d) *Feature software.*

7) List the popular digital switching systems.

Answer

a) *DMS 100*
b) *NEAX–61*
c) *AXE – 10*
d) *CDOT*
e) *System X*

8) List the digital switching systems which are popular in Tanzania.

Answer

a) *AXE 10*
b) *Huawei MSAN*
c) *NEAX – 61*
d) *AXE 10*
e) *GX500*

3. LECTURE 03: Signalling Techniques in Switching Systems

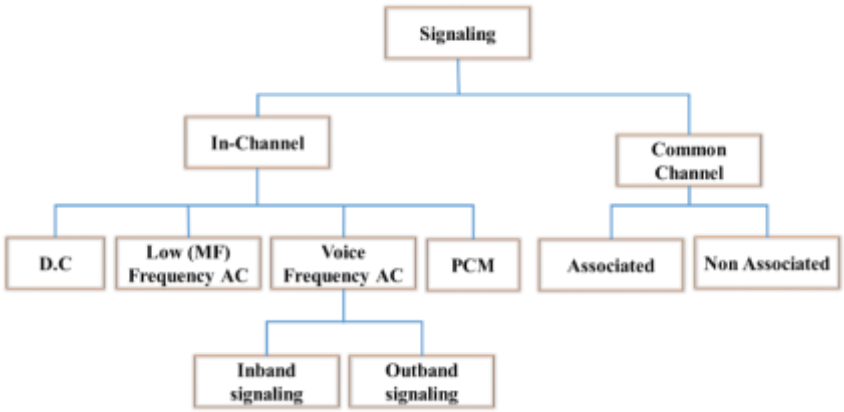
1) Define the term signalling as applied in telecommunication switching systems

Answer

Signalling is the process of generating and exchanging information among components of a telecommunication system to establish, monitor or release connections and to control related network and system operations".

2) With an aid of diagram show Signaling Technique Classification

Answer



3) How does a switch know whether a particular talk path is busy or idle?

Answer

Idle represented by the "on-hook" condition while busy" refers to the off-hook condition.

4) What are the different forms of signaling?

Answer

a) *Supervisory signals or line signals (Subscriber loop signaling)*
b) *Routing signals or register signals (Intraexchange or register signaling)*
c) *Management signals or interregister signaling (interregister signaling)*

5) Give the three generic signaling functions, and explain the purpose of each.

Answer

i. ***Supervisory Signaling****: provides information on line or circuit condition and indicates whether a circuit is in use or idle. It informs the switch circuits whether a calling party is*

"off hook" or on hook" or whether a called party is "off hook" or "on hook" and interconnecting trunk

ii. ***Routing signals or register signals****: Information transfer related to call setup is usually referred to as register signals. The basic information is the dilled code which indicates to the subsequent switching centres the required routing*

iii. ***Management signals or interregister signalling****: used to convey information or control between exchanges also referred as inter exchange signalling. It involves remote switching of private circuits, routing plans, modification of routing plans, traffic over load, priority of the call, class of service etc.*

6) Differentiate between line signaling and interregister signaling.

Answer

line signaling this is performed by link-by-link basis, it passes signals exchange to exchange or end-to end signalling which is between originating and terminating exchange. while for interregister signaling refer above qns.

Alternatives answer

Address information is provided between modern switching machines by interregister signaling, and the supervisory function is provided by line signaling.

7) There are seven ways to transmit signaling information list five.

Answer

i. *Duration of pulses (pulse duration bears a specific meaning)*
ii. *Combination of pulses*
iii. *Frequency of signal*
iv. *Combination of frequencies*
v. *Presence or absence of a signal*
vi. *Binary code*
vii. *For dc systems, the direction or level of transmitted current*

8) ABriley describe how E-lead and M-lead signaling (E & M signaling) works

Answer

The E lead always carries signal from the signalling apparatus to the switching equipment and the M lead carries signals from the switching equipment to the signalling apparatus.

9) Define Nyquist sampling theorem as applied Pulse-code modulation

Answer

If a band-limited signal is sampled at regular intervals of time and at a rate equal to or higher than twice the highest significant signal frequency, then the sample contains all the information of the original signal. The original signal may then be reconstructed by use of a low-pass filter.

10) Following the Nyquist sampling theorem, calculate the sampling rate of a 4-kHz voice channel, 7.5-kHz program channel and 4.2-MHz video channel.

Answer/Solution

Sampling rate >= 2 x highest significant signal frequency

Thus for 4-kHz voice channel is 8kHz, 7.5-kHz is 15kHz and 4.2-MHz is 8.4MHz.

11) For a 24-channel PCM system, calculate the period of one frame.

Answer/solution

For normal conversation uses nominal 4-kHz voice channel

Therefore, sampling rate is >= 2 x highest significant signal frequency (Nyquist sampling theorem)

2 4kHz = 8,000 samples per second (8kHz)*

For a group of 24 such voice channels are to be sampled = 8 kHz

==> group period = 1/8000Hz = 125μ

for each voice channel to be sampled successively = 125/24 = 5.2μ

12) How many bits are in a conventional PCM voice sample?

Answer

64 kbits/s

Explanation

In conventional voice there is 8000 frames per second, signal structure represents a channel bandwidth of 64 kbits/s (i.e., 8 bits/byte × 8000 bytes/second = 64 kbits/s).

13) With aid of diagram brief explain what is Inband and Out band Signaling?

Answer

Inband Signaling: *control signal frequencies are within the speech band (300– 3400 Hz),*

Out band: *signaling has frequencies above the voice band but below the upper limit of 4 kHz.*

14) Distinguish Inchannel signaling and Common Channel Signaling?

Answer

Sn	***In-Channel***	***Common Channel Signaling***
1	*Trunks must be held during signaling*	*Trunks are not required for signaling*
2	*Signal repertoire is limited*	*Extensive signal is repertoire is possible*
3	*Interference between voice and Control Signal may occur*	*No Interference since the channels are physically separate*
4	*Signaling equipment is required for every trunk and hence is expensive*	*Only one equipment is required for a whole group of trunks making CCS much cheaper*
5	*There is potential for misuse by customer who can generate signals to mimic signaling*	*Control channel is un-accessible to users*
6	*Signaling is relatively slow*	*Signaling is significantly faster*
7	*Speech circuit reliability is assured*	*There is no automatic test of the speech circuit*
8	*It is difficult to add or change a signal since all trunks must be altered*	*Signals can be added or altered at any time due to separate signaling channel*
9	*it is difficult to handle signaling during the speech period*	*Signaling can be handled at any time due to the separate signaling channel*

15) List the advantages and disadvantages of Inband Signaling?

Answer

Advantage of Inband Signaling

a) Inband signaling can be used on any transmission medium.

b) The control signals can be sent to every part where a speech signal can reach.

c) Flexibility of operation,

d) It is operations are simpler.

Disadvantage Inband Signaling

a) Voice path clogged with signaling

b) Busy calls, congestion, and "ring-no-answers" result in 20-35% of incomplete calls

c) Slower call setup due to channel sharing

16) What is the Goal of Signaling System 7?

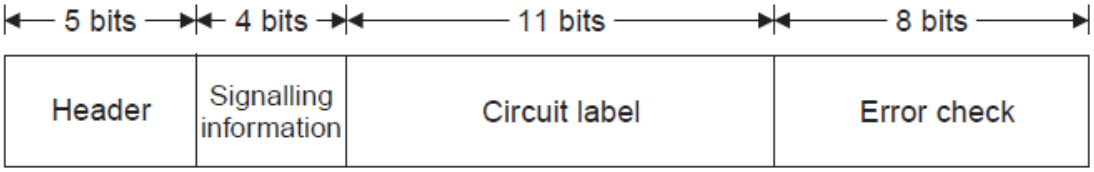
Answer

The Goal of SS7 is to suggest internationally standardized CCS system with general applications fields to enable digital communication networks (SPC switches) work efficiently.

17) Draw the CCS Signaling message formats.

Answer

CCS Signaling Message Format



18) Mention two basic categories of functions of layer 3 of SS No. 7?

Answer

Basic categories of functions of layer 3 of SS No. 7 are

i. Directly controls the connection establishment

ii. Transport of messages in addition to the functions provided by the data-link layer.

19) What is the basic purpose of layer 3?

Answer

basic purpose of layer includes

i. Routing and Relaying.

ii. Network Connection.

iii. Conveying User Information.

iv. Network Connection Multiplexing.

v. Segmenting and Reassembly (SAR).

vi. Error Detection

vii. Error Recovery.

viii. Sequencing

ix. Congestion Control and User Data Flow Control.

20) What is STP, SSP and SCP for each draw its Symbol

Answer

a) ***Signal Transfer Points (STPs)*** *receive and routes incoming singling messages towards the proper destination. Also, they perform specialized routing functions.*

STP Symbol

b) ***Signal Switching Points (SSP):*** *Telephone switches (end offices or tandems) equipped with SS7 - capable software and terminating signaling links. SSP originate, terminate, or switch calls.*

SSP Symbol

c) *Signal Control Points (SCPs) are databases that provide information necessary for advanced call processing capabilities.*

SCP Symbol

21) Describe SS No. 7 relationship with OSI. Why does it truncate at OSI layer 4?

Answer:

SS7 truncates OSI to 4 layers, because each additional layer implies more processing time.

22) List three types of signal units used in SS No. 7. Explain the basic function of each.

Answer

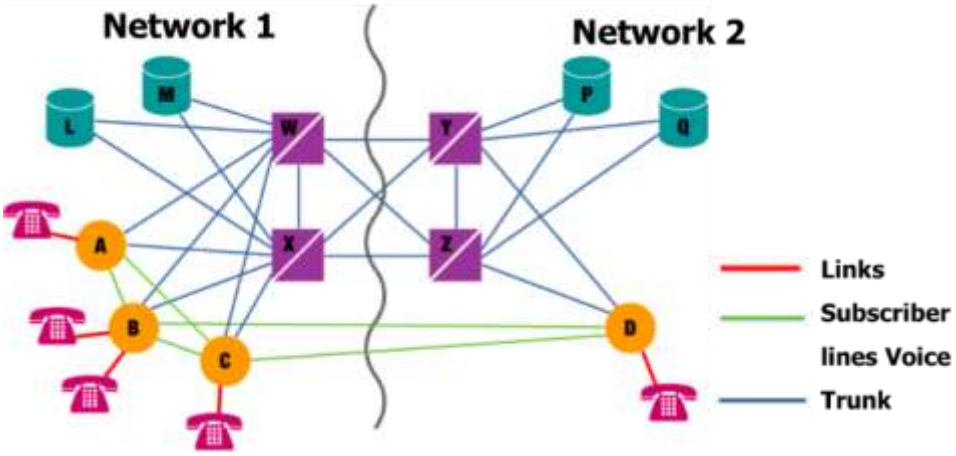
i. *Fill-in signal unit (FISU)*
ii. *Line status signal unit (LSSU)*
iii. *Message signal unit (MSU)*

1. *The MSU transfers information supplied by a user part (level 4) via the signalling network level (level 3).*
2. *The LSSU is used for link initialization and flow control.*
3. *The FISU is sent to maintain alignment when there is no signal traffic.*

23) Draw SS7 network architecture.

Answer

SS7 Network Architecture



24) What are the signaling link types?

Answer

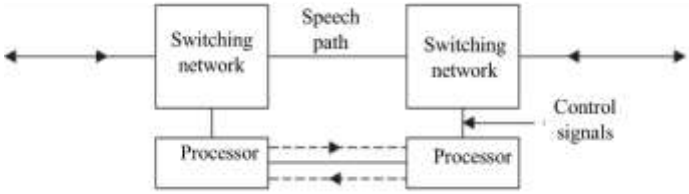
SS7 signaling link types Signaling links are logically organized by link type (A through F) according to their use in the SS7 signaling network.

25) What are the three ways of implementing CCS? Explain each types of signaling with neat diagrams.

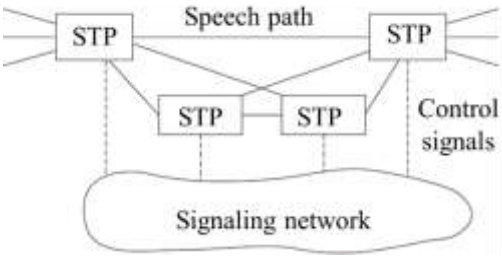
Answer

Implemented in three ways as follows

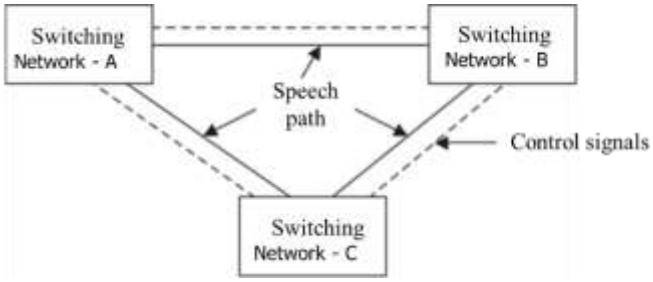
a) *Channel associated mode: there is a direct link between two exchanges where signaling path passes through the same set of switches as does the payload/speech.*



b) *Channel Non-Associated mode: there are separate control of the networks from the switching Nodes. In multi-exchange network, signal message passing through several intermediate nodes.*



c) *Quasi-Associated mode: Signaling messages are routed through one intermediate node for short distance communication. (simplified paths between exchanges).*



26) List the advantages and disadvantages of CCS.

Answer

a) Advantages of CCS

i. For each associated trunk group, only one set of signaling facility is required.

ii. Provides efficient routing procedure.

iii. Allows signaling at any time in the entire call duration, not only at the beginning.

iv. Provides acceptable quality for network related signaling tones

v. There is no chance of mutual interference and the error rate is very low.

vi. Hi signal capacity, thus providing more new services.

vii. Great flexibility, provides more new services simply by modifying software.

viii. Line signaling device is not needed at any trunk station, reduce investment costs.

ix. Information exchanged between processor at high speed allows maintenance or network management.

b) Disadvantages of CCS

i. More over heads due to, in an established circuit, the signaling information are stored, processed and then forwarded to next node.

ii. Thus, a high degree of reliability is required for the common channel.

iii. The integrity of speech path is not assured. Since signaling information is not actually sent over speech paths in CCS,

iv. The error rate of the common channel signaling system must be very low.

v. Its reliability must be much high, because once the data link fails, all related calls between the two related switches shall be affected.

vi. Bi-directional trunk working modes exist conflict of seizure (A Sudden Disorder).

vii. *Compatibility problem in mult-vendor environment. The SS7 systems that every transnational corporation produces are having some problems in compatibleness.*

27) List the purpose and features of SS7.

Answer

a) Purpose of SS7

i. *SS7 is a prerequisite for introduction of, Internal control and network intelligence essential to an ISDN, Intelligent Network (IN), and Personal Communication Systems (PCS)*
ii. *To access remote database to lookup*
iii. *Increased revenue generation,*
iv. *Enables quick and efficient call setup and teardown across the network*
v. *Full use of the channel for the talk*
vi. *Enhanced call features (forwarding, name/number display and conference*
vii. *Rerouting of network by using automatic protection switching services*
viii. *Uses packet Switching concept hence, capable of preventing the misrouted calls, duplication of call requests and lost packets*

b) Features of SS7

i. *Standardized by the ITU.*
ii. *Suitable for any transmission medium*
iii. *Optimized to work with digital SPC exchanges utilizing 64 kbps digital channels, it is suitable for operation over analog channels.*
iv. *Suitable for various services such as Voice, text, data, images and video.*
v. *Transport mechanism is application independent*
vi. *High performance and flexibility*
vii. *High reliability for message transfer*
viii. *Faster, efficient in the call setup and teardown process*

28) Explain all the signalling link types of SS7 link architecture.

Answer

a) *A links Link: interconnect an STP and either an SSP or SCPA stand for "Access".*
b) *B (Bridge) links: Connects one STP to another STP.*
c) *C (Cross) links: Interconnect mated STPs. They are used to enhance the reliability of the signaling network in instances where one or several links are unavailable.*

d) *D links (Diagonal): quad of links interconnecting mated pairs of STPs at different hierarchical levels.*

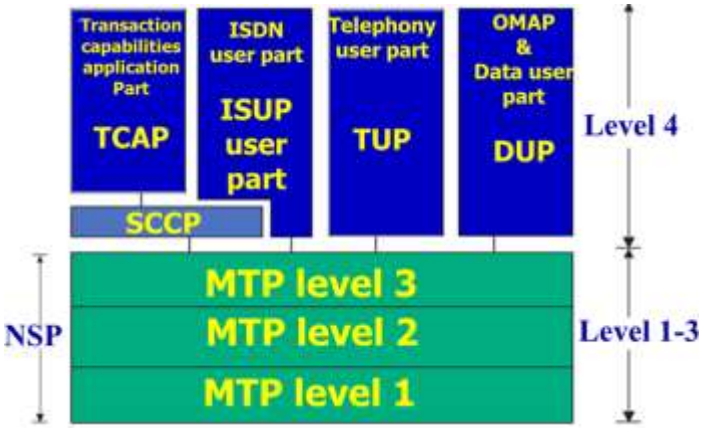
e) *E links (Extended): provide an alternate signaling path if an SSP's home STP cannot be reached via an A link.*

f) *F (Fully Associated) are links that directly connect two signaling end points. F links allow associated signaling only.*

29) Explain with neat diagram the protocol architecture of SS7.

Answer

The protocol architecture of SS7 is shown in figure below



a) *Signaling Connection Control Part (SCCP): Defines the physical, electrical and functional characteristics of the digital signaling link.*

b) *MTP level 2: Provides link layer functionality, ensures the two end points of a signaling link can reliably exchange signaling messages.*

c) *MTP level 3: Provides network layer functionality. Its functions includes node addressing, routing alternate routing and congestion control.*

d) *Signaling Connection Control Part (SCCP): provides connectionless and connection-oriented network services.*

e) *Transaction Compatibilities Application Part (TCAP): Defines the message and protocol used to communicate between applications in nodes. Used for Database services.*

f) *Telephone Use Part (TUP) is an analog protocol that performs basic telephone call connect and disconnect. Such as establishment, maintenance, and termination of telephone calls.*

g) *ISUP (ISDN User Part): Supports basic telephone call connect/disconnect between end offices.*

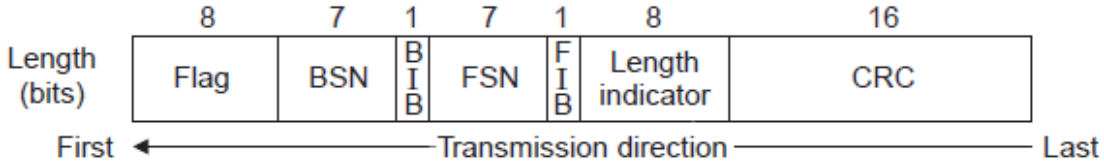
h) *DUP (Data User part): Defines the necessary call control, and facility registration and cancellation related elements for international common channel signaling by use of SS7 for circuit-switched data transmission services.*

i) *Operations, Maintenance and Administration part (OMAP): Defines messages and protocol designed to assist administrators of the SS7 network.*

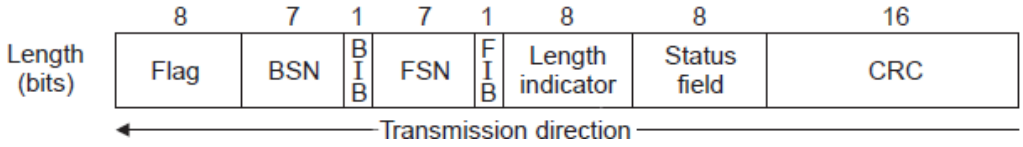
30) Name three types of signalling units used in SS7. With neat diagrams explain each field associated with the signaling units.

Answer

a) *Fill-in signal unit (FISU)*



b) *Line status signal unit (LSSU)*



c) *Message signal unit (MSU)*

i. ***Flag:*** *The flag indicates the beginning of a new signal unit and implies the end of the previous signal unit (if any).*

ii. ***Backward Sequence Number (BSN).*** *Used to acknowledge the receipt of signal units by the remote signaling point.*

iii. *Backward Indicator Bit (BIB): A negative acknowledgement is indicated by inverting the BIB bit, which remains unchanged for all subsequent positive acknowledgement*

iv. *Forward Sequence Number (FSN) it contains the sequence number of the signal unit. The FSN identifies the SU uniquely using modulo 128 count.*

v. *The Forward Indicator Bit (FIB) is used in error recovery like the BIB.*

vi. *Cyclic Redundancy Check (CRC). Is 16bit field used to detect and correct data transmission errors.*

vii. *Length Indicator (LI). 8 bit bytes serves both as a check on the integrity of the SU and as a means of discrimination between different types of SUS at level2.*

viii. *Service information octet (SIO): Indicates the user part according to the message (e.g., telephone, data or ISDN).*

ix. *Signaling Information Field (SIF) may consist of up to 272 octets, it contains the information to be transmitted.*

4. LECTURE 04: Traffic Engineering

1) Define the term Traffic Engineering as applied in Communication Switching systems and brief explaining its purpose?

Answer

a) Traffic Engineering provides the basis for analysis and design of telecommunication networks or model.

b) The Purpose of Traffic Engineering is to

i. Provides means to determine the major equipment required to provide a particular level of service for a given traffic pattern and volume.

ii. It helps to predicts accessibility and utilization of telephone lines, channel and trunks and cost effectiveness of various sizes and configuration of networks.

2) What are the two basic parameters that define "traffic"?

Answer:

calling rate and holding time,

3) Define calling rate and holding time.

Answer

a) Calling rate is the average number of requests for connection that are made per unit time.

b) *Holding time is the length of time that a resource is being held (e.g. duration of a phone call)*

4) What is traffic pattern?

Answer

Traffic pattern the nature of telephone traffic and its distribution with respect to time (traffic load) which is normally 24 hours. It helps in determining the number of lines/Servers required to serve the subscriber needs. The variations are not uniform and varies season to season, month to month, day to day and hour to hour

5) Define Traffic Intensity:

Answer

Is a measure of the average occupancy of a resource during a specified period of time, normally a busy hour

6) Briefly explain the following terms Busy Hour, Peak Busy Hour, and Time Consistent Busy Hour.

Answer

a) Busy Hour. The busy hour refers to the traffic volume or number of call attempts, and is that continuous 1-h period lying wholly in the time interval concerned for which this quantity (i.e., traffic volume or call attempts) is greatest.

b) Peak Busy Hour. The busy hour each day; it usually is not the same over a number of days.

c) Time Consistent Busy Hour. The 1-h period starting at the same time each day for which the average traffic volume or call-attempt count of the exchange or resource group concerned is greatest over the days under consideration.

7) Write short notes on (a) Erlang and (b) Centum Call Seconds (CCS) (c) Traffic volume

Answer

a) Erlang is the unit used to describe the average number of calls simultaneously in progress over a certain time.

b) Centum Call Seconds (CCS) is measures the exact same traffic intensity as the Erlangs but expresses it as the number of 100 second holding times required per hour. CCS = 36 x Erlangs

c) Traffic volume - for an interval is the sum of all the traffic holding times for that interval

8) Define Grade Of Service.

Answer

Grade of Service (GOS) is the ratio of lost traffic to offered traffic.

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

9) A particular exchange has been dimensioned to handle 1000 calls during the busy hour. On a certain day during the BH 1100 calls are offered. What is the resulting grade of service?

Answer/Solution

$$Grade\ of\ service = \frac{Number\ of\ lost\ calls}{Total\ number\ of\ offered\ calls}$$

$$GoS = \frac{1100-1000}{1100} = 0.0909$$

10) a) What is Congestion b) list and explain the two types of congestion.

Answer

a) Congestion is the probability that the offered traffic load exceeds predefined value or capacity of a resource; hence, no new calls can be accepted

b) There are two ways of specifying congestion.

i. Time congestion is the percentage of time that all servers in a group are busy.

ii. Call or Demand Congestion is the proportion of calls arising that do not find a free server.

11) Comment on modelling of traffic.

Answer

To analyze the statistical characteristics of a switching system, traffic flow and service time, Traffic modeling is a mathematical expression of physical quantity to represents the behavior of the quantity under consideration. Also, the model provides an analytical solution to a teletraffic problems. As the switching system may be represented in different ways, different models are possible. Depending on the particular system and particular circumstance, a suitable model can be selected.

12) Distinguish offered traffic from carried traffic.

Answer

Carried traffic *is the volume of traffic actually carried by a switch,*

offered traffic *is the volume of traffic offered to a switch.*

13) On a particular traffic relation, the calling rate is 461 and the average call duration is 1.5 min during the BH. What is the traffic intensity in CCS, in erlangs?

Answer/Solution

$A = C \times T$

Where

C designates the number of calls originated during a period of 1 h

T is the average holding time,

*461*1.5min/60min = 11.525 Elangs*

1 erlang = 30 EBHC = 36 CCS = 60 Cm

*11.525*36CCS = 414.9CCS*

14) What is Erlang loss system? Name three models of the loss system.

Answer

a) The Erlang loss system is defined by the following specifications.

i. The arrival process of calls is assumed to be Poisson with a rate of λ calls per hour.

ii. The holding times are assumed to be mutually independent and identically distributed random variables (1/μ seconds).

iii. Calls are served in the order of arrival.

b) There are three models of loss systems.

i. Lost calls cleared (LCC)

ii. Lost calls returned (LCR)

iii. Lost calls held (LCH)

15) Give the expression of Erlangs-B formula.

Answer

Erlang B Formula: All blocked calls are cleared

$$P_B(C, A) = \frac{\frac{A^C}{C!}}{\sum_{k=0}^{C} \frac{A^k}{k!}}$$

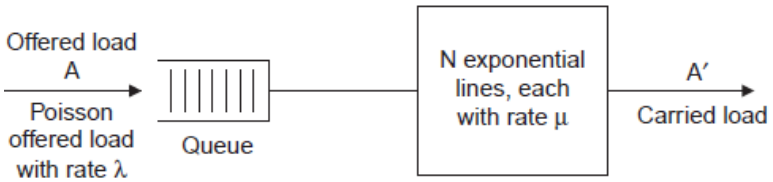
Where

A is the traffic intensity

C=N is the number of channels

16) Draw the queuing model of delay systems.

Answer



17) Give the expression of Erlang-C formula.

Answer

Erlang delay (C) system can be modeled

$$P(0) = \frac{1}{\sum_{k=0}^{N} \frac{A^k}{k!} + \frac{A^N}{N!}\left(\frac{A}{N-A}\right)}$$

Or

$$\text{Prob. (delay)} = P(>0)\ C(N, A) = \frac{BN}{N - A(1 - B)}$$

Where

B = Blocking probability for a LCC system

N = Number of servers

A = Offered load (Erlangs

18) A group of users made 30 calls in one hour, and each call had an average duration of 5 minutes, find the number of Erlangs

Solution

Erlangs = 30 X 50mins/60min = 2.5Erlangs

19) If a group of 20 trunk carries 10erlangs and the average call duration is 3mins, calculate (a) average number of calls in progress (b) total number of calls originating per hour:

Solution

Given data : No. of trunks = 20

traffic intensity = 10 erlangs

holding time h = 3 minutes

observation period T = 60 minutes (generally).

(a) Traffic intensity per trunk $= \frac{10erlangs}{20} = 0.5Erlangs/Trunk$

Average no. of calls per trunk for 1 erlang for 60 minutes = 20

For 0.5 erlang, average no. of calls in progress = 10.

(b) Traffic intensity $A = \frac{nh}{T} = 10Erlangs$

total number of calls originating per hours

$$n = \frac{AT}{h} = \frac{10\ x\ 60mins}{3mins} = 200\ calls$$

20) Consider a group of 1200 subscribers who generate 600 calls during the busy hour. The average holding time is 2.2 minutes. What is the offered traffic in Erlang, CCS and call minutes (CM).

Solution

Traffic intensity in erlangs = A = $\frac{\mathbf{600 * 2.2}}{\mathbf{60}}$ ***= 22 erlangs***

*Traffic intensity in CCS = 36E =36*22 = 792CCS*

*Traffic intensity in CS = 100*CCS =792*100 = 79200 CS*

Traffic intensity in CM = CS/60 =79200/60 = 1320 CM

21) During a busy hour, 1400 calls were offered to a group of trunks and 14 calls were lost. The average call duration has 3 minutes. Find (a) Traffic offered (b) Traffic carried (c) GOS and (d) The total duration of period of congestion

Solution:

a) *During a busy hour (Traffic offered)* $A = \frac{1400\ X\ 3}{60} = 70E$

b) *Traffic carried Ao* $= \frac{(1400-14)\ X\ 3}{60} = 69.3E$

Where A – A0 = 70 – 69.3 = 0.7 E (lost traffic)

c) $GOS = \frac{0.7}{69.3} = 0.01$

d) *Total duration = 0.01 × 3600 = 36 seconds*

22) A call established at 1am between a mobile and MSC. Assuming a continuous connection and data transfer rate at 30kbit/s, determine the traffic intensity if the call is terminated at 1.50am.

Solution:

*Traffic intensity = (1 call) *(50mins) *(1 hour/60 min) = 0.833Er*

23) Consider a PSTN which receives 240 calls/hr. Each call lasts an average of 5 minutes. What is the outgoing traffic intensity to the public network?

Solution:

*Traffic Offered (A) = μ *H*

μ = 240 calls/hr and H = 5 minutes

A = (240 calls /hr) x (5 min/call) = 1200 min/hr. = 20 Erlangs

24) Consider a trunk group with an offered load 4.5E and a blocking probability of 0.01. If the offered traffic increased to 13E, to keep same blocking probability, find the number of trunks needed. Also calculate the trunk occupancies.

Solution:

Given A = 4.5, B = 0.01 From Erlang Table No. of trunks (N/C) = 10

For the increase in load of 13E, from Erlang table N/C = 21 for same B = 0.01 required

The trunk occupancies calculated as

$$\eta = \frac{A_{ca}}{C} = \frac{A\ [1 - P_B]}{C}$$

For N or C = 10, A = 4.5 η = 4.5(1 -0.001)/10 = 0.4455

For N or C = 21, A = 13 η = 13(1 -0.001)/10 = 0.613

25) A message switching network is to be designed for 90% utilization of its transmission link. Assuming exponentially distributed message lengths and an arrivals rate of 10 messages per min. What is the average waiting time and what is the probability that the waiting time exceeds 3 minutes?

Solution:

Given A = ρ = 90% = 0.9. λ = 10 messages/minute. Assume N = 1

For N = 1, prob (delay) = P(> 0) = ρ = 0.9. Also A = ρ = 0.9.

The average service time h = Prob. (delay)/λ = 0.9/10 = 0.09

*Average waiting time W (t) avg = P(>0)*h/(N – A) = 0.9 x 0.09/(1- 0.9) = 0.81 min.*

Prob. of the waiting time exceeding 3 minutes

*= P(> 3) = P(> 3) *$e^{-(N-A)t/h}$ = 0.9 × $e^{-(1-0.09)3/0.09}$ = 0.032*

Thus 3.2% of the message experience queuing delay of more than 3 minutes.

26) A group of 7 trunks is offered 4E of traffic, find (a) the grade of service (b) the probability that only one trunk is busy (c) the probability that only one trunk is free and (d) the probability that at least one trunk is free.

Solution

a) *The grade of service*

Hint using Erlang B formula

k = N, the probability of loss is given by

$$P(N) = B(N, A) = \frac{A^N}{N! \sum_{k=0}^{N} \left(\frac{A^k}{k!} \right)}$$

Where K=N Number of trunks/Servers

A Traffic load/Intensity

$$B(7, 4) = \frac{4^7}{7! \left[1 + \frac{4}{1} + \frac{4^2}{2!} + \frac{4^3}{3!} + \frac{4^4}{4!} + \frac{4^5}{5!} + \frac{4^6}{6!} + \frac{4^7}{7!} \right]}$$

Grade of Service = B = 0.052 = GOS. = (1-0.052) % = 95%

b) The probability that only one trunk is busy

$$P(1) = \frac{4/1!}{62.35} = 0.064$$

c) The probability that only one trunk is free

$$P(6) = 4^6/6!/\sum_{k=0}^{k=6}\left(\frac{4^k}{k!}\right)$$

$$P(6) = \frac{4^6}{7!\left[1+\frac{4}{1}+\frac{4^2}{2!}+\frac{4^3}{3!}+\frac{4^4}{4!}+\frac{4^5}{5!}+\frac{4^6}{6!}\right]}$$

=0.0912

d) The probability that at least one trunk is free

P(k < 7) = 1 – P(7) = 1 – B = 1 – 0.052 = 0.948. (Note use Erlang B form to find P(7)

27) Based on the Erlang B formula and given a BH requirement for a grade of service of 0.005 and a BH traffic intensity of 25 erlangs on a certain traffic relation, how many trunks are required? *Hint use the Poisson tables and Erlang B formula*

Answer/Solution

$$E_B = \frac{A^n/n!}{1 + A + A^2/2! + \cdots + A^n/n!}$$

28) Consider TTCL Fixed PSTN with a trunk group of 10 circuits serving a first attempt offered traffic load of 7erlangs. a) What is the blocking probability? b) If the number of circuits increased to 13, what is the blocking probability? c) Find the blocking probability for the retries assuming random retries for all blocked calls.

Solution

As 7E of traffic arise from a large number of subscribers, infinite source analysis (or Erlang B loss system) is justified

a) Blocking probability

For A = 7E, N = 10, from the table the blocking probability B = 0.079

b) If the number of servers increased to 13, for the same traffic of A = 7E, the blocking probability is B = 0.02 or approximately 2%.

c) Blocking probability for the retries for the given N = 10, A = 7, the blocking probability

Traffic intensity (A) = λh/T

➔ *Arrival rate (λ) = AT/h*

h is average holding time assumed as 3 minutes

*λ =7*60/3 = 140*

New holding time (λ')= λ/(1-B) = 140/(1-0.079)= 152

*Hence for λ'= 152 new (A') = λ'h/T = 152*3/60 = 7.6E*

Thus, the total traffic load including retries is approximately 7.6E. The corresponding B = 0.1 or 10%.

29) A DIT message switching network is to be designed for 90% utilization (*ρ)* of its transmission link. Assuming exponentially distributed message lengths and an arrivals rate of 10 messages per min. a) What is the average waiting time and b) what is the probability that the waiting time exceeds 3 minutes? (*hint delay system, consider little*)

Answer/Solution

Given A = ρ = 90% = 0.9. λ = 10 messages/minute. Assume N = 1

For N = 1, prob (delay) = P(> 0) = ρ = 0.9. Also, A = Offered load (Erlangs) A = ρ = 0.9.

The average service time h = Prob. (delay)/λ = 0.9/10 = 0.09

a) Average waiting time W(t)avg = P(>0)h/(N – A) = 0.9 x 0.09/(1- 0.9) = 0.81 min.

b) Prob. of the waiting time exceeding 3 minutes

= P(> 3) = P(> 0) $e^{-(N-A)t/h}$ = 0.9 × $e^{-(1-0.09)3/0.09}$ = 0.032

Thus 3.2% of the message experience queuing delay of more than 3 minutes.

30) A TTCL MOBILE support 10 digital speech channels. Assume the probability of blocking is 1.0%. a) From the Erlang B chart find the traffic intensity. b) How many 3 minutes of calls does this represent?

Answer/Solution

From the Erlang B Chart the traffic intensity = ~5 Erlangs

A = λ h

λ = A/h = 5/(3 mins/60) = 100 calls

31) A telephone switching board at DIT can handle 120 phones. Determine a) the outgoing traffic intensity and b) the number of channels, assuming the followings.

- ✓ On average 5 calls/hour per phone,
- ✓ Average call duration time = 4 minutes,
- ✓ 60% of all calls made are external.

- ✓ QoS = 0.9%

Solution

a) *Outgoing traffic*

*Total Arrival Rate λ_T = (120 call*5 calls/hour) *60% =360 call/hour*

Holding time h = 4 mins/call

*==>> Total Traffic Offered A_T = 360 * 4 * (1 hour/60mins) = 24 Erlangs.*

Thus 24 hours of circuit talk time is required for every hour of elapsed time

b) *The number of channels*

From Erlang Chart -No. of channels N required is = ~ 34

32) The principal of DIT hire you to design PBAX with 120 phones. Assuming the number of call is 3/hour/line, the average call duration is 4 minutes, and 55 % of all call are made external via a T-1 trunk (24 channels) to the PSTN. Determine carried traffic and channel usage.

Answer/Solution

a) *Carried traffic (Offered traffic)*

A = μ x h = (150 phones x 3 calls/hr. x 58%) x (4mins. /call) x (1 hour/60mins.) = 17.4E

b) *Channel usage*

Blocking Probability P_B, N = 24 and A = 17.4E

Therefore, from the Erlang B Chart or formula P_B = 0.03

Carried Traffic, Aca = A (1- PB) = 17.4 (1-.03) =16.9 Erlangs

Channel usage η = Aca / C = 16.9/24 = 0.7 or 70%

Note: 16.9E of traffic attempts to go across the T1 trunk and 0.5 Erlang is blocked

33) At Block Four (4), on average, there are 1800 new calls in an hour, and the average holding time is 3 minutes. Then the traffic intensity is

Solution

Traffic intensity A = nh/T = *λ h = (1800/60mins) *3mins= 90Erlangs*

34) Assume you have an office which has PBX with 4 channels on a link and the offered traffic is a = 2Erlangs. Then the call blocking probability B_c is.

Solution

Call blocking probability Bc is

$$P(N) = B(N, A) = \frac{A^N}{N! \sum_{k=0}^{N} \left(\frac{A^k}{k!}\right)}$$

Where K=N Number of trunks/Servers

A Traffic load/Intensity

$$P(4,2) = \frac{2^4}{4!\left[1 + \frac{2}{1} + \frac{2^2}{2!} + \frac{2^3}{3!} + \frac{2^4}{4!}\right]}$$

$$P(4,2) = \frac{16}{24[1 + 2 + 2 + 1.33 + 0.666]}$$

= 0.095293 = 9.5%

35) Consider telephone traffic carried by a 5trinks in PSTN. Use a pure loss system model. New calls arrive according to a Poisson process at rate 2 calls per minute, and call holding times are independently and identically distributed with mean 3mins. Compute

(a) the traffic offered,

(b) the traffic carried, and

(c) The traffic lost.

Solution

a) Traffic intensity (Offered traffic)

*A = nh/T = λ *h = 2 calls per minute*3 minutes. = 6E*

b) The traffic carried,

A_C = A (1 – P_B (N, A)) Erlangs

Blocking probability P_B (N, A) can be calculated use the B formula as follows

From formula

$$P(5,6) = \frac{6^5}{5! * \left[1 + \frac{6}{1} + \frac{6^2}{2!} + \frac{6^3}{3!} + \frac{6^4}{4!} + \frac{6^5}{5!}\right]}$$

$$\frac{7776}{120 * 178.8}$$

0.362416107

*A_C= 6E *(1-0.362416107) = 3.826Erlangs*

c) The traffic lost

*A*P (5,6) = 6*0.362416107=2.17Erlangs*

36) Consider the processor of a packet router in a packet switched data network. Traffic consists of data packets to be processed. Use a pure waiting system model with a single server. New packets arrive according to a Poisson process at rate 2 packets per ms, and packet processing times are independently and exponentially distributed with mean 0.4ms.

(a) What is the traffic load?

(b) What is the probability that an arriving packet will be processed immediately after the arrival (without any waiting)?

(c) What is the probability that a packet has to wait longer than 3ms?

Answer/Solution

The traffic loads

$$\rho = A = \lambda h$$

Where λ is arrival rate, holding time

*=2ppms*0.4ms= 0.8*

The probability that an arriving packet will be processed immediately after the arrival (without any waiting)?

The average service time h = Prob. (delay)/λ = 0.8/2 = 0.4

Prob. of the waiting time exceeding 3 minutes

= P(> 2) = P(> 0) $e^{-(N-A)t/h}$ = 0.8 × $e^{-(1-0.8)3/0.4}$ = 0.2253 (asummed N =1)*

37) Consider a link between DIT main Campus and Mwanza Campus; the two packet routers. Assume that, on average, 50,000 new packets arrive in a second, the mean packet length is 1500bytes, and the link speed is 1Gbps. Then the traffic load (as well as, the utilization) is?

Answer/Solution

Then the traffic load (as well as, the utilization) is

ρ = λ/μ

But μ = C/L

Hence ρ = λL/C

Where λ is arrival rate, L is packet length and C link speed

*ρ = 50,000*1500*8/1,000,000,000 = 0.60 = 60%*

38) DIT main Campus PBAX has 4 operators and receives 300 calls during a busy hour. The average holding time is 36 seconds. Assume that call arrivals are poisoning and service time is negative exponential distribution. Calculate

a) The percentage of calls on queue

b) Average delay

c) Percentage of calls delayed for more than 45 seconds, 30 seconds and 20 sec.

Answer/Solution

Given data
N = 3, n = 300 calls, h = 36 sec.
λ=300/60min =5calls per mins
h= 36/60 = 0.6min

$$A = \frac{n * h}{T} = \frac{300 * 0.6}{60} = 3erlangs$$

i. *The percentage of calls on queue*

$$\text{Prob. (delay)} = P(>0)\ C(N, A) = \frac{BN}{N - A\,(1 - B)}$$

$$P(N) = B(N, A) = \frac{A^N}{N! \sum_{k=0}^{N} \left(\frac{A^k}{k!}\right)}$$

Where

B = Blocking probability for a LCC system

N = Number of servers

A = Offered load (Erlangs)

$$= \frac{3^4}{4! \sum_{k=0}^{4} \left(\frac{3^k}{k!}\right)}$$

$$= \frac{81}{24 * \left(\frac{3^0}{0} + \frac{3^1}{1} + \frac{3^2}{2!} + \frac{3^3}{3!} + \frac{3^4}{4!}\right)}$$

$$= \frac{81}{24 * 16.375}$$

P(B)= 0.2061

hence

$$C(4,3) = \frac{BN}{N - A * (1 - B)}$$

$$C(4,3) = \frac{0.2061 * 4}{4 - 3 * (1 - 0.2061)}$$

0.509433962

50.94%

ii. average waiting time

$$w(t)_{average} = \frac{C(N,A) * h}{N - A}$$

$$w(t)_{average} = \frac{0.509433962 * 36}{4 - 3}$$

18.34 Seconds

iii. percentage of calls delayed for more than 45 seconds, 30 seconds and 20 sec.

Percentage of calls delayed for more than time t

$$(P >) = (P > 0) * e^{-(N-A)*t/h}$$

Where

N number of servers/operators,

A traffic, t average time

h holding time

delayed for more than 45 seconds

$$= 0.509433962 * e^{-(4-3)*45/36}$$

=0.14595283= 14.6%

delayed for more than 30 seconds **=22.1%**

delayed for more than 20 seconds **=29.2%**

39) Consider elastic data traffic carried by a 100Mbps link in a packet switched network. Use a pure sharing system model with a single server. New flows arrive according to a Poisson process at rate 8 flows per second, and the average size of the files to be transferred is 10Mbit.

a) What is the traffic load?

b) What is the throughput of a flow?

c) What is the average file transfer time?

Answer/Solution

Given data

*C (link speed) 100-Mbps = 100*10⁶bps*

Flow rate λ 8 pps

*Packet length 10 *10⁶bs (take note this is in bits not bytes hence factor of 8 is not applied)*

a) The traffic load

$\rho = \lambda/\mu$

But $\mu = C/L$

Hence $\rho = \lambda L/C$

*=8pps * 10 *10⁶bs/100*10⁶bps= 0.8 = 80%*

The throughput of a flow Ø

= (L- *λ) =L(1- ρ) = 100Mbps(1-0.8) = 20mbps*

b) The average file transfer time

= L / Ø = 10Mb/20Mbps = 0.5sec

40) Assume that flows arrive at rate = 600 flows per second and the link speed is C = 1000 Mbps = 1.0 Gbps.

Answer/Solution

The system is stable since

$\rho = \lambda/\mu = \lambda L/C = 600/1000 = 0.6 = 60\%$

$Ø = Xput(1000,600;1) = 1000 - 600 = 400\ Mbps = 0.4\ Gbps$

41) GbE (gigabit Ethernet) and SONET/SDH are competitors for an all-optical (data) network. Why would you think GbE would be more friendly to our cause than SONET/SDH?

Answer

Because the cost of interface equipment for GbE fiber transport links is significantly less than for a SONET or SDH link.

42) Consider a part of TTCL trunk network, which is connected to the rest of the network through four of its nodes. In this subnetwork, the average number of packets has been measured to be 1000. Let the arrival rates of the packets from other parts of the network to these four Routers be Ilala (λ_1) = 200pps, Kijitonyama (λ_2) = 300pps, Ubungo (λ_3) = 400pps, and Pugu Road (λ_4) = 500pps (pps =packets per second). How long does a packet stay in the subnetwork on average? ***(Tip: Use Little's formula)***

Solution

L=1000ps

$\lambda_T = (\lambda_1 + \lambda_1 + \lambda_1 + \lambda_1) = (200 + 300 + 400 + 500)$ pps =1400pps

According to little formula

$$T = \frac{N}{\lambda} = \frac{L}{\lambda}$$

$$T = \frac{1000}{1400} \approx 0.71\text{sec}$$

On average packet stay in the subnetwork for 0.71secs

43) eGOVe Router with four incoming links from different regions namely Arusha, Mwanza, Dodoma and Mbeya of capacity 155Mbps. The average packet arrival rates from these four links are tabled below:

No:	Link	Packets/mSecond
1.	Arusha	10
2.	Mwanza	12
3.	Dodoma	5
4.	Mbeya	3

The average packet length is 400bytes. Model this system as a pure waiting system of type (***with one server and an infinite buffer***).

a) What is the minimum capacity required for the link from SIMUNET outwards (outgoing link) in order for the system to be stable?

b) Assume then that the capacity of the outgoing link is also 155Mbps. What is the traffic load? What is the average number of packets in the multiplexer? What is the mean time that the packets stay in the multiplexer (Waiting time+transmission time)?

Answer/Solution

Total arrival rate/traffic flow $\lambda_T = (\lambda_1 + \lambda_1 + \lambda_1 + \lambda_1) = (10 + 12 + 5 + 3) = 30*10^3 pps$

*Link Speed C 155Mbps , Packet length L 400bytes = 400*8bits = 3200bits*

For M/M/1 system is stable if , $\rho = \frac{\lambda}{\mu} < 1$ *therefore,*

For the system to be stable

$\rho = \lambda L/C < 1 \Rightarrow C > \lambda L = 30*10^3 pps * 3200bits = 96*10^6 bits/sec = 96Mbps$

for capacity of the outgoing link 155Mbps the traffic load is

$\rho = \lambda/\mu = 96mbps/155mbps = 0.62 = 62\%$

For an M/M/1 queue we know that the average number of packets is

$$X = \frac{\rho}{1-\rho} = \frac{0.62}{1-062} = 1.63$$

Little's formula on the other hand gives the mean time spent in the system

$T = L/(\mu - \lambda)$

$T = \frac{3200}{(155-96)*1{,}000{,}000} = 0.054msec$

44) Consider TTCL Backbone IP/MPLS network: In this network traffic passing through a Gateway Router at Kijitonyama. Assume that new packets arrive at the gateway router from different links namely Ubungo-maziwa, Manzese, Telephone House, Pugu Road, etc at the total rate of 10-packets/ms. The average size of the packets is 575bytes (1 byte=8 bits). The Gateway router has several output ports each of which has the capacity of 2 Mbps. If the port assigned to an arriving packet is busy, the packet stays in the buffer to wait for transmission. Measurements indicate that the packets stay in the Central router 5ms on average, including both the waiting time and the transmission time.

(a) What is the average number of packets in the Central router?

(b) What is the average waiting time of all packets in the buffer?

(c) How many packets are there in the buffers on average?

Answer/Solution

a) The average number of packets in the Central router

Packets arrive 10-packets/ms $\lambda = 10*10^3 pps$

Using the little Formula average number of packets in the gateway router is obtained $N = \lambda * T_{Total} = 10pkts/ms * 5ms = 50pkts$

b) *The average waiting time of all packets in the buffer*

The packets stay in the router 5ms on average, including the waiting time and the transmission time.

The average waiting time Tw is therefore the difference between the average total time 5ms and the average transmission time

Transmission Time $T = L/C = 575bytes * 8bit/byte/2*10^6 bp = 2.3msec$

Waiting time = 5ms-2.3ms = 2.7msec

c) *Number of packets in the buffers on average*

$N_w = \lambda T_w = 10ppms * 2.7msec = 27packets$

5. LECTURE 05: Telephone Network Organization

1) What is the basic goal of the network management?

Answer

To maintain efficient operations during equipment failures and traffic overloads. Also controlling the flow of call requests during network overload

2) What is the various network planning? Explain each planning in brief.

Answer

1) ***Routing plans:*** *procedures that determine which path in a network are assigned to particular connections.*
2) ***Numbering plans:*** *used to identify the subscribers connected in a telecommunication network. The main objective is to standardize the number length wherever practical according to ITU and national regulatory (TCRA) recommendations*
3) ***Charging plan:*** *The cost of providing a telecommunication network consists of the capital cost and the current operating expenses.*
4) ***Transmission plan:*** *involves plans for various communication methods, sources of transmission, models of transmission*
5) ***Signaling plan:*** *Involves the plan on how the variety of switching system, transmission systems and subscriber equipment in a telecommunication network may exchange signalling to enable the network to function as a whole.*

3) Give at least four major benefits to the network operator derived by implementing a network management system.

Answer

i. It keeps the network operating at peak performance.
ii. It informs the operator of impending deterioration.
iii. It provides easy alternative routing and work-arounds when deterioration and/or failure take place.
iv. It provides the tools for pinpointing cause/causes of performance deterioration or failure.
v. It serves as the front-line command post for network survivability.

4) Describe the basic purpose of alternative routing? What does it improve?

Answer

When an exchange has the option of using more than one route to the next exchange, an alternative routing scheme can be employed.

Two main types are available:

1. *when there is a choice of direct circuit groups between the two exchanges;*
2. *when there is a choice of direct and indirect routes between the two exchanges.*

5) Give the three basic methods of connecting exchanges. (These are the three basic network types.)

Answer

Centralized Model (Star), Distributed/Mesh model and Hierarchical system

6) Distinguish a tandem exchange from a transit exchange.

Answer

Tandem Exchange/Switch is a telephone central office Exchange/switch that links telco end offices together and does not connect to the customer directly. Also called a "Class 4 switch" or "TDM switch," while A transit exchange is a switch connecting circuits (or junctions) between switches but not serving subscribers directly. The main purpose of transit exchanges is to handle the flow of medium and long distance inter-urban traffic. There are main transit centres and secondary transit centres.

7) Write short notes on three types of networks.

Answer

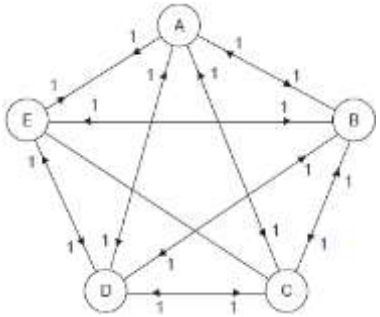
1. ***Public Switched Network****: It allows access to the end office, connects through the long-distance network, and delivers to the end point. Example: - TTCL, Tigo, Vodacom, Hallotel, SEACOM etc.*
2. ***Private networks****: Many companies, depending on their size and need, create or build their own networks. If their networks are underutilized, they may give their network for hire or lease. These networks employ mixture of technologies.*
3. ***Hybrid networks****: To provide a service, if an organization uses both private and public networks, the network is referred as hybrid network*

8) Explain in detail, the basic topologies of the routing plan.

Answer

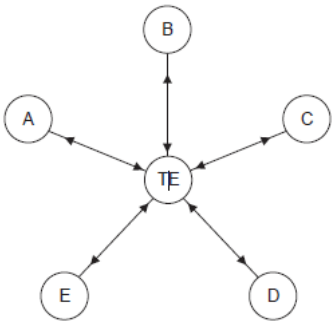
The basic Topology of Routing plan are

a) Mesh-connected network:



This topology offers the highest Availability, 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/Trunks and hence it is very costly

b) Star topology



In star Topology, the number of lines is equal to the number of stations. Utilizes an intermediate exchange called a Tandem exchange. Through the TE all other exchanges communicate.

c) Hierarchical networks

Many star networks may be inter connected by using an additional TE exchange, leading to two level star network. An orderly construction of multilevel star networks leads to hierarchical networks.

9) List and explain briefly the ITU recommendations related to numbering.

Answer

ITU Recommendations in Numbering

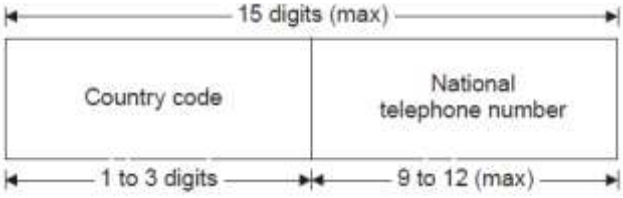
1. ***Recommendation E.164*** *It provides the number structure and functionality for three categories of numbers used for international public telecommunication these are*
    a. *National telephone services.*
    b. *Global telephone services.*
    c. *International networks.*
2. ***Recommendation E.123.*** *This defines a standard way to write telephone numbers, email addresses and web addresses.*

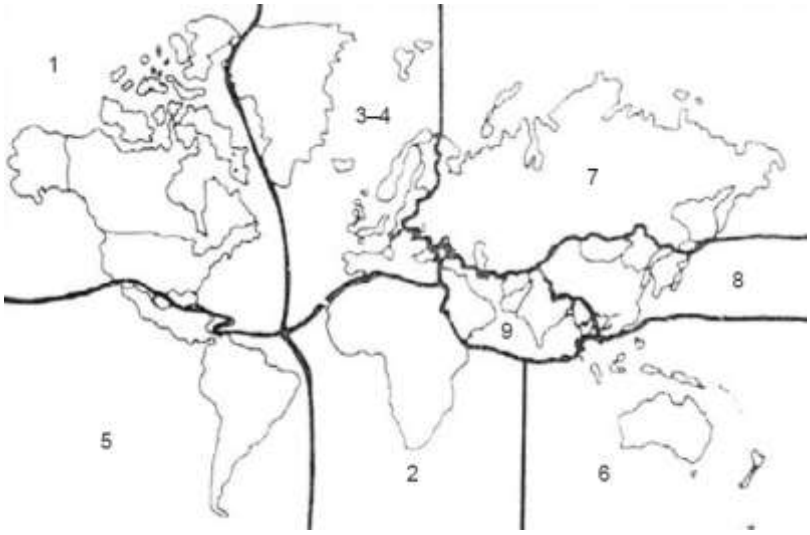
3. ***Recommendation E.162.*** *This recommendation describes that the originating country must analyses a maximum of seven digits of the E.164 international number.*

10) Explain the international telephone numbering format.

Answer

For the international numbering plan, the world has been divided into nine geographical areas/zones as shown in figure below. The general rule is that within each global region each country code starts with the same digit. Digit '0' is not used to indicate zone. Generally, '0' is used as Trunk prefix and '00' is used for international prefix. The international telephone number starts with one to three-digit country code followed by 9 to 12 subscriber number. The dialing procedure is that the international prefix '00' should be dialed first followed by the telephone number. For Tanzania is +255 (000255) ie +2555 XXX XXX XXX





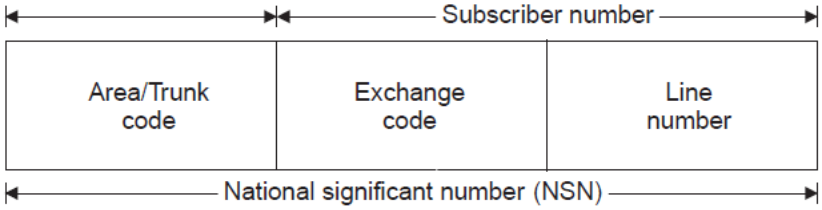
11) Explain the nation numbering format.

Answer

National Numbering Plane may be open; semi open or closed. Each country decides what rules to follow when issuing telephone numbers, the following are common numbering plans followed by Nations.

1. *An **open numbering plane** or non-uniform numbering scheme allows variations in the number of digits to be used to identify the subscriber.*
2. *A **closed numbering plan** or uniform numbering plan refers to a numbering plan which allows telephone numbers of a predetermined length. Special services (toll free, premium rate, etc.) are excluded from this rule.*
3. *A **semi-open plan permits** number lengths to differ by almost one or two digits.*

***Dialing procedure:** in closed numbering plan requires users to dial all numbers at all times. This means that local-local calling also requires the area code to be dialed, and*
the trunk prefix. In open dialing plan local calls can be placed without the trunk prefix and area code.



12) Tabulate the PSTN numbering format followed in Tanzania.

13) Name at least five items that can be listed under quality of service (QoS) in switching systems.

Answer

1. *lost calls or blockage*
2. *Delay before receiving dial tone ("dial-tone delay").*
3. *Postdial(ing) delay (time from completion of dialing a number to first ring of telephone called).*
4. *Availability of service tones (busy tone, telephone out of order, ATB, etc.).*
5. *Correctness of billing.*
6. *Reasonable cost to customer of service.*
7. *Responsiveness to servicing requests.*
8. *Responsiveness and courtesy of operators.*
9. *Time to installation of new telephone, and, by some, the additional services offered by the telephone company.*

14) Considering both quality of service and economy, give at least five constraints or planning factors that go into the design of a local telephone network.

Answer

1. *Geographic extension of the local area of interest.*
2. *Number of inhabitants and existing telephone density.*
3. *Calling habits.*
4. *Percentage of business telephones.*
5. *Location of existing telephone exchanges and extension of their serving areas.*
6. *Trunking scheme.*
7. *Present signaling and transmission characteristics.*

15) Give two basic functions of a telephone number.

Answer

1. *it activates the necessary equipment for proper call charging.*
2. *Routing of calls*

16) Differentiate between uniform and nonuniform numbering.

Answer

i. *uniform numbering is a numbering scheme in which the length of the subscriber numbers is uniform inside a given numbering area.*

ii. *nonuniform numbering as a scheme in which the subscriber numbers vary in length within a given numbering area.*

17) Give at least three traffic parameters that are measured at a switch that give valuable insight to planners, system design engineers, and telephone company/administration managers.

Answer

i. *seizures (call attempts),*

ii. *completed calls,*

iii. *traffic intensity (involving holding times),*

iv. *congestion*

18) In what period during a weekday is traffic measurement most important?

Answer: *Busy Hour*

19) Describe the effects of uniform and nonuniform numbering on signaling/switching. Why is uniform numbering more advantageous to signaling/switching?

Answer

i. *uniform numbering is a numbering scheme in which the length of the subscriber numbers is uniform inside a given numbering area therefore it simplifies a signaling system whereby the local exchange or transit exchanges know when all digits are received. There are two advantages to this sort of scheme:*
   1. *The switch can proceed with the call once all digits are received because it "knows" when the last digit (either the sixth or seventh) has been received.*
   2. *"Knowing" the number of digits to expect provides inherent error control and makes "time out" simpler.*

ii. *nonuniform numbering as a scheme in which the subscriber numbers vary in length within a given numbering area particularly on direct distance dialing in the international service, switches require considerably more intelligence built in. It is the initial digit or digits that will tell how many digits are to follow.*

20) What are the three basic underlying considerations in the design of a long distance (toll) network?

Answer

i. *Routing scheme given inlet and outlet points and their traffic intensities,*

ii. *Switching scheme and associated signaling,*

iii. *Transmission plan.*

21) How can the utilization factor of trunks be improved?

Answer:

Concentrate light, discretely offered traffic from a multiplicity of sources and thus enhance the utilization factor of transmission trunks;

6. LECTURE 06: Telecommunication Networks Management

1) Give at least four major benefits to the network operator derived by implementing a network management system.

Answer

i. It keeps the network operating at peak performance.

ii. It informs the operator of impending deterioration.

iii. It provides easy alternative routing and work-arounds when deterioration and/or failure take place.

iv. It provides the tools for pinpointing cause/causes of performance deterioration or failure.

v. It serves as the front-line command post for network survivability.

2) lists five network-specific characteristics that the troubleshooter should have familiarity with or data on.

Answer

1. *Network Utilization*.
   - *i. The average network utilization; How does it vary through the work day?*
   - *ii. Characteristics of congestion, if any, should be known, and where and under what circumstances might it be expected*
2. *Network Applications*.
   - *i. What are the dominant network applications on the network?*
   - *ii. What version numbers is it running?*
3. *Network Protocol Software*.
   - *i. Protocols are running on the network*
   - *ii. The performance characteristics of the software, and are these characteristics being achieved*
4. *Network Hardware*.
   - *i. Manufacturers of the network interface controllers; media attachment units, servers, hubs, and other connected hardware*
   - *ii. The versions of interface controllers; media attachment units, servers, hubs, and other connected*
   - *iii. Their Performance characteristics Expected and if they are Met*
5. *Inter-networking Equipment*.
   - *i. Manufacturers of repeaters, bridges, routers, and gateways on the network*
   - *ii. The Versions of software and firmware are they running*
   - *iii. What are the performance characteristics?*

3) Name the five traditional tasks of network management.

Answer

i. *Fault management*
ii. *Configuration management*
iii. *Performance management*
iv. *Security management*
v. *Accounting management*

4) Discuss fault management and describe some of the capability it should incorporate.

Answer

fault management provides information on the status of the network and subnetworks. The "information on the status" should not only display faults (meaning failures) and their location, but should also provide information on deteriorated performance. means to bypass troubled sections of a network, as well as to patch-in new equipment for deteriorated or failed equipment.

5) It has been said that a network management center is the front-line command post for network _____

Answer

Survivability

6) Give the four steps involved in finding a "fault" in a telecommunication network.

Answer

i. *Observing symptoms*
ii. *Developing an hypothesis*
iii. *Testing the hypothesis*
iv. *Forming conclusions*

7) Describe how a well-engineered network management system can often cut the time almost to zero for isolating faults.

Answer

expertise built on experience of the troubleshooter and the availability of essential test equipment. Troubleshooting time can be reduced by having o ideal network management systems.

8) From a PSTN perspective, network management may be called "surveillance and control." Mention the two major objectives of surveillance and control.

Answer

i. *Maintain a high level of network utilization.*
ii. *Minimize the effects of network overloads.*
iii. *Support the BOC's National Security Emergency Preparedness commitment.*

9) Distinguish "message traffic" from "non-message traffic."

Answer

Message traffic in communication switching systems means telephone traffic which has a high probability of completion.

While

When unusual conditions occur in the network and cause increased short holding-time calls

10) Describe at least three NTM controls.

Answer

i. *Keep All Trunks Filled with Messages.*
ii. *Give Priority to Single Link Connections.*
iii. *Use of Available Trunking.*
iv. *Inhibit Switching Congestion.*

11) What is a focused overload? Name two measures to mitigate effects of focused overloads.

Answer

A focused overload is generally directed toward a particular location and may result from media stimulation (e.g., news programs, advertisements, call-in contests, telethons) or events that cause mass calling to government or public service agencies, or public utilities.

12) List four of the automatic (traffic flow) controls one might encounter in a modern computer-controlled (SPC) switch.

Answer

i. *Selective dynamic overload control (SDOC)*
ii. *Selective trunk reservation (STR)*
iii. *DOC (dynamic overload control)*
iv. *Trunk reservation*
v. *Selective incoming load control (SILC)*

13) There are really four distinguishable network management protocols.

Answer

i. *The TCP/IP (ARPANET) community: SNMP*
ii. *The ISO/OSI community: CMIP*
iii. *The ITU has fielded the Telecommunication Management Network TMN)*
iv. *ILMI (Interim Local Management Interface) developed for ATM networks*

14) What are the three components of SNMP? Use the acronyms and write out their meaning.

Answer

i. *The management protocol itself*
ii. *The MIB (management information base)*
iii. *The SMI (structure management information)*

15) What does the MIB do for agents?

Answer

Agents use the MIB to provide a view of the local data that are available for manipulation by the network management station.

16) In SNMP, what does an agent do when an unexpected event occurs?

Answer

These agents initiate traps to the management station when an unexpected event occurs

17) Identify the five fundamental functional areas of telecommunications Network TMN.

Answer

i. *Performance management*
ii. *Fault management*
iii. *Configuration management*
iv. *Accounting management*
v. *Security management*

18) With neat diagram, illustrate the different levels of network management.

Answer

7. Lecture 07: Introduction to Telecommunication Billing Systems

1) List down three ways the telecom operators charges their subscribers for services offered.

Answer

i. An initial charge for providing a network connection (as installation charges)
ii. A rental or leasing charge
iii. Call charges.

2) Mention two categories of charging for individual calls

Answer

i. Duration independent charging
ii. Duration dependent charging

3) Differentiate Proratable from Non-Proratable Charges

Answer

pricing apply only for the number of days customer is going to use the service while in non-Proratable, a billing system would charge the customer for the whole month which would not be fair with the customer.

4) Compare Pre-pay Billing and Post-pay Billing

Answer

Pre-pay Billing*: A mechanism where customer pays in advance then starts use service for the specified period. customers do not receive invoice and are charged in real time by Intelligent Network.*

Post-pay Billing*: it is a Conventional billing, customers buy products and services and use them throughout the month, and by end of the month, invoices are generated by the SP then sent invoices to the customers to settle their payment.*

5) Explain briefly the following terms as applied to Telecommunication Switching systems.

i. Interconnect Billing
ii. Roaming Charges
iii. Convergent Billing

Answer

i. Interconnect Billing: Interconnect billing is related to inter-carrier or sometime called partner settlements. Interconnect services provided to its customers by other SPs.
ii. Roaming Charges: Charges customers incurs When goes from one network operator's coverage area to another operator's coverage., Home operator

pays marginal charges to the foreign operator to provide services to their customers. These charges are settled through roaming billing. (Uses TAP3 protocol)

iii. *Convergent Billing: Is the integration of all service charges onto a single customer invoice. (creating a unified view of the customer and all services (Mobile, Fixed, IP, etc.,).*

6) Sketch the Telecom Billing System Architecture

Answer

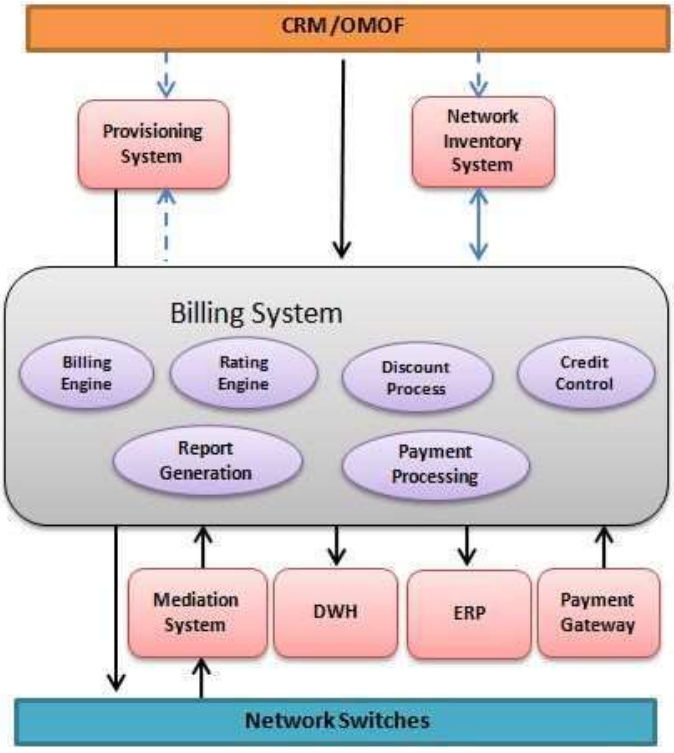


Figure 7.1. *simple Telecom Billing System Architecture*

8. Assignments

1) List at list five drawbacks or challenges designers faced in making VoIP a reality.

Answer

1. *Mouth-to-ear delay*
2. *Impact of errored frames (packets)*
3. *Lost frames (packets)*
4. *Variation of packet arrival time, jitter buffering*
5. *Prioritizing VoIP traffic over regular internet and data services*
6. *Talker echo*
7. *Distortion*
8. *Sufficient bit rate capacity on interconnecting transmission media*
9. *Voice coding algorithm standardization*
10. *Optimized standard packet payload size*
11. *Packet overhead*
12. *Silence suppression*

2) Differentiate RTP and RTCP.

Answer

RTP (real-time protocol) or RTCP (real-time control protocol). RTP deals with media content while RTCP works with the signaling functions of status and control. This protocol information is embedded in UDP, which is reliably transported by TCP.

3) Define sip as applied in modern switching systems

Answer

SIP is based on RFC 2543 [2] and is an application layer signaling protocol. It deals with interactive multimedia communication sessions between end-users.

4) In the SIP protocol, what are end-users called.

Answer: *end-users are called user agents*

5) What are the two modes with which a caller can set up a call with SIP.

Answer: *redirect and proxy*

6) H.248 is a call-control protocol that communicates between a _____and a___ ?

Answer: *gateway controller and a gateway*

7) Name at least three services other than speech telephony that already had been integrated into the PSTN prior to the advent of ISDN.

Answer: *Facsimile (fax), telegraph and telex*

8) Name at least five communication services that ISDN will support.

Answer

1. *Digital voice*
2. *64-kbit/s data, both circuit- and packet-switched*
3. *Telex/teletext*
4. *Facsimile*
5. *Slow-scan video*

9) Distinguish primary rate and basic rate.

Answer

In one configuration, called the basic rate, the D-channel has a 16-kbit/s data rate; in another, called the primary rate, it is 64 kbits/s.

10) Which OSI layers are involved with the B-channel and D-channel for a voice connection?

Answer

NT1, or network termination 1, provides the physical layer interface; it is essentially equivalent to OSI layer 1