

**CS2060 HIGH SPEED NETWORKS 3 0 0 100****AIM**

To highlight the features of different technologies involved in High Speed Networking and their performance.

**OBJECTIVES**

- Students will get an introduction about ATM and Frame relay.
- Students will be provided with an up-to-date survey of developments in High Speed Networks.
- Enable the students to know techniques involved to support real-time traffic and congestion control.
- Students will be provided with different levels of quality of service (Q.S) to different applications.

**UNIT I HIGH SPEED NETWORKS**

Frame Relay Networks – Asynchronous transfer mode – ATM Protocol Architecture, ATM logical Connection, ATM Cell – ATM Service Categories – AAL.

High Speed LANs: Fast Ethernet, Gigabit Ethernet, Fiber Channel – Wireless LANs: applications, requirements – Architecture of 802.11

**UNIT II CONGESTION AND TRAFFIC MANAGEMENT**

Queuing Analysis- Queuing Models – Single Server Queues – Effects of Congestion – Congestion Control – Traffic Management – Congestion Control in Packet Switching Networks – Frame Relay Congestion Control.

**UNIT III TCP AND ATM CONGESTION CONTROL**

TCP Flow control – TCP Congestion Control – Retransmission – Timer Management – Exponential RTO backoff – KARN's Algorithm – Window Management – Performance of TCP over ATM.

Traffic and Congestion control in ATM – Requirements – Attributes – Traffic Management Frame work, Traffic Control – ABR traffic Management – ABR rate Control, RM cell formats, ABR Capacity allocations – GFR traffic management.

**UNIT IV INTEGRATED AND DIFFERENTIATED SERVICES**

Integrated Services Architecture – Approach, Components, Services- Queuing

Discipline, FQ, PS, BRfq, GPS, WFQ – Random Early Detection, Differentiated Services

**UNIT V PROTOCOLS FOR QOS SUPPORT**

RSVP – Goals & Characteristics, Data Flow, RSVP operations, Protocol Mechanisms –

Multiprotocol Label Switching – Operations, Label Stacking, and Protocol details – RTP –

Protocol Architecture, Data Transfer Protocol, RTCP.

**TOTAL: 45****TEXT BOOK**

1. William Stallings, “HIGH SPEED NETWORKS AND INTERNET”, Pearson Education, Second Edition, 2002.

**REFERENCES**

1. Warland & Pravin Varaiya, “HIGH PERFORMANCE COMMUNICATION NETWORKS”, Jean Harcourt Asia Pvt. Ltd., II Edition, 2001.
2. Irvan Pepelnjk, Jim Guichard and Jeff Aparcar, “MPLS and VPN architecture”, Cisco Press, Volume 1 and 2, 2003

## UNIT I

### 1. Define ISDN?

The integrated services digital network is to provide a unique user network interface (UNI) for the support of the basic set of narrow band(NB) services that is voice and low speed data thus providing a narrowband integrated access.

### 2. What are the features of an ISDN?

1. Standard user network interface (UNI)
2. Integrated digital transport
3. Service integration
4. Intelligent network services

### 3. What is constant bit rate (CBR)?

CBR is used to provide circuit emulation services. The corresponding bandwidth allocated on the peak of the traffic sources so that a virtually loss free communication service is obtained with prescribed targets of cell transfer delay (CTD) and cell delay variation (CDV)

### 4. What is available bit rate (ABR)?

It is used to support data traffic sources. In this class a minimum bandwidth can be required by the source that is guaranteed by the network. The service is supported with the guarantee of CLR or CTD.

### 5. What is unspecified bit rate (UBR)?

It is used to support data sources willing to use just the capacity left available by all the other without any objective on CLR and CTD.

### 6. Define ATM adaptation layer (AAL)?

A collection of standardized protocols that provide services to higher layers by adapting user traffic to a cell format.

### 7. Define AAL1 (AAL type 1)?

An AAL used for the transport of constant bit rate (CBR) traffic (ie. Audio and video) and for emulating TDM based circuits.

### 8. Define AAL2 (AAL type2)?

An AAL used for supporting time dependent variable bit rate (VBR-RT) connection oriented traffic (ie.packetized video and audio).

### 9.What is AAL3/4(AAL type 3 and 4)?

An AAL used for supporting both connectionless and connection oriented variable bit rate (VBR) traffic.It is also used to support SMDS.

10. What is AAL5 (AAL type5)?

The most common AAL type used for the transport of data packets.

11. Define ATM?

A broadband switching and multiplexing, connection-oriented, high performance and cost effective integrated technology for supporting BISDN services.

12. What are the features of SDH?

1. Provision of single worldwide transmission network
2. Easy multiplexing and demultiplexing
3. Flexibility in adapting internal signal structure
4. Provision of operation and maintenance functions.

13. What are the layers present in SDH?

1. Circuit layer 2. path layer 3. transmission layer

14. Give the SDH multiplexing elements?

Container, virtual container, tributary unit, tributary unit group, administrative unit, administrative unit group, synchronous transport module.

15. What is meant by floating mode of multiplexing?

Pointer information allows a VC to float within its TU is called mode of multiplexing.

16. What are the elements present in VC?

A VC consists of a Container and the path overhead processed in the SDH multiplexer.

17. What are the functions of a tributary unit group?

It performs the function of assembling together several TU's without further overhead.

18. What is path overhead?

The header needed to perform the functions at the path layer is path overhead.

19. What is the need for plesiochronous digital hierarchy?

The need is to develop a step-by-step hierarchical multiplexing in which higher level multiplexing are needed.

20. What is SS7?

SS7 defines a signaling network features and the protocol architecture of the common channel signaling used in ISDN.

## UNIT II

### 1. Define switch?

A switch is simply a box with some number of ports that different devices such as workstations, routers and other switches attach to.

### 2. What are the techniques available to accomplish switch path control?

1. address learning 2. Spanning tree 3. Broadcast and discover 4. link state routing 5. explicit signaling.

### 3. Define VLAN?

VLAN is a broadcast domain whose members use LAN switching to communicate as if they shared the same physical segment.

### 4. What are the uses of VLAN?

VLAN are useful for administrative, security and broadcast control.

### 5. What are the two internal forwarding techniques used in LAN switch?

1. Cut through 2. Store and forward

### 6. What is cut through forwarding?

A switch begins to forward the packet as soon as the destination address is examined and verified. The forwarding of the first path of the packet can begin even as the remainder of the packet is being read into the input port switch buffers

### 7. What are the advantages of using twisted pair star LAN?

1. Two wire system is susceptible to crosstalk and noise
2. A twisted pair can pass relatively wide range of frequencies.
3. Attenuation is in the range of 20db/mile at 500 khz
4. Transmission is not affected by interference.

### 8. What are the properties of VC connections?

Each VC is identified by a VC identifier. Cells belonging to the single message follow the same VC. Cells remain in the original order till they reach the destination.

### 9. What are the advantages of VLAN?

1. Configuration 2. Security 3. Network efficiency 4. Broadcast containment

### 10. How the Broadcast containment is possible in VLAN?

A properly configured and operational VLAN should prevent or minimize broadcast leakage from one VLAN to another.

11. What is meant by tag control information (TCI)?

The TCI consists of a three bit user priority field that is used to indicate the frames priority as it is forwarded through switches supporting the IEEE 802.1P specification.

12. What is the need for the canonical format indicator (CFI)?

The one bit CFI indicates if the MAC address information is in canonical format.

13. Why switching is so popular?

Switching technologies offer much greater performance and capacity at much lower price. Advances in silicon are placing more networks processing on expensive chips which prices down and boosts performance by orders of magnitude over older software based processing.

14. What is meant by LAN switching?

LAN switching is used to move data packets between workstations on the same or different segments.

15. What is meant by VLAN switching?

VLAN switching takes the form of a virtual connection that is provisioned between two end points such as a pair of routers.

16. What are the properties of switching?

1. operate at layer 2 and below of any protocol stack 2. performed in hardware

17. Define switch forwarding?

The information available in the data packet and maintained in the switch enables the switch to rapidly move data packets from an input port to an output port.

18. What is the need for broadcast and discover technique?

It is commonly used in LAN switching and bridging to locate switched path through the network.

19. Define spanning tree explorer (STE)?

If the spanning tree is in place the explorer packet may be opt to follow the spanning tree path to the destination is called as STE.

20. What is the need for the connection identifier (CI)?

CI contained in the packet is used to determine the output port. CI is also called as label.

21. Define all routers explorer (ARE)?

If the explorer packet is flooded through out the entire network is called as ARE.

**UNIT III****1. Define non blocking?**

If an input output connection between an arbitrary idle inlet and outlet can be established by the network independent of the network state at setup time is called as non blocking.

**2. Define blocking?**

If atleast one I/O connection between an arbitrary idle inlet and outlet cannot be established by the network owing to internal congestion due to the already established

I/O connections is called as blocking.

**3. What are the types of non blocking network?**

1. Strict sense non-blocking. 2. Wide sense non-blocking 3. Rearrangeable nonblocking.

**4. What is the cost index of a cross bar network?**

The cost index that is the number of cross points for a cross bar network is  $C=N^2$ .

**5. What is meant by full connection?**

If each matrix in stage  $i(i=1,2,\dots,s-1)$  is connected to all the matrices in stages  $i-1$  and  $i+1$  is called as full connection.

**6. What is meant by partial connection?**

If each matrix in stage  $i(i=1,2,\dots,s-1)$  is not connected to all the matrices in stages  $i-1$  and  $i+1$  is called as partial connections.

**7. When two network are said to be isotropic?**

Two network are said to be isotropic, if after relabelling the inlets, outlets and the matrices of the first network with the respective labels of the second network, first network can be made identical to the second network by moving its matrices and correspondingly its attached links.

**8. When the two network are said to be topologically equivalent?**

Two network are topologically equivalent if an isomorphism holds between the underlying graphs of the two network

**9. Define packet self routing property?**

Each switching element(SE) is capable of routing autonomously the received packets to their destinations. such feature is known as self routing property.

10. What are the four types of network permutations in banyan network?

1. h-shuffle 2. h-unshuffle 3. butterfly permutation 4. identity Permutation.

11. What is h-shuffle permutation?

The h-shuffle permutation consists in a circular left shift by one bit position of the  $h+1$  least significant bit of the inlet address.

12. What is h-unshuffle permutation?

The h-unshuffle permutation consists in a circular right shift by one bit position of the  $h+1$  least significant bit of the inlet address.

13. What are the two banyan network properties?

1. Buddy property 2. constrained reachable property.

14. What are the two algorithms to build merging networks?

1. Odd-even merging 2. Bitonic merging

15. Define Circular Bitonic Sequence?

Circular Bitonic Sequence is a sequence obtained by shifting circularly the elements of a bitonic sequence by an arbitrary number of positions  $K$ .

16. What is Slepian-Duguid theorem?

A three stage network is rearrangeable if and only if  $r_2 > \max(n, m)$ .

17. Define partially self routing?

If packet self routing takes place only in the position of the network then it is called as partially self routing.

18. What are the four basic techniques available for a partial connection multistage network?

1. Vertical replication (VR)
2. Vertical replication coupled with horizontal replication
3. Link dilation
4. EGS network.

19. What is the need for call processing?

Call processing whose task is to receive from the input port controller (IPC) the virtual call request and to apply the appropriate algorithm to decide whether to accept or refuse the call.



20. Distinguish between blocking and non blocking network?

If an I/O connection between an arbitrary idle inlet and the outlet can be established by the network independent of the network state at set up time is called as non blocking.

If at least one I/O connection between an arbitrary idle inlet and the outlet cannot be established by the network owing to internal congestion due to the already established I/O connection is called as blocking.

#### UNIT IV

1. What are the types of Queuing?

1. Input Queuing
2. Output Queuing
3. Shared Queuing

2. What are the three parameters used to describe the switching fabric performance?

1. Switch throughput
2. Average packet delay
3. Packet loss probability

3. Define switch throughput?

It is defined as the probability that a packet received on an input link is successfully switched and transmitted by the addressed switch output.

4. What is maximum throughput?

The maximum throughput also referred as the switch capacity indicates the load carried by the switch for an offered load  $\rho = 1$ . 75. What is average packet delay? The average number of slots it takes for a packet received at a switch inlet to cross the network and thus to be transmitted downstream by the addressed switch outlet ( $T = 1$ ).

5. What is packet loss probability?

Probability that a packet received at a switch input is lost due to buffer overflow ( $0 < p \leq 1$ ).

6. What are the internal protocols available to enable the downstream transmission of packets?

1. Backpressure
2. Queue loss

7. What is back pressure?

Signals are exchanged between switching elements in adjacent stages so that the generic SE can grant a packet transmission to its upstream SE's only within the current idle buffer capacity.

8. What are the types of back pressure?

1. Global back pressure
2. Local back pressure

9. Define local back pressure?

The number of buffer places that can be filled in the generic SE in stage  $i$  at slot  $t$  by upstream SE's is simply given by the number of idle positions at the end of slot  $t-1$ .

10. Define global back pressure?

The number of buffer places that can be filled in the generic SE in stage  $i$  at slot  $t$  by upstream SE's is simply given by the number of idle positions at the end of slot  $t-1$  increased by the number of packets that are going to be transmitted by the SE in the slot.

11. Define input queuing?

Cells addressing different switch outlets are stored at the switch input interface as long as there conflict-free switching through the inter connection network is possible.

12. Define output queuing?

Multiple cells addressing the same switch outlet are first switched through the interconnection network and then stored in the switch output while waiting to be transmitted down stream.

13. What is shared queuing?

The queuing capability shared by all switch input and output interfaces is available for all cells that cannot be switched immediately to the desired switch outlet.

14. What are the blocks involved in an  $N \times M$  ATM switch?

1.  $N$  input port controller
2. Non blocking interconnection network
3.  $M$  output port controller

15. What are the assumptions made in an input queuing?

$B_i > 0, B_o = B_s = 0$  and  $K=1$

16.. What are the algorithms involved for an input queuing?

1. Three phase algorithm
2. Ring reservation algorithm

17. What are the phases present in three phase switch?

1. probe phase
2. Acknowledgement phase
3. data phase

18. What is signal latency in a network?

The number of bit times it takes for a signal to cross the network is called signal latency.

19. Why combined input and output queuing is necessary?

The combined architecture adopt a k-non blocking self routing multistage structure where the shared queue is removed. The virtual queue, input and output queue are mutually independent discrete time systems. In this queuing technique the number of cells entering the virtual queues in a slot approaches infinity and the queue joined by each cell is randomly and independently selected.

20. What is the assumption made in an output queuing?

$B_o > 0$ ,  $B_i = B_s = 0$  and Output speed up  $K > 1$

21. What is cross bar tree switch?

Cross bar tree switch consists of a set of N planes each inter connecting a switch inlet to all the N output concentrators.

22. What is the assumption made in a shared queuing?

$B_s > 0$ ,  $B_i = B_o = 0$  and  $K = 1$ .

23. What is the need for an delay network in the starlite switch?

The recirculation or delay network of size  $P \times P$  acts as a distributed shared buffer and feeds back to the routing network up to  $P = N$  Bs packets that could not be switched in the preceding slot.

24. What are the blocks involved in a trap network?

1. Marker
2. Running adder winner
3. Running adder loser
4. Concentrator.

**UNIT V****1. Define ARP?**

A TCP/ IP protocol used for resolving local network addresses by mapping a physical address to an IP address is called ARP.

**2. What are the classes in IP addressing?**

1. Overlay model
2. Peer model.

**3. What are applications of Address resolution server?**

1. Maintains a table/cache of LAN or network layer addresses and associated ATM addresses.
2. Maintains responds to queries for information from associated clients.

**4. Define ATMARP?**

ATMARP is a protocol and message formats that enable a client to request and receive resolution of a destinations IP address with an ATM address from an ATMARP server so that the client may establish an SVC to the destination.

**5. What are the functions of ATMARP client?**

1. Queries the ATMARP sever for address mappings and caches responses.
2. Establish SVCs to other devices on the same LIS

**6. What is the need for ATMARP server?**

1. Maintains a table of IP/ATM mappings
2. Responds to queries from ATMARP client
3. Run on a stand alone device or in a route server or router.

**7. Define IP?**

A networking protocol for providing a connectionless service to the higher transport protocol.

**8 Define IP switch**

A device or system that can forward IP packets at layer three and possesses a switching component that enables packets to be switched at layer two as well.

**9. What is the function of an IP switch?**

IP switch decides which packet will be forwarded at layer three and which will be switched at layer two and then to redirect some or all packets over a layer two switched path.

10. Define logical address group?

A collection of hosts and routers connected to a physical NBMA network that is capable of establishing a short cut path with host and routers on different subnets.

11. Define LIS?

An IP subnet consisting of ATM attached devices that share a common address prefix and can communicate with each using ATM PVCs or SVCs.

12. What is the need for classical IP?

A protocol is developed for IP over ATM networks so that common applications can be supported in an ATM environment. The main issues for the transport of IP over ATM are packet encapsulation and the address resolution.

13. Define cell loss priority?

A 1-bit field in the ATM cell header that corresponds to the loss priority of a cell.

14. What is Multicast address Resolution Server?

An address resolution protocol that resolves IP multicast group address with ATM addresses so that IP multicast can operate on top of an ATM network.

15. Define IP multicast?

IP network provides a service in which packets addressed to a group address are delivered by routers to those networks with group members. A group membership protocol (IGMP) is used by hosts to tell routers which multicast group they wish to join/leave and the routers run a multicast routing protocol to build a delivery tree from source's network out to all networks that have group members.

16. What is non Broadcast Multi-access Network?

A network that consists of devices attached to a common infrastructure but does not have any native broadcast capability.

17. What is payload?

IT is a part of ATM cell. It contains the actual information carried and occupies 48 bytes.

18. What is mean by peer model?

This model occurs when the network forwarding nodes operate on a single topology. This model supports a single IP topology and a single IP topology and a single IP address space.

19. Define topology driven IP switching?

An IP switching solution that builds a shortcut path based on the presence of entries in a routing table. Examples are ARIS and Tag switching.

20. List out the properties of IPV6?

1. Improved addressing structure (128 bit address)
2. Improved security and authentication
3. Simplified header format
4. Flexible support for options.

21. What are the characteristics of Overlay model?

1. Uses separate addressing
2. Runs separate routing protocols at IP
3. Requires address resolution between IP and ATM and user network interfaces.
4. Uses virtual IP switches

22. What is MARS cluster?

A cluster is a group of ATM attached endpoints that use the same MARS server to register their group membership information with and to receive group membership updates from.

23. Define cluster control VC?

The cluster control VC is a point to multipoint VC that is routed at the MARS and branches out to all cluster members. It is used by the MARS server to distribute group membership.

24. What is MCS?

MCS serves as an intermediate point between the MARS senders and the receivers. It is responsible for registering its ATM address along with the IP multicast group address.

25. Define Holding time in NHRP?

Holding time is the amount of time that the information is contained in the Client Information Element (CLE) is considered valid.

**16 Marks Question and Answers**

1. Explain the network evolution through ISDN to BISDN?

LAN

Unique user network interface (UNI)

Broad band NB ISDN services

2. What are the features of an ISDN? Explain ISDN in detail?

1. Standard user network interface (UNI)

2. Integrated digital transport

3. Service integration

4. Intelligent network services.

3. Explain ATM Adaptation Layer (AAL) in detail?

AAL1 (AAL type1)

AAL2 (AAL type2)

AAL3/4(AAL types 3 and 4)

AAL5 (AAL types 5)

4. Explain the switch forwarding techniques in detail?

Types

Operation

Advantage and Disadvantage

5. Explain switch path control in detail?

Types

Operation

Advantage and Disadvantage

6. Explain the rearrange able network?

Full connection network

Partial connection network

7. Write short notes on the network which satisfies Self routing property?

Banyan network

Construction

Explanation

8. Explain the input queuing technique in detail?

Three phase switch

Ring reservation switch

Example

9. Explain the output queuing technique in detail?

Knock out switch

Example

10. Explain the shared queuing technique in detail?

Starlight switch

Example

11. Explain the input output queuing techniques in detail?

Three phase switch

12. Explain the input shared queuing techniques in detail?

Three phase switch

Starlight switch

Example

13. Explain the output shared queuing techniques in detail?

Sunshine switch

Example

14. Explain the IP switching types?

Flow driven

Topology driven

15. Explain the concept of IP over ATM address?

CLIP protocol

Address resolution protocol

16. Explain the concept of Next-Hop Resolution Protocol?

Next-Hop Resolution Protocol

Address resolution protocol

Example

17. Explain the concept of multicasting in detail?

Multicasting using VC and MACs

Address resolution protocol

Example

18. Explain IPV6 over ATM?

IPV4 evolution

IPV6



19. Briefly explain the types of addressing model used in IP switching?

Overlay model

Peer model

20. Give the performance analysis of various queued switches?

Maximum throughput

Average packet delay

Packet loss probability

APRIL