ELEC3506/9506 Communication Networks Tutorial 7 Solution

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How to make your USS feedback count

Your Unit of Study Survey (USS) feedback is **confidential**.

It's a way to share what you enjoyed and found most useful in your learning, and to provide constructive feedback. It's also a way to 'pay it forward' for the students coming behind you, so that their **learning experience** in this class is as good, or even better, than your own.

When you complete your USS survey (https://student-surveys.sydney.edu.au), please:

Be specific.
Which class tasks, assessments or other activities helped you to learn? *Why* were they helpful? Which one(s) *didn't* help you to learn? *Why* didn't they work for you?

Be constructive.
What practical changes can you suggest to class tasks, assessments or other activities, to help the next class learn better?

Be relevant.
Imagine you are the teacher. What sort of feedback would you find most useful to help make your teaching more effective?

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USS PRIZES

To thank you for participating, each unit of study survey (USS) completed between 1 July 2023 and 31 December 2023, we will give you an entry into the Semester 2 USS prize draw, to be drawn on Monday 5th February 2024.

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The more surveys you complete, the more chances you have to win!

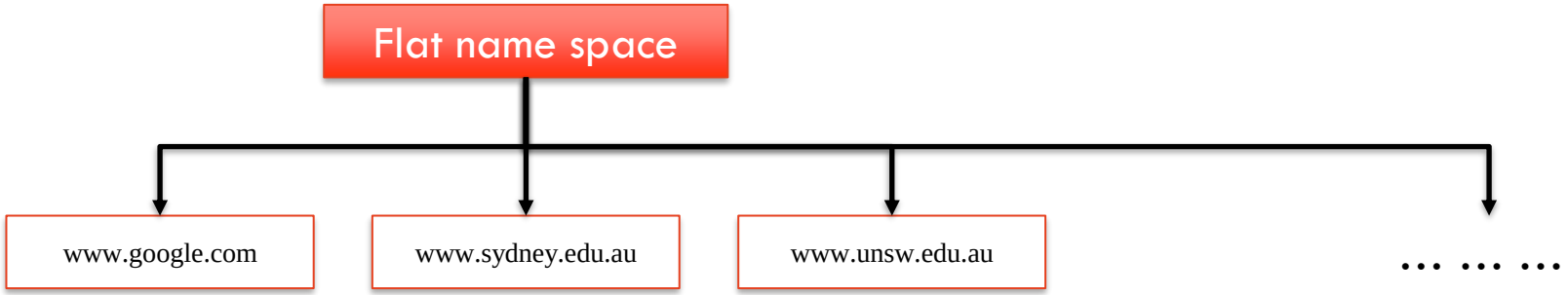
If you have any questions, please email student.surveys@sydney.edu.au.

Tutorial 7 : Application Layer & WAN Technologies

- Q1. What is an advantage of a hierarchical name space over a flat name space for a system the size of the Internet?

In a flat name space, a name is assigned to an address. Which is a sequence of characters without any structure.

Searching in a large name space of a flat structure is slow



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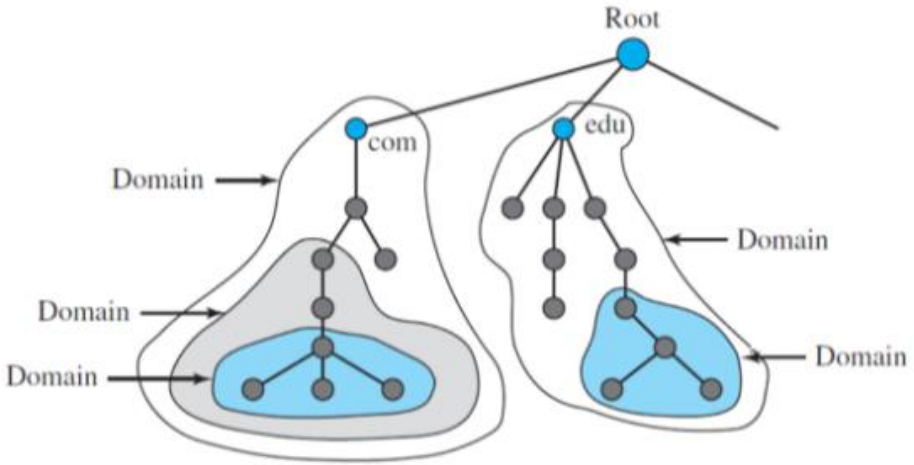
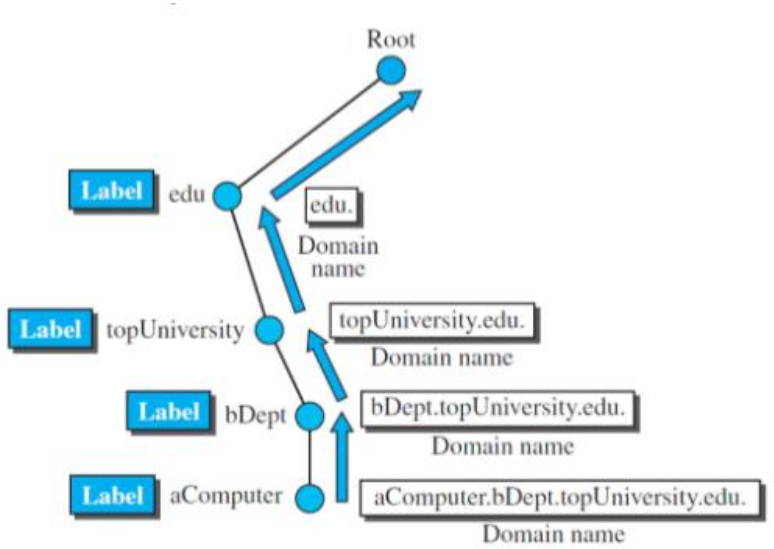
– Q1. What is an advantage of a hierarchical name space over a flat name space for a system the size of the Internet?

In a hierarchical name space, each name is made of several parts. The first part can define the nature of the organization, and the second part can define the name of an organization, and so on

Advantages:

- The authority to assign and control the name spaces can be decentralized. A central authority can assign the part of the name that defines the nature of the organization, the name of the organization, etc. The responsibility for the rest of the name can be given to the organization itself.
- When the name space is large, searching for a name in a hierarchical structure is **much faster**





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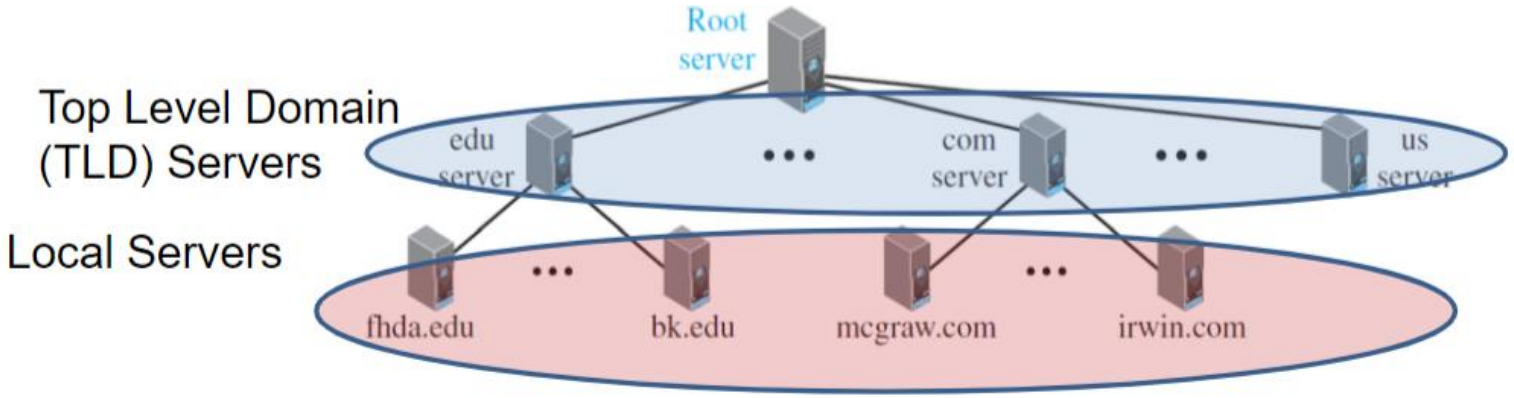
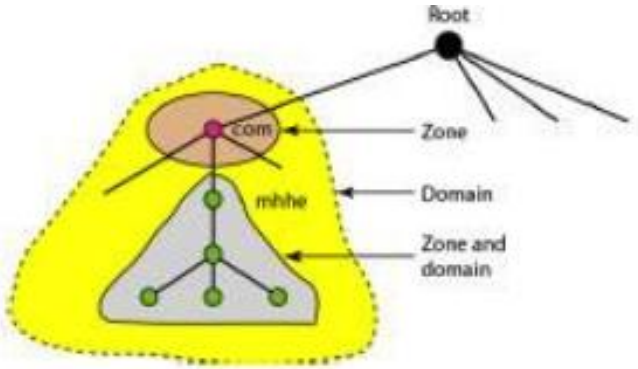
– Q2. What is the difference between a primary and a secondary DNS?

Since the complete domain name hierarchy cannot be stored in a single server, it is divided among many servers. A server is responsible for or has authority over a zone.





Primary DNS server: It stores a file about the zone for which it is an authority. It is responsible for creating, maintaining, and updating the zone file and storing it on the local disk

Secondary DNS server: It transfers the complete information about a zone from another server (primary or secondary) and stores the file on its local disk. (act as a backup. It is read-only)

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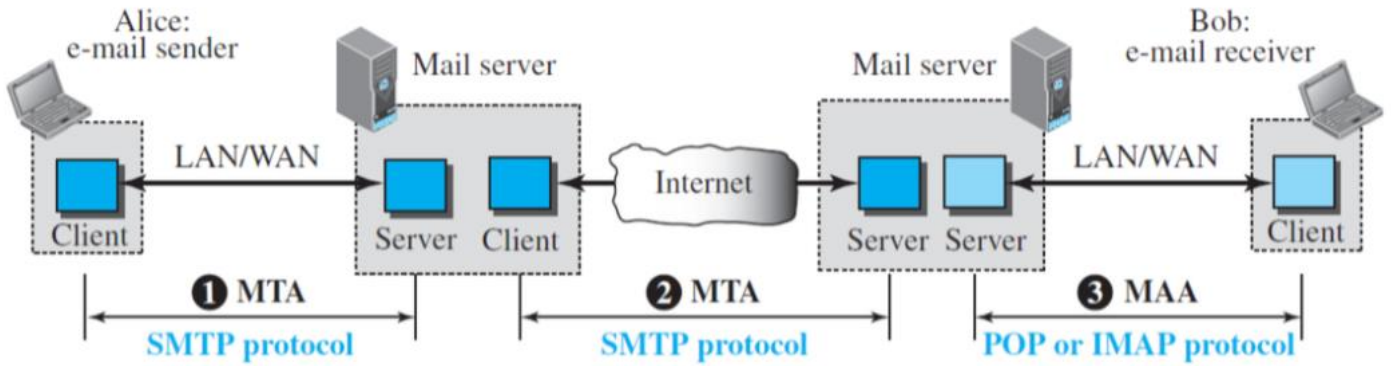
- Q3. Why do we need POP3 or IMAP for electronic mail?

SMTP (simple mail transfer protocol) is a push protocol; it pushes the message from the client to the server.



POP3 and IMAP:

- They are used to retrieve email messages from a mail server to a user's email client.
- They allow email messages to be stored on the mail server. This means that your messages are not tied to a specific device.
- ….

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– Q4. What is the purpose of FTP?

- File Transfer Protocol (FTP) is the standard mechanism provided by TCP/IP for copying a file from one host to another.
- FTP can be used for **backing up** files from one computer to another.
- FTP allows users to access and manage files stored on a **remote server**.

Although transferring files from one system to another seems simple, some problems must be dealt with. For example, two systems may have:

- Different file name conventions
- Different ways to represent text and data
- Different directory structures

All these problems are solved by FTP

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– Q5. What anonymous FTP?

To use FTP, a user needs an account (user name) and a password on the remote server.

Anonymous FTP allows users to access files without an account or password on a remote server.
Some sites have a set of files available for public access to enable anonymous FTP. Users can download those files without an account and password.

Limited access to the system under anonymous FTP:
In most cases, anonymous FTP users are restricted from uploading files to the server or making any modifications

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– Q6. How is HTTP related to WWW?

HTTP (hypertext transfer protocol) is a file transfer protocol (like FTP) that facilitates access to WWW (World Wide Web).

- When you access a URL, the browser sends an HTTP request to the web server specified in the URL. (HTTP request). The web server then sends an HTTP response containing the requested content.
- HTTP is designed to handle hypertext, including links (hyperlinks) to other web pages or resources.

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– Q7. What is a URL and what are its components?

A client that wants to access a web page needs the address. The **uniform resource locator (URL)** used by HTTP is a standard **for locating** any kind of information (i.e., documents) distributed throughout the world on the internet.

The **protocol** (or scheme) is the client/server program (e.g., FTP, HTTP, HTTPS, WAIS, GOPHER, etc.) used to retrieve the document.

The **host** (usually, an IP address) is the computer on which the information is located. Web pages are usually stored in computers, and computers are given alias names that usually begin with the characters “www”.

The **port number** of the server is an optional item in the URL. It is inserted between the host and the path, and it is separated from the host by a colon.

The **path** is the pathname of the file where the information is located.

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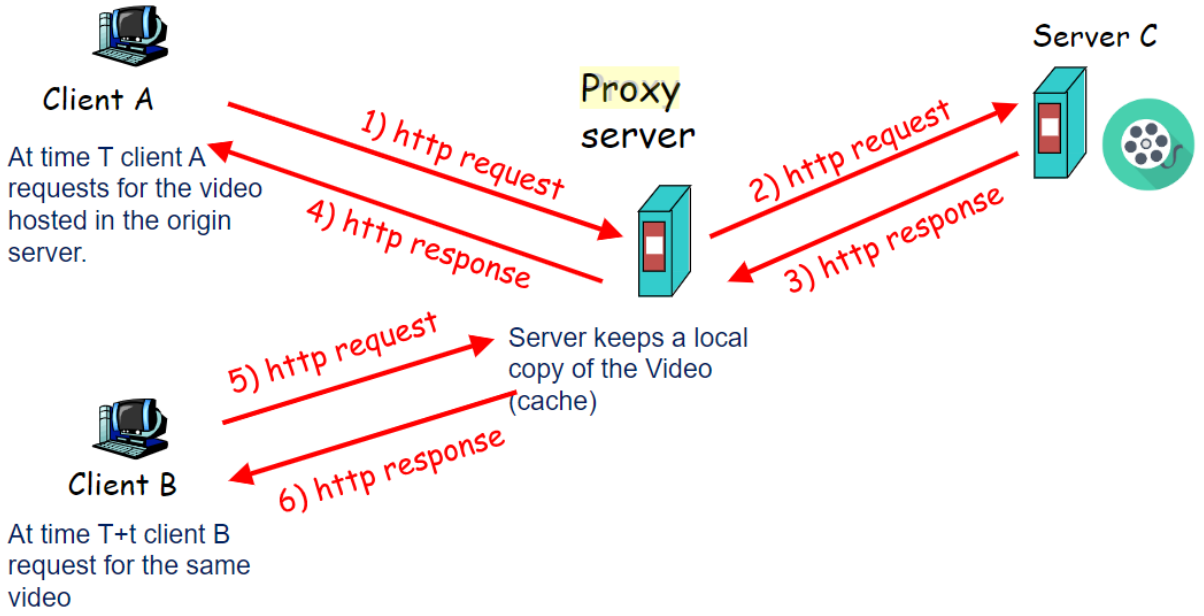
– Q8. What is a proxy server and how is it related to HTTP?

A **proxy server** is a computer that keeps copies of responses to recent request.

- A client sends a request to the proxy server
- The proxy server checks its caches
- If the response is not found in its cache, the proxy server sends the request to the web server.
- All incoming responses that are sent to the proxy server are stored for future requests from other clients.

The proxy server reduces load on the original server, decreases traffic, and improve latency.

HTTP supports proxy servers.
The proxy server acts on behalf of the client by forwarding the request to the target web server and returning the server's response to the client.



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– Q9. What does HTML stand for and what is its function?

HTML stands for **hypertext markup language** and its is used to create static webpage to be displayed to user.

```
<!DOCTYPE html>
<html>
<body>

<h1>My First Heading</h1>

<p>My first paragraph.</p>

</body>
</html>
```

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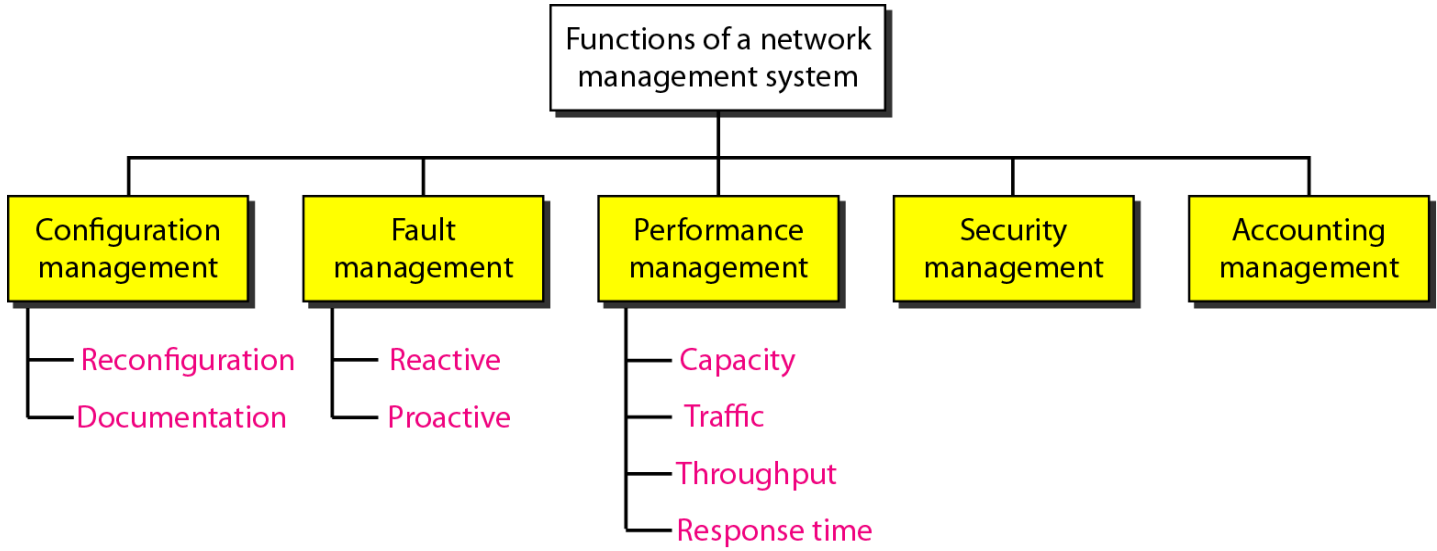
– Q10. What are the SNMP components?

The **Simple Network Management Protocol (SNMP)** is a framework for managing devices on the internet, such as routers, switches, and servers.

It provides a set of fundamental operations for monitoring and maintaining the internet.



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– Q10.

SNMP uses the concept of **manager** and **agent**.

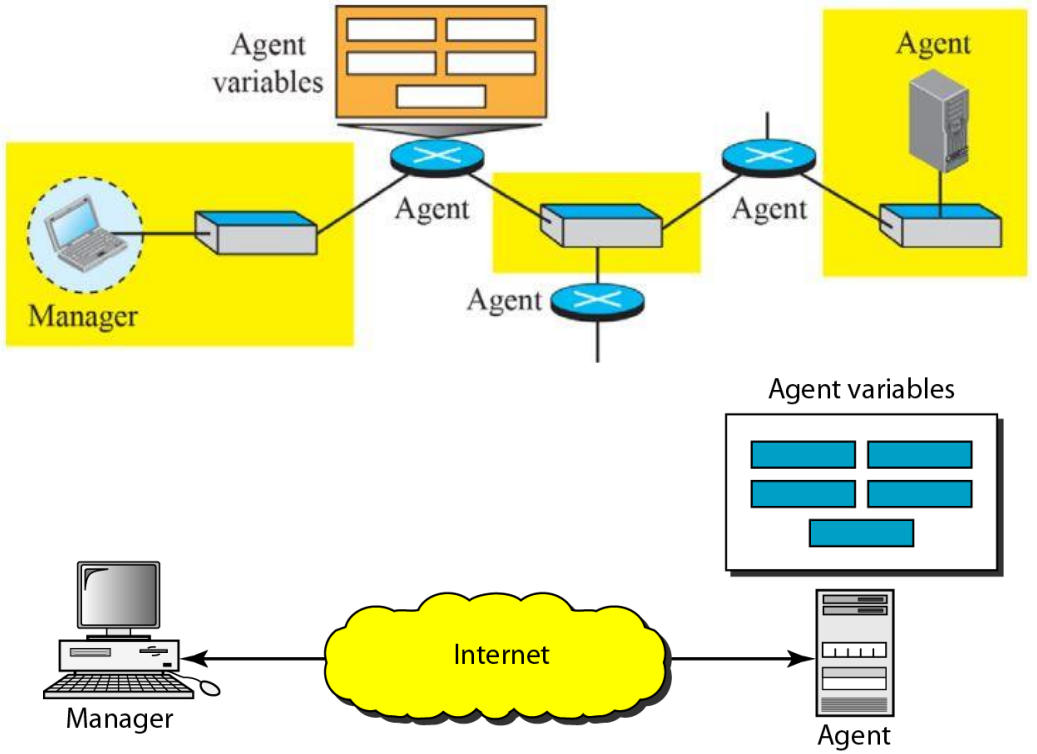
- **Manager**: a host that runs the **SNMP client program**.
- **Agent**: a router or host that runs the **SNMP server program**.

Three basic ideas for management with SNMP

Manager checks an agent by requesting information of the agent.
Manager forces the agent to perform a task by resetting values in the agent database.
Agent warns the manager of unusual situation

SNMP defines the format of packets exchanged between a manager and an agent.
It reads and changes the status (values) of objects (variables) in SNMP packets.
In order to manage tasks efficiently SNMP uses two protocols,

- Structure of management information (SMI).
- Management information base (MIB)



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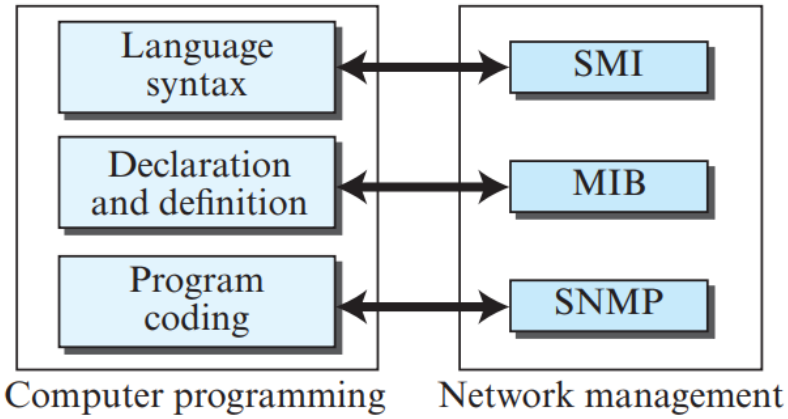
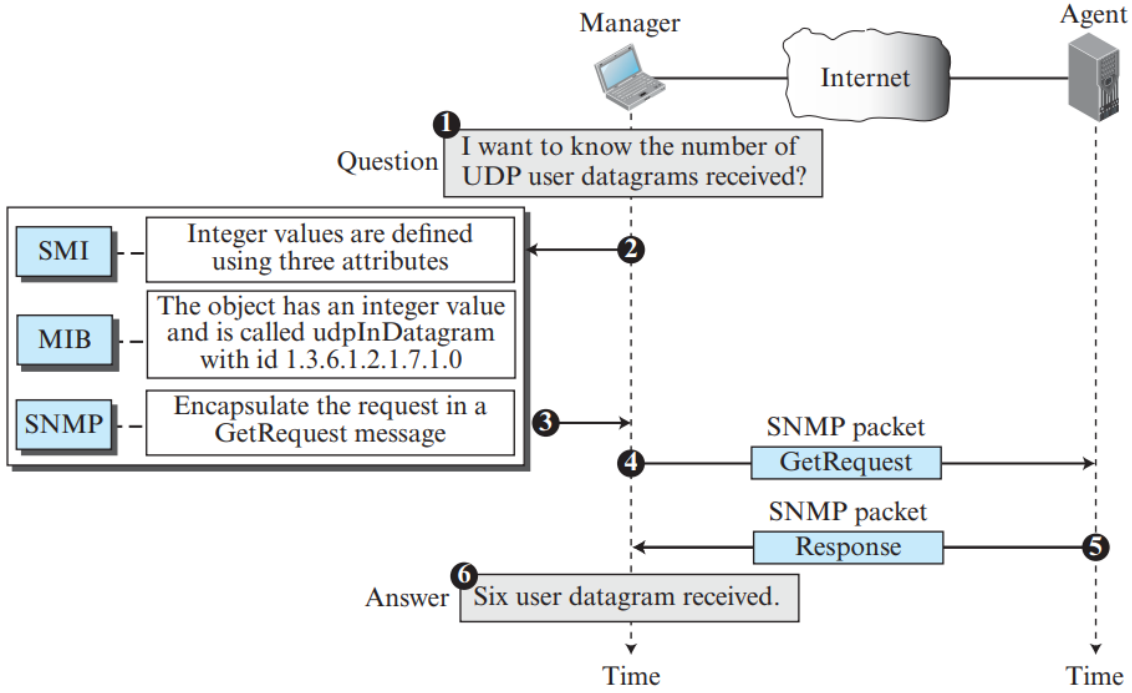
– Q10.

SNMP Components

Internet management needs the cooperation of the following components through SNMP protocols;

- **Managed Objects**: Computers, Routers, Bridges, a variable in a router, value, etc.
- **Protocol itself**: SNMP
- **Structure of Management Information (SMI):** It generally deals with the naming of objects, defining their range and length, and showing how to encode objects and values in the MIB.
- **Management Information Base (MIB):** MIB creates a collection of named objects, their types, and their relationships to each other in an entity to be managed.
- **SNMP Agent**: Handles transactions between a Managed Entity MIB and an SNMP Manager.
- **SNMP Manager**: Component that interfaces with the SNMP Agent to provide network control.





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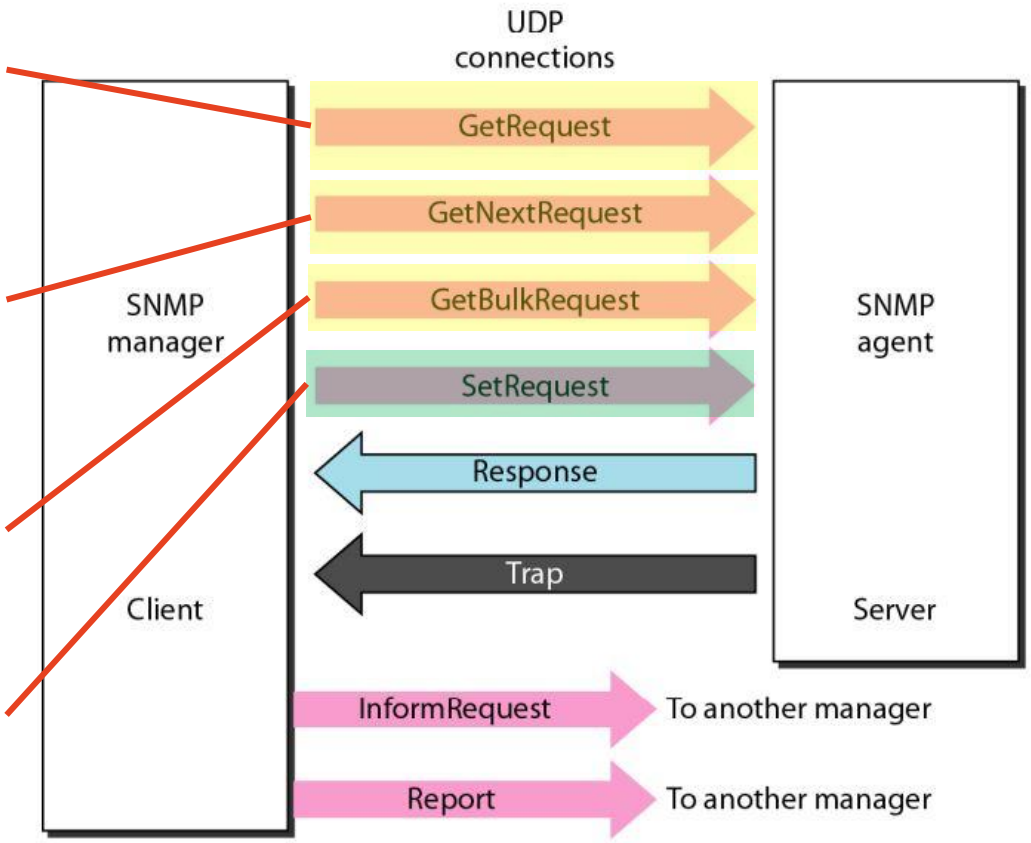
– Q11. List the SNMP v1 and v2 message types and their function

SNMP defines eight types of packets (or protocol data units, PDUs):

- **GetRequest**: The GetRequest Protocol Data Unit (PDU) is sent from the manager (client) to the agent (server) to retrieve the value of a variable or a set of variables.
- **GetNextRequest**: The GetNextRequest PDU is sent from the manager to the agent to retrieve the value of a variable. It is mostly used to retrieve the values of the entries in a table.
- **GetBulkRequest**: The GetBulkRequest PDU is sent from the manager to the agent to retrieve a large amount of data. It can be used instead of multiple GetRequest and GetNextRequest PDUs.
- **SetRequest:** The SetRequest is sent from the manager to the agent to set (store) a value in a variable.



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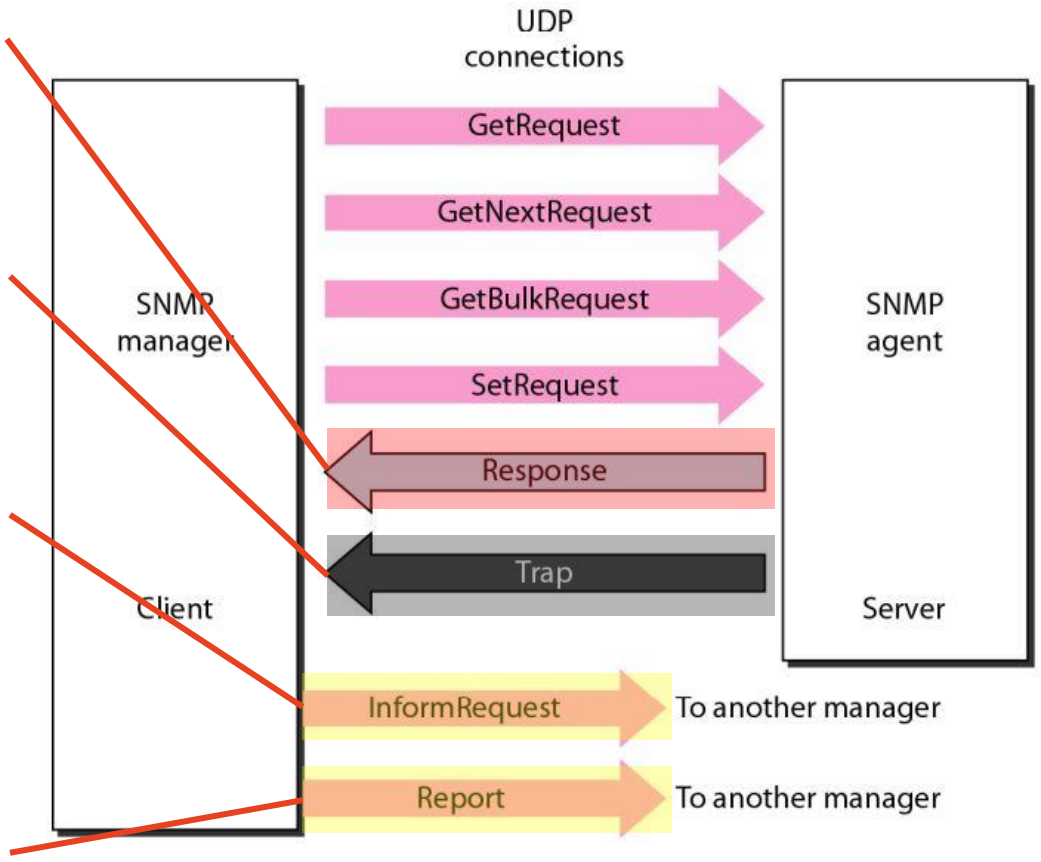
– Q11. List the SNMP v1 and v2 message types and their function

- **Response**: The Response is sent from an agent to a manager in response to GetRequest or GetNextRequest. It contains the value(s) of the variable(s) requested by the manager.
- **Trap**: The Trap (also called SNMPv2 Trap to distinguish it from SNMPv1 Trap) PDU is sent from the agent to the manager to report an event. For example, if the agent is rebooted, it informs the manager and reports the time of rebooting.
- **InformRequest**: The InformRequest PDU is sent from one manager to another remote manager to get the value of some variables from agents under the control of the remote manager. The remote manager responds with a Response PDU.
- **Report**: The Report PDU is designed to report some types of errors between managers.



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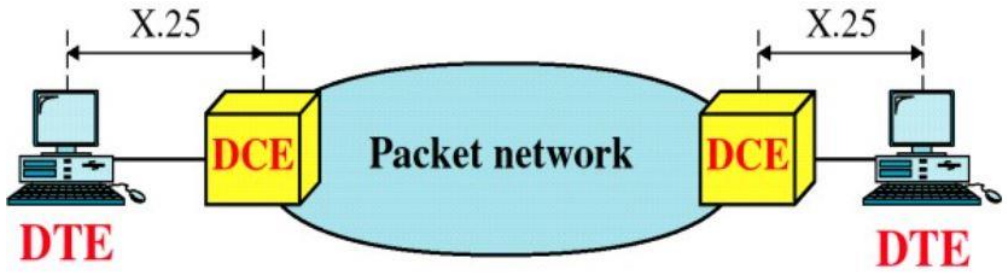
– Q12. What is the major drawback of the x.25 standard?

x.25 Standard

- X.25 is the first public network that was developed by ITU-T.
- It specifies an interface for exchanging data packets between the packet mode end system called data terminal equipment (DTE) and the access node of switched packet data network called data circuit terminating equipment (DCE).
- The DTE is operated by the user, while the DCE is operated by the service provider.



Major drawback of x.25 Standard

- Because of the modern high quality transmission media, the error rate of transmission systems have dramatically reduced. Any remaining error can be easily caught by error control in the end systems. Therefore, the overhead of X.25 for error control becomes unnecessary
- X.25 has its own network layer which again encapsulates a datagram passed by a network layer of the Internet. Therefore, double encapsulation and hence double overhead.
- For data only, however, in today's communication network, we are looking for integrated solution.
- X.25 has a low data rate (64 kbps)
- Not suitable for delay sensitive applications (Live streaming) due to the queuing delay.

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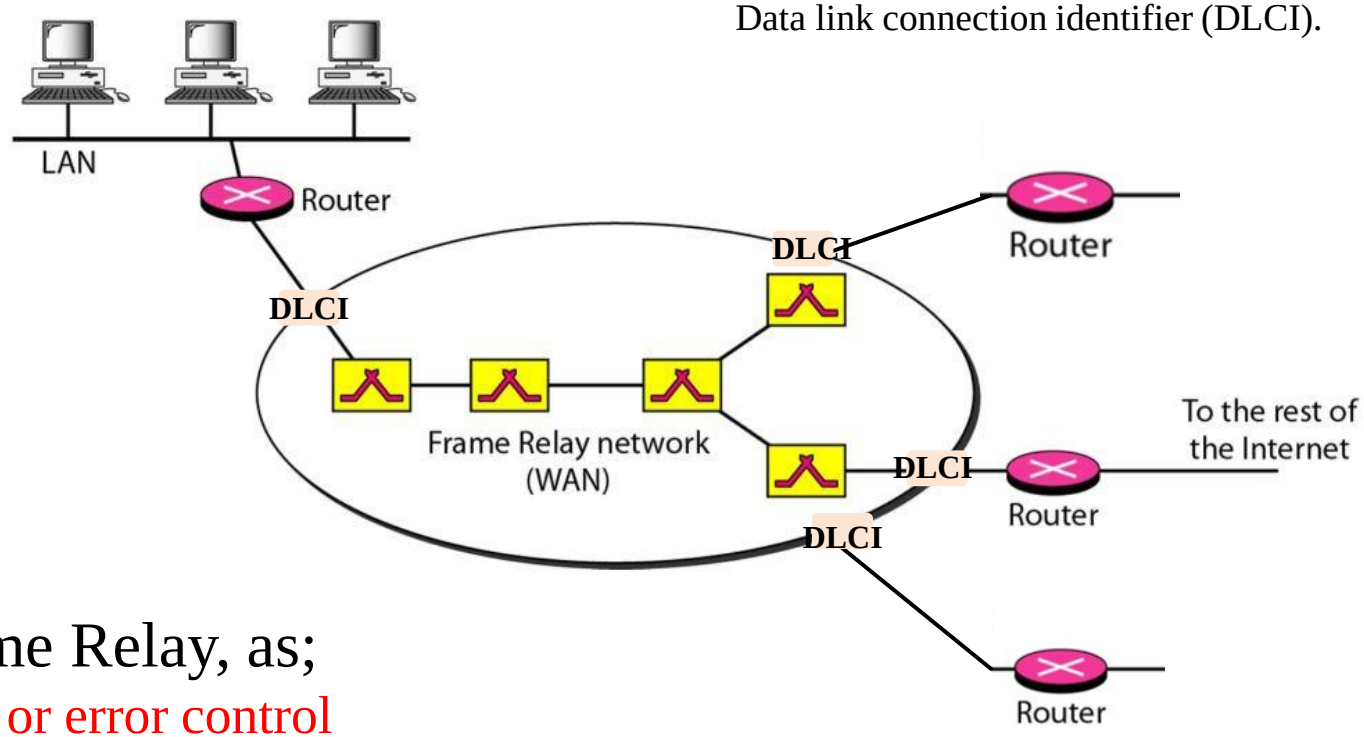
– Q13. There are no sequence numbers in Frame Relay. Why?

Data link connection identifier (DLCI).

Frame Relay is a virtual-circuit wide-area network (WAN) that was designed in response to demands for a new type of WAN in the late 1980s and early 1990s. (a simple and efficient data link layer (Layer 2) protocol)



There are no sequence numbers in Frame Relay, as;

- **Frame relay** does not provide flow control or error control
- Hence, **frame relay** does not use the sliding window protocol
- Therefore, in **frame relay**, there is no need for sequence numbers

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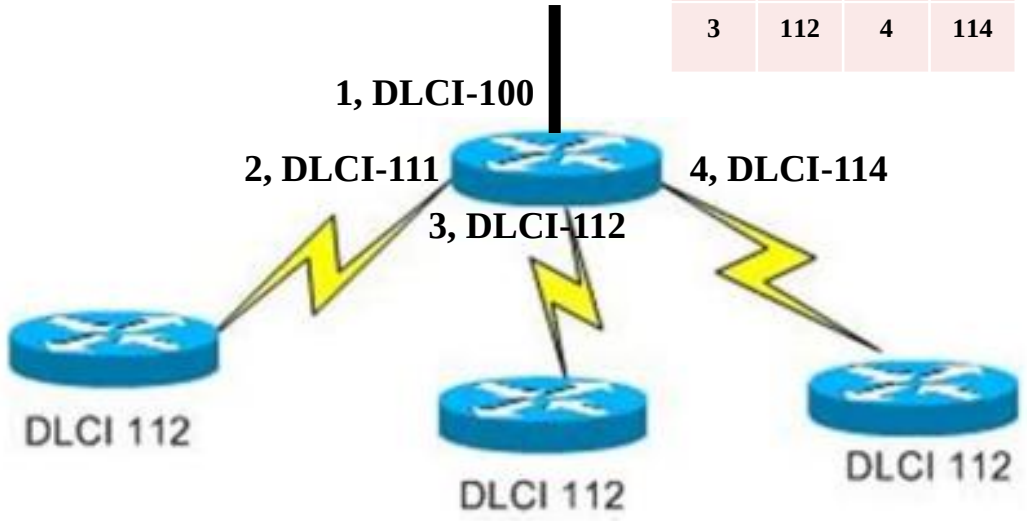
– Q14. Can two devices connected to the same Frame Relay network use the same DLCIs?

- DLCIs have local significance only, meaning they are only meaningful to the device to which they are assigned.
- DLCI numbers are not advertised to other routers.
- Other routers can use the same DLCI numbers without causing connectivity issues.
- Since DLCIs are not advertised, the routers have no idea that other routers are using the same DLCI.

- Here, all three routers are using the same DLCI to reach the hub router.
- Frame Relay communication is achieved by mapping this DLCI to the remote router's IP address using the Reverse Address Resolution Protocol (RARP) protocol

Incoming		Outgoing	
Port	DLCI	Port	DLCI
1	100	2	111
2	111	3	112
3	112	4	114



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– Q15. Compare an SVC with a PVC

Asynchronous Transfer Mode (ATM) uses two types of connections.
a) **Switched virtual circuit (SVC)** & b) **Permanent virtual circuit (PVC)**

- An SVC is a temporary switched connection that is established upon the request of an endpoint (User end)
- SVC is terminated when data transmission is over.
- SVC involves three phases, namely, **call setup, data transfer, and call clearing**.
- Each time an endpoint wants to make a connection with another endpoint, a new virtual circuit must be established
- SVC is cost effective; it works like bandwidth on demand way.

- PVC is a constant (fixed) connection established between two endpoints (User end).
- PVC does not need to terminate for every instance of communication between the endpoint.
- PVC does not require **call setup and call clearing phases** and always remains in the **data transfer phase**.
- PVC is costly, because two parties pay for the connection all the time even when it is not in use.
- If a source needs connections with several destinations, it needs a PVC for each connection

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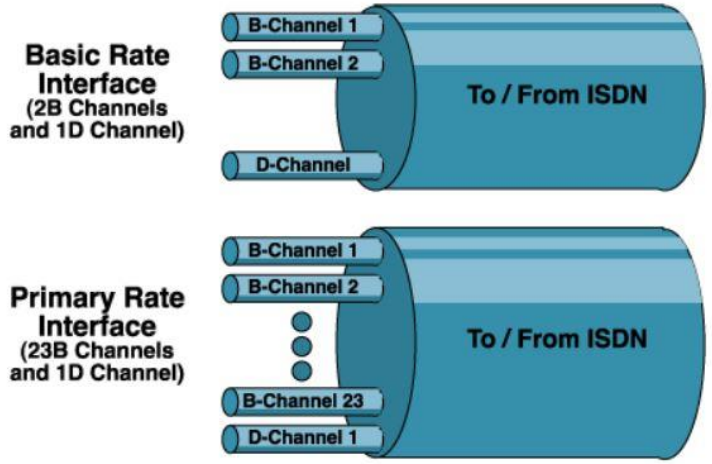
B (Bearer) Channels are used for carrying user data, such as voice, video, or digital information.
D (Delta or Data) Channels are used for signaling, call setup, and control functions.

– Q16. What are the two popular ISDN standards?

ISDN stands for **integrated services digital network**.
The idea behind ISDN is to digitize the telephone network, so that all the data, including **audio**, **video,** and **text** could be transmitted over existing telephone lines.
ISDN caters to the needs of both voice and non-voice applications of the same network.
The two most popular types of 'ISDN standard' is:

a) Basic rate interface (BRI) & b) Primary rate interface (PRI)



Basic rate interface (BRI)

- It comprises two B channels and one D channel, thus, referred to as **2B + D** channel.
- The BRI-D channel operates at 16 kbps.
- Two full-duplex 64kbps B channels + one full-duplex 16kbps D channel: 144 kbps
- It is primarily used at home for connecting to the internet or business networks.
- Can be used for voice plus several data applications

Primary rate interface (PRI)

- **(23B + D):** It comprises up to 23 B channels and one D channel in North America and Japan. (1.544Mbps)
- **(30B + D):** In countries such as Europe, Australia, and other parts of the world, it comprises 30 B channels and one D channel. (2.048Mbps)
- The PRI-D channel operates at 64 kbps.
- It is primarily used in business, replacing the leased lines that can provide the same bandwidth and signal quality but with more flexibility

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– Q17. How is an ATM virtual connection identified?

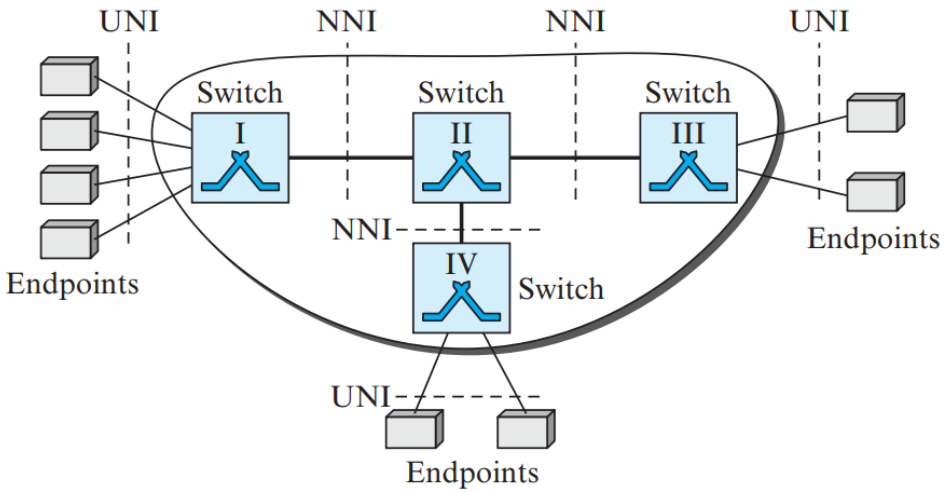
Asynchronous transfer mode (ATM) is the cell relay protocol allowing for the high-speed interconnection of all the world's networks.

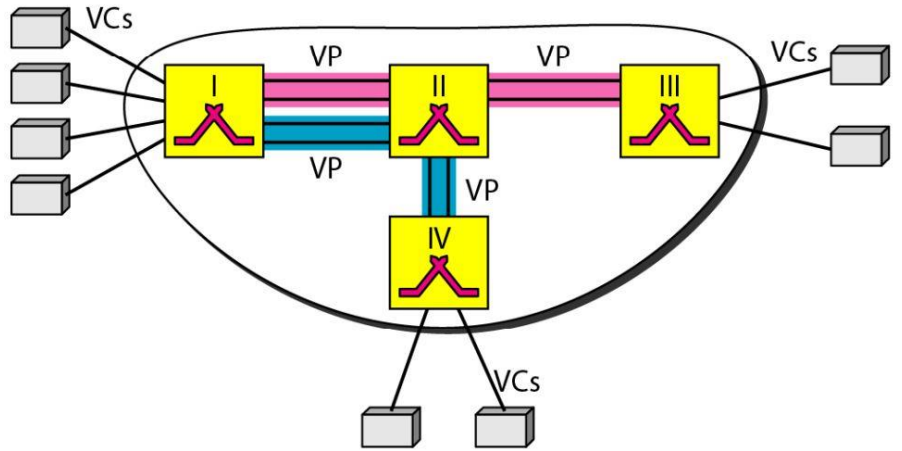
ATM is a switched wide area network that

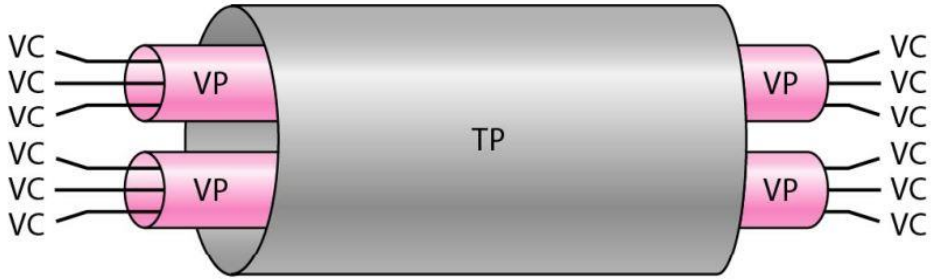
- Encodes data into small packets of fixed size (53 bytes), called cells, and
- Uses asynchronous time-division multiplexing (TDM)
- User-to-network interface (UNI)
- Network-to-network interfaces (NNIs)

Two ATM endpoints are connected through transmission path (**TP**), virtual path (**VP**), and virtual circuits (**VC**).

- **TP**: The physical connection between an endpoint and a switch or between two switches
- **VP**: provides a set of connections between two switches. A TP is divided into several VPs.
- **VC**: logically connects two points. A combination of VCs forms a VP







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– Q17. How is an ATM virtual connection identified?

Virtual Connection Identifier

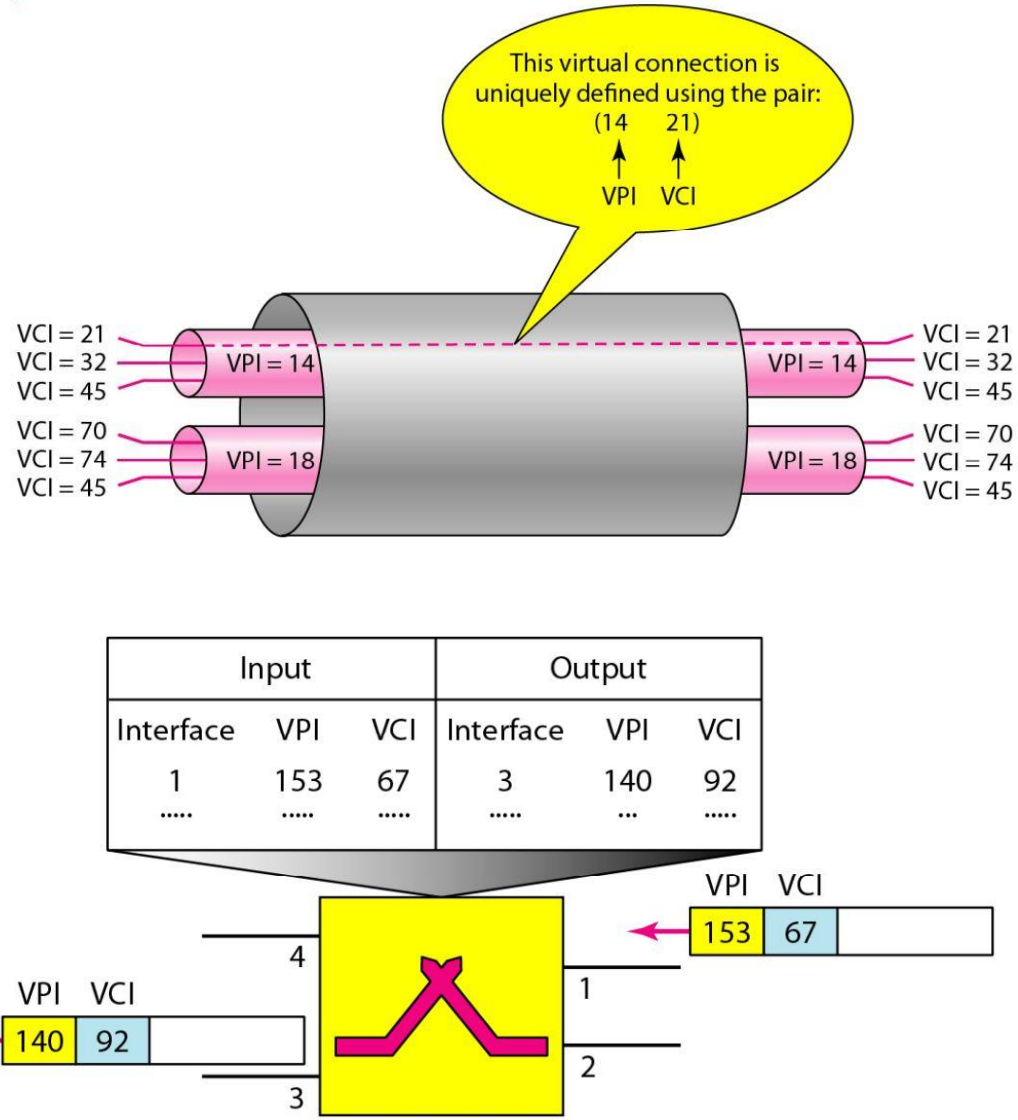
In a virtual circuit network, to route data from one endpoint to another, the virtual connections need to be identified.

Each virtual connection is identified by the combination of

- **Virtual path identifier (VPI)**
- **Virtual circuit identifier (VCI)**

VPI uniquely identifies the virtual path while **VCI** uniquely identifies the virtual circuit.

- ATM uses switches to route the cell from a source endpoint to the destination endpoint.
- A switch routes the cell using both the VPIs and the VCIs.
- A cell with a VPI of 153 and VCI of 67 arrives at switch interface (port) 1.
- The switch checks its switching table. The output corresponds to the interface 3 with VPI 140, and VCI 92.
- It changes the VPI and VCI in the header to 140 and 92, respectively, and sends the cell out through interface 3.



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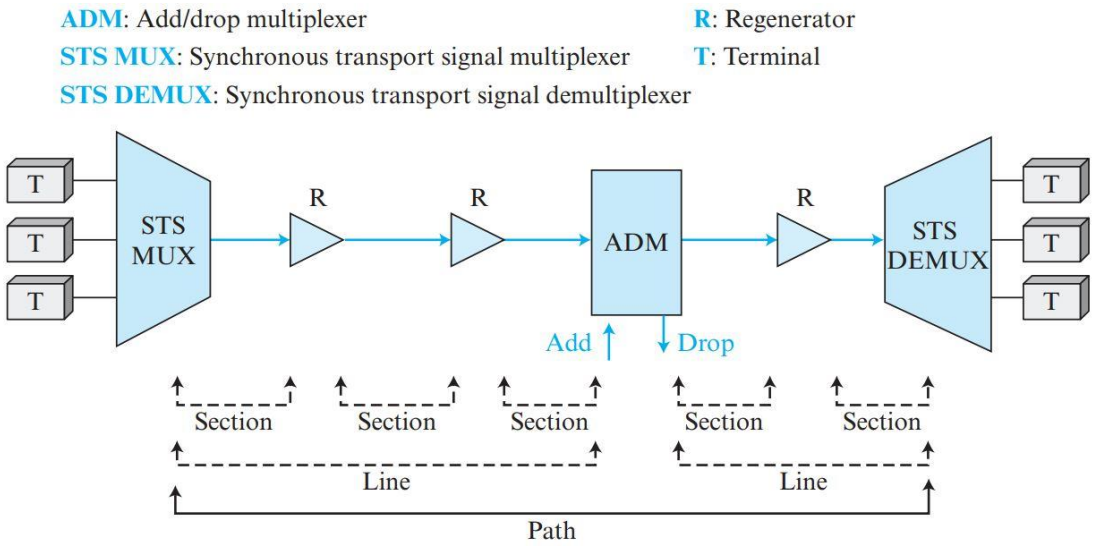
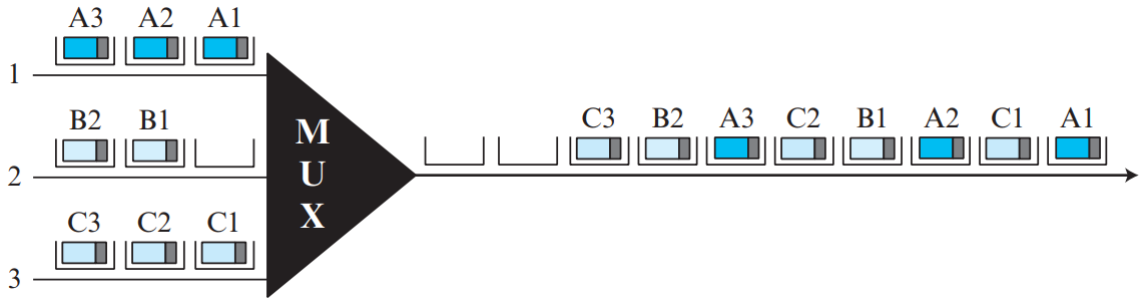
– Q18. Why is SONET called a synchronous network?

Synchronous Optical Network (SONET) is a high-speed network, that is used as a transport network to carry loads from other networks.

- SONET is a synchronous network using synchronous TDM multiplexing
- A single clock handle the timing of transmission and equipment across the entire network.
- This network wide synchronization adds a level of predictability to the system.





- All clocks in the system are locked to a master clock.
- Each synchronous transport signals **(**STS) level (STS-1 to STS-192) supports a certain data rate.
- A **section** is the optical link connecting two neighbor devices.
- A **line** is the portion of the network between two multiplexers.
- A **path** is the end-to-end portion of the network between two STS multiplexers.

Multiplexing is synchronous TDM, and all clocks in the network are locked to a master clock to **achieve synchronization**.

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– Q19. Consider a network setup as below in which you would like to assess the benefit of using web caching, assuming cache hit rate is 0.4: 40% requests satisfied at the cache, 60% requests satisfied at the origin.

Scenario:

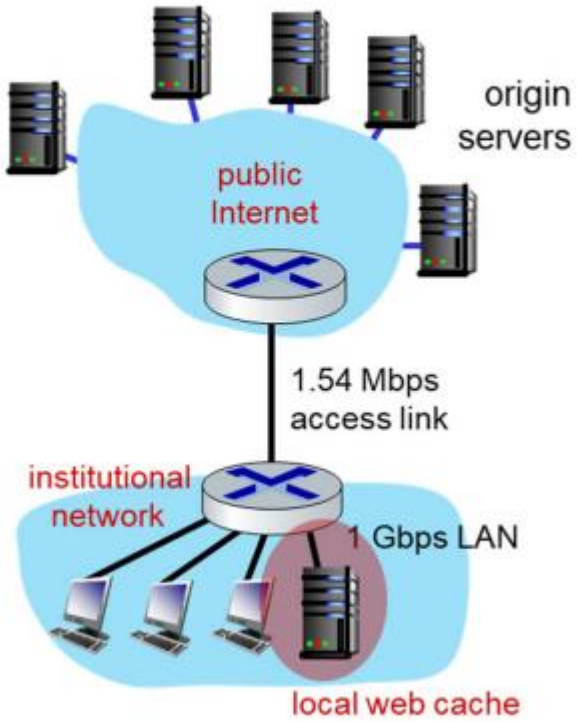
- access link rate: R=1.54 Mbps
- RTT from public router to server: 2 sec
- Web object size: L=100K bits
- Avg request rate from browsers to origin servers: 15/sec
  - avg data rate to browsers: 1.50 Mbps

Performance:

- LAN utilization: .?
- access link utilization = ?
- average end-end delay = ?

How to compute link utilization, delay?

Cost: web cache (cheap!)



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– Q19.

We need to calculate the delay when the cache is and not used.

60% of requests use the access link. The data rate to browsers over access link $= \ 0.6 \ * \ 1.50Mbps = 0.9Mbps$. The link utilisation is $p = \ 0.9Mbps/1.54Mbps \ = 0.58$.

One way link delay $= \frac{L}{R(1-p)} = \frac{0.065}{(1-p)} \approx 0.16 \ sec \ (R = 1.54Mbps)$

40% of requests use the local link. The data rate to browsers over access link $= \ 0.4 \ * \ 1.50Mbps = 0.6Mbps$. The link utilisation is $p = \ 0.6Mbps/1Gbps \approx 0.0006$.

One way link delay $= \frac{L}{R(1-p)} = \frac{0.0001}{(1-p)} \approx 0.0001 \ sec(R = 1Gbps)$

Average end-end delay$= \ 0.6 \ * \ (delay \ from \ origin \ server) \ + \ 0.4 \ * \ (delay \ when \ satisfied \ at \ cache)$

$= \ 0.6 \ (RTT \ of \ 2 \ \text{secs} + 2 * 0.16 \ \text{secs}) \ + \ 0.4 \ (\sim 2 * 0.0001 \ secs) \ = \ \sim 1.392 \ \text{sec}$

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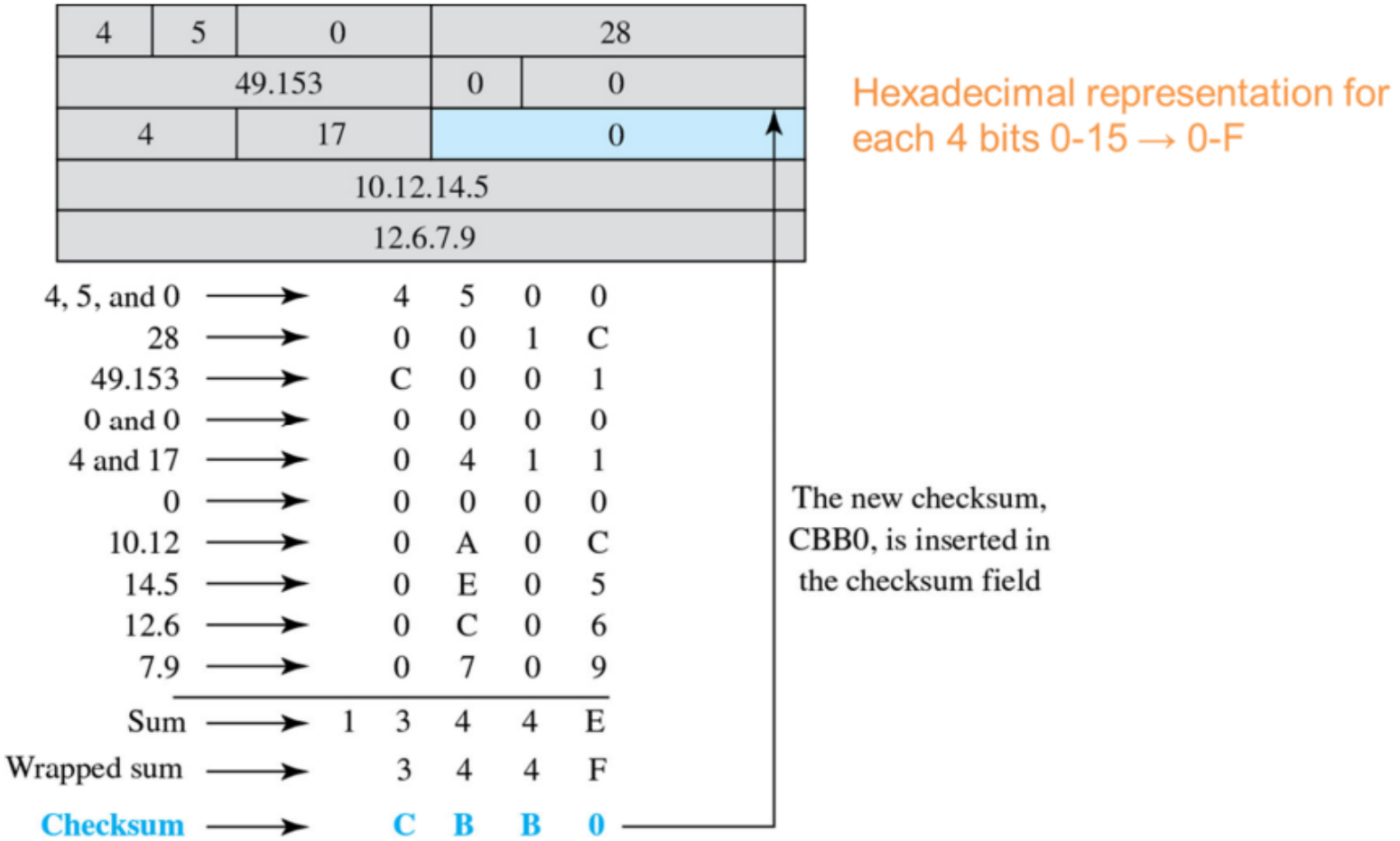
– Q20. Consider the below TCP headers considered in the lecture. Please verify that the sum, wrapped sum and checksum calculation is correct.



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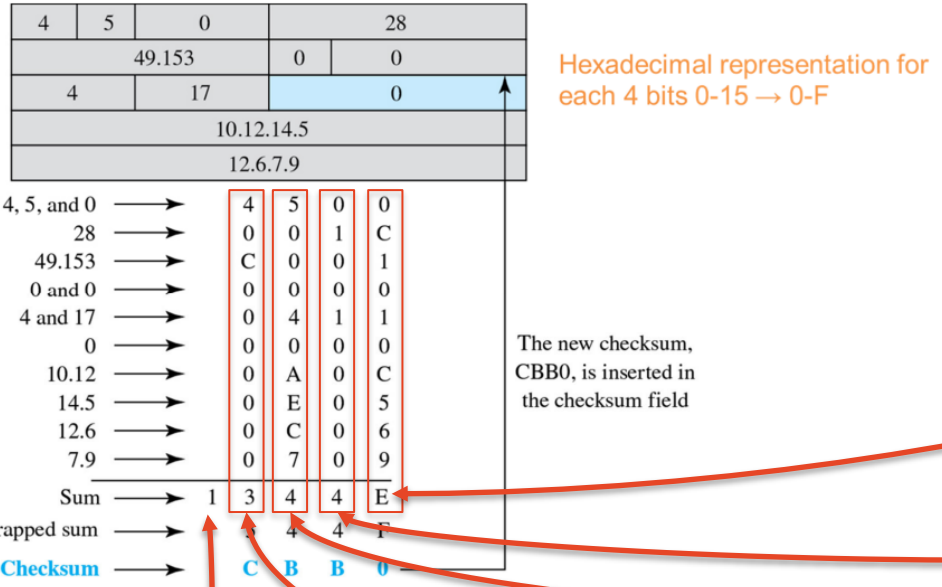
– Q20.



1^{st} column $= C + 1 + 1 + C + 5 + 6 + 9$

$= 12 + 1 + 1 + 12 + 5 + 6 + 9 = 46$

$= (2 * 16) + 14 = E$

2^{nd} column $= 2 + 1 + 1 = 4$

3^{rd} column $= 5 + 4 + A + E + C + 7$

$= 5 + 4 + 10 + 14 + 12 + 7 = 54$

$= (3 * 16) + 4 = 4$

4^{th} column $= 3 + 4 + C = 19$

$= (1 * 16) + 3 = 3$

Sum $1\ 3\ 4\ 4\ E$ → Warpped Sum $3\ 4\ 4\ F$ → Checksum $C\ B\ B\ 0$

$15 - 3 = 12 = C$

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- Q21. Consider two TCP headers, E666 and D555, please calculate its sum, wrapped sum and checksum. What happen when the received headers are now E665 and D556. Can the error be detected?

We will be using decimal approach here as described in the lecture to represent the two headers.

Note: when adding numbers, a carryout from the most significant bit needs to be added to the result

When the TCP headers are changed, the errors will not be detected,