

Chapter 18- Introduction to Network Layer

NETWORK-LAYER SERVICES

1- Packetizing

is definitely packetizing: encapsulating the payload in a network layer packet at the source and decapsulating the payload from the network-layer packet at the destination.

2- Routing and Forwarding

Routing finding the best route – path – from the source to destination to deliver the packet

Forwarding is using the forwarding table to apply an action by a router when a packet arrives at its interface from one network and forward it to another network

PACKET SWITCHING

switch that creates a connection between an input port and an output port (or a set of output ports), just as an electrical switch connects the input to the output to let electricity flow.

- **packet switching** is used at the **network layer** because data at this layer is a packet. Circuit switching is used at the physical layer
- There **2 different approaches to route the packets**:
 - 1- the datagram approach
 - 2- the virtual circuit approach

Datagram Approach	Virtual Circuit Approach
provide a connectionless service in which the network-layer protocol treats each packet independently, with each packet having no relationship to any other packet.	there is a relationship between all packets belonging to a message. Before all datagrams in a message can be sent, a virtual connection should be set up to define the path for the datagrams

NETWORK-LAYER PERFORMANCE

The performance of a network can be measured in terms of **delay, throughput, and packet loss**. **Congestion control** is an issue that can improve the performance.

<i>Delay</i>	<i>Throughput</i>	<i>Packet loss</i>	<i>Congestion Control</i>
a packet, from its source to its destination, encounters delays The delays in a network can be divided into four types: transmission delay, propagation delay, processing delay, and queuing delay.	number of bits passing through the point in a second, which is actually the transmission rate of data at that point. In a path from source to destination, a packet may pass through several links (networks), each with a different transmission rate	is the number of packets lost during transmission	Congestion control is a mechanism for improving performance. Congestion at the network layer is related to two issues, throughput and delay

IPv4 ADDRESSES

An IPv4 address is a 32-bit address that uniquely and universally defines the connection of a host or a router to the Internet.

- The IP address is the address of the connection, not the host or the router. It changes when moving to different network.
- The IP address unique, means defines only one connection to the internet
- The IP address universal, means that the addressing system must be accepted by any host that wants to be connected to the Internet

Address Space

An address space is the total number of addresses used by the protocol

A prefix can be:

- fixed length : called **classful addressing schema**
- variable length: called **classless addressing schema.**

- classful addressing schema	classless addressing schema
three fixed-length prefixes were designed instead of one ($n = 8$, $n = 16$, and $n = 24$). The whole address space was divided into five classes (class A, B, C, D, and E),	In classless addressing, the whole address space is divided into variable length blocks that belong to no classes, a block of 1, 2, 4, 128 addresses, a block needs to be power of 2,

DHCP

address assignment in an organization can be done automatically using the Dynamic Host Configuration Protocol (DHCP). DHCP is an application-layer program, using the client-server paradigm, that actually helps TCP/IP at the network layer.

NAT Network Address Translation

Network Address Translation (NAT). The technology allows a site to use a set of private addresses for internal communication and a set of global Internet addresses (at least one) for communication with the rest of the world - mapping between private and universal addresses, and support virtual private networks-. Through the use of NAT-capable router that runs NAT software

FORWARDING OF IP PACKETS

forwarding means to place the packet in its route to its destination. Means delivering packet to next hub.

We can use IP which in connectionless protocol as a connection oriented protocol to forward packets:

- When IP is used as a **connectionless** protocol, forwarding is based on the **destination address** of the IP datagram;
- When the IP is used as a **connection-oriented** protocol, forwarding is based on the **label attached to an IP datagram.**

Destination Address Forwarding	Forwarding Based on Label
This is a traditional approach, which is prevalent today. In this case, forwarding requires a host or a router to have a forwarding table. When a host has a packet to send or when a router has received a packet to be forwarded, it looks at this table to find the next hop to deliver the packet to.	In a connection-oriented network (virtual-circuit approach), a switch forwards a packet based on the label attached to the packet. Routing is normally based on searching the contents of a table; switching can be done by accessing a table using an index. In other words, routing involves searching; switching involves accessing.

Routers as Packet Switches

the packet switches that are used in the network layer are called routers. Routers can be configured to act as either a datagram switch or a virtual-circuit switch