Chapter 5
Network Layer

Presented By

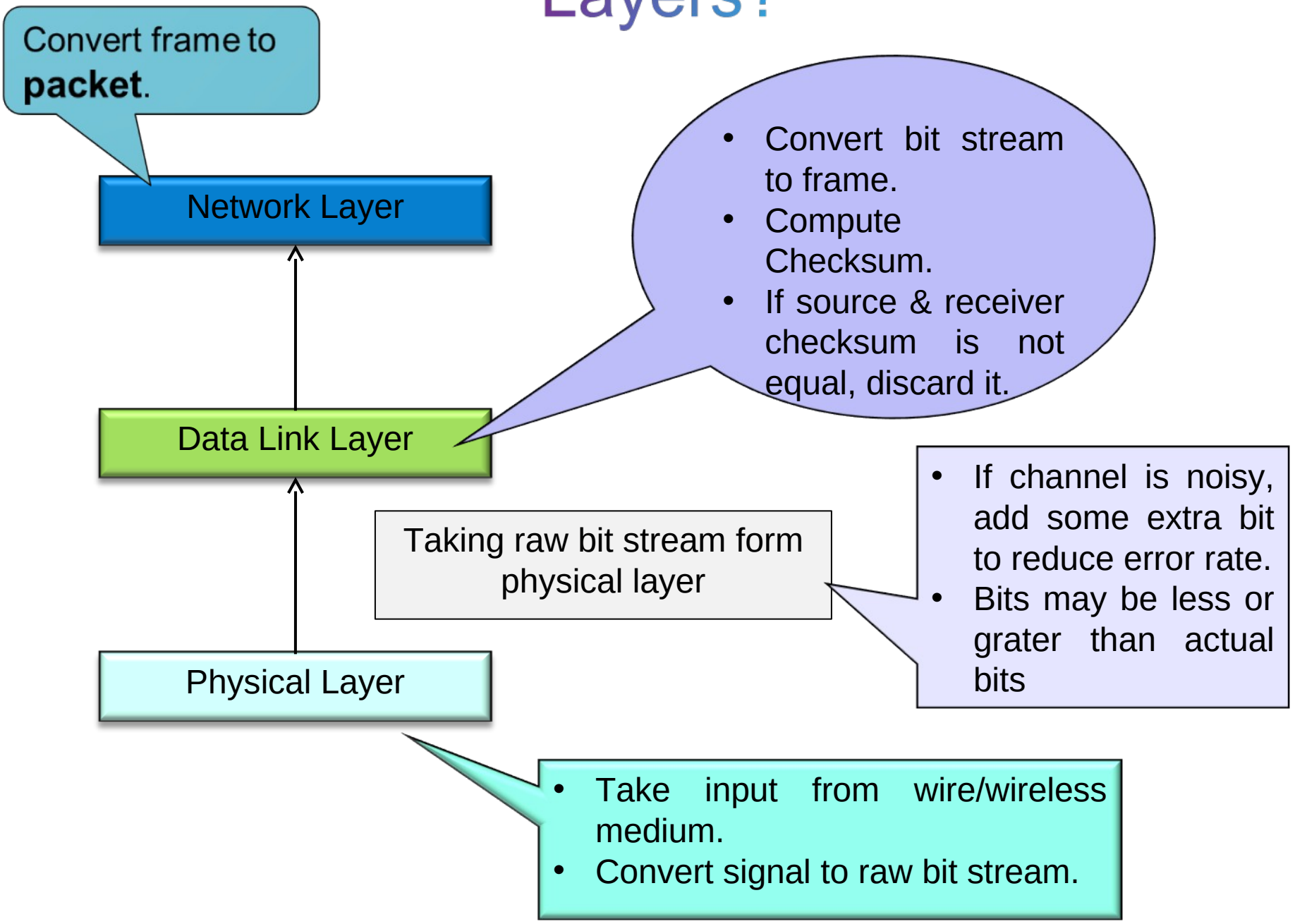
Zahirul Islam

Lecturer

Dept. of Computer Science & Engineering

Rajshahi University of Engineering & Technology

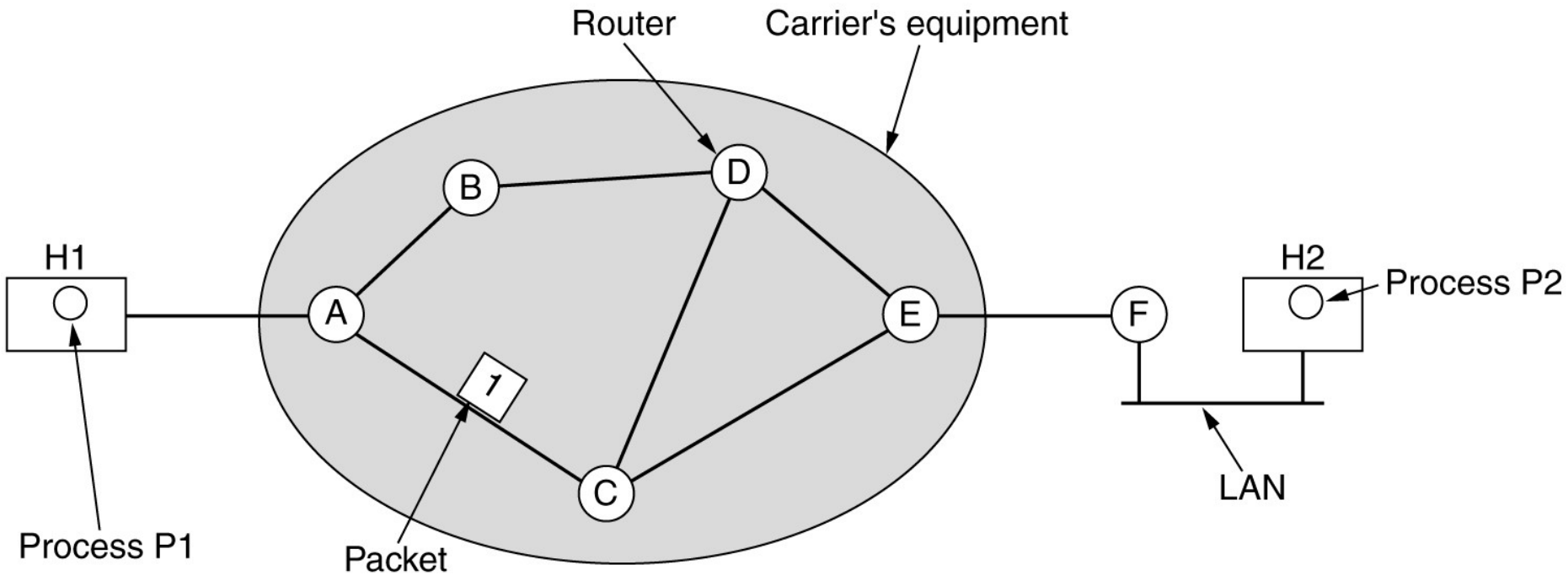
Layers?


Convert frame to **packet**.
Network Layer
• Convert bit stream to frame.
• Compute Checksum.
• If source & receiver checksum is not equal, discard it.
Data Link Layer
Taking raw bit stream form physical layer
• If channel is noisy, add some extra bit to reduce error rate.
• Bits may be less or grater than actual bits
Physical Layer
• Take input from wire/wireless medium.
• Convert signal to raw bit stream.

Network Layer Design Issue

- Store-and-Forward Packet Switching
- Services Provided to the Transport Layer
- Implementation of Connectionless Service
- Implementation of Connection-Oriented Service
- Comparison of Virtual-Circuit and Datagram Subnets

Store-and-Forward Packet Switching



The environment of the network layer protocols.

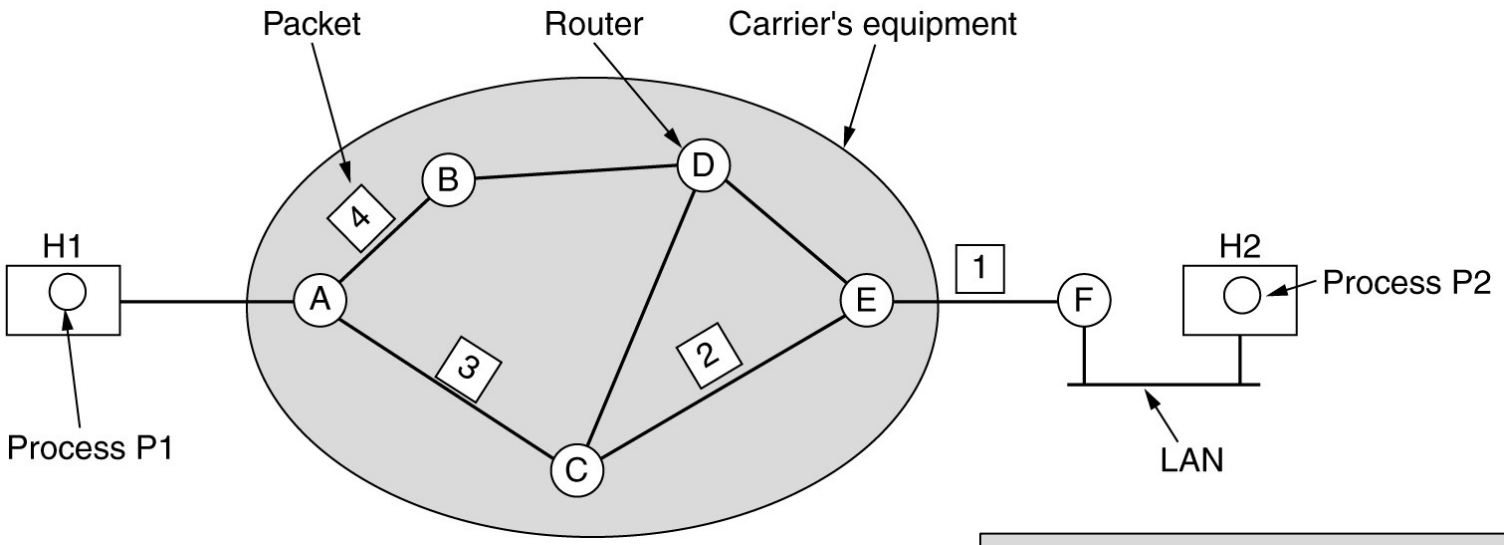
Store-and-Forward Packet Switching (1)

- A host with a packet to send transmit it to the nearest router, either on it's own LAN or over a point-to-point link to the ISP.
- The packet is stored there until it has fully arrived and the link has finished its processing by verifying the checksum.
- Then it is forwarded to the next router along the path until it reaches the destination host, where it is delivered.

Services Provided to the Transport Layer

- An important question is precisely what kind of services the network layer provides to the transport layer?
- **Dealing with the following goals in mind:**
  1. The services should be independent of the router technology.
  2. The transport layer should be shielded from the number, type, and topology of the routers present.
  3. The network addresses made available to the transport layer should use a uniform numbering plan, even across LANs and WANs.

Implementation of Connectionless Service



A's table

Dest.	initially	later
A	–	–
B	B	B
C	C	C
D	B	B
E	C	B
F	C	B

C's table

Dest.	Line
A	A
B	A
C	–
D	D
E	E
F	E

E's table

Dest.	Line
A	C
B	D
C	C
D	D
E	–
F	F

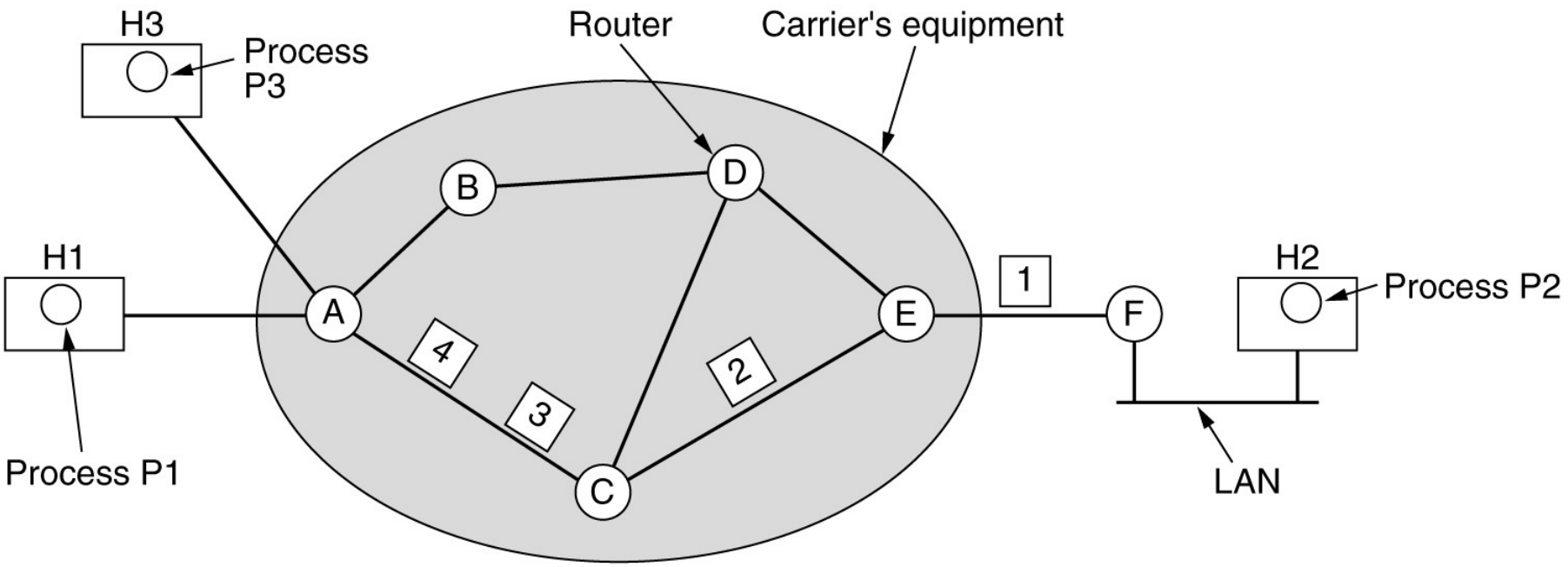
- Packet frequently called as **datagram.**
- The network is called a **datagram network.**

Routing within a diagram subnet.

Implementation of Connection-Oriented Service

- In connection-oriented service a path from the source router all the way to the destination router must be established before any data packets can be sent.
- This connection is called a **VC (virtual circuit).**
- The network is called a **virtual-circuit network.**

Implementation of Connection-Oriented Service(1)



A's table

In		Out	
H1	1	C	1
H3	1	C	2

C's table

A	1	E	1
A	2	E	2

E's table

C	1	F	1
C	2	F	2

Routing within a virtual-circuit subnet.

Implementation of Connection-Oriented Service(2)

- Host H1 has established connection 1 with host H2.
- This connection is remembered as the first entry in each of the routing tables.
- What happens if H3 also wants to establish a connection to H2?
- Normally It chooses connection identifier 1 [but 1 is already used]. That's the problem!!!
- So have to choose different connection identifier I,e 2.
- This process is called **label switching.**

Comparison of Virtual-Circuit and Datagram Subnets

Issue	Datagram subnet	Virtual-circuit subnet
Circuit setup	Not needed	Required
Addressing	Each packet contains the full source and destination address	Each packet contains a short VC number
State information	Routers do not hold state information about connections	Each VC requires router table space per connection
Routing	Each packet is routed independently	Route chosen when VC is set up; all packets follow it
Effect of router failures	None, except for packets lost during the crash	All VCs that passed through the failed router are terminated
Quality of service	Difficult	Easy if enough resources can be allocated in advance for each VC
Congestion control	Difficult	Easy if enough resources can be allocated in advance for each VC

Routing Algorithms

- Main function of Network Layer:
  - ✓ Routing of packets form the source machine to the destination machine.
- Routing Algorithms:
  - ✓ Network Layer Software responsible for deciding which output line an incoming packed should be transmitted on.
  - ✓ Datagrams: require computation of decision making tables for each packed.
  - ✓ Virtual Circuit: routing decision are made only when a new virtual circuit is being set up.
  - ✓ Session Routing: data packets follow the same routing for the entire session.

Network Performance Measures

- Two Performance Measures
  - ✓ Quantity of Service (Throughput)
    - How much data travels across the net?
    - How long does it take to transfer long files?
  - ✓ Quality of Service (Average packet delay)
    - How long does it take for a packet to arrive at its destination?
    - How responsive is the system to user commands?
    - Can the network support real-time delivery such as audio and video?

Fairness versus Optimality

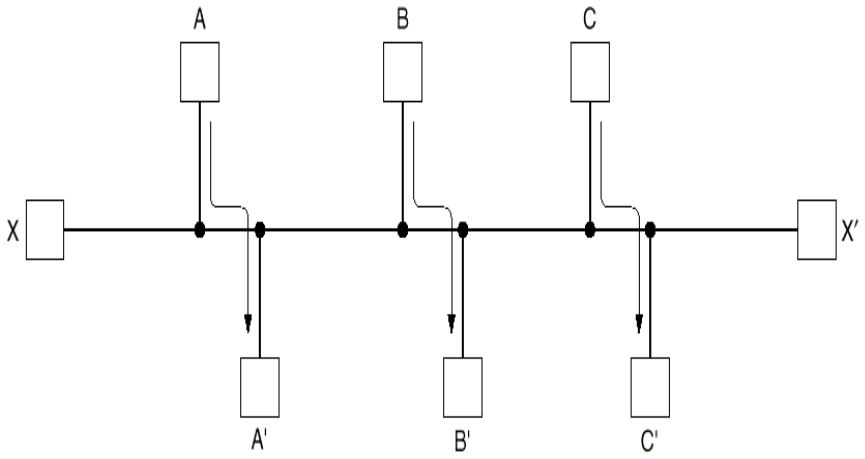


Fig. 5-4. Conflict between fairness and optimality.

a) Quantity of service versus quality of service.

b) To optimize throughput, saturate paths between A and A', B and B', and C and C', but what happens to the response time from X to X'?