Chapter 4

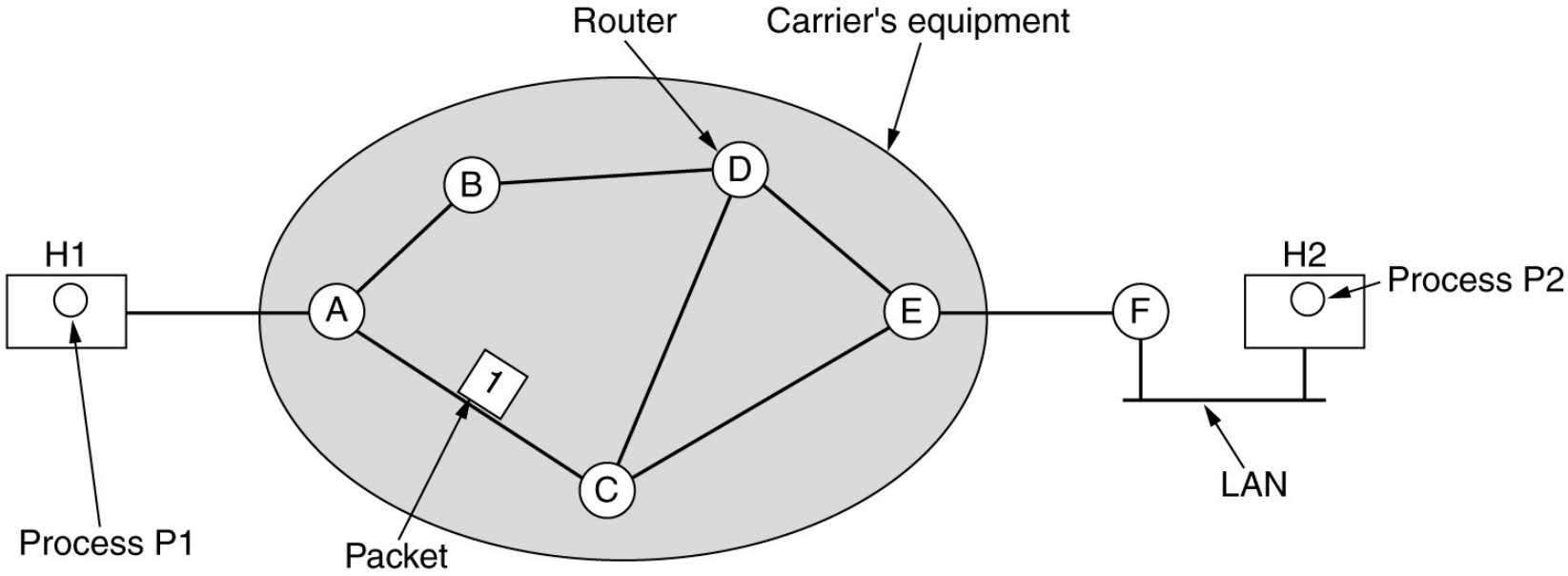
The Network Layer

- Network layer is concerned with getting packets from the source all the way to the destination.
- Getting to the destination may require making many hops at intermediate routers along the way.
- DLL has the more modest goal of just moving frames from one end of a wire to the other.
- Network layer is the lowest layer that deals with end-to-end transmission.

Network Layer Design Isues

- 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 major components of the network are the ISP's equipment (routers connected by transmission lines), shown inside the shaded oval, and the customers' equipment, shown outside the oval.

- Host *H1 is directly connected to* one of the ISP's routers, (a *home computer that is plugged into a* DSL modem).

- In contrast, *H2 is on a LAN, which might be an office Ethernet,* with a router, *F, owned and operated by the customer. This router has a leased* line to the ISP's equipment. We have shown *F as being outside the oval because* it does not belong to the ISP.

- A host with a packet to send transmits it to the nearest router, either on its 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. This mechanism is store-and-forward packet switching.

The network layer provides services to the transport layer at the network layer/transport layer interface. An important question is precisely what kind of services the network layer provides to the transport layer. The services need to be carefully designed 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.

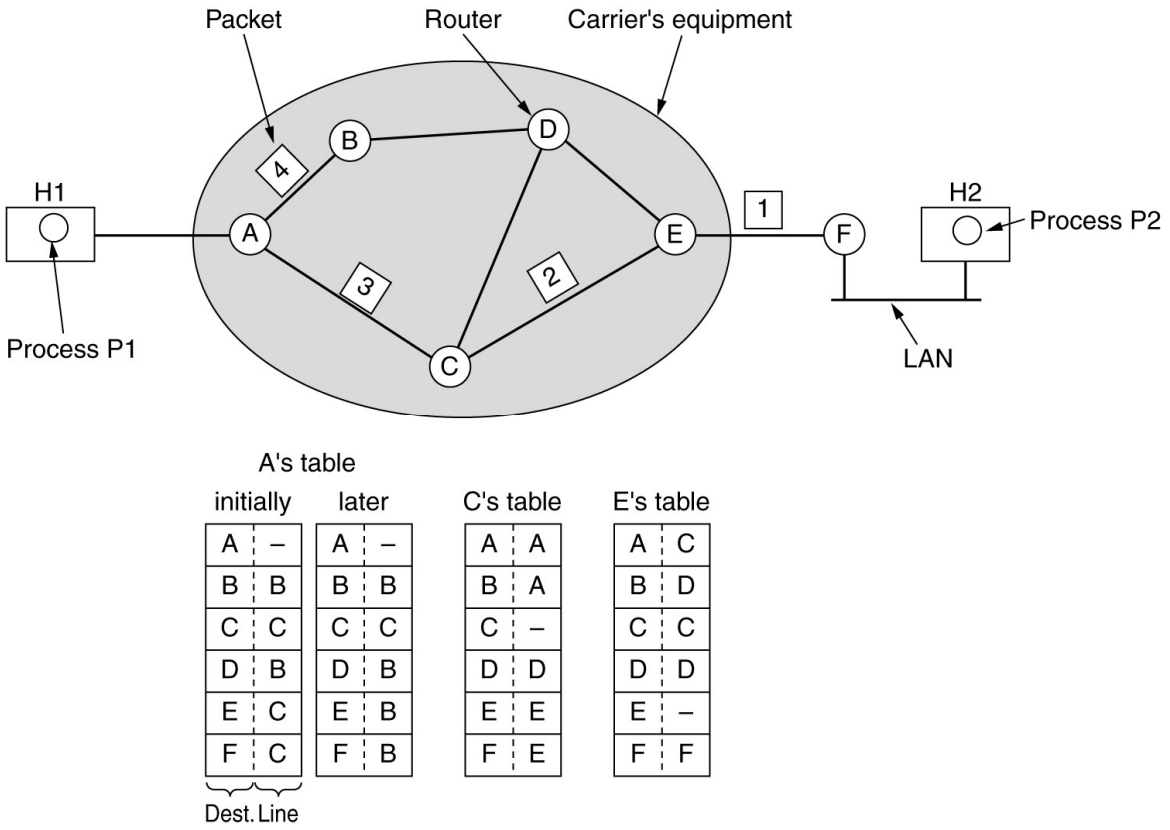
- If connectionless service is offered, packets are injected into the network individually and routed independently of each other. No advance setup is needed.

- Packets are called datagrams (in analogy with telegrams) and the network is called a datagram network.

- If connection-oriented service is used, 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), in analogy with the physical circuits set up by the telephone system, and the network is called a virtual-circuit network.

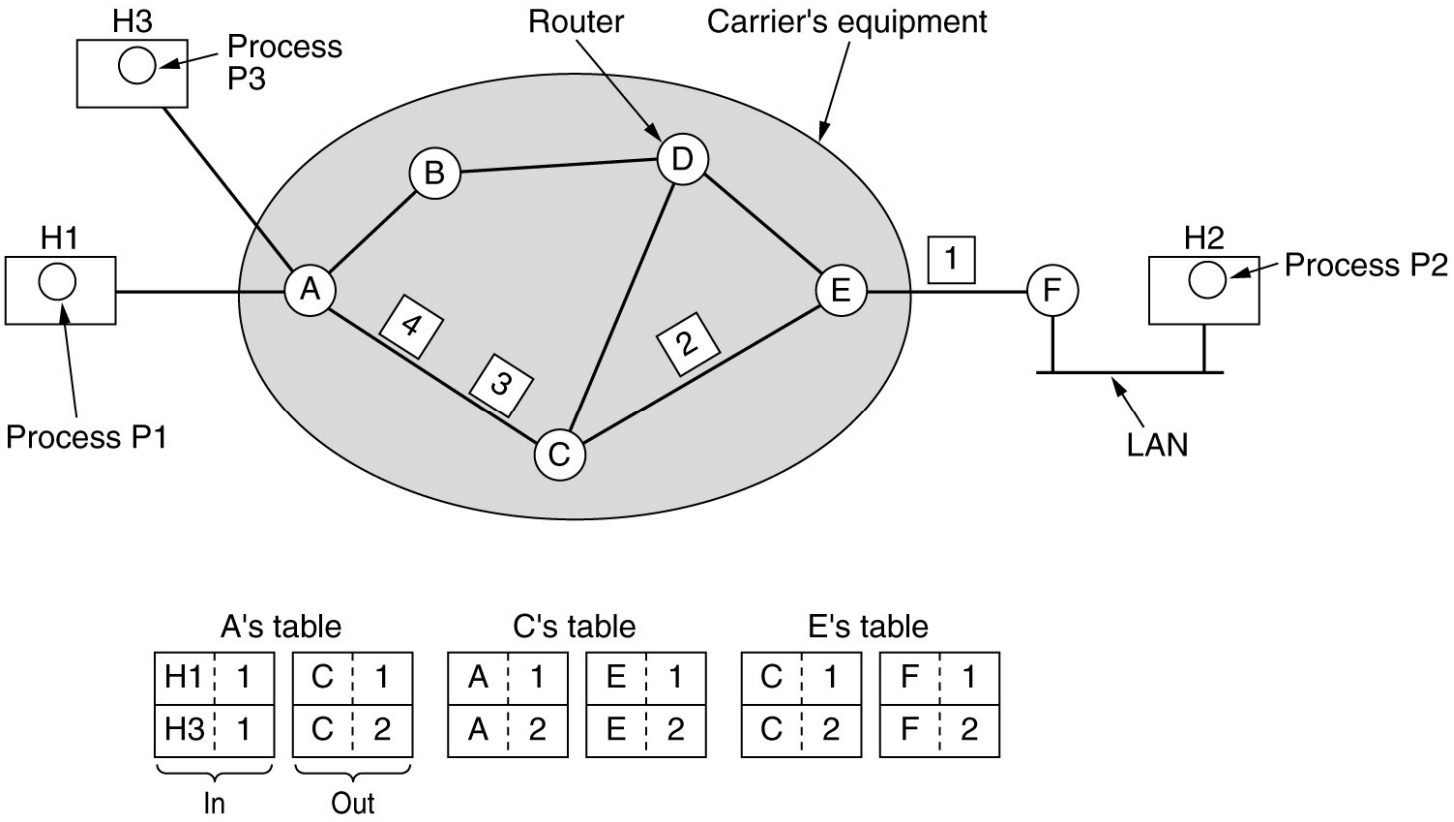
Implementation of Connectionless Service



A's table initially		A's table later		C's table		E's table	
A	–	A	–	A	A	A	C
B	B	B	B	B	A	B	D
C	C	C	C	C	–	C	C
D	B	D	B	D	D	D	D
E	C	E	B	E	E	E	–
F	C	F	B	F	E	F	F

Routing within a diagram subnet.

Implementation of Connection-Oriented Service



Routing within a virtual-circuit subnet.

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