

Chapter 5: The Network Layer

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- 5.1.2 Datagram vs virtual circuit
- 5.2.3 Flooding
- 5.2.5 Distance vector routing
- 5.2.6 Link state routing
- 5.5.1 IP
- 5.5.2 IP Addresses

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Datagram vs Virtual Circuit

Issue	Datagram	Virtual Ckt
Connection	N/A	Required
State	In packet	In switches
Routing	Per packet	At connection setup
Faults	Few packets lost	All Vcs terminated
Congestion control	Difficult	By reservation

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Transport vs Network Layer

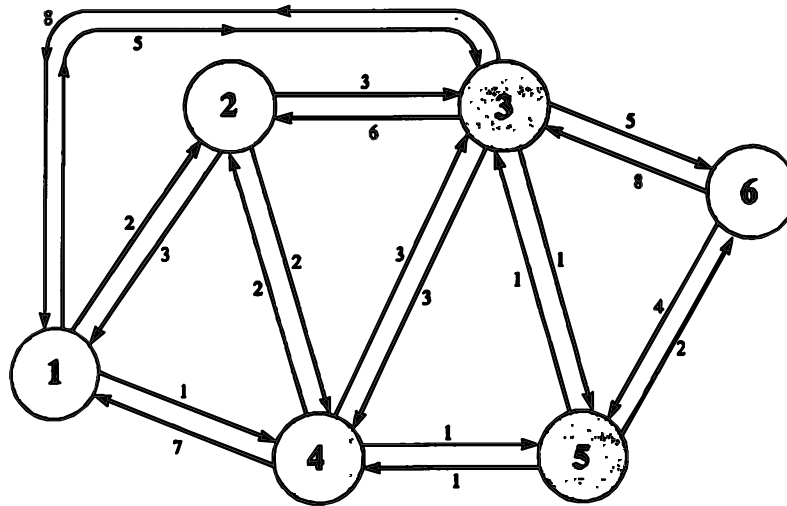
Transport	Network	
	Datagram	VC
Connectionless	UDP over IP	UDP over IP+ATM
Connection-oriented	TCP over IP	AAL over ATM

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Routing



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Fig 8.8

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Rooting or Routing

- ❑ *Rooting* is what fans do at football games, what pics do for truffles under oak trees in the Vaucluse, and what nursery workers intent on propagation do to cuttings from plants.
- ❑ *Routing* is how one creates a beveled edge on a table top or sends a corps of infantrymen into full scale, disorganized retreat

Ref: Piscitello and Chapin, p413

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Routeing or Routing

- Routeing: British
- Routing: American
- Since Oxford English Dictionary is much heavier than any other dictionary of American English, British English generally prevails in the documents produced by ISO and CCITT; wherefore, most of the international standards for routing standards use the routeing spelling.

Ref: Piscitello and Chapin, p413

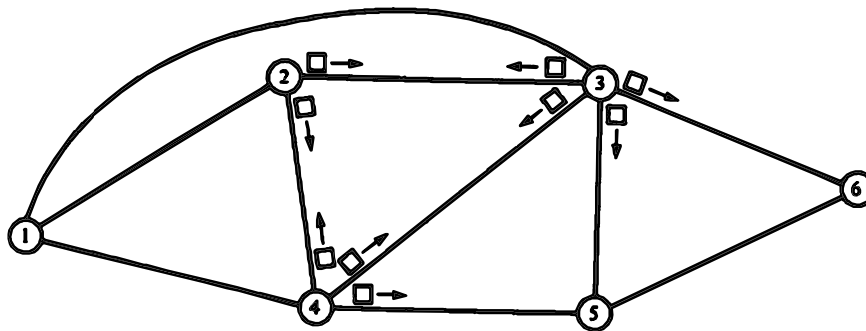
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Flooding

- Uses all possible paths
- Uses minimum hop path Used for source routing



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Fig 8.11b

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Routing Techniques Elements

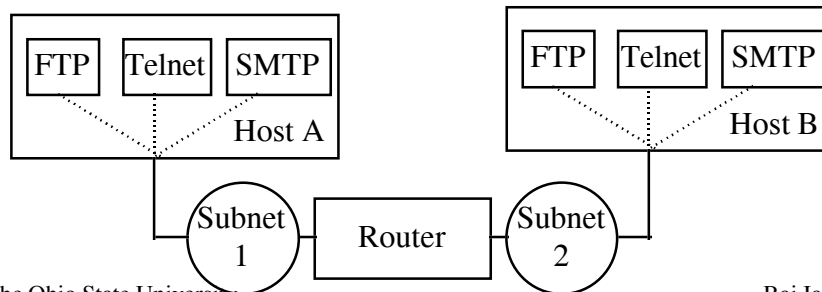
- ❑ **Performance criterion:** *Hops, Distance, Speed, Delay, Cost*
- ❑ **Decision time:** *Packet, session*
- ❑ **Decision place:** *Distributed, centralized, Source*
- ❑ **Network information source:** *None, local, adjacent nodes, nodes along route, all nodes*
- ❑ **Routing strategy:** *Fixed, adaptive, random, flooding*
- ❑ **Adaptive routing update time:** *Continuous, periodic, topology change, major load change*

Distance Vector vs Link State

- ❑ **Distance Vector:** Each router sends a vector of distances to its neighbors. The vector contains distances to all nodes in the network. Older method. Count to infinity problem.
- ❑ **Link State:** Each router sends a vector of distances to all nodes. The vector contains only distances to neighbors. Newer method. Used currently in internet.

Internetworking Terms

- ❑ End-system: Host
- ❑ Network: Provides data transfer between end-systems
- ❑ Internet: A collection of networks
- ❑ Subnetwork: Each component of an internet
- ❑ Port: Application processes in the host



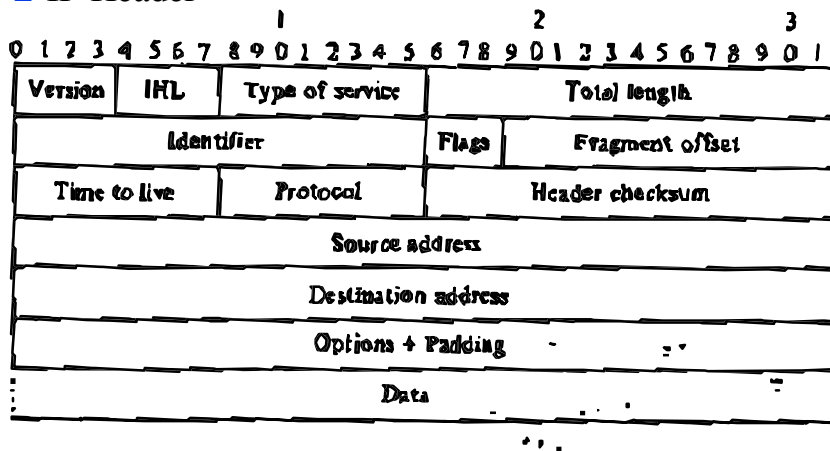
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Internet Protocol (IP)

- ❑ IP Header



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IP Header

- ❑ Version (4 bits)
- ❑ Internet header length (4 bits): in 32-bit words. Min header is 5 words or 20 bytes.
- ❑ Type of service (8 bits): Reliability, precedence, delay, and throughput
- ❑ Total length (16 bits): header+data in bytes
- ❑ Identifier (16 bits): Helps uniquely identify the datagram during its life for a given source, destination address

IP Header

- ❑ Flags (3 bits): More flag - used for fragmentation
No-fragmentation
Reserved
- ❑ Fragment offset (13 bits): In units of 8 bytes
- ❑ Time to live (8 bits): Specified in router hops
- ❑ Protocol (8 bits): Next level protocol to receive the data
- ❑ Header checksum (16 bits): 1's complement sum of all 16-bit words in the header
- ❑ Source Address (32 bits)

- ❑ Destination Address (32 bits)
- ❑ Options (variable): Security, source route, record route, stream id (used for voice) for reserved resources, timestamp recording
- ❑ Padding (variable): Makes header length a multiple of 4
- ❑ Data (variable): Data + header $\leq 65,535$ bytes

IP Address

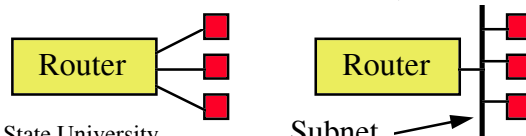
- ❑ Class A:

0	Network	Local
1	7	24
		bits
- ❑ Class B:

10	Network	Local
2	14	16
		bits
- ❑ Class C:

110	Network	Local
3	21	8
		bits
- ❑ Class D:

1110	Host Group (Multicast)
4	28
	bits
- ❑ Local = Subnet + Host (Variable length)



Summary



- Datagram vs virtual circuits
- Distance vector vs link state routing
- IP header and addresses
- subnetworks and ports

Homework

- Read sections 5.1.3, 5.2.2, 5.2.3, 5.2.5, 5.2.6, 5.5.1, 5.5.2, 5.5.3
- Problems: 8, 9, 26, 27, 28