Chapter 5:
The Network Layer

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Overview

- 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

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

Transport vs Network Layer

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

Routing

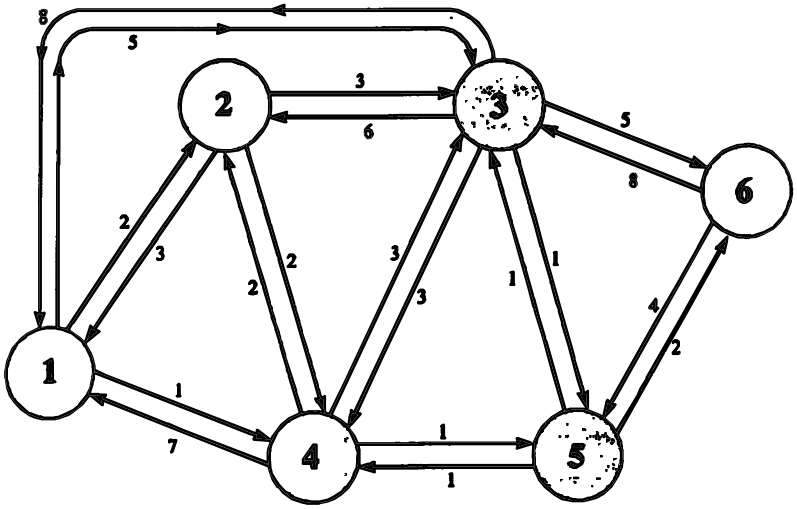


Fig 8.8

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 infanctrymen into full scale, disorganized retreat

Ref: Piscitello and Chapin, p413

Routeing or Routing

- Routeing: British
- Routing: American
- Since Oxford English Dictionary is much heavier than any other dictionary of American English, British English generally prevalis 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

Flooding

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

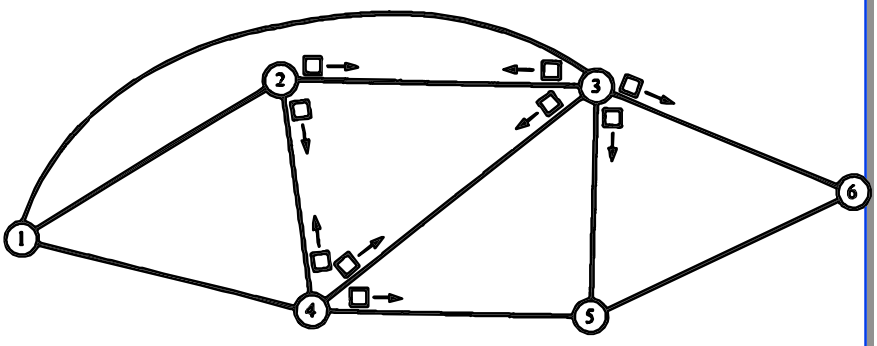


Fig 8.11b

Routing Techniques Elements

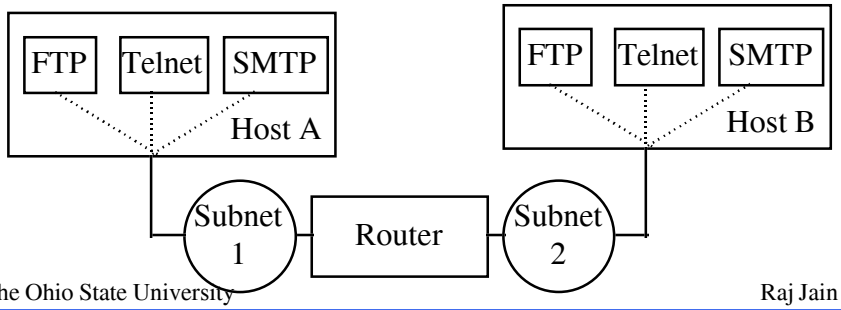
- **Performance criterion**: *Hops*, Distance, *Speed*, Delay, Cost
- **Decision time**: *Packet*, session
- **Decision place**: *Distributed*, centralized, Source
- **Network information source**: None, local, *adjacent nodes*, nodes along route, all nodes
- **Routing strategy**: Fixed, *adaptive*, 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.

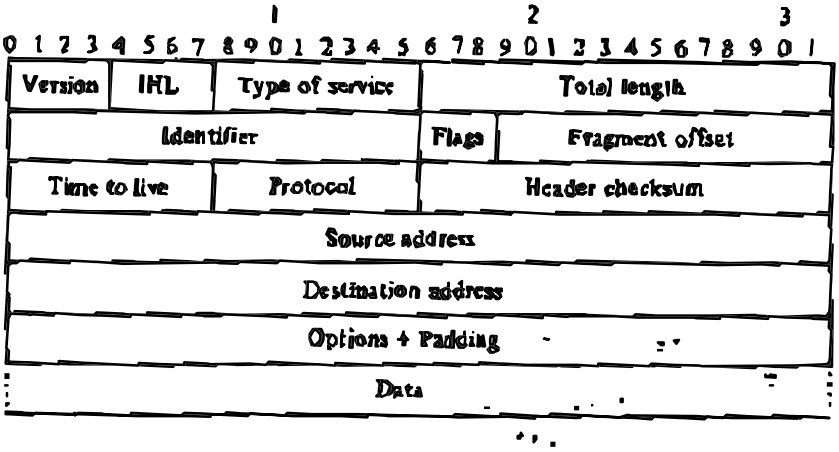
Internetworking Terms

- 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



Internet Protocol (IP)

- IP Header



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

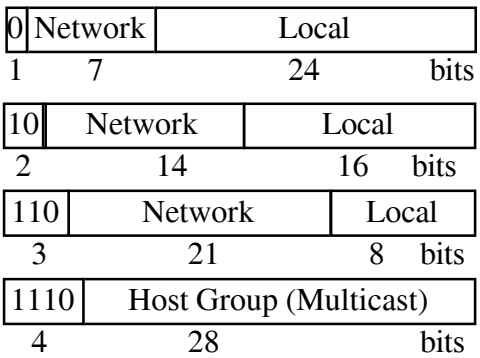
IP Header

- 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)

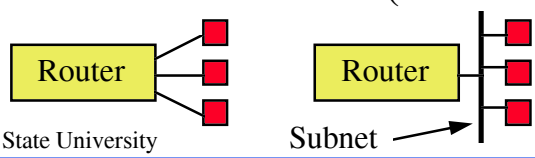
- Destination Address (32 bits)
- Options (variable): Security, source route, record route, stream id (used for voice) for reserved resources, timestamp recording
- Padding (variable): Makes header length a multiple of 4
- Data (variable): Data + header ≤ 65,535 bytes

IP Address

- Class A:
- Class B:
- Class C:
- Class D:



- 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