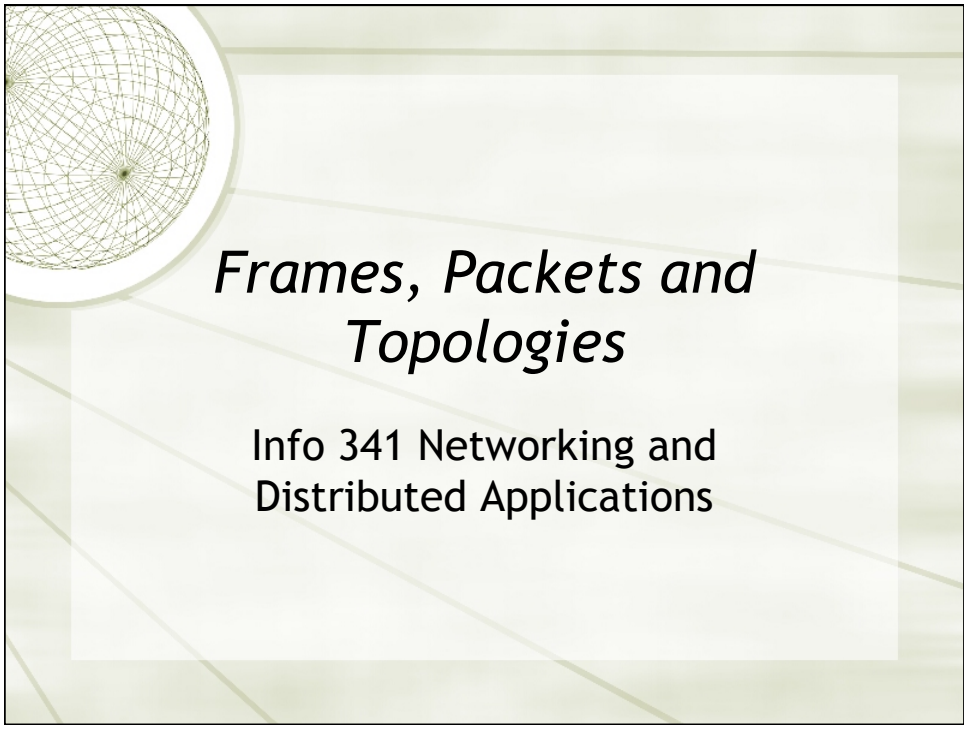
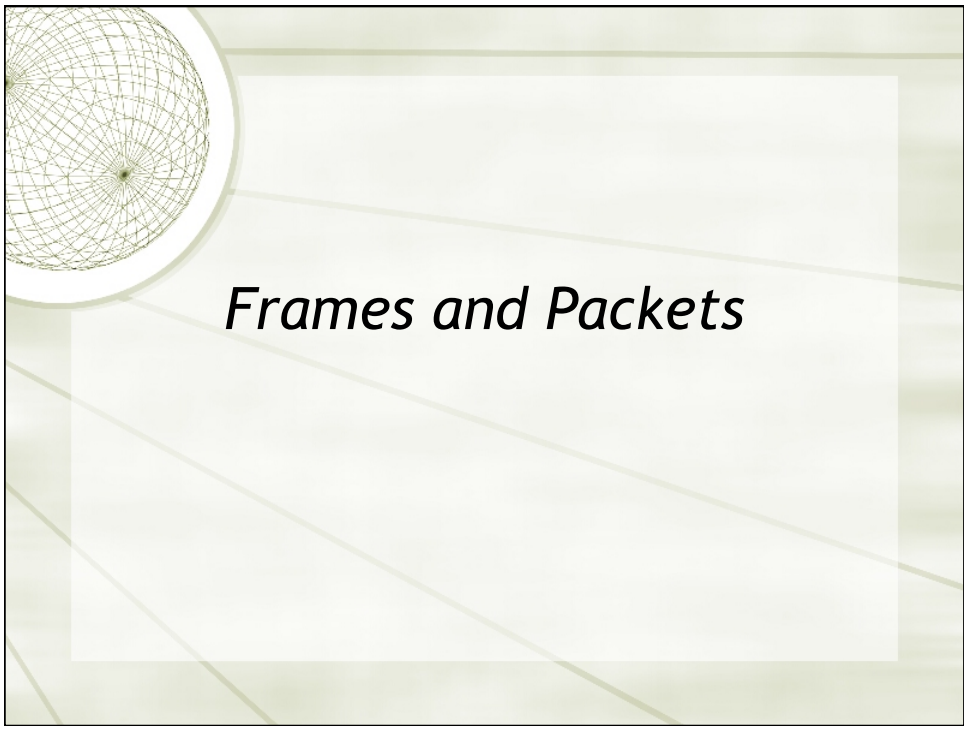

Frames, Packets and Topologies
Info 341 Networking and Distributed Applications


Frames and Packets

Motivating Packets

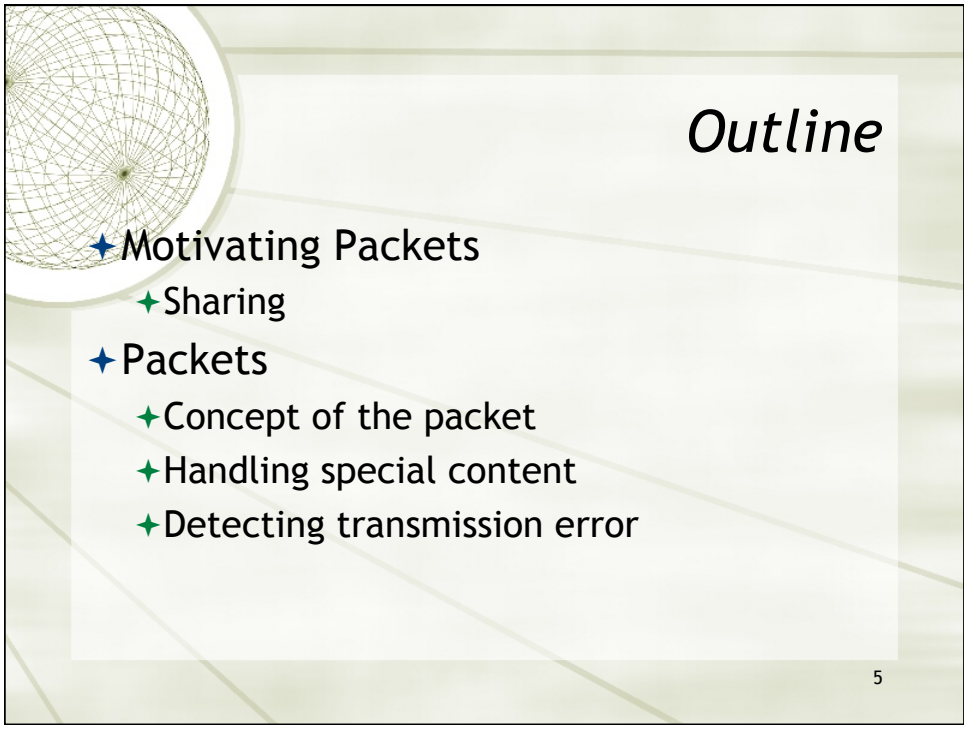
- What if a network required everything to be sent as a single chunk
  - What happens when you download a really large file, like a DVD?

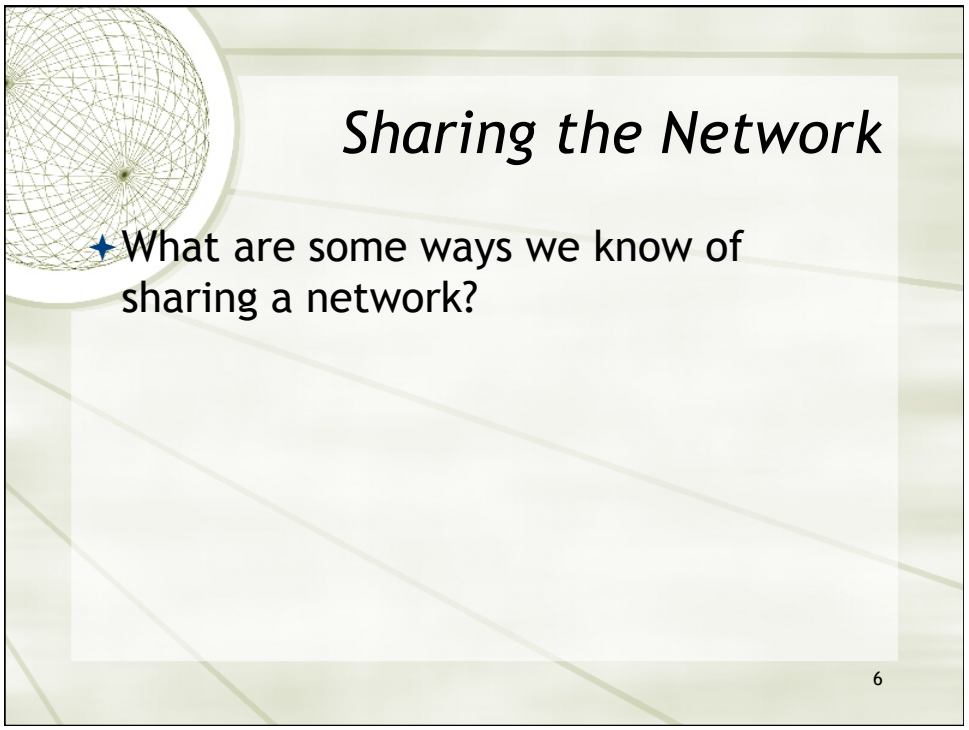
3

Motivating Packets

- What if a network required everything to be sent as a single chunk
  - What happens when you download a really large file, like a DVD?
  - Does every one else just wait?
  - What happens if someone just sends?
  - What if there is an error in the middle of the transmission?

4


Outline
Motivating Packets
Sharing
Packets
Concept of the packet
Handling special content
Detecting transmission error
5


Sharing the Network
What are some ways we know of sharing a network?
6

Sharing the Network

- What are some ways we know of sharing a network?
  - Multiplexing
    - Frequency Division Multiplexing
    - Time Division Multiplexing
  - How does this contrast with circuit switching?

7

What is a packet?

- Packets are chunks of data
- Packets are binary data on a network
  - Contents are often written in hexadecimal
- Packets facilitate sharing the network
  - A form of time division multiplexing
- We'll use the term 'packet' for as the most general way of describing data on a network.

8

Packets = payload + overhead

- Payload (the data)
- Overhead
  - Destination address
  - Source address
  - Packet format/type
  - Error detection
- Each device that communicates on a network needs a locally unique address

9

Payloads

- Special content
  - Some data values are special
    - Special meaning, reserved
    - Special non-printing ASCII characters
      - soh, eot, esc
- How do you send special data?

10

Byte Stuffing

- Mechanism for transmitting special data
  - Example
    - Characters ‘soh’ and ‘eot’ have special meaning
    - What if you want to send the ‘soh’ character as part of payload?

11

Byte Stuffing Example

- Suppose your message contained a special character

c	o	n	t	a	i	n	s		s	o	h		h	e	r	e		□

- In hexadecimal

63	6F	6E	74	61	69	6E	73	20	73	6F	68	20	68	65	72	65	20	**01**

- Byte stuffing ensures that the special character *soh* (01 in hex) is not in the data

63	6F	6E	74	61	69	6E	73	20	73	6F	68	20	68	65	72	65	20	1B	78

- Sometimes known as an ‘escape sequence’

12

Byte Stuffing Example

- Special character replaced with a sequence

Data	Sent
soh	esc x
eot	esc y
esc	esc z

- After byte stuffing data is safe in any packet

01	63	6F	6E	74	61	69	6E	73	20	73	6F	68	20	68	65	72	65	20	1B	78	04

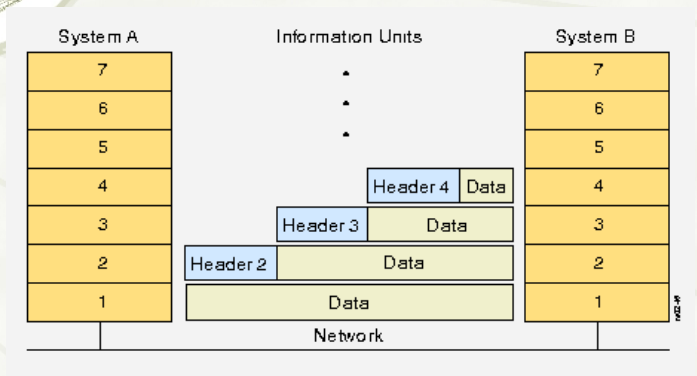
13

Encapsulate Packets within Packets

- Sometimes the data in a packet - is a packet
  - Encapsulation, or enveloping
- Network hardware packet
  - The hardware defines what the 'native' packet format - called a **frame**
  - Outer most packet is always the hardware packet type

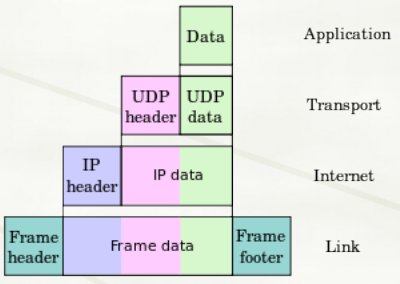
14

Visualizing encapsulation



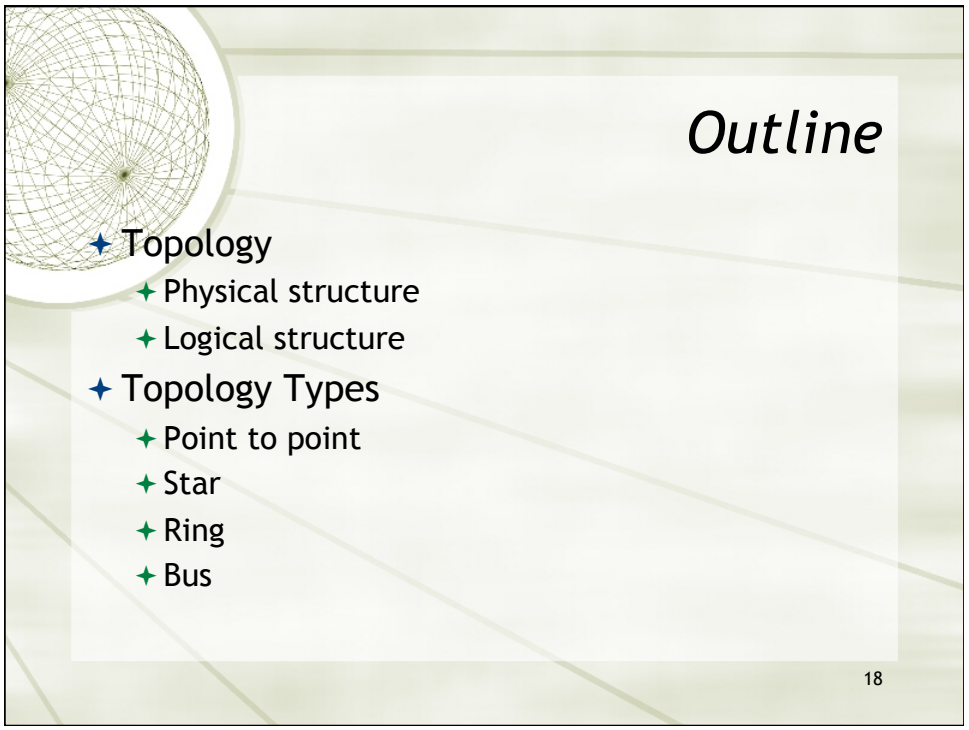
15

Visualizing encapsulation



16


Network Topologies


Outline
Topology
Physical structure
Logical structure
Topology Types
Point to point
Star
Ring
Bus
18

Locality of Reference

- An organizing principle for many phenomenon
  - Consider 'client' files in a physical file

19

Locality of Reference

- An organizing principle for many phenomenon
  - Consider 'client' files in a physical file
- Two key types
  - Physical locality of reference
  - Temporal locality of reference

20

Topology

- Two views of network topology
  - Physical topology
    - The actual layout of the network
    - How it is physically built
  - Logical topology
    - How data is organized and transported across the network.

21

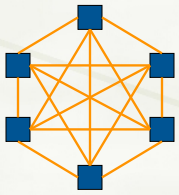
Topologies

- Point-to-Point
- Star
- Ring
- Bus

22

Point-to-Point

- Each computer has a direct connection to every other computer in the network
- Very robust
- Highly redundant

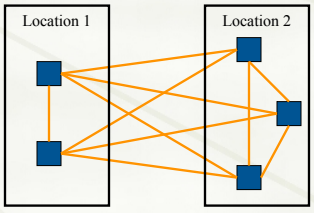


23

How Many Connections?

- Rate of interconnection increases quickly

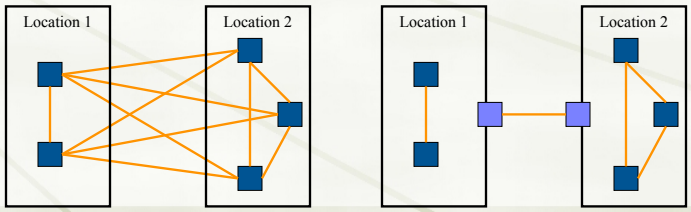
  Connections = $(N^2 - N)/2$



24

Point-to-Point

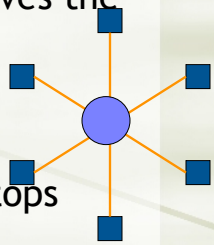
- For long distance networks, point-to-point is not efficient
- Maybe better to have one connection?



25

Star

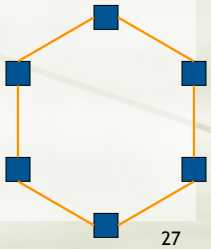
- Each computer has one connection to a central connector device
  - A central point (hub/switch) receives the data and communicates it to the destination
  - Small number of connections
  - If central point fails, everything stops



26

Ring

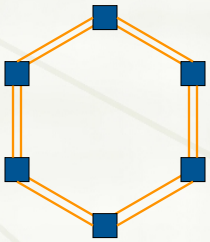
- Each computer has two connections
- Connected in series, if one computer fails ring breaks
- Adding computers slows network
- Shared medium

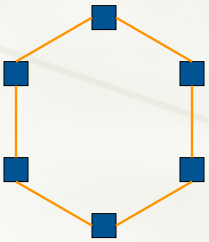


27

Ring

- Token Ring
- FDDI (Fiber Distributed Data Interface)
  - Double-counter directional rings

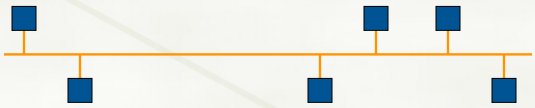




28

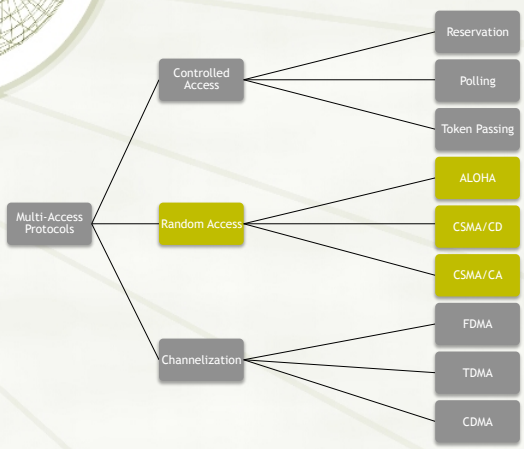
Bus

- Each computer needs one connection
- All computers receive the data
- Shared medium



29

Protocols for Shared Access



30

Random Access Protocols

- ALOHA
  - Early radio network protocol
- CSMA/CD – Carrier Sense Multi-Access/ Collision Detection
  - Ethernet
- CSMA/CA – Carrier Sense Multi-Access/Collision Avoidance
  - WiFi

31

CSMA/CD

- Key Features of CSMA/CD
  - Carrier Sense
    - Detect if a packet is being sent – if you only see the carrier, then no packet is currently being sent
  - Collision Detection
    - Listen when sending, if signal is different from what is sent, then collision
  - Exponential Backoff
    - When collision happens calculate a random time to wait before sending

32

CSMA/CA

- Key Features
  - Collision Avoidance handles "hidden" node problem
  - Computer 2 sees 1 and 3, but 1 is hidden from 3 because of signal attenuation

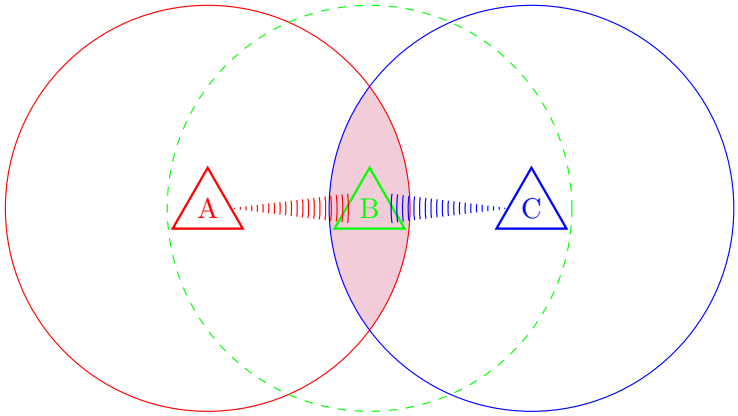

Computer 1


Computer 2


Computer 3

33

Visualizing the Hidden terminal problem



34

CSMA/CA

- Key Features
  - Computer 1 sends a request to send
  - Computer 2 sends a clear to send signal
    - Notifies Computer 1 *and* Computer 3
  - Computer 1 sends data
  - Does not prevent a collision


Computer 1


Computer 2


Computer 3

35