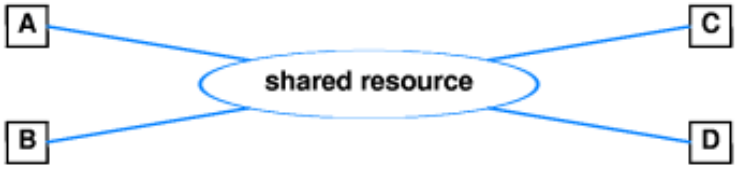
Data Communications 102

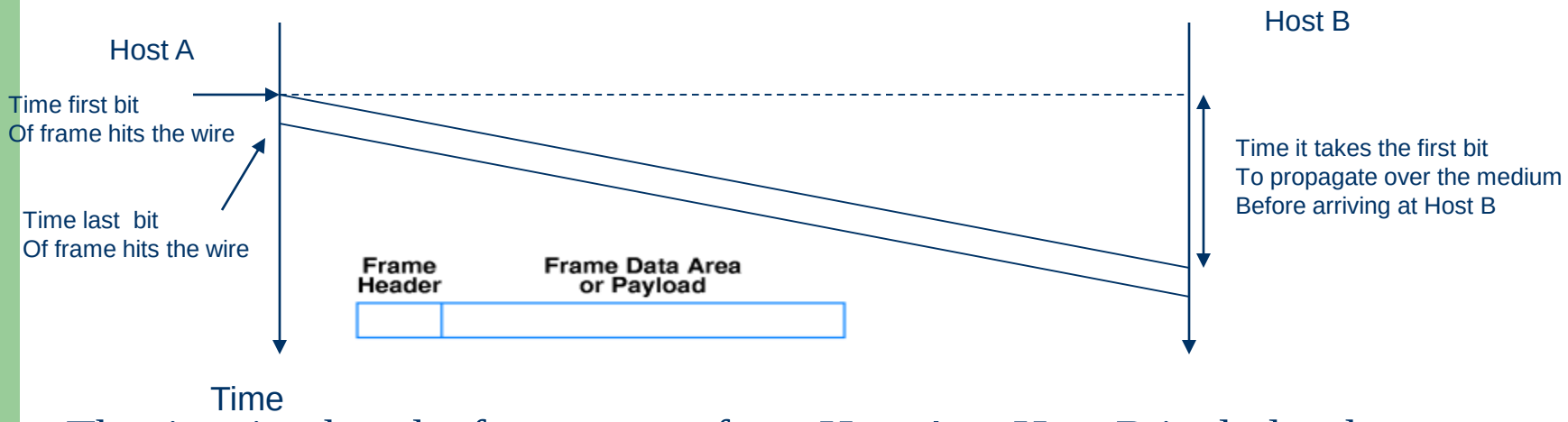
- To efficiently and fairly share resources….



Data is divided into small blocks called packets. Computers effectively take turn sending packets over a packet switched network.

Data Communications 102

- A packet is referred to as a frame once it ‘hits’ the wire.



The time it takes the frame to get from Host A to Host B includes the transmission time as well as the propagation delay.

Data Communications 102

- What if a bit gets damaged while it is in flight?
  - A transmitter must abide by a large number of very specific details : Tx power level, a modulation method that should match channel conditions, amount of redundancy added to the transmissions to correct for small levels of bit errors.
  - The transmission propagates over the medium which does add background noise. The receiver must be able to differentiate the transmission signal from the noise.
    - Think about trying to converse with someone in a crowded room where other conversations make it difficult to hear and understand your conversation.
    - The received signal to noise level is a measure that quantifies how well a receiver might be able to decode the transmission. A high quality radio receiver is effectively filter out the noise such that very small rx capture thresholds are required
    - Improvements are possible if 1:Tx power increases (Radio power or better antennas); 2:Noise floor reduced; 3:More robust modulation method improves the chances that bits are decoded correctly even in poor SNR conditions.

Data Communications 102

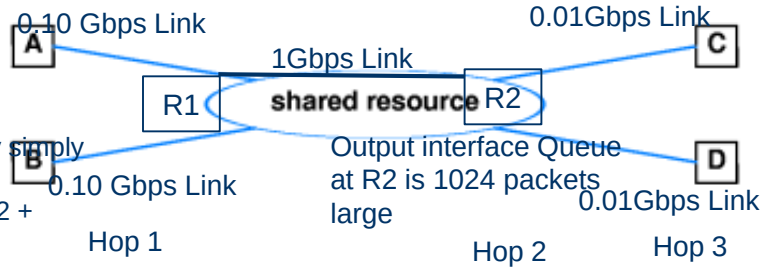
- Errors must be detected and optionally recovered.
- Error detection:
  - Methods such as a checksum is a mathematical signature of the source data.
    - The sender computes sending CRC=f(Message) and adds to the frame
    - The receiver computes the received CRC=f(Message')
    - No error is the sent and received CRC are identical
- Error Recovery:
  - Sliding window error recovery
    - Go-Back-N: can send a window of N packets before stalling. Acks from the receiver clock out new packets at the sender.
    - If a packet is dropped, a timeout at the sender forces the sender to retransmit the entire current window.
  - Forward Error Correction (FEC) , also called coding: A certain amount of redundant information is sent with each frame transmission. The strength of the coding should match the channel conditions.

Data Communications 102

- One more possible cause for frames to not be received correctly: congestion!
- Occurs when demand exceeds capacity
- Four nodes, traffic flows from A->C and B->D.
  - Traffic models: Constant bit rate (A fixed size packet sent periodically)
    - Flow AC : Packet size 100 bytes sent every 100 ms -→ sending rate of 100 * 8 / 0.1 = 8000 bps
    - Flow BD, packet size 1500 bytes every
  - Bottleneck links: R2-C and R2-D (10 Mbps)
  - Case 1: Flow A-C demand is 100 Mbps
    - Result: Queueing at R2.
  - Case 2: Flow B-D demand is infinite

Example (assume all link prop delays are 1millisecond)

- Flow AC one way latency:
  - Consider 1 packet sent by A to C
  - Packet size 100 bytes, lets assume all overhead is modeled by simply adding 40 bytes to the user data size.
  - One way latency: (Packet Tx time + prop Delay)Hop1 + ()Hop2 + ()Hop3
  - This assumes a smart queue scheduler operating at R2!!!!
- Flow BD one way latency:
  - Sends a new packet ever 1500*8 / 100,000, 000 = 0.12 milliseconds.
  - One way latency: (Packet Tx time + prop Delay)Hop1 + ()Hop2 + ()Hop3
  - So data arrives at R2 at a rate much higher than the last hop data rate. R2 queues the excess. However since the traffic model is UDP (set up to emulate a CBR traffic generator
  -



Ethernet

- On a shared communication channel (e.g., an Ethernet network)
  - Enhances network resource utilization
  - Three main topologies: star, ring and bus

- What is an Ethernet ?

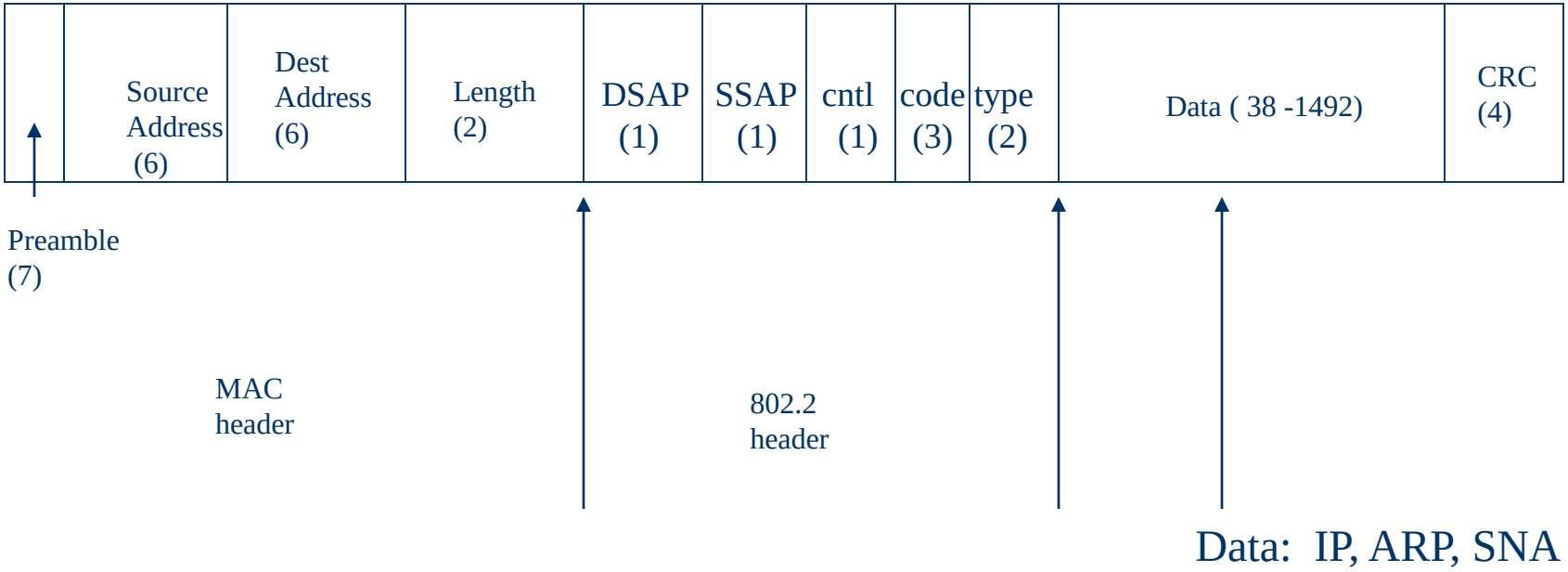
Ethernet

- Ethernet is a bus network in which multiple computers share a single transmission medium. While one computer transmits a frame, all others must wait.
- How do nodes coordinate ?

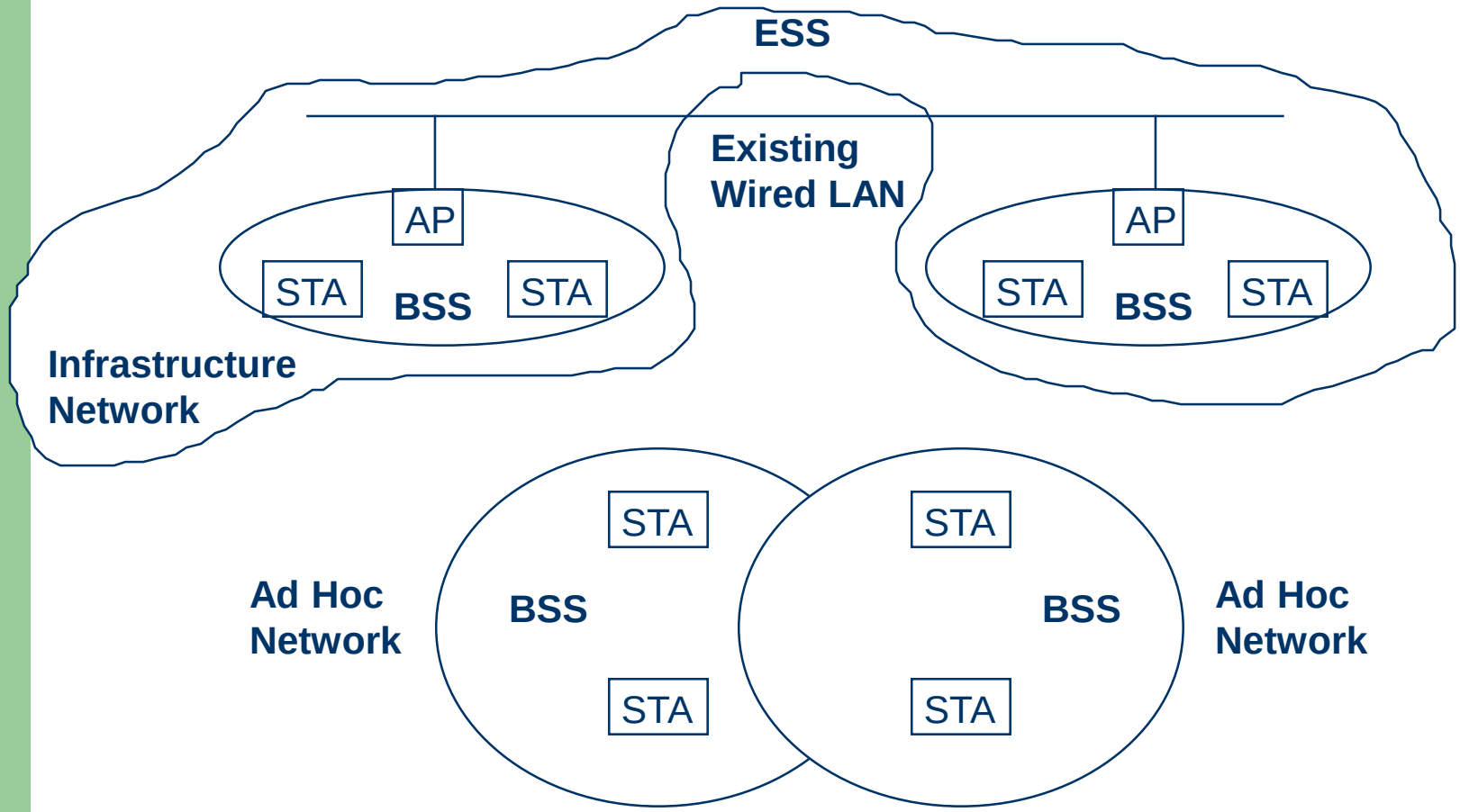
Ethernet

- All computers participate in a distributed coordination scheme called carrier sense multiple access with collision detection (CSMA/CD).
  - Uses electrical activity to determine status.
  - A computer checks for carrier to determine if it can transmit (i.e., carrier sense).
  - What if two computers detect no carrier at exactly the same time…when they both transmit, the interference between their two signals is called a collision.
    - A transmitting station will detect a collision by checking for carrier as it transmits. (CSMA/CD).
  - Once a collision occurs, the station selects a random delay and waits before trying again.
    - The range of the delay doubles with each consecutive collision.

IEEE LAN (802.2/802.3) Frame Format



Overview, 802.11 Architecture



Wireless LANS (WiFi, 802.11)

- 802.3 (Ethernet) uses CSMA/CD, Carrier Sense Multiple Access with 100% Collision Detect for reliable data transfer
- 802.11 has CSMA/CA (Collision Avoidance)
  - Large differences in signal strengths
  - Collisions can only be inferred afterward
    - Transmitters fail to get a response
    - Receivers see corrupted data through a CRC error

Wireless LANS (WiFi, 802.11)

- Carrier sensed by each node before transmission
  - If busy, defer transmission by randomly selected backoff interval.
  - If idle for more than DIFS: Distributed Inter-Frame Space(=128 microseconds), each node decrements backoff timer
    - The node whose timer value reaches zero first, transmits data

Wireless LANS (WiFi, 802.11)

- Virtual Carrier sense mechanism
  - Makes use of short control packets RTS/CTS to avoid collision and ‘hidden node’ problem