CSC4200/5200 – COMPUTER NETWORKING

ETHERNET

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Tennessee TECH

Apps (HTTP)

Data

Apps (HTTP)

Transport (TCP/UDP)

Segments

Transport (TCP/UDP)

Network (IP)

Packets

Network (IP)

Link (Ethernet)

Frames

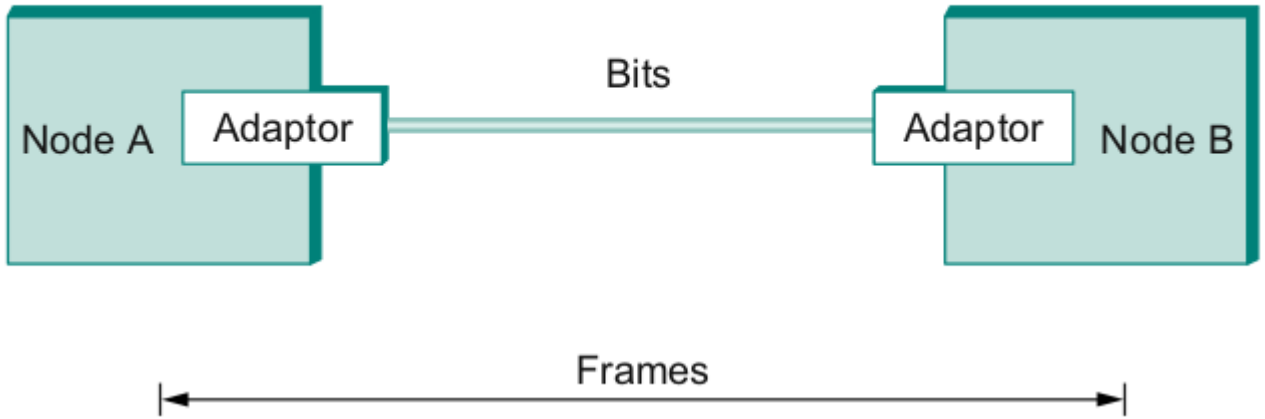
Ethernet Interface

Ethernet Interface

Link (Ethernet)

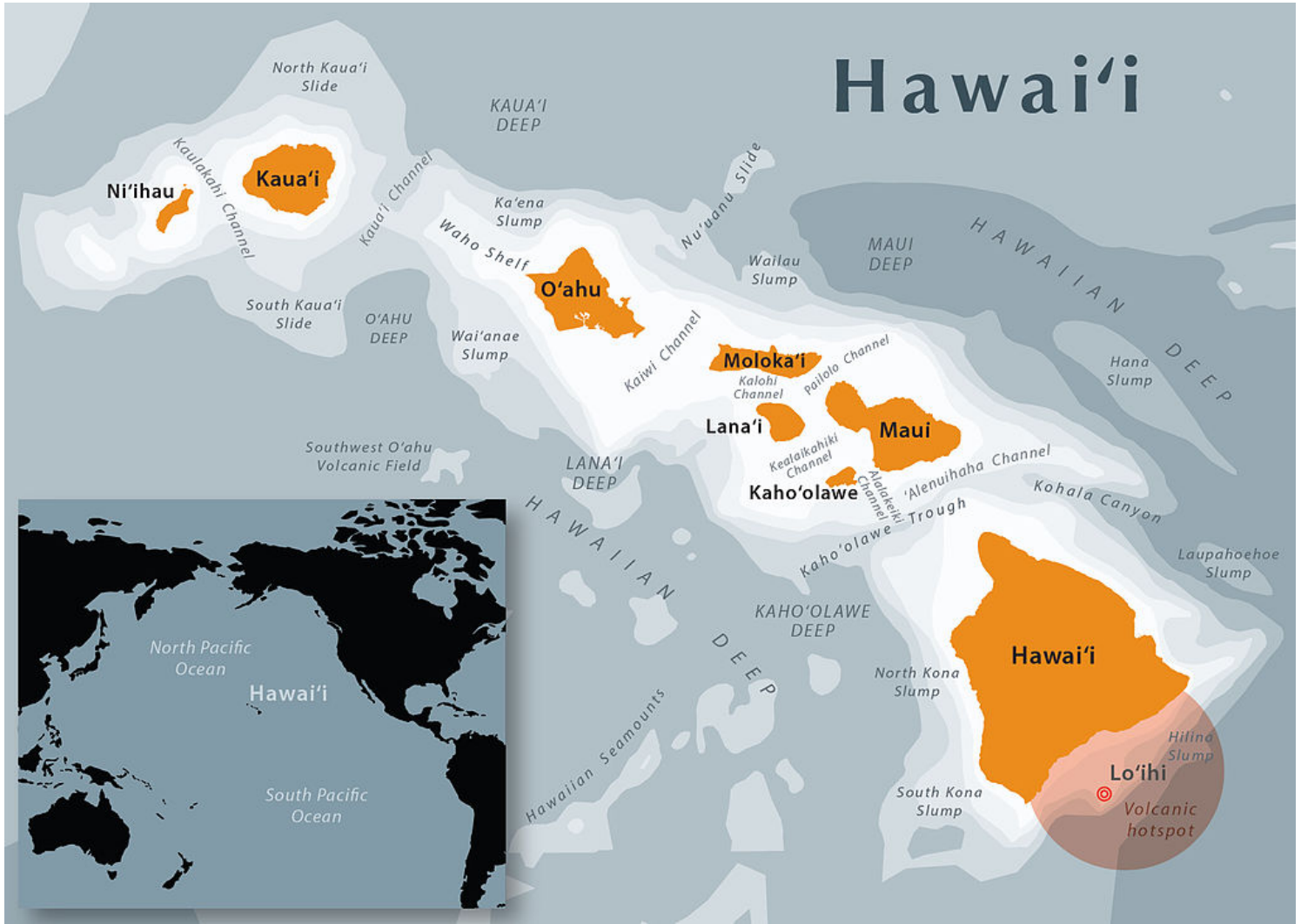
Bits (1010001)

So far...



- We have connected two machines using point to point wires
  - Encoded bits
  - Sent bits as Frames
  - Caught and corrected errors
  - Tuned efficiency and reliability using sliding window
- What happens when there are more than two machines?

Map of Hawaii



wikipedia

AlohaNET

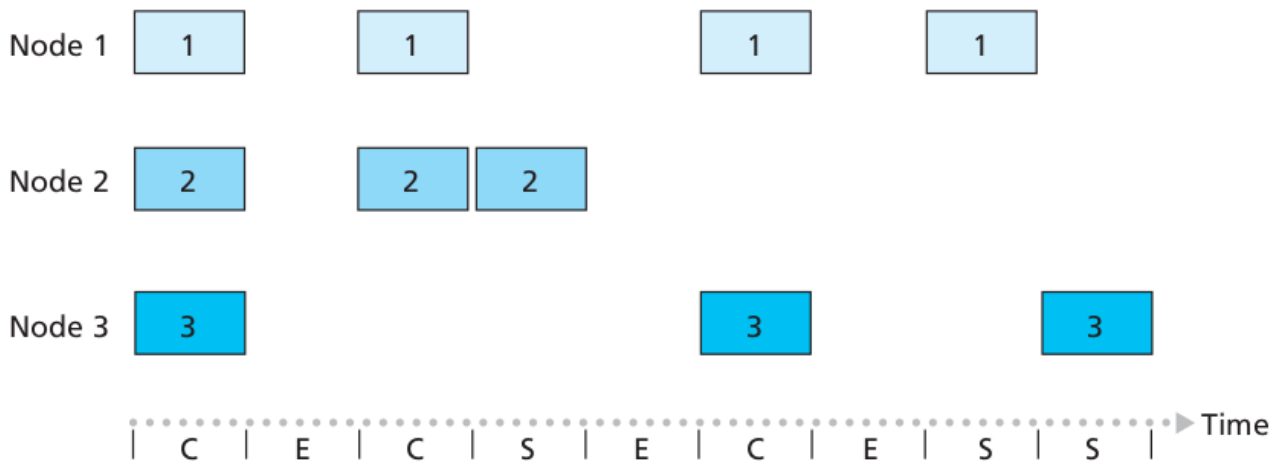
- Connect University of Hawai‘i’s computers using wireless radio to main campus in Oahu

- Random access to radio channel
  - If you have data, send
  - If you hear someone else, collision! Resend “later”

- Fixed frequency channels
  - Shared medium

Abramson, Norman. "Development of the ALOHANET." IEEE transactions on Information Theory 31.2 (1985): 119-123.

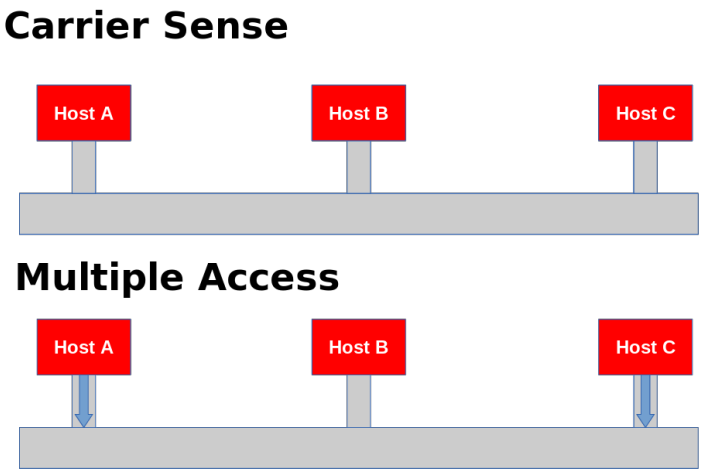
Slotted ALOHA – Problems?



- Wasted slots
- Idle slots
- Need to sync
- Low efficiency

CSMA

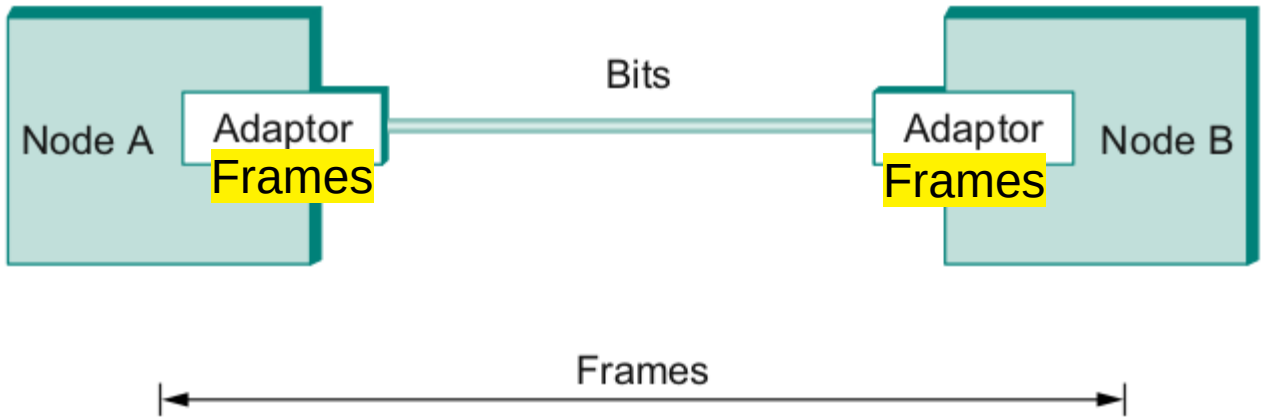
wikipedia



- Listen first -
  - If chennel is idle, send
  - If channel is busy, wait and send later
- Propagation delay
  - You may not hear others before it’s too late!

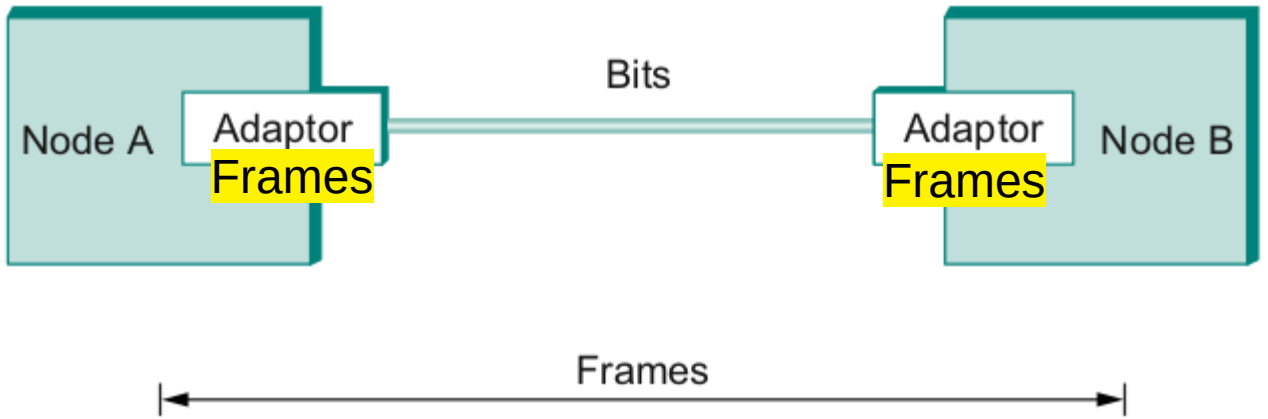
Ethernet – Wire as Shared Medium

- Most successful local area networking technology of last 20 years.
- Developed in the mid-1970s by researchers at the Xerox Palo Alto Research Centers (PARC).
- For alohanet the medium was the atmosphere, for ethernet, coax cables

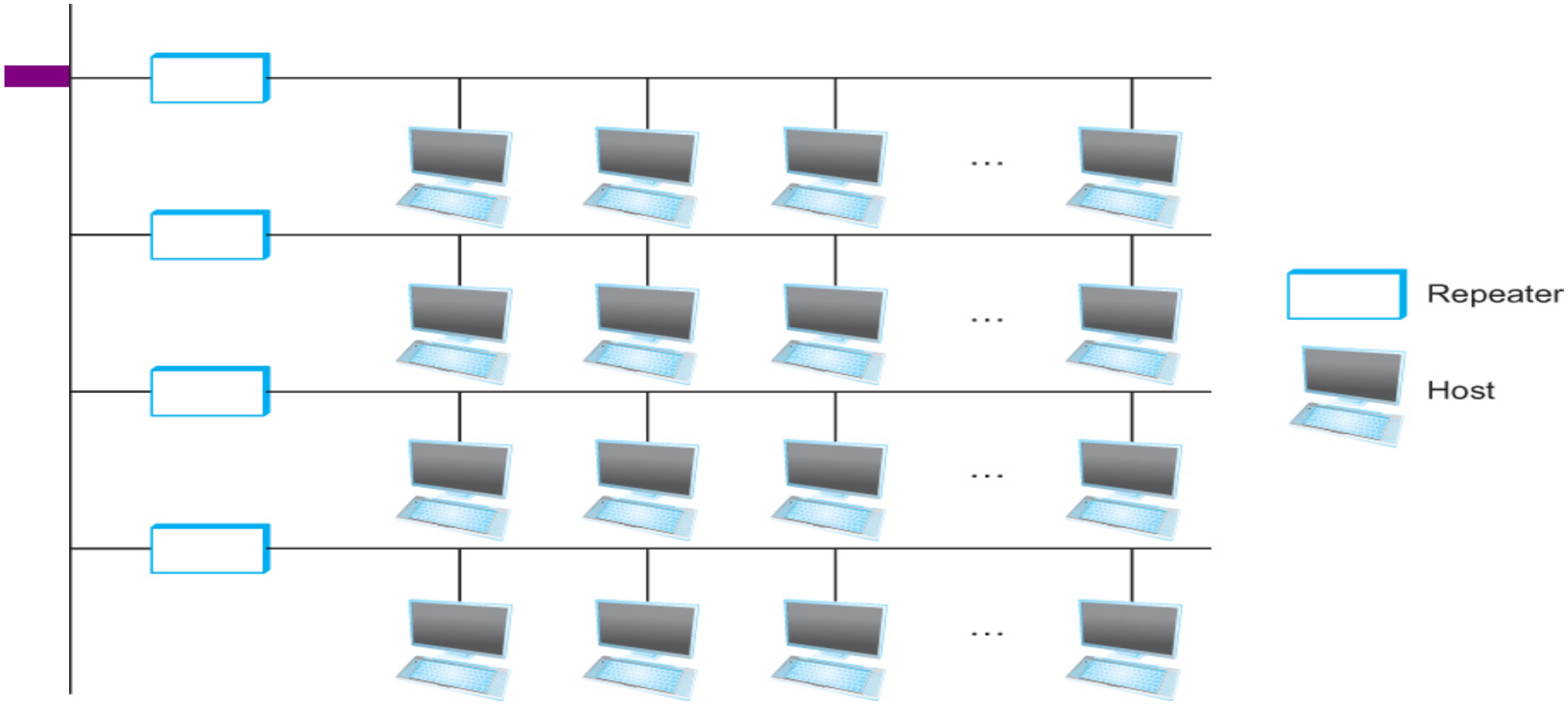


Ethernet – IEEE Standard 802.3

- How to allow many adaptors to send frames over the wire?
  - Access protocol



Ethernet



Ethernet repeater

Ethernet – Random Access

- How to allow many adaptors to send frames over the wire?
  - **Random access**

  - When you have data – send at Full channel rate!
  - No coordination needed.

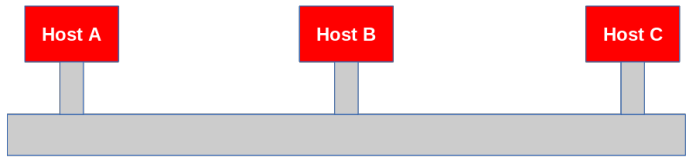
- If collision happens
  - Detect
  - Recover
  - Retransmit

CSMA/CD – Listen first, talk later!

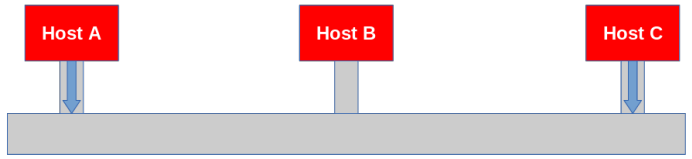
- CSMA – Carrier sense Multiple access
  - Listen if anyone is transmitting
  - Wait until carrier is free, do not interrupt others
  - **What is the carrier here?**
- CD – Collision Detection
  - If you hear anyone while talking, **collision, stop!**
  - Monitor signal strength at the adapter
  - Higher than normal = collision
- Random wait before retransmitting
  - **Why?**

CSMA/CD – Ethernet

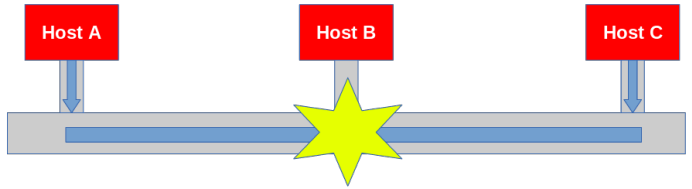
1) Carrier Sense



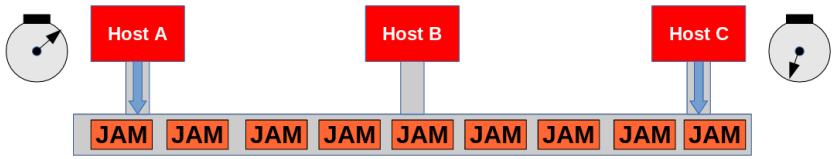
2) Multiple Access



3) Collision

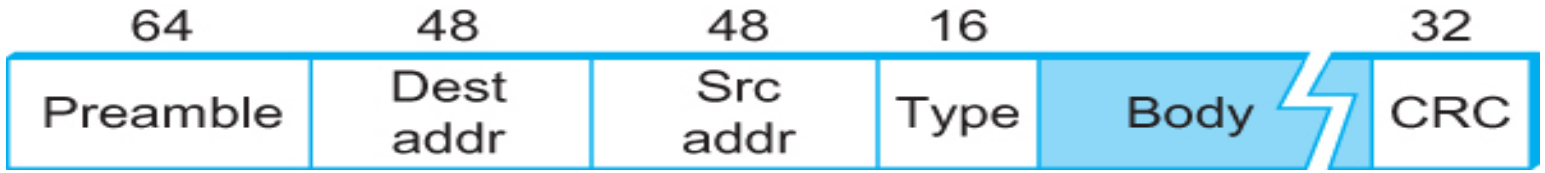


4) Collision Detection (Back off Algorithmus)



- CS – wait until idle
  - Channel idle – trasmit
  - Channel busy – wait
- CD – listen while transmitting
  - No collision: transmission successful
  - Collission: abort, send jam signal (32bit special sequence)
- Wait random time
  - Try again
  - After m^{th} collision, $t = random(0, 2^{m} - 1)$,
  - Wait t*512 bit times before retry

Ethernet Frame



Ethernet Frame Format

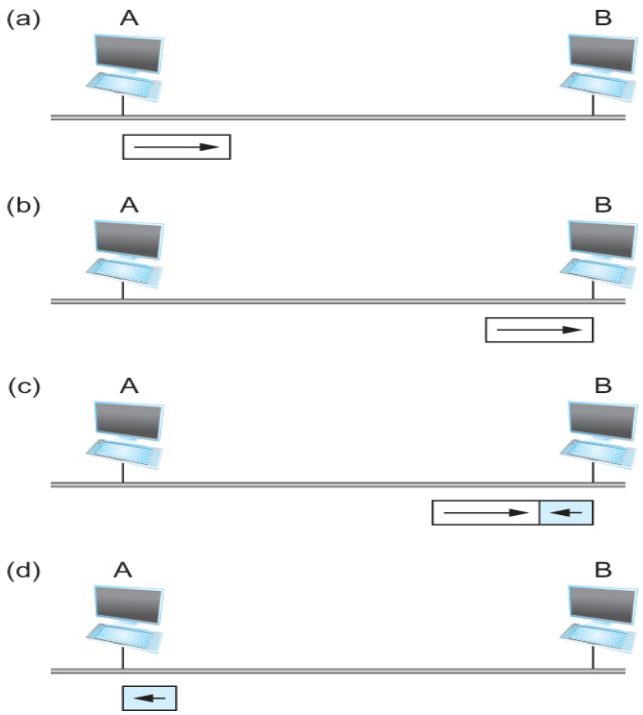
Ethernet Transmitter Algorithm

- An adaptor may begin transmitting at/near the same time
  - Either because both found the line to be idle,
  - Or, both had been waiting for a busy line to become idle.
- Simultaneously transmitted frames collide

- Each sender can detect collisions (CDMA/CS)
  - **Detection MUST happen during transmission**
  - Each transmits a 32-bit jamming sequence
  - Will minimally send **96** bits (*runt* frame)
    - 64-bit preamble + 32-bit jamming sequence
    - Works if hosts are close to each other

  - Worst case: transmitter may need to send up to **512** bits
    - Every Ethernet frame must be at least 512 bits (64 bytes) long.
    - 14 bytes of header + 46 bytes of data + 4 bytes of CRC

Ethernet Transmitter Algorithm



Worst-case scenario:

(a) A sends a frame at time *t;*

(b) A's frame arrives at B at time *t + d;*

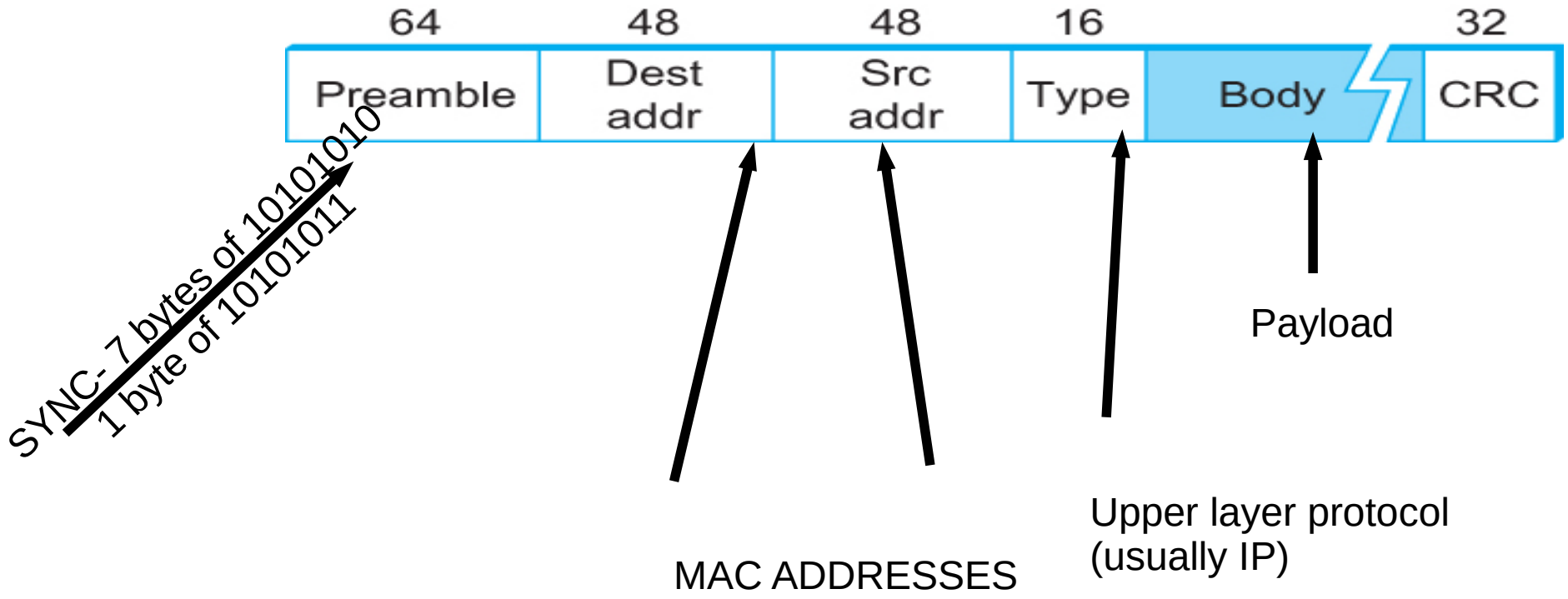
(c) B begins transmitting at time t + d, collides with A's frame;

(d) B's runt (32-bit) frame arrives at A at time *t + 2d.*

Ethernet Transmitter Algorithm

- Ethernet max length = 2500 meters
- RTT in worst case is 51.2 μs, which corresponds to the transmission time of 512 bits
- Each ethernet frame MUST be at least 512 bits

Ethernet Frame



Next Steps

- Read Through - Chapter 2.6
- Next lecture – WiFi, Zigbee, and Bluetooth