CSC4200/5200 – COMPUTER NETWORKING

CONNECTING MACHINES TO A NETWORK

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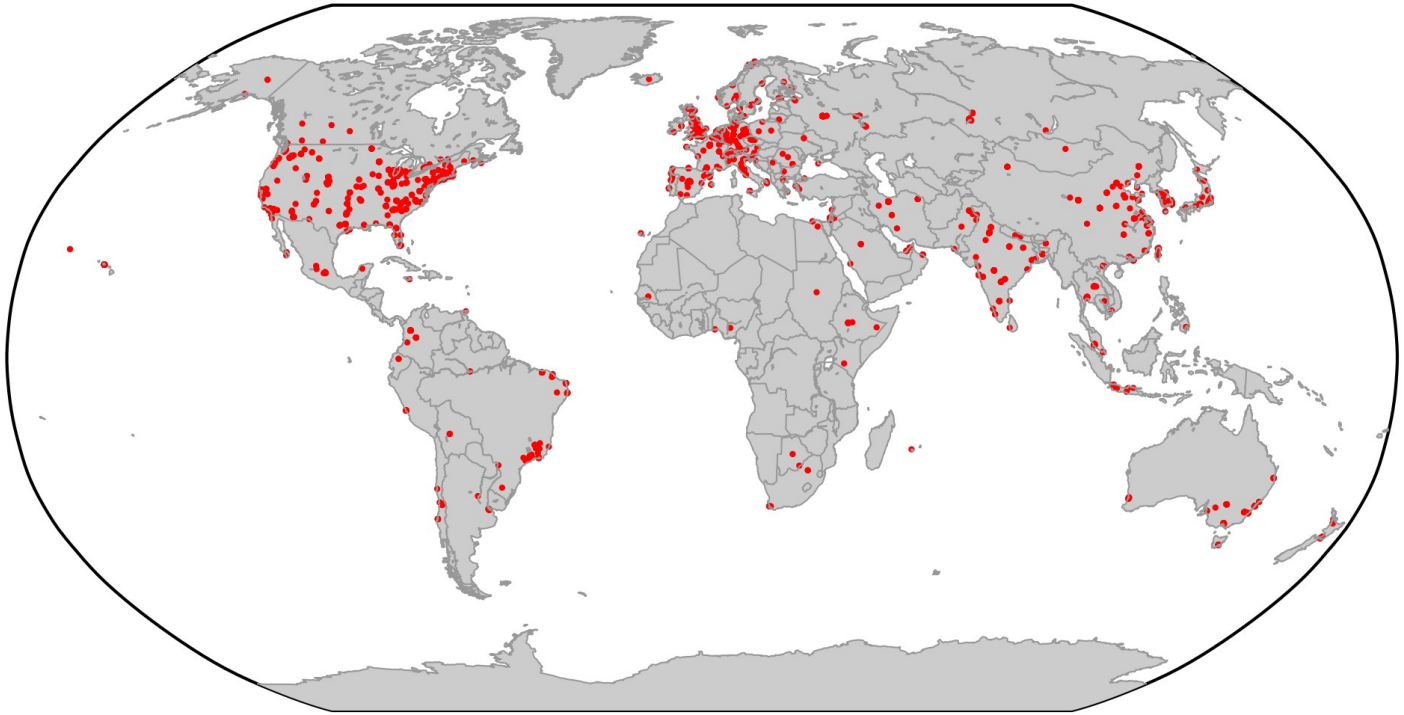
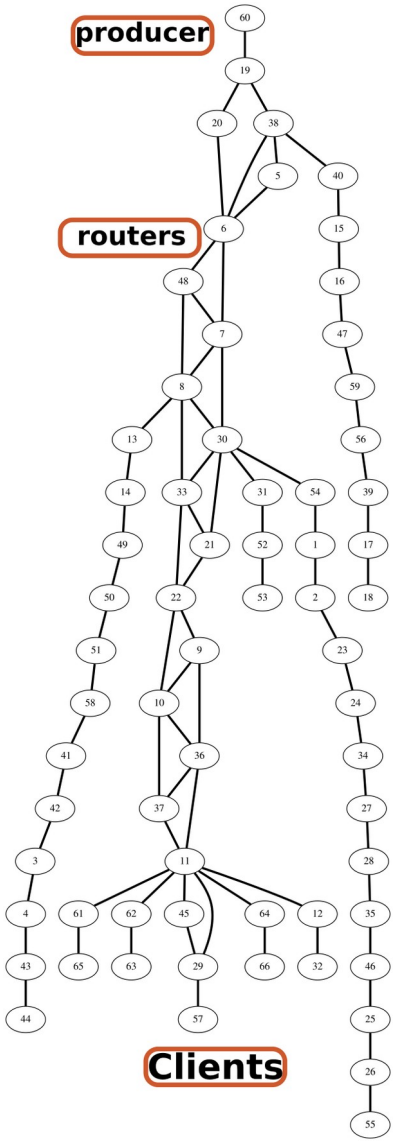
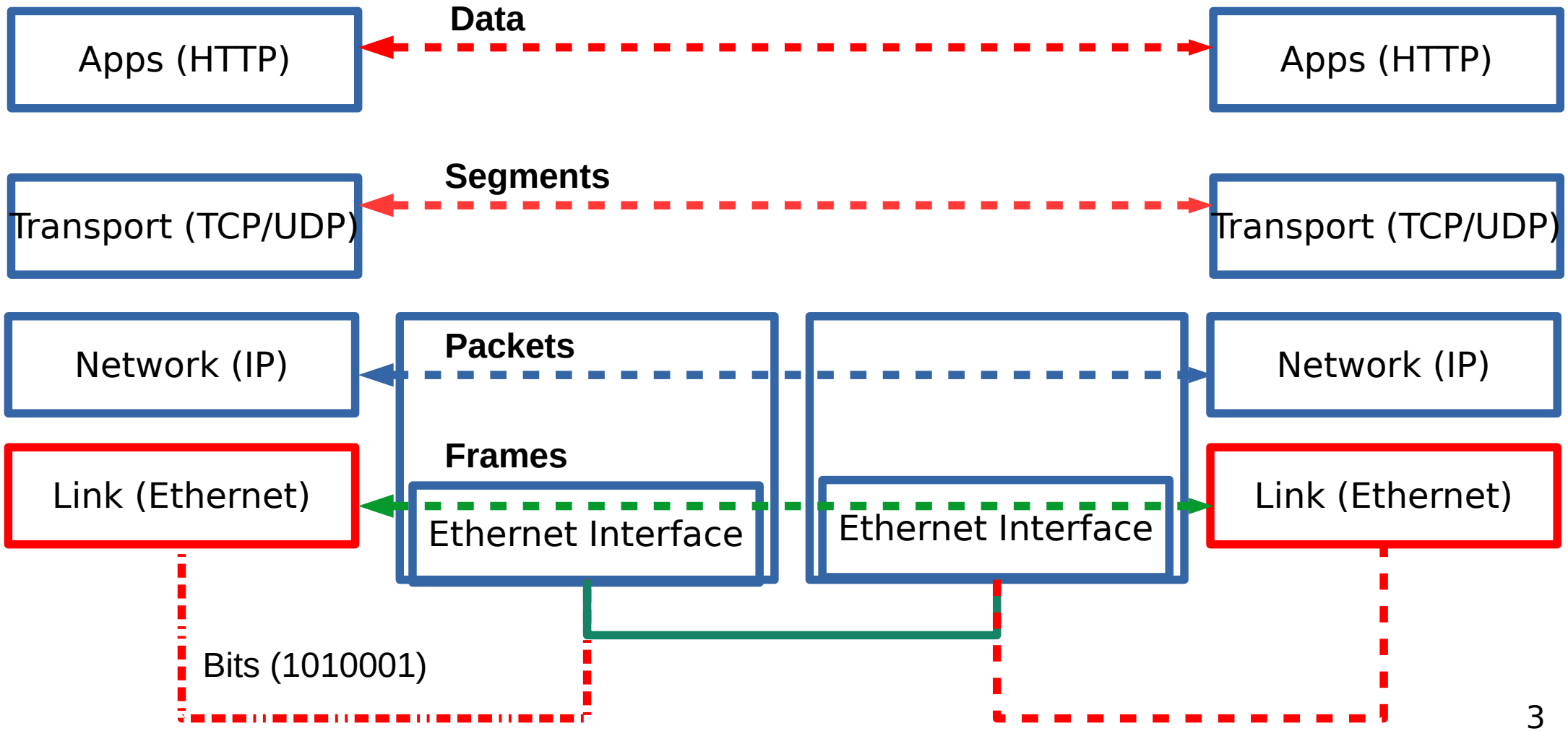
Tennessee TECH

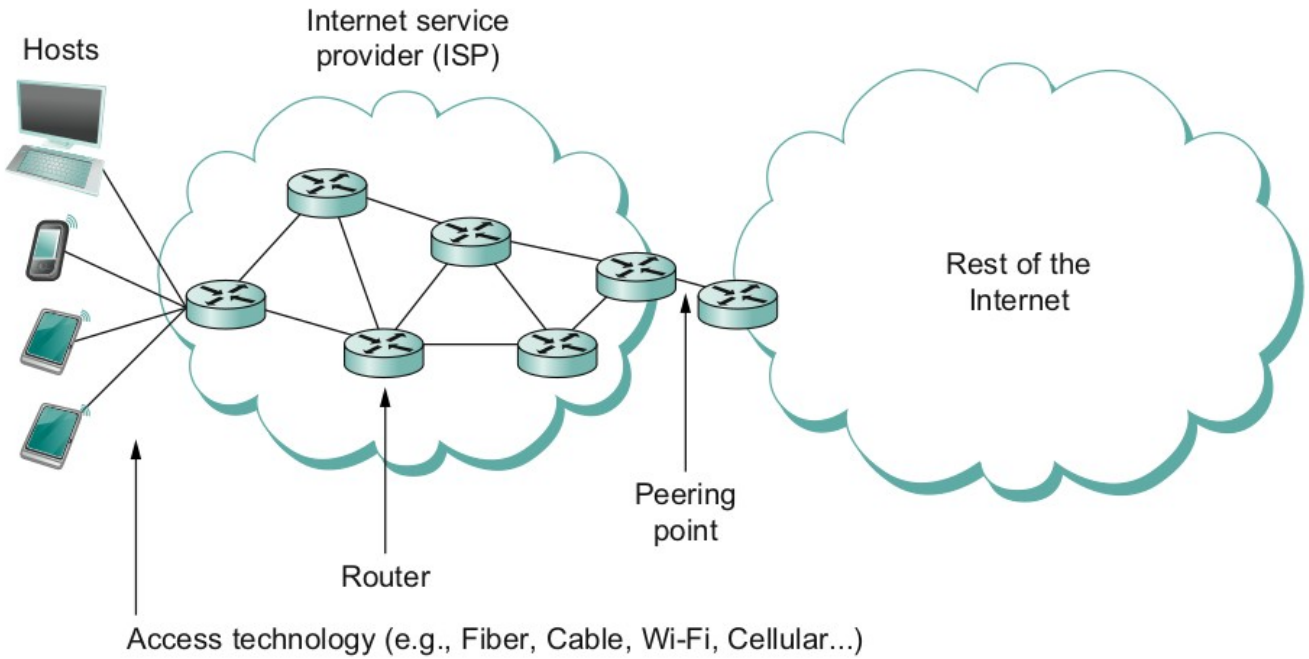
Recap – Network = Graph (Nodes + Links)






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)

What does it take to create a link?



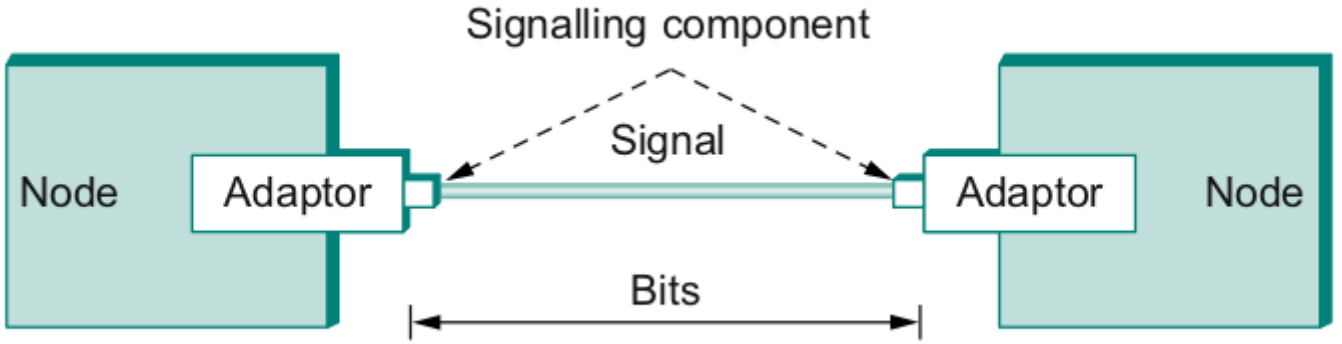
- Common abstractions
  - Why?

Two Steps to a Link

- Create a physical medium between nodes **(wire, fiber, air!)**
- Make it carry bits
  - **Encoding** bits so that the other end understands **(encoding)**
  - Create bag of bits to create messages (**framing**)
  - Detect errors in frames (**error detection**)
  - Deal with lost frames **(reliable delivery)**
  - Create shared access to link, e.g, WiFi **(media access)**

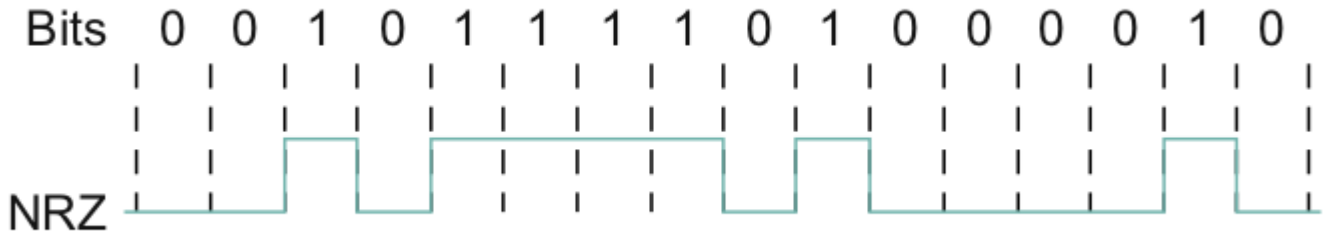
Packet to Low level Signals

- Bit pattern - 0101001
  - Must encode it into electrical signals and then decode it on the other end!



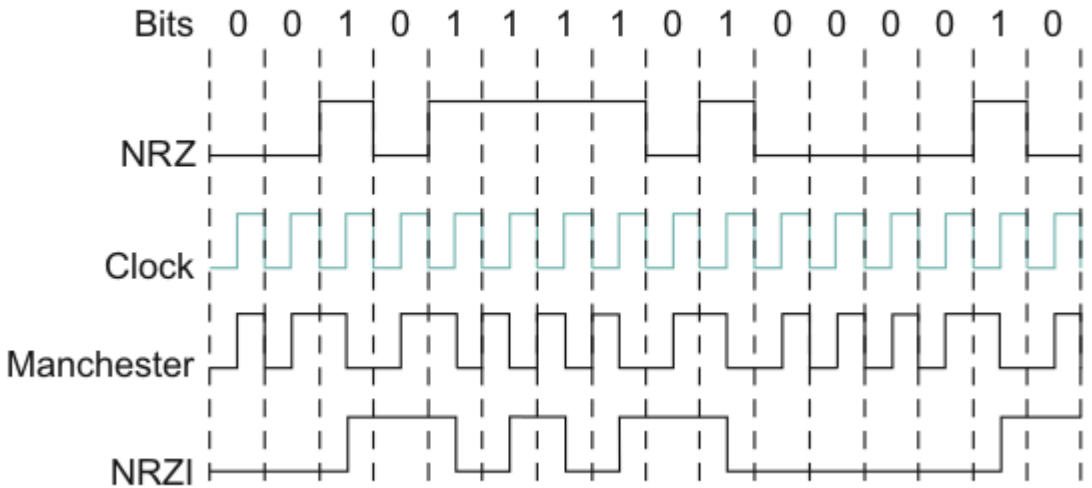
One easy way - NRZ

- 0 = low, 1= high
- Problem if you have too many 0s or 1s in a row
  - Baseline wander (read it in the book)

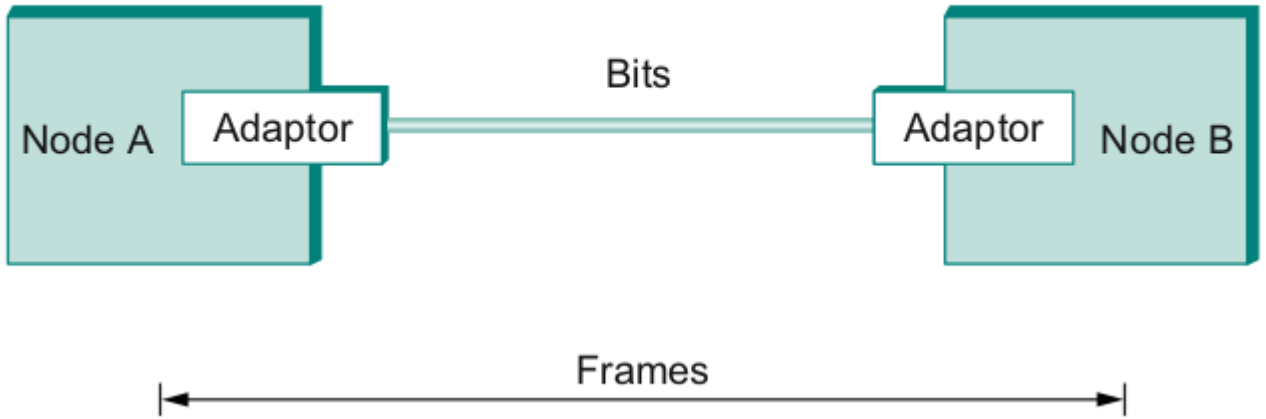


Other ways – NRZI/ Manchester Encoding

- NRZI – 1=transition, 0= Don’t
- Machester encoding – XOR of clock + NRZ data



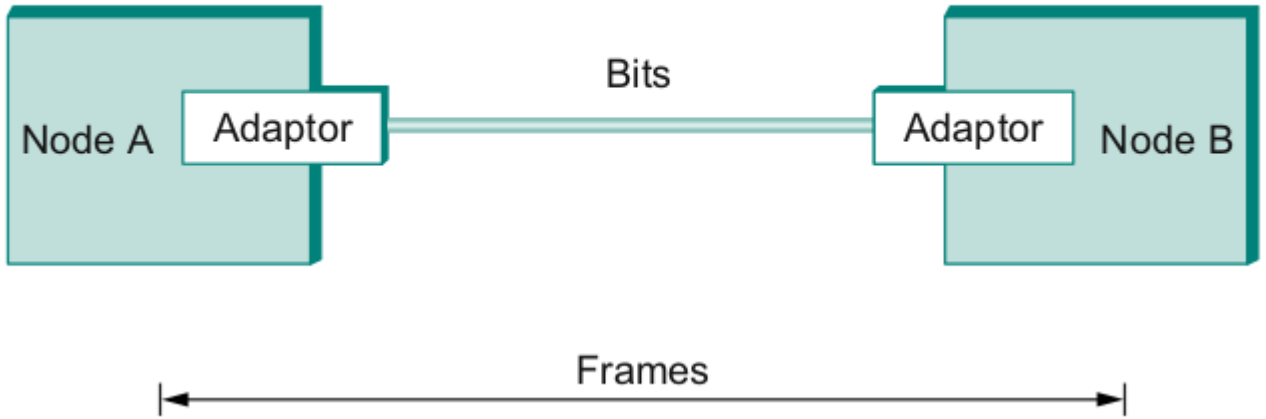
Frames – bag of bits



- Bits - between adaptors
- Frames – between hosts (two computers want to exchange messages)
  - The job of an adaptor is to find frames in a bit sequence

- Frames are link layer protocols

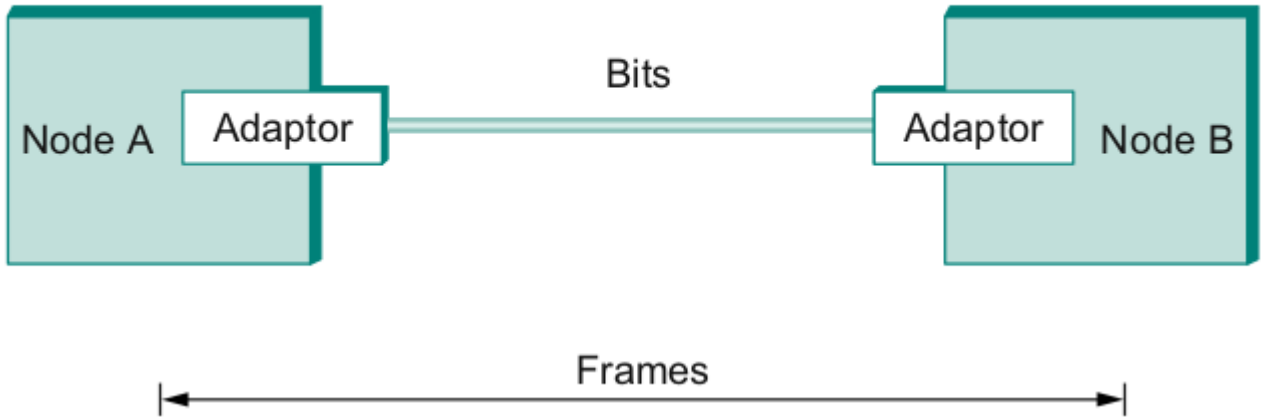
Frames – bag of bits



Bits flow between adaptors, frames between hosts

Let’s see it in wireshark!

Frames – bag of bits



- Sending side – encapsulation, add error check bits, flow control
- Receiving side – extract frames, check for error, flow control

Framing

- Point-to-point
  - Special start of text character denoted as Flag
    - 0 1 1 1 1 1 1 0
  - Address, control : default numbers
  - Protocol for demux : IP / IPX
  - Payload : negotiated (1500 bytes)
  - Checksum : for error detection

Point to Point Links

- Requirements:
  - Packet framing: encapsulation of network-layer datagram in data link frame
  - Bit transparency: Does not care about what its carrying
  - Error Detection: Correction is on upper layers
  - Connection liveness
  - Network layer address negotiation

Point to Point Links

- Flag: 01111110
  - Address: Does nothing
  - Control; Does nothing
  - Protocol: IP/ATM
  - Payload: Whatever
  - Checksum: Discussing later
- Flag: 01111110

Point to Point Links – Byte stuffing

- Flag: 01111110
  - Data transparency means it can also carry 01111110
  - How do you differentiate between data and flag?
    - Two back to back sequences of 01111110
    - Two sequences = Data, discard first
    - One sequence = Flag

Error Detection

- Bit errors are introduced into frames
  - Because of electrical interference and thermal noises
- Detecting Error
- Correction Error
- Two approaches when the recipient detects an error
  - Notify the sender that the message was corrupted, so the sender can send again.
    - If the error is rare, then the retransmitted message will be error-free
  - Using some error correct detection and correction algorithm, the receiver reconstructs the message

Error Detection

- Common technique for detecting transmission error
  - CRC (Cyclic Redundancy Check)
    - Used in HDLC, DDCMP, CSMA/CD, Token Ring
  - Other approaches
    - Two Dimensional Parity (BISYNC)
    - Checksum (IP)

Error Detection

- Basic Idea of Error Detection
  - To add redundant information to a frame that can be used to determine if errors have been introduced

0	1	0	1	0	**0**

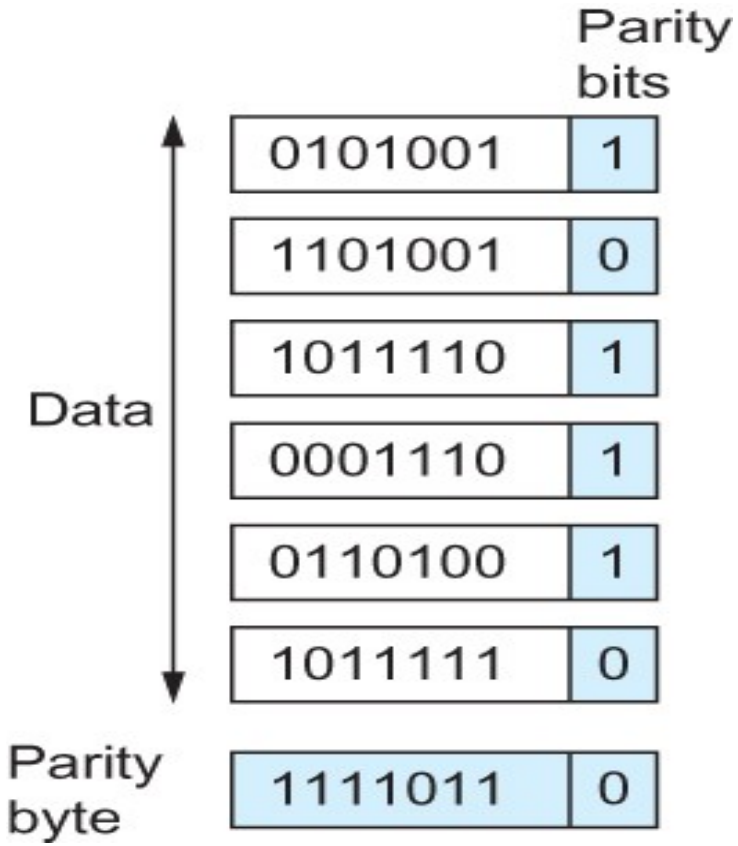
0	1	0	1	1	**1**

Number of 1s
- Odd 1s = Parity bit 0
- Even 1s = Parity bit 1

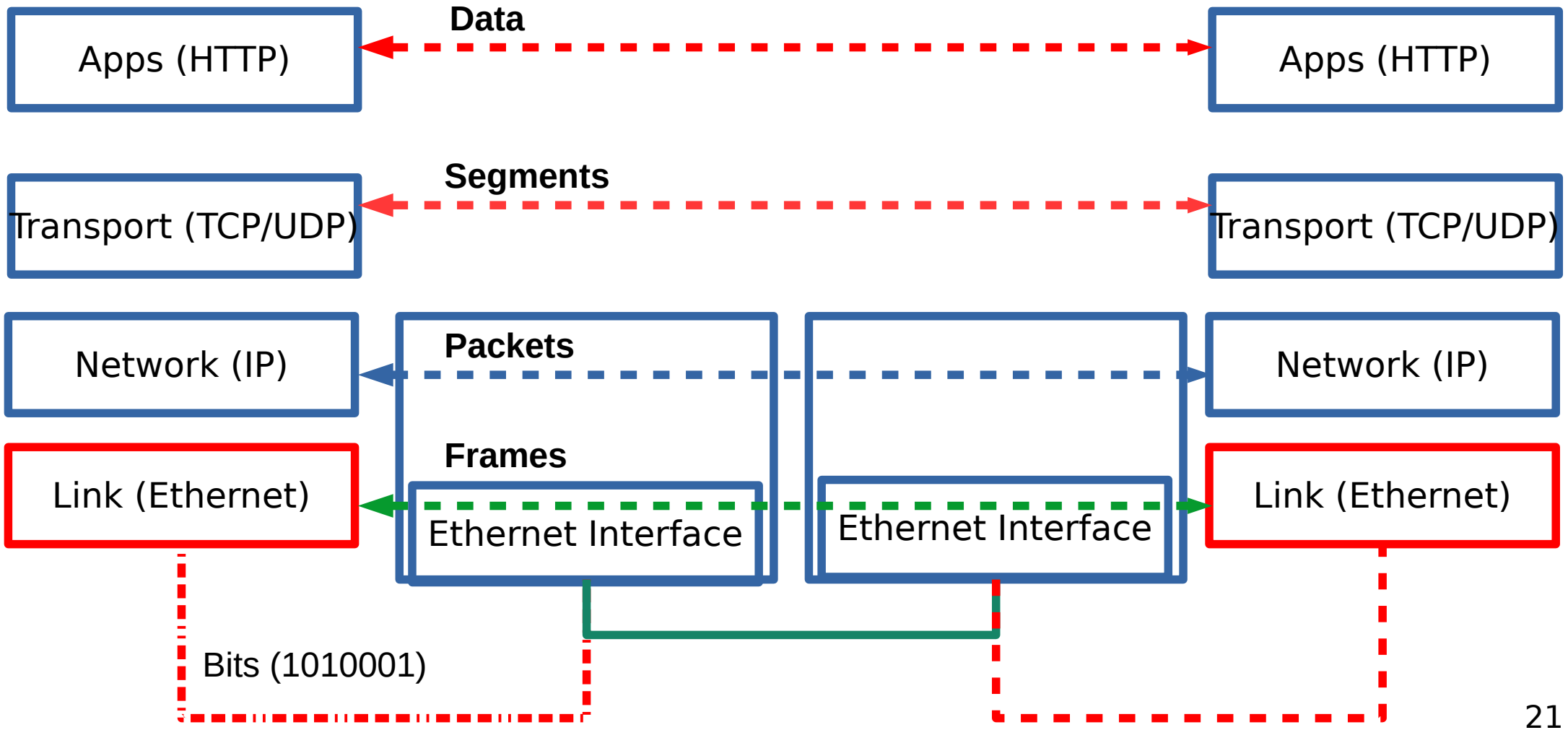
Two-dimensional parity

- Two-dimensional parity does a similar calculation
- Extra parity byte for the entire frame, in addition to a parity bit for each byte
- Two-dimensional parity catches all 1-, 2-, and 3-bit errors and most 4-bit errors

Two-dimensional parity



Two Dimensional Parity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All these for what?

- Handles bit transmission errors that might occur
- Link access – who can access the link at a given time?
- Flow control – control the pace that does not overwhelm sending and receiving devices
- **Reliable delivery – next topic**
- It permits the transmission of data to Layer 3, the network layer, where it is addressed and routed.

Reading Assignment

- Chapter 2 - Overview: https://book.systemsapproach.org/direct/problem.html#problem-connecting-to-a-network **- 5 minutes**
- Chapter 2.2 Encoding (only up to figure 25)
  - **https://book.systemsapproach.org/direct/encoding.html#encoding**
  - **10 minutes**
- Chapter 2.4 (Up to Cyclic Redundancy Check)
  - **https://book.systemsapproach.org/direct/error.html#error-detection**
  - **10 minutes**
- Next lecture – CRC and Reliable Delivery