CS120: Computer Networks

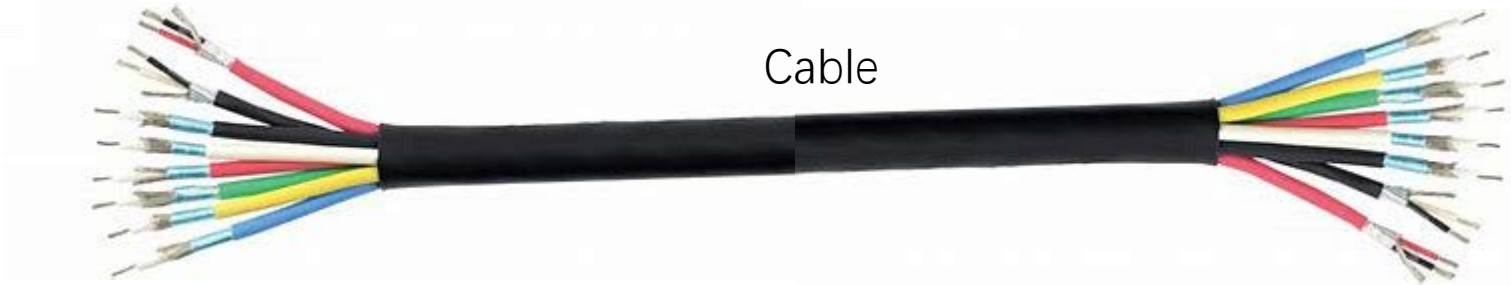
Lecture 6. Multiple Access 1

Zhice Yang

The Multiplexing Problem

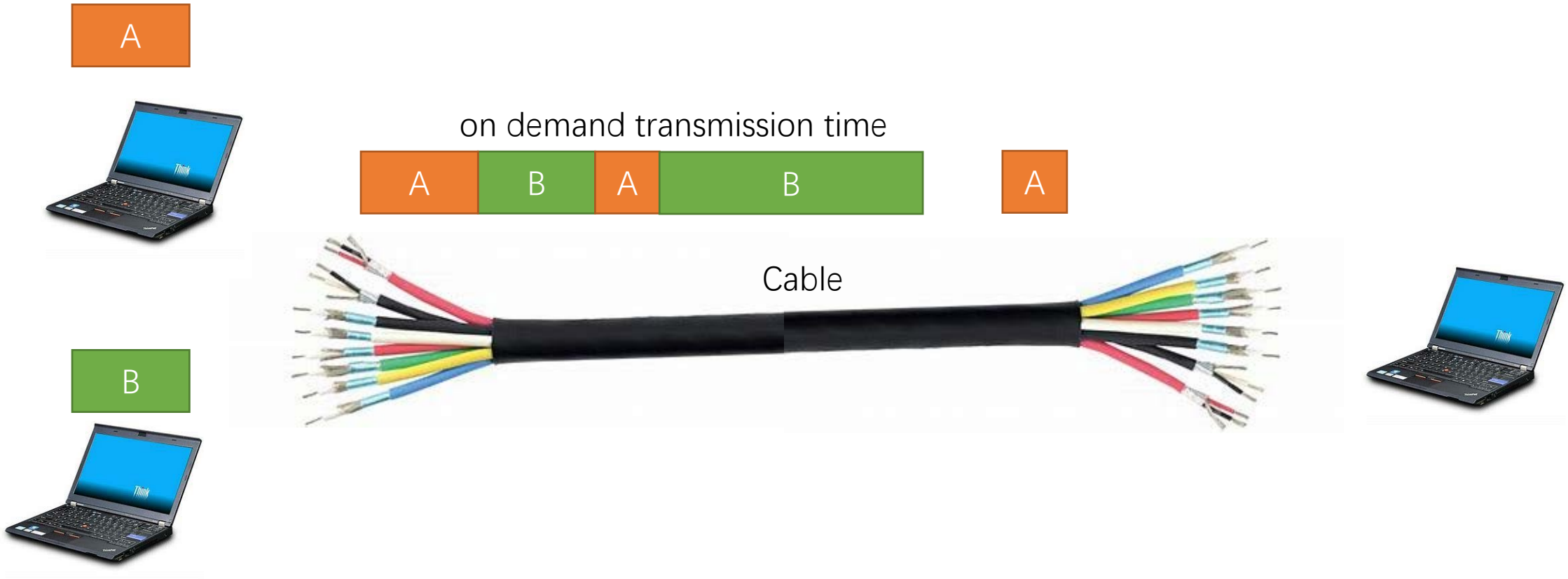
A

B



Multiplexing Approaches

- Packet Switching



Multiple Access

- Multiple access method determines how multiple users use the multiplexing approach

Multiplexing Method – Multiple Seats in One Cabin

Multiple Access Method

Ticket

First come first served

Why Multiple Access Protocol?

- Two Types of Channels:
  - Private
    - Point-to-point link between node, e.g., Current Ethernet
  - ✓Broadcast
    - Shared communication medium, e.g., Wireless, Original Ethernet
      - Two or more simultaneous transmissions
        - ➢ collision

Why Multiple Access Protocol?

- Two Types of Channels:
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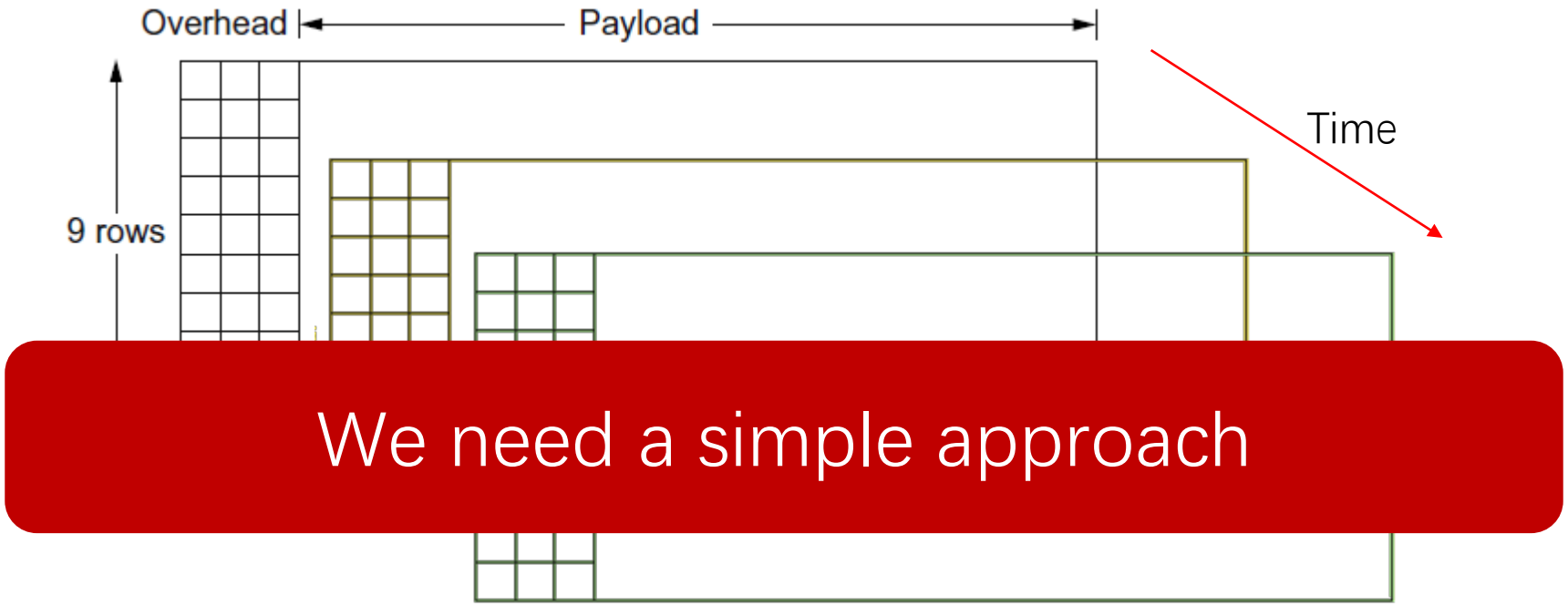
- Protocol: Multiple Access Control (MAC)
  - Determines how nodes share channel, i.e., determine when node can transmit

Multiplexing => Multiple Access

- TDM =>TDMA: Time Division Multiple Access
- FDM => FDMA: Frequency Division Multiple Access

Telephone

- Clock-Based Framing
  - Synchronous Optical Network (SONET)/Synchronous Digital Hierarchy (SDH)



We need a simple approach

Ethernet

- Brief History

parc
A Xerox Company

3com

IEEE 802.3

Ethernet

How to avoid collisions ?

Media Access Control (MAC)

An Ideal Multiple Access Protocol

- Consider a Broadcast Channel of Rate R bps
  - When one node wants to transmit, it can send at rate R.
  - When M nodes want to transmit, each can send at average rate R/M
  - Fully decentralized
    - No special node to coordinate transmissions
    - No synchronization of clocks, slots, etc.

MAC Protocols

- Fixed Partitioning
  - eg.: TDMA, FDMA
  - Avoid Collisions
- Random Access
  - eg.: CSMA
  - Allow Collisions
- Scheduling
  - eg.: Token Ring, Polling

Random Access MAC

- When node has packet to send
  - Try best to transmit at full channel data rate R
  - Two or more transmitting nodes-> Collision
- Core Design Goals
  - How to detect collisions
  - How to recover from collisions (e.g., via delayed retransmissions)
- Protocols
  - Transmit and Pray
  - Slotted ALOHA
  - CSMA

Trivial MAC

- Transmit and Pray
  - Good solution at low load
  - Plenty of collisions at high load
    - Low throughput

Slotted ALOHA

- Assumptions
  - Same Frame Length
  - Nodes are synchronized
  - Nodes start to transmit only at the beginning of slot
  - Nodes can detect collision
- Operation Rule
  - No collision: node can send new frame in next slot
  - Collision: node retransmits frame in each subsequent slot with probability p until success

Slotted ALOHA

- Cons:
  - Collisions, wasting slots
  - Idle slots
  - Clock synchronization

Carrier Sense Multiple Access (CSMA)

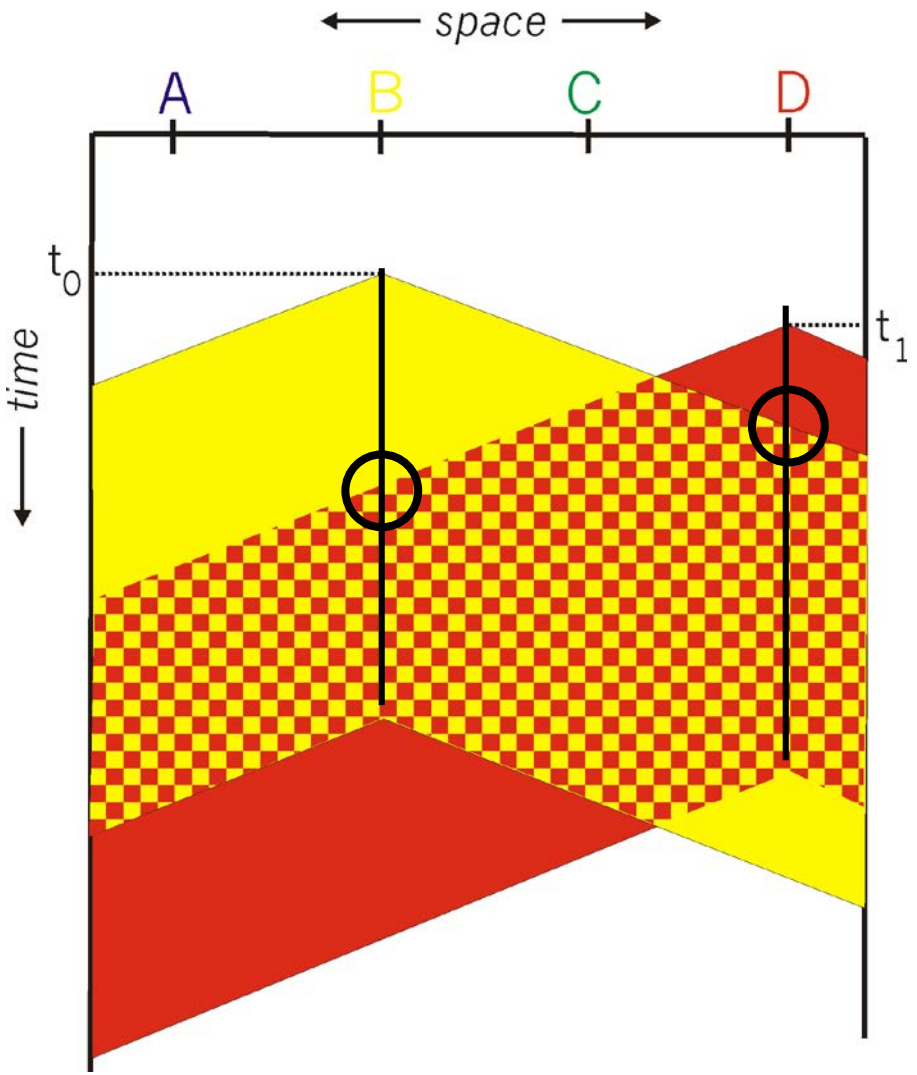
- CSMA: Listen before Transmit
  - If channel is sensed idle: transmit entire frame
  - If channel is sensed busy: defer transmission

Can collisions still occur?

CSMA: Collisions

- Collisions can still occur
  - Due to propagation delay
- When collision occurs
  - Entire packet wasted

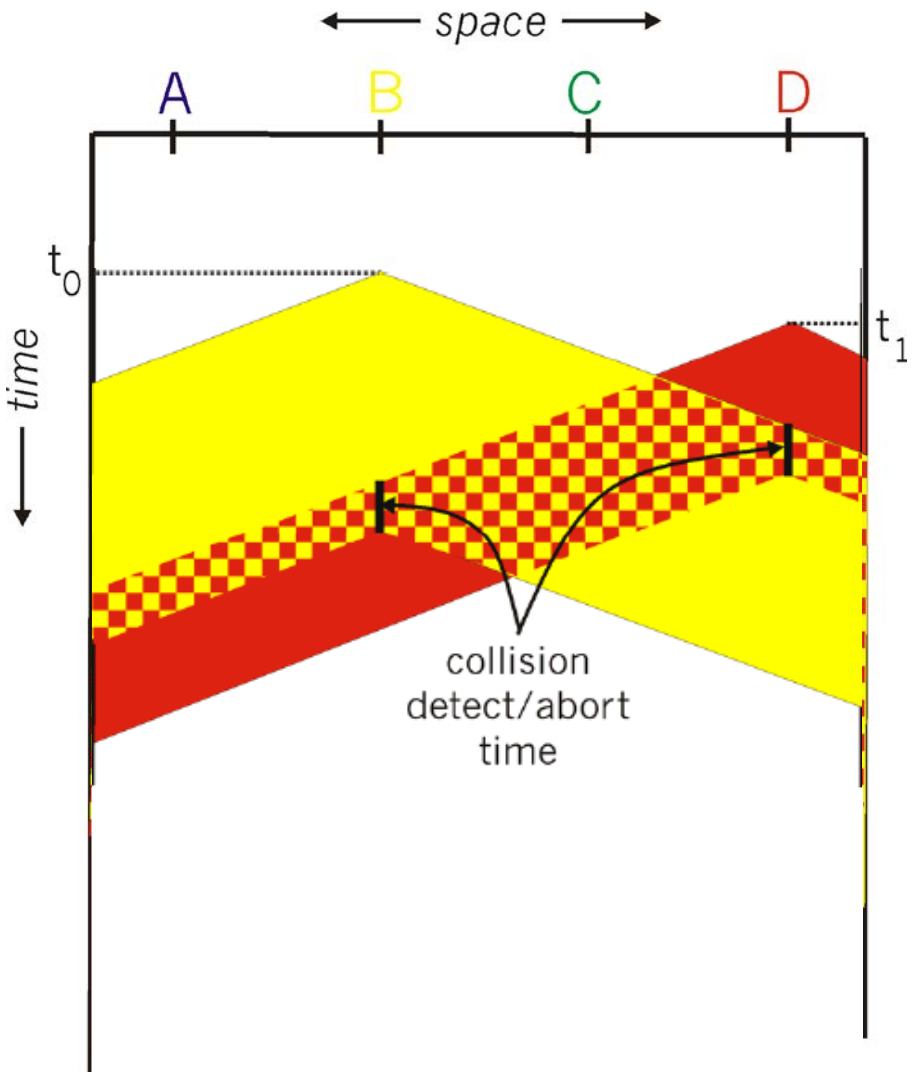
How to handle collision ?



CSMA + Collision Detection (CSMA/CD)

- Keep listening to channel while transmitting

- Abort the transition if collision is detected
  - Opt1: Transmitted signal != sensed signal
  - Opt2: Energy detection
  - Then, retransmit



CSMA/CD

- The Effective Range
  - What if B stopped transmission before it detects collations ?
    - Collision detection failed
      - No retransmission

CSMA/CD

- The Effective Range
  - What if B stopped transmission before it detects collations ?
    - Collision detection failed
      - No retransmission
  - Minimum Packet Size
    - eg. Range 2500m (Local Area Network)
    - => MaxRTT * rate

Ethernet CSMA/CD Protocol

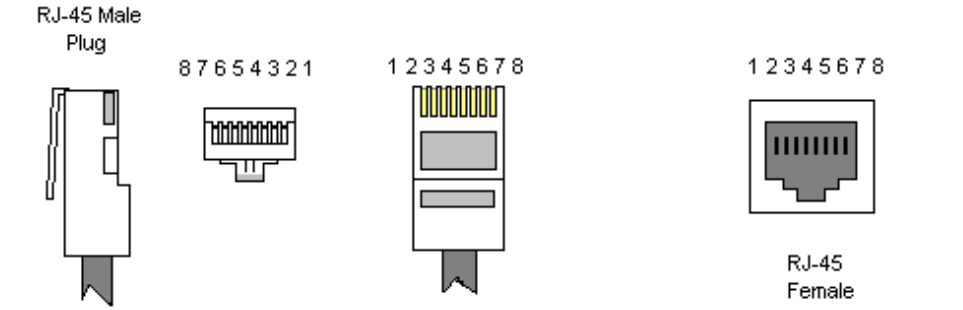
- If channel idle
  - starts transmission
- Else (channel busy)
  - Waits until channel idle.
- If the entire frame is transmitted without detecting another transmission
  - done
  - go idle
- Else
  - Aborts and sends jam signal
  - Backoff
  - go idle to retransmit (max 16 times)

Ethernet CSMA/CD

- Exponential Backoff
  - After m_{th} collisions, chooses K at random from {0,1,2, ⋯, 2^m-1}
    - if m>11
      - chooses K at random from {0,1,2, ⋯, 1024}
    - if m=16
      - done
      - go idle
  - Waits K*one time slot

More about Ethernet

Ethernet Cable



Color Standard
EIA/TIA T568A

Ethernet Patch Cable

	RJ45 Pin#		Pin# RJ45		
TX+	Green/White Tracer	1	1 Green/White Tracer		PR 3
TX-	Green	2	2 Green		
RX+	Orange/White Tracer	3	3 Orange/White Tracer		PR 2
	Blue	4	4 Blue		PR 1
	Blue/White Tracer	5	5 Blue/White Tracer		
RX-	Orange	6	6 Orange		PR 2
	Brown/White Tracer	7	7 Brown/White Tracer		PR 4
	Brown	8	8 Brown		

Color Standard
EIA/TIA T568A

Ethernet Crossover Cable

	RJ45 Pin#		Pin# RJ45	
	Green/White Tracer	1	1 Orange/White Tracer	
	Green	2	2 Orange	
	Orange/White Tracer	3	3 Green/White Tracer	
	Blue	4	4 Brown/White Tracer	
	Blue/White Tracer	5	5 Brown	
	Orange	6	6 Green	
	Brown/White Tracer	7	7 Blue	
	Brown	8	8 Blue/White Tracer	

"A" is earlier

Inside the Ethernet Hub

Ethernet Frame

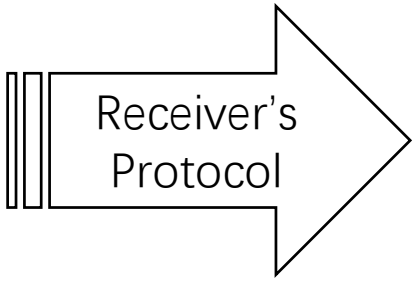
- Line Code: Manchester coded (10BASE-T)
- Preamble
  - 7 bytes with pattern 10101010 followed by one byte with pattern 10101011
  - Sync and Clock Recovery

Ethernet Frame (Address)

- Every Ethernet adapter has an address, the MAC address
  - 6bytes
  - Find your MAC addresss
    - `ifconfig`
    - `ipconfig /all`
  - Find the manufacturer of your adapter
    - http://coffer.com/mac_find/
  - You can change the MAC address

Ethernet Frame (Address)

- Unicast Address
- Broadcast Address
  - All 1s
- Multicast Address
  - First bit 1



Find if the received packet contains correct address, then pass the error free packet to the host

Ethernet Frame

- Type
  - IPV4, ARP, RoCE, etc.
  - Length
- Body 46-1500 B
- CRC 32
- NO ACK

Reference

- Textbook 2.6
- http://www.ee.columbia.edu/~bbathula/courses/HPCN/lecture04.pdf