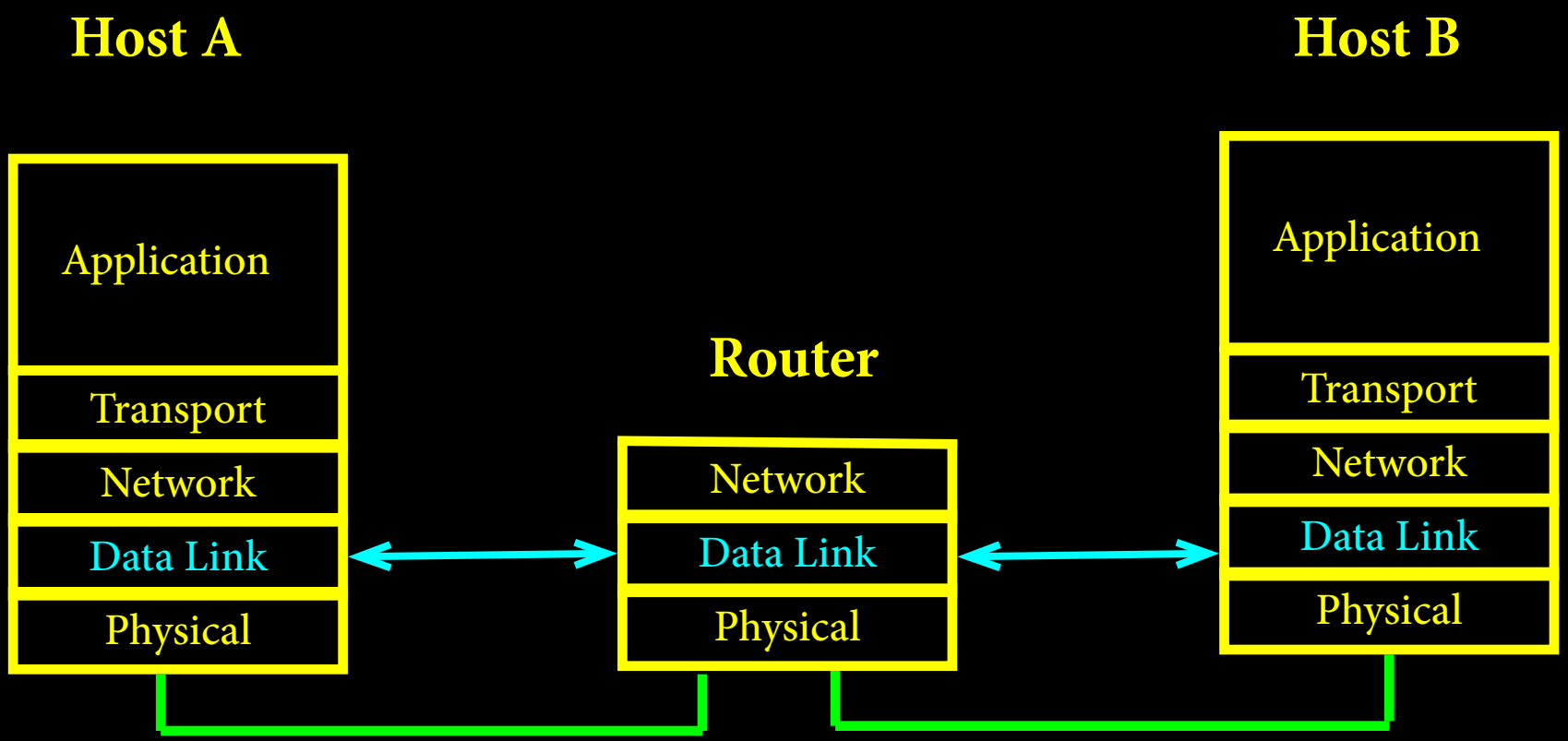
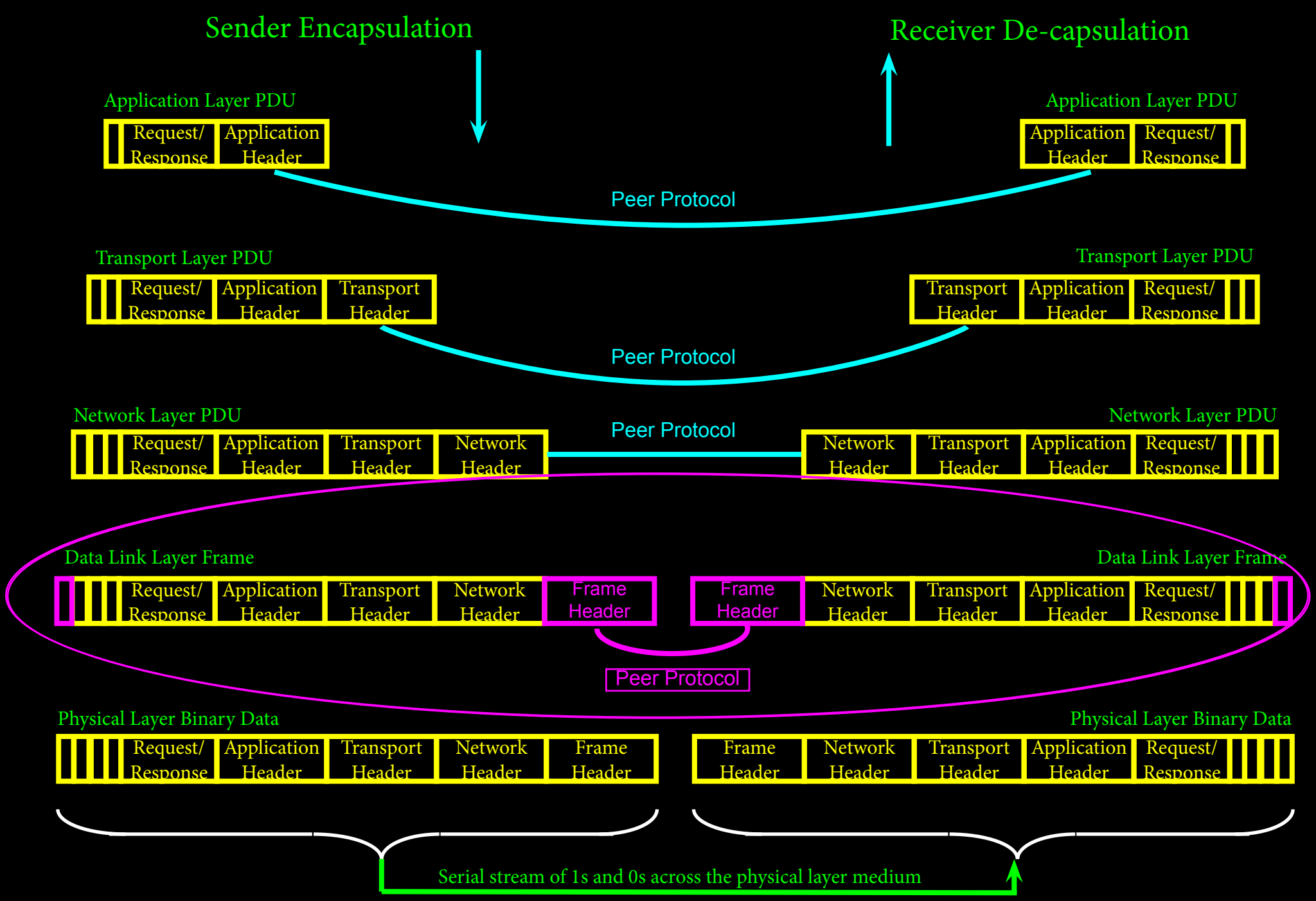
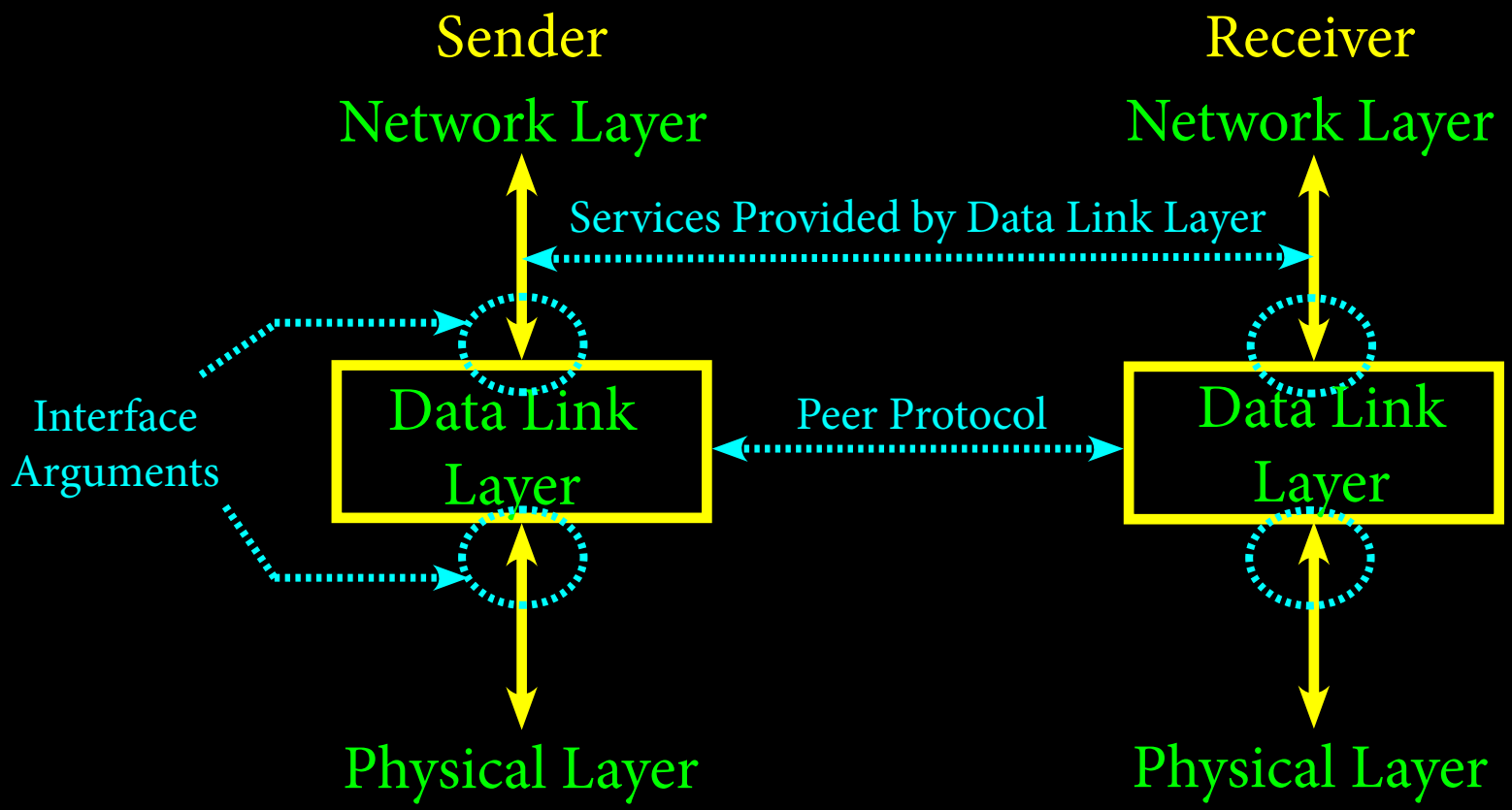
TCP/IP Reference Model




Sender Encapsulation
Receiver De-capsulation
Application Layer PDU
Request/ Response
Application Header
Application Layer PDU
Application Header
Request/ Response
Peer Protocol
Transport Layer PDU
Request/ Response
Application Header
Transport Header
Transport Layer PDU
Transport Header
Application Header
Request/ Response
Peer Protocol
Network Layer PDU
Request/ Response
Application Header
Transport Header
Network Header
Peer Protocol
Network Layer PDU
Network Header
Transport Header
Application Header
Request/ Response
Data Link Layer Frame
Request/ Response
Application Header
Transport Header
Network Header
Frame Header
Frame Header
Network Header
Transport Header
Application Header
Request/ Response
Data Link Layer Frame
Peer Protocol
Physical Layer Binary Data
Request/ Response
Application Header
Transport Header
Network Header
Frame Header
Physical Layer Binary Data
Frame Header
Network Header
Transport Header
Application Header
Request/ Response
Serial stream of 1s and 0s across the physical layer medium

TCP/IP Data Link Layer Attributes



Data Link Layer Services:

1. Addressing and Media Access Control (MAC)

2. Error detection

3. Synchronization aka message delineation, aka framing, includes parallel-to-serial-to-parallel registration

Data Link Layer Services (continued)

Addressing and Media Access Control:

Basic Types of Media Access Control

Contention Access (e.g. Ethernet)

All devices connected to a shared medium have an equal opportunity to access the medium for sending data

Each device waits for the shared medium to become idle before attempting to send

Controlled Access

Devices connected to a shared medium must wait for permission to be allowed to send

Polling - a central device “polls” other devices connected to the shared medium asking it if has data to send. (E.g. IBM’s SNA)

Token Passing - A special token is passed from device to device all connected together in a ring. The device currently “owning the token” is allowed to send. (E.g. IBM’s Token Ring LAN)

Data Link Layer Services (continued)

Addressing and Media Access Control:

Unique 48-bit MAC address assigned to each NIC

MAC addresses assignments controlled by the IEEE Registration Authority

Ethernet's media access control uses a controlled access technology called Carrier Sense, Multiple Access with Collision Detect (CSMA/CD)

CS --> Detection of the absence of a transmission signal
Success is when there is a failure to detect a signal

False positive --> no detection of a signal when there really is a signal
False negative --> detection of a signal when there really is not a signal

False positives cause an excessive number of collisions (e.g. Wi-Fi hidden nodes)
False negatives cause an unnecessary delay in transmission (e.g. Wi-Fi exposed nodes)

CS is not:
- A signal present on the transmission medium when it is not busy
- A predetermined bit pattern
- A shift or change in a bit pattern

Data Link Layer Services (continued)

Addressing and Media Access Control:

Unique 48-bit MAC address assigned to each NIC

MAC addresses assignments controlled by the IEEE Registration Authority

Ethernet's media access control uses a controlled access technology called Carrier Sense, Multiple Access with Collision Detect (CSMA/CD)

MA --> All devices connected to the shared transmission medium MUST have an equal opportunity to detect CS

Should a device have an unequal opportunity to detect CS, then it may create either false positives or false negative

Data Link Layer Services (continued)

Addressing and Media Access Control:

Unique 48-bit MAC address assigned to each NIC

MAC addresses assignments controlled by the IEEE Registration Authority

Ethernet's media access control uses a controlled access technology called
Carrier Sense, Multiple Access with Collision Detect (CSMA/CD)

CD --> A sending device listens for its own bits being sent.
When sending device receives bits different than whet it sent, a collision is assumed

Device(s) detecting a collision wait a random amount of time
then begins the CS process again

Data Link Layer Services (continued)

Error Detection (*not correction*):

Subtitle on page 77 of textbook should read:

“Simple example of error detectiopn”

not

“Simple example of error correction”

Data Link Layer Services (continued)

Error Detection (*not correction*):

Ethernet uses a 32-bit Cyclic Redundancy Check - CRC to detect errors during transmission

The CRC polynomial is a simple series of bit shifts and binary adds

A process hardware performs very-very efficiently

Line CRC - Calculated by sender and sent as the 4-byte trailer

Received CRC - Calculated by the receiver as bits are received off the transmission medium

Receiver compares line CRC with received CRC

When equal - then no error during transmission

When not equal - a transmission error is assumed and frame is discarded

Data Link Layer Services (continued)

Error Detection (*not correction*):

Where is end of frame?

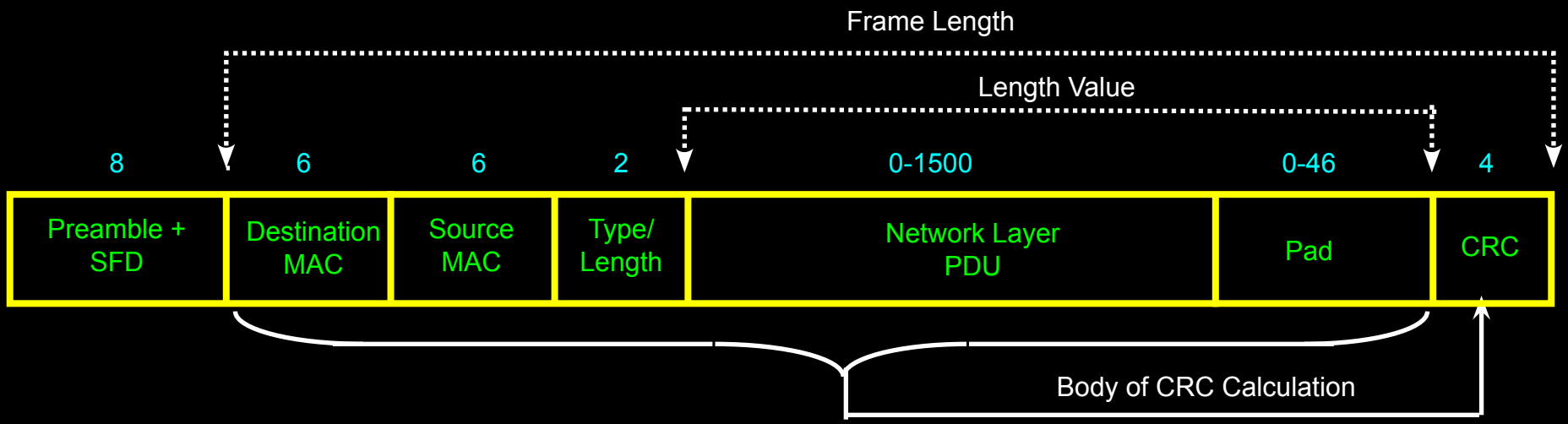
Two methods:

1. Sender and receiver agree to a fixed length frame
2. Length of frame part of information in the frame header

Data Link Layer Services (continued)

Error Detection (*not correction*):

Ethernet 802.3 Frame:



Notes:

1. SFD - Start of Frame Delimiter
   aka. SOF Start Of Frame

2, When Type/Length value is 1500 or greater then field is interpreted as a Type value, and length is a fixed 1500

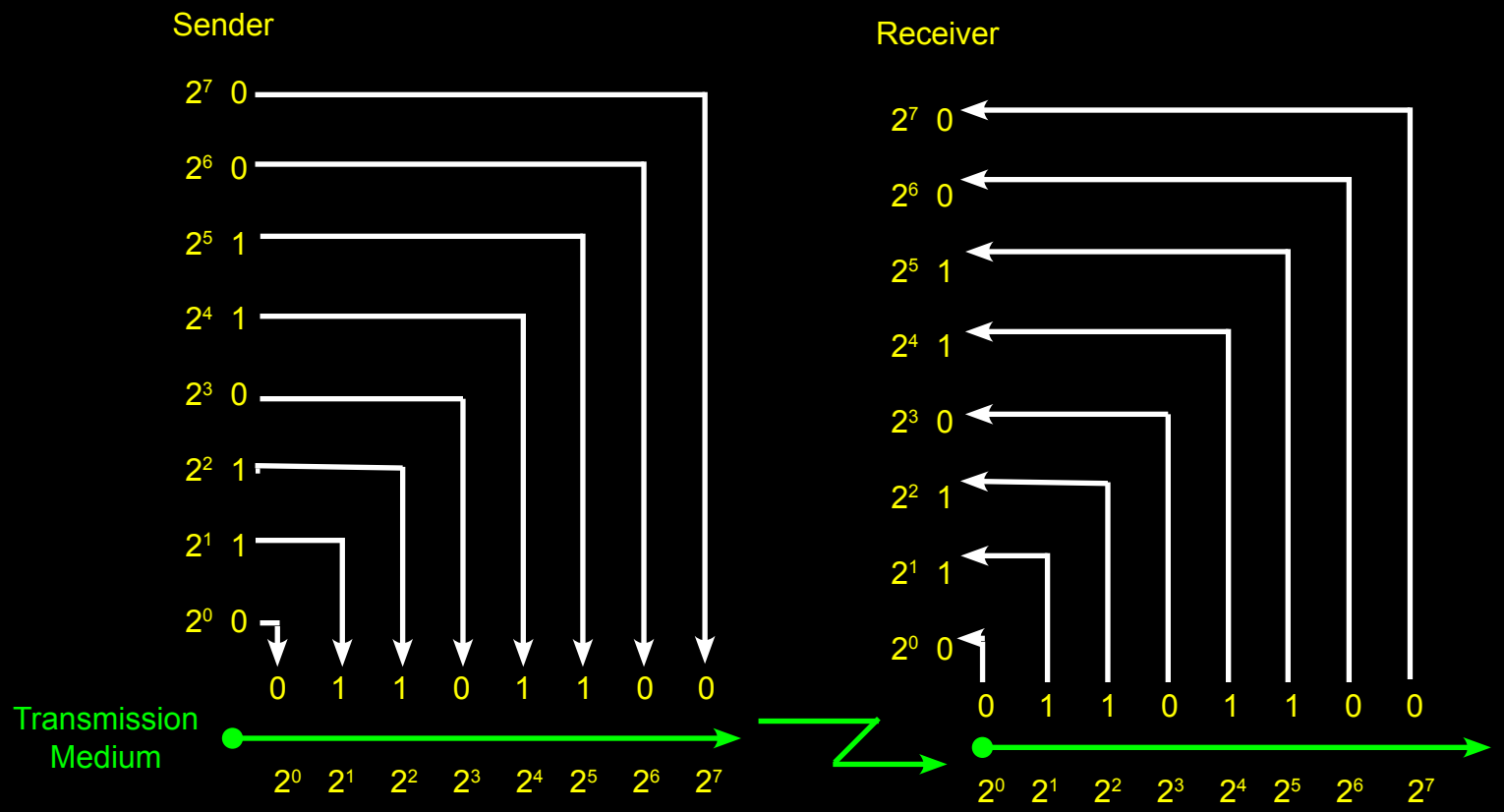
3. When Type/Length value is less then 1500 then field is interpreted as a Length value, and type is IPv4

4. Minimum frame length = 64

Data Link Layer Services (continued)

Synchronization (message delineation):

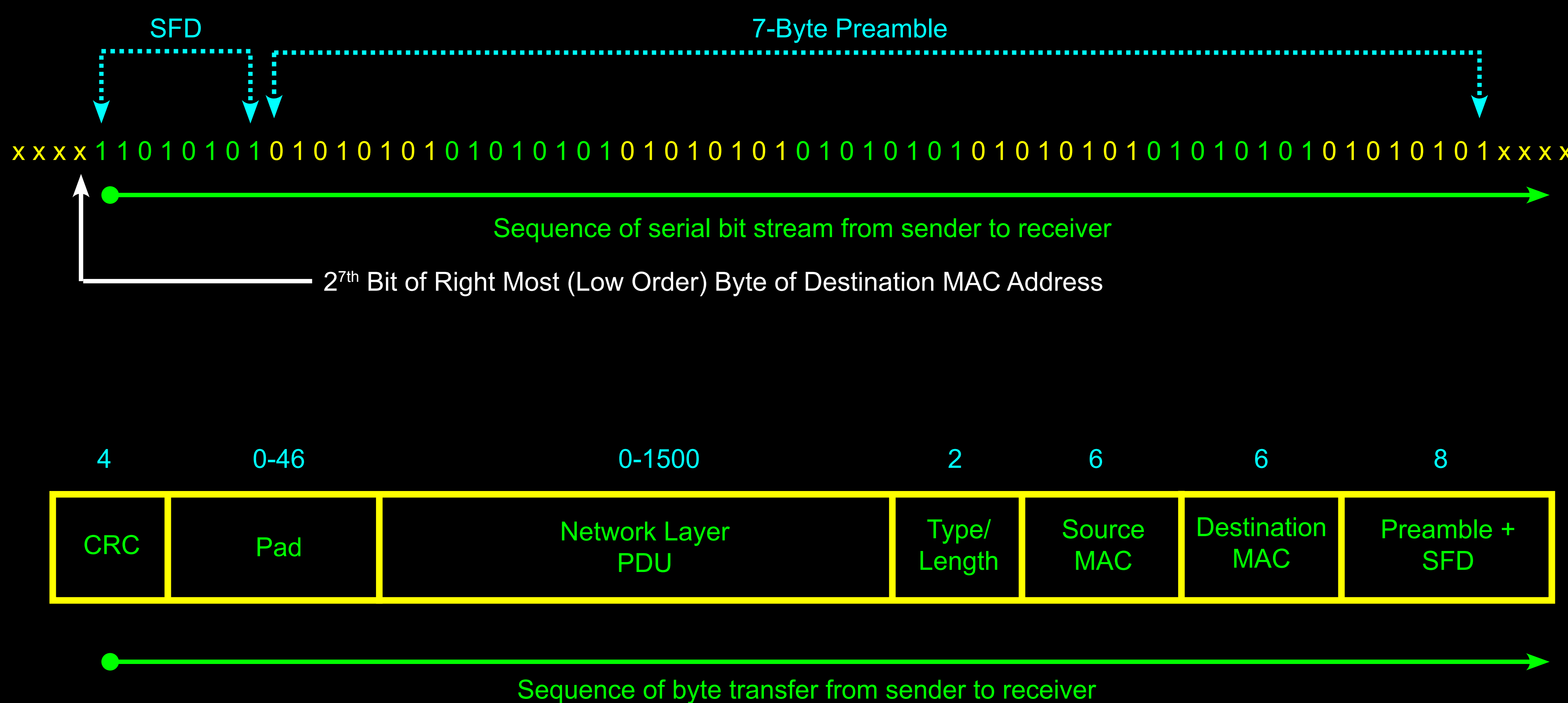
Big Endian Parallel-to-Serial-to-Parallel Registration



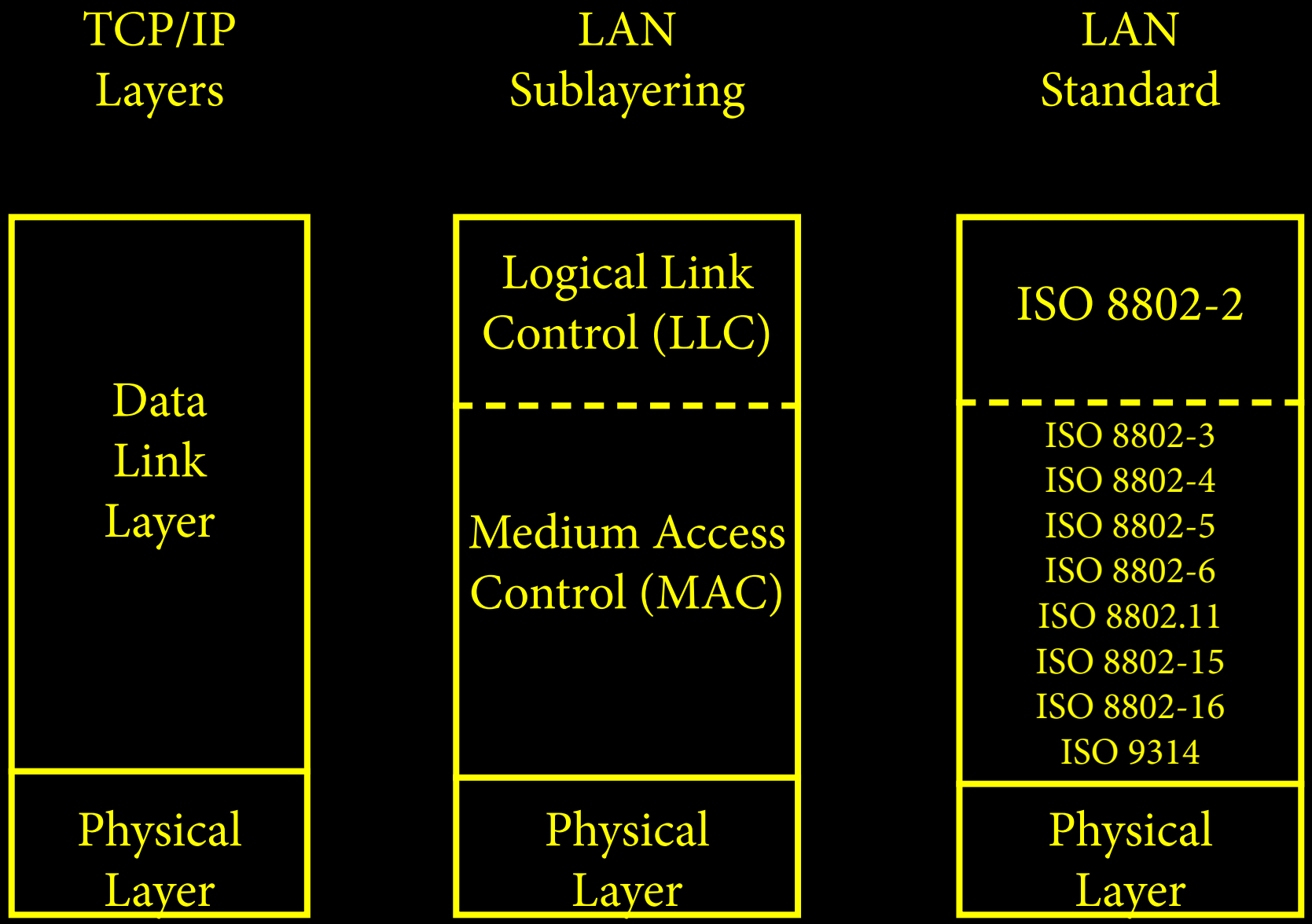
Data Link Layer Services (continued)

Synchronization (message delineation):

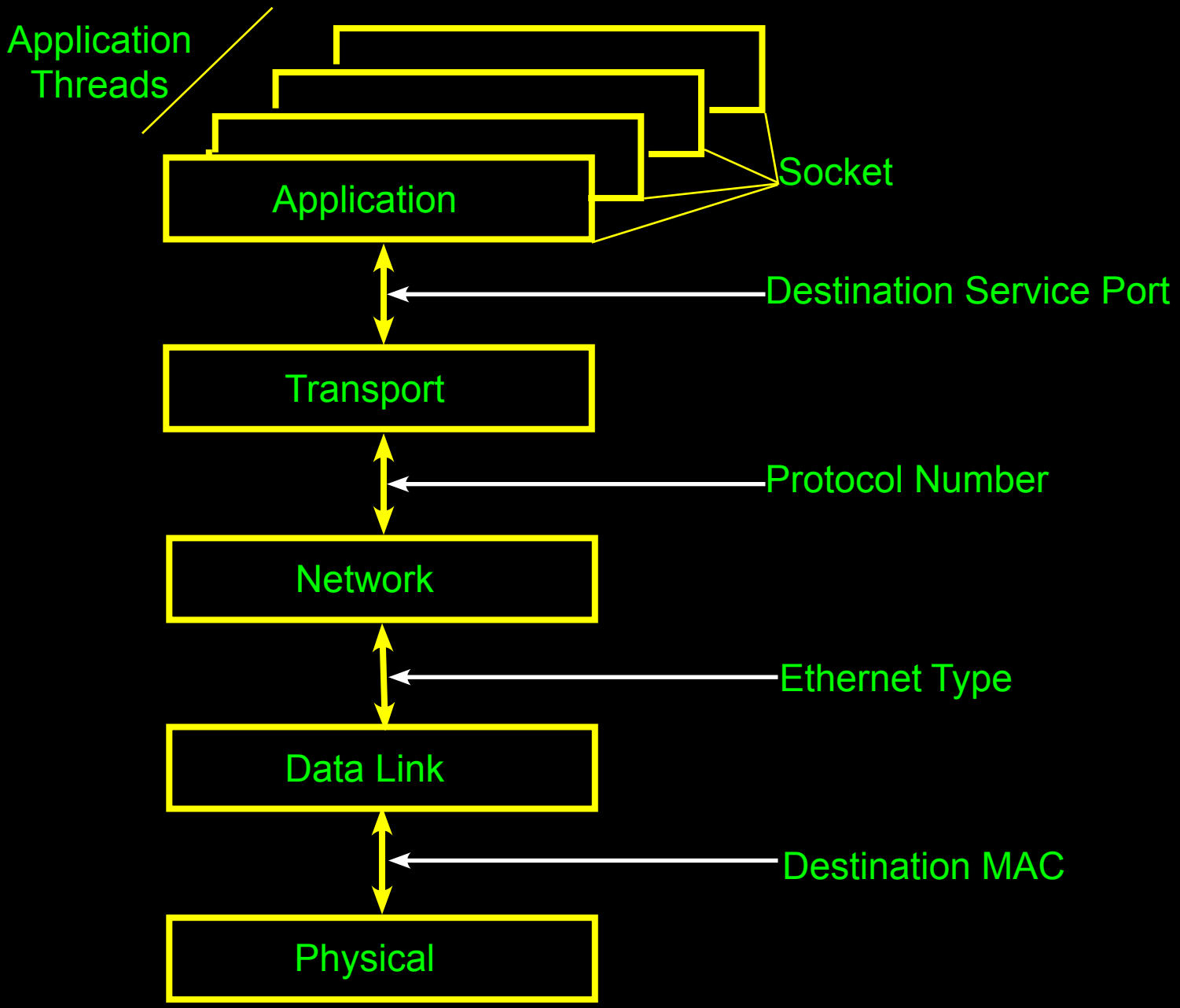
Which bit in the received serial stream begins an 8-bit byte?



Data Link Layer Protocols



TCP/IP Layer-to-Layer Interface Identifications
aka The Demultiplexing of an Ethernet Frame



Demultiplexing of received Ethernet frame