

CS2031

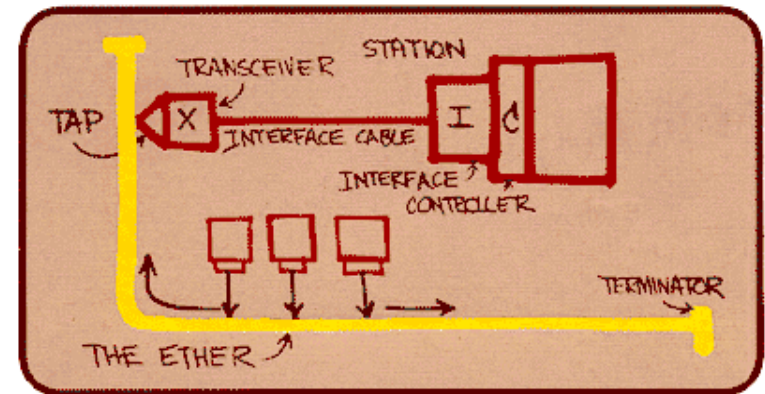
Telecommunications II

Ethernet

Ethernet

- Developed by Metcalfe 1972/3
- Standards in 1978, 1995, 1998

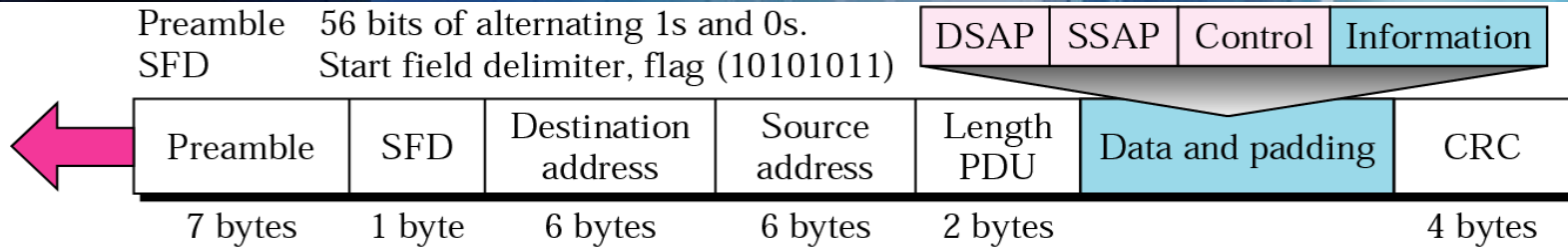
- Types of Ethernet
 - Original Ethernet
 - Switched Ethernet
 - Fast Ethernet
 - Gigabit Ethernet



Metcalfe's Ethernet sketch

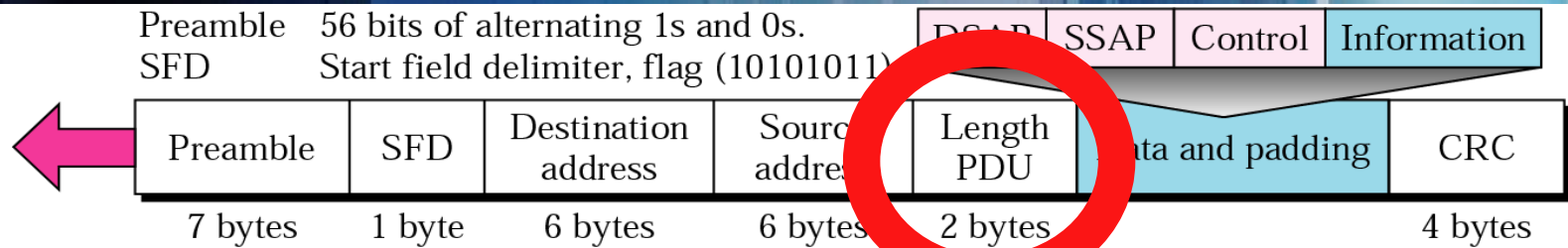
- Manchester Encoding
- Medium Access Control
 - CSMA/CD

802.3 MAC Format



- 64-bit frame preamble (10101010) used to synchronize reception
 - 7 bit preamble (10101010) + 1 start flag (10101011)
- Maximum frame length: 1536 bytes
 - ⇒ max 1500 bytes payload
- Minimum frame length: 64 bytes
 - ⇒ min 46 bytes payload

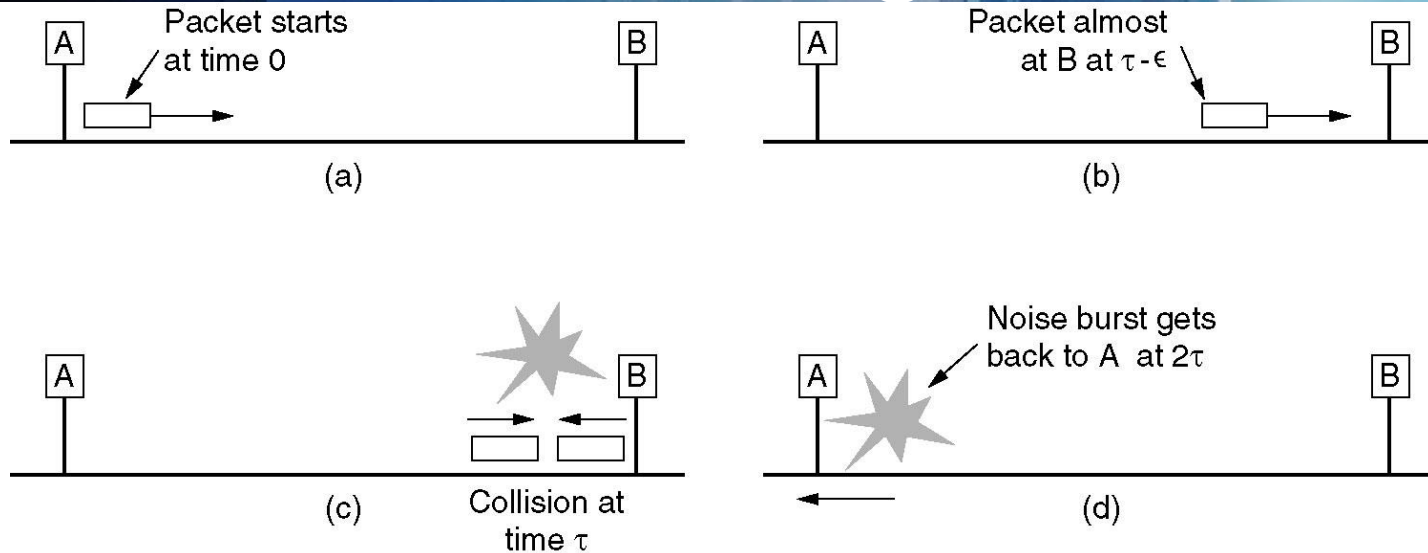
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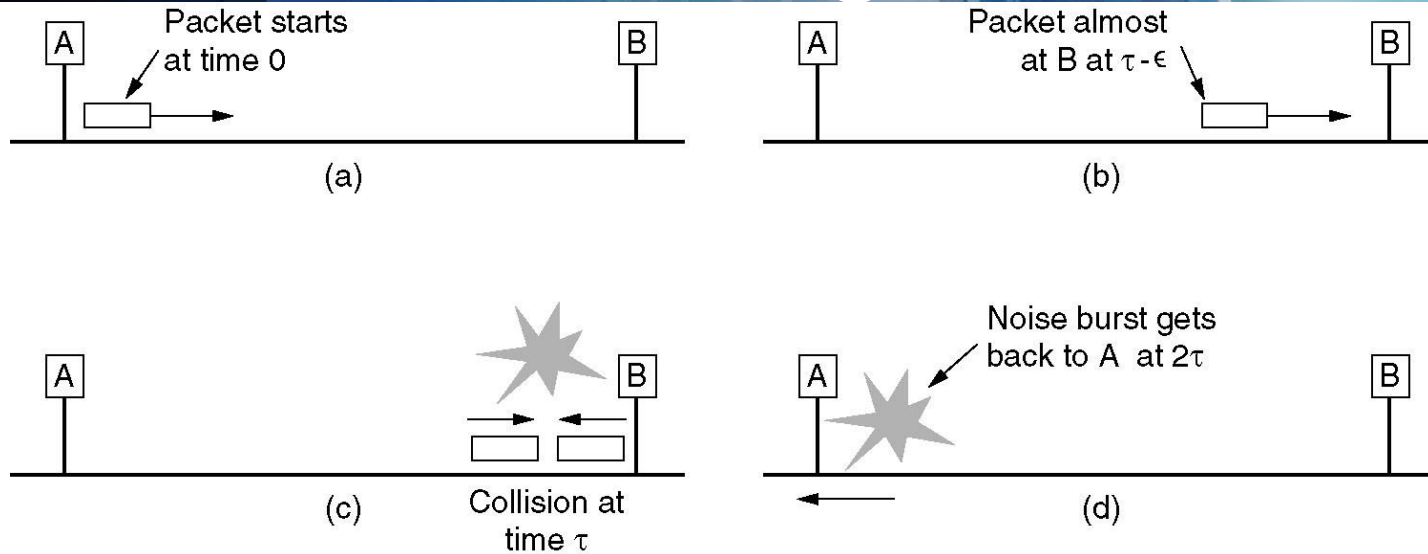
Length: Up to 0x600
Type: eg. 0x800 IP
0x806 ARP

Frame Length



- Sender starts at $t = 0$
 - Packet takes τ time to get to B
 - Shortly before B starts transmitting
 - But discovers collision with A's signal
 - 48-bit Jamming signal takes τ time to get to B
- \Rightarrow It takes at 2τ to detect a collision

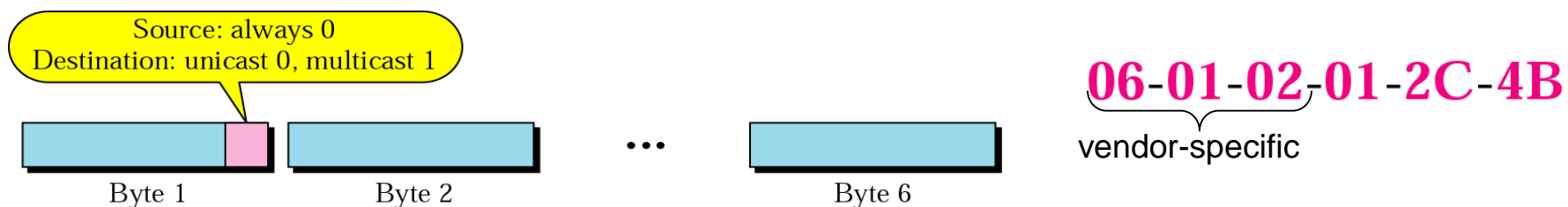
Frame Length II



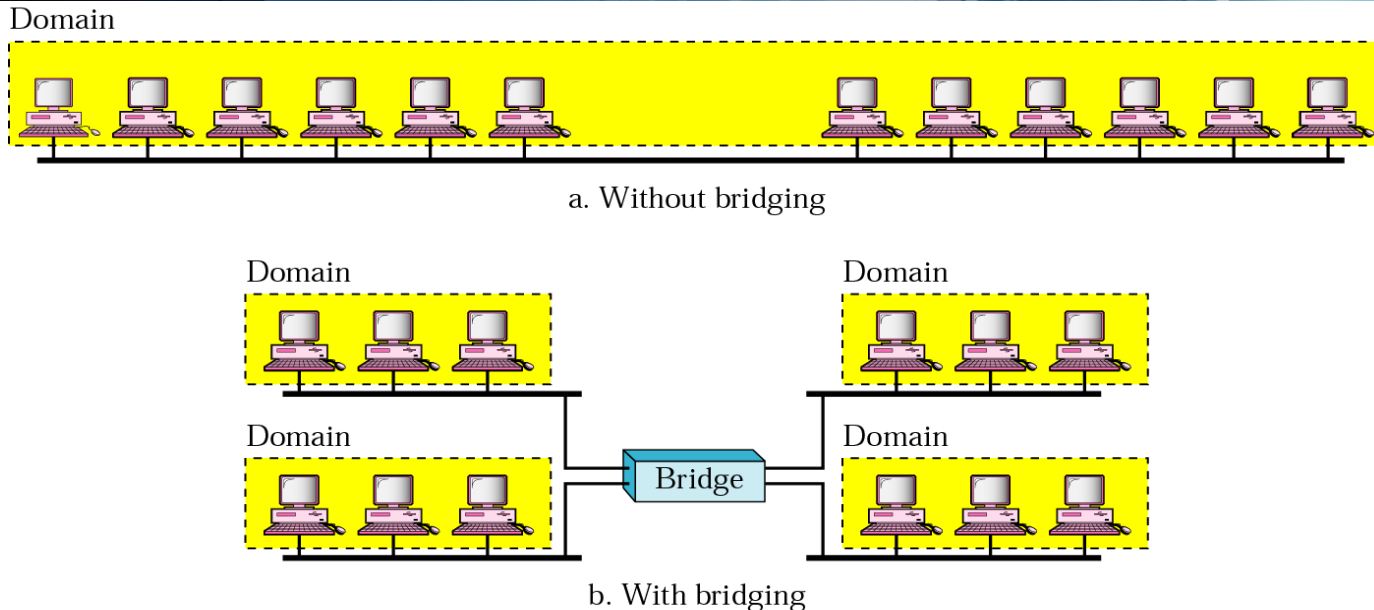
- It takes at 2τ to detect a collision
- Roundtrip time = 100 μ sec
- 10 Mbit/s \Rightarrow 500 bits
~512 bits or 64 bytes

Ethernet Addresses

- Types of Addresses:
 - Unicast – delivered to one station
 - 00-10-4B 3Com 3C905-TX PCI
 - 00-A0-C9 Intel (PRO100B and PRO100+)
 - Multicast – delivered to a set of stations
 - 01-80-C2-00-00-00 Spanning tree (for bridges)
 - 03-00-00-00-00-01 NETBIOS
 - Broadcast – delivered to all stations
 - FF-FF-FF-FF-FF-FF

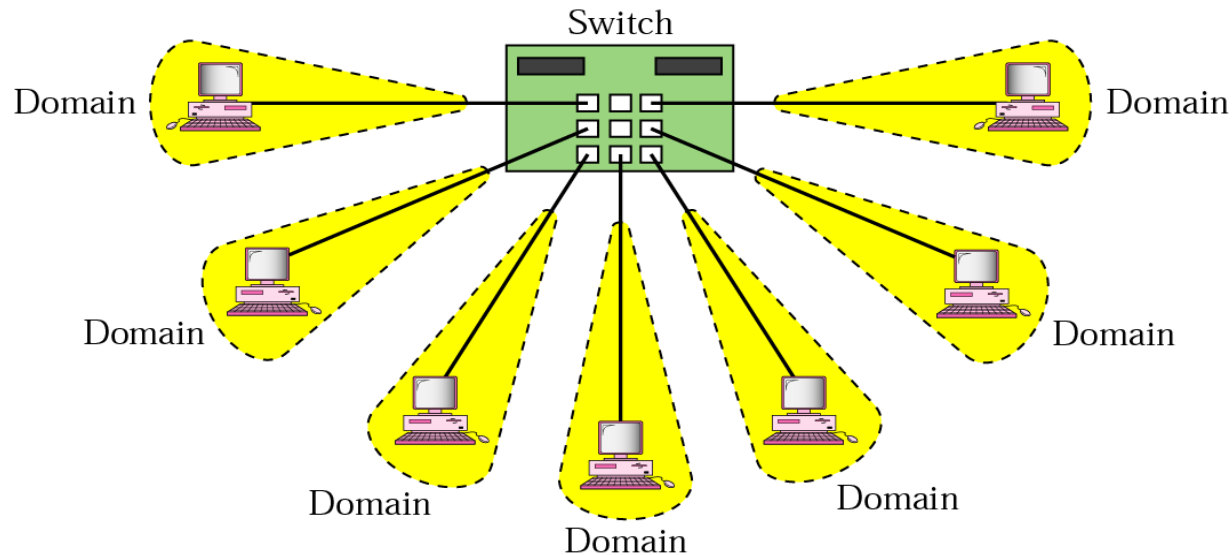


Collision Domains



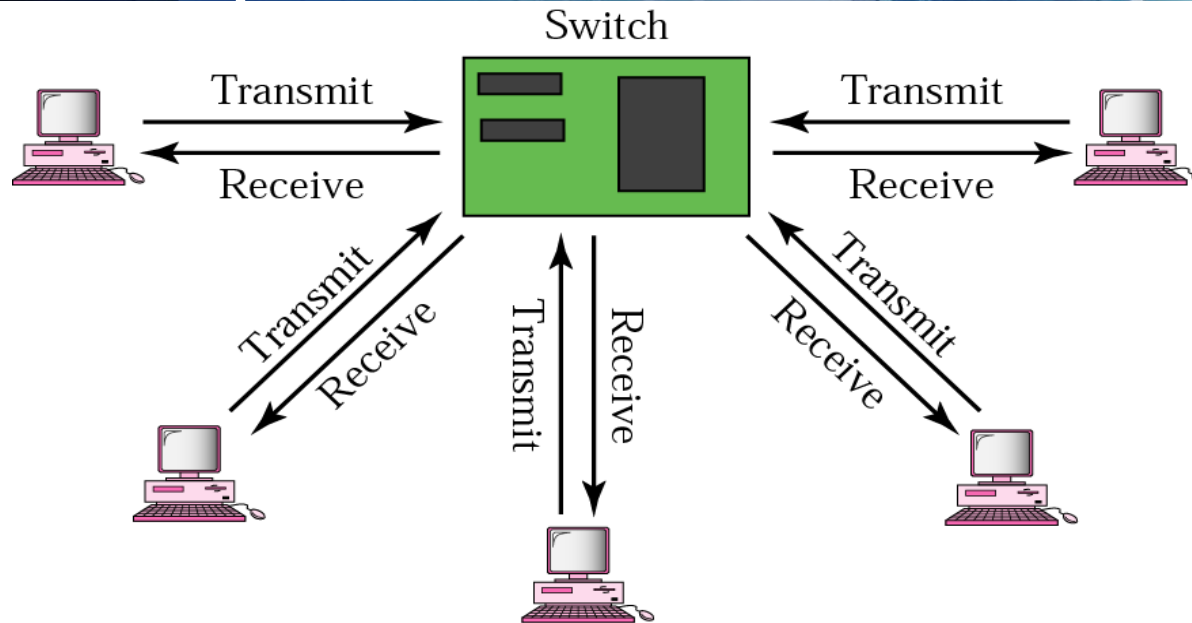
- Extension of Networks:
 - Repeaters, Hubs - Physical Layer
 - Bridges, Switches - Data Link Layer
 - Routers - Network Layer
- Collision domains:
 - Collision affects all machines in one segment

Switched Ethernet



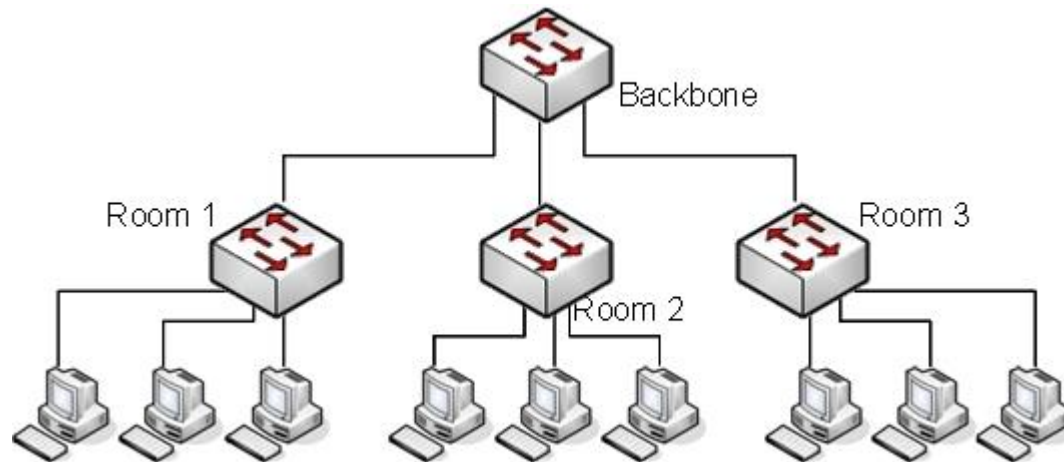
- Switch delivers packets to individual machines
 - Without affecting communication with other machines
- Collisions only occur on individual links

Full-duplex Switched Ethernet



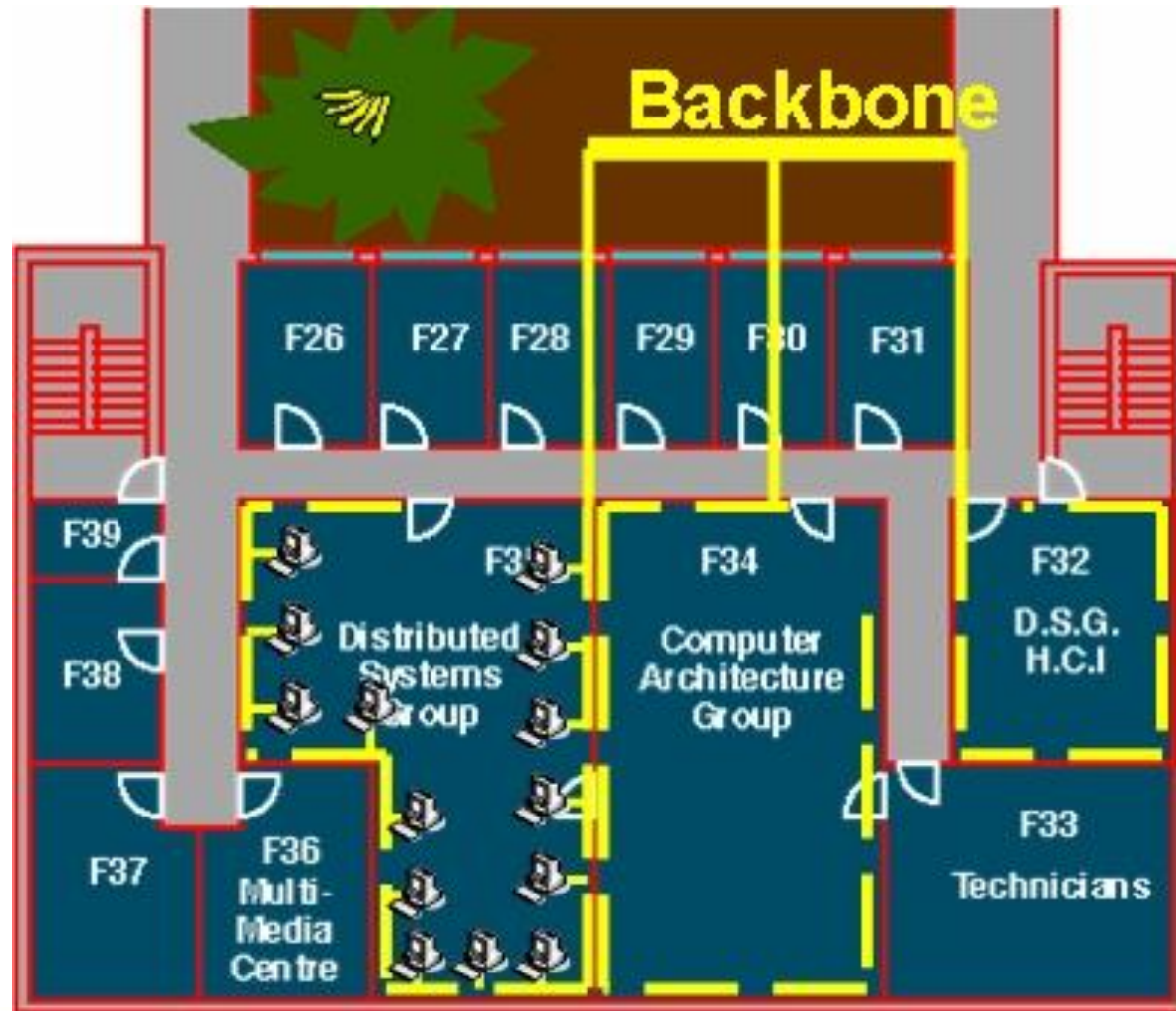
- No collisions
 - One channel to send
 - One channel to transmit

Switched Networks

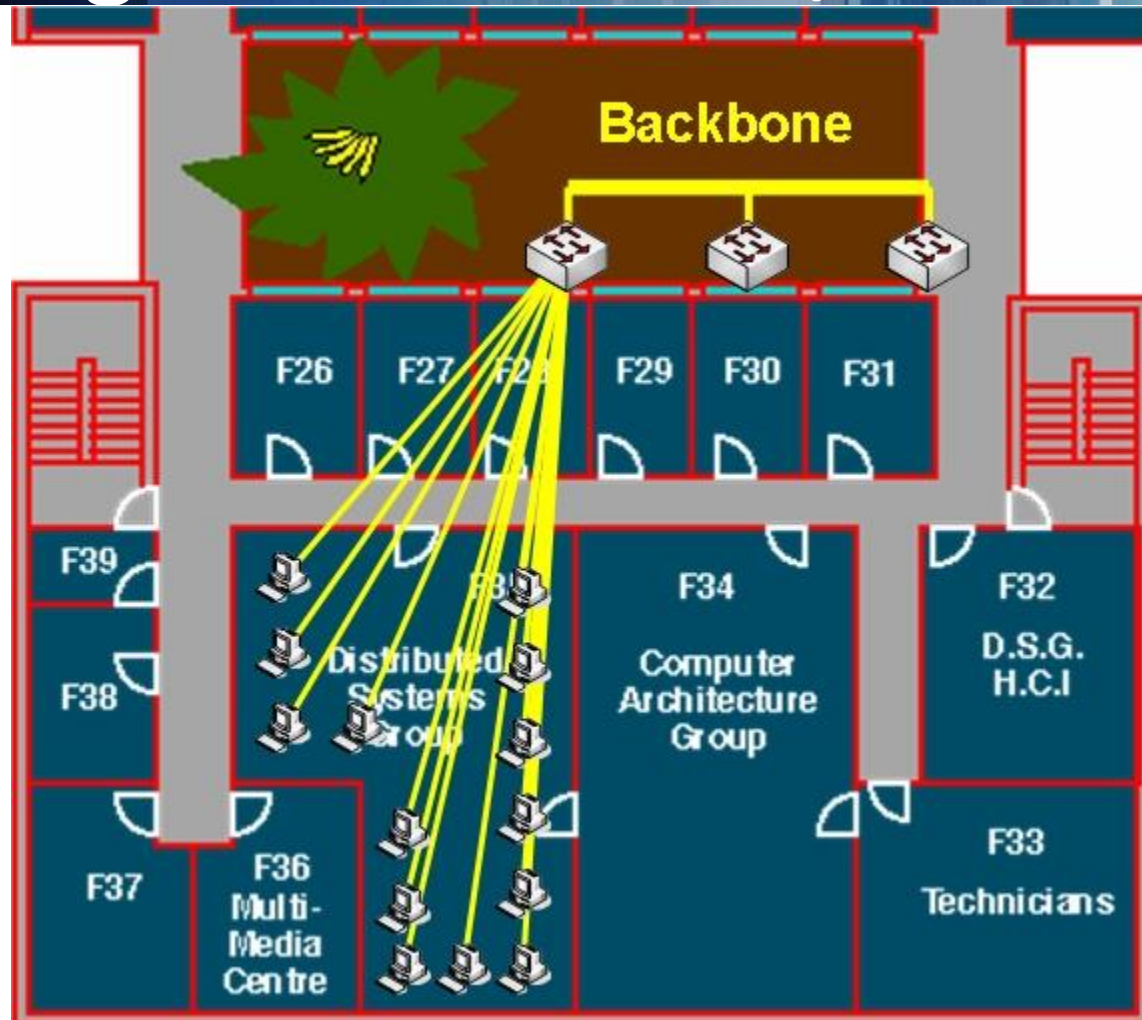


- Hierarchical Organization
- Separation into Segments
- Keep traffic in one segment - if possible

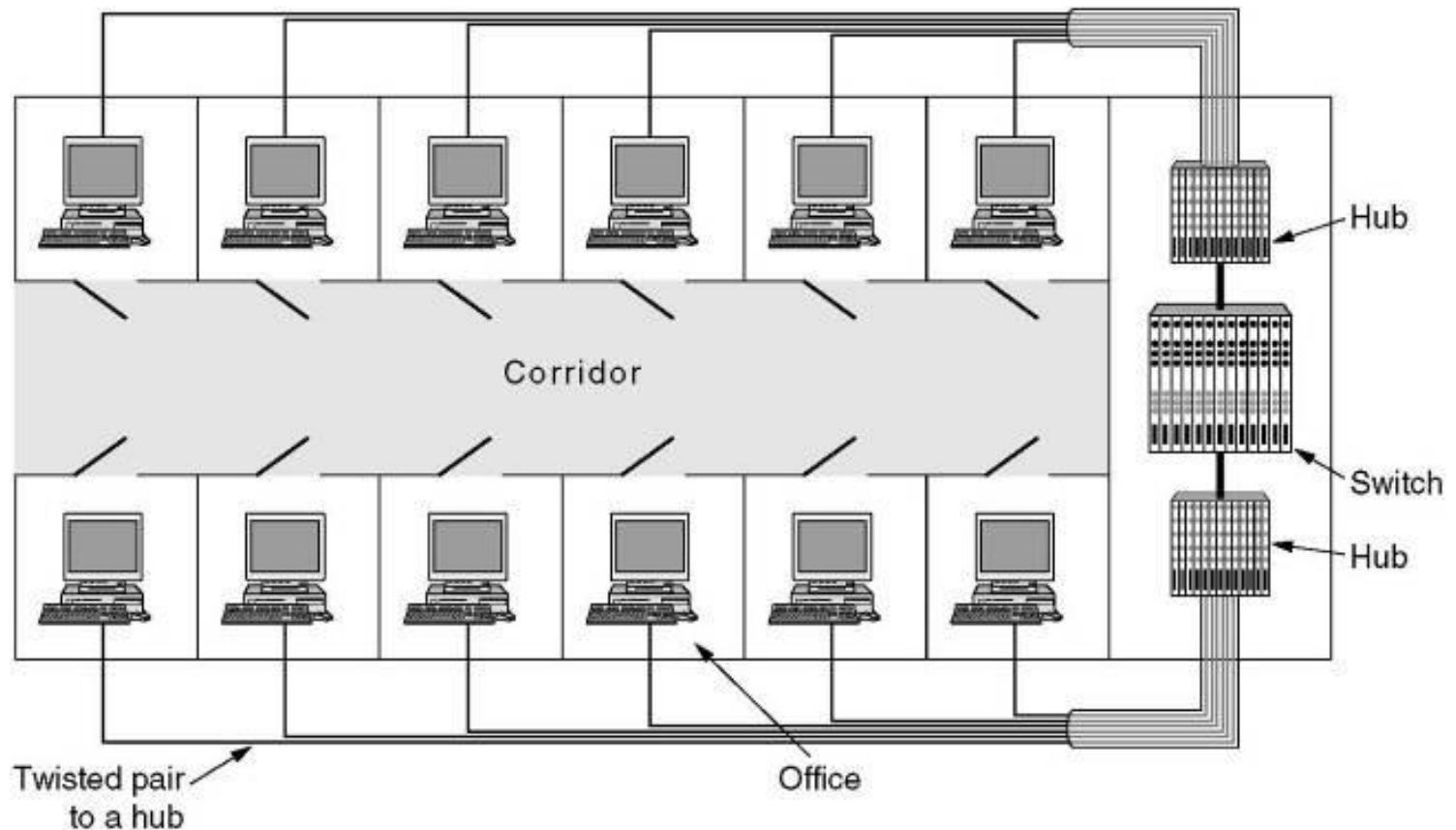
College Network – 10Base2



College Network–10/100BaseT

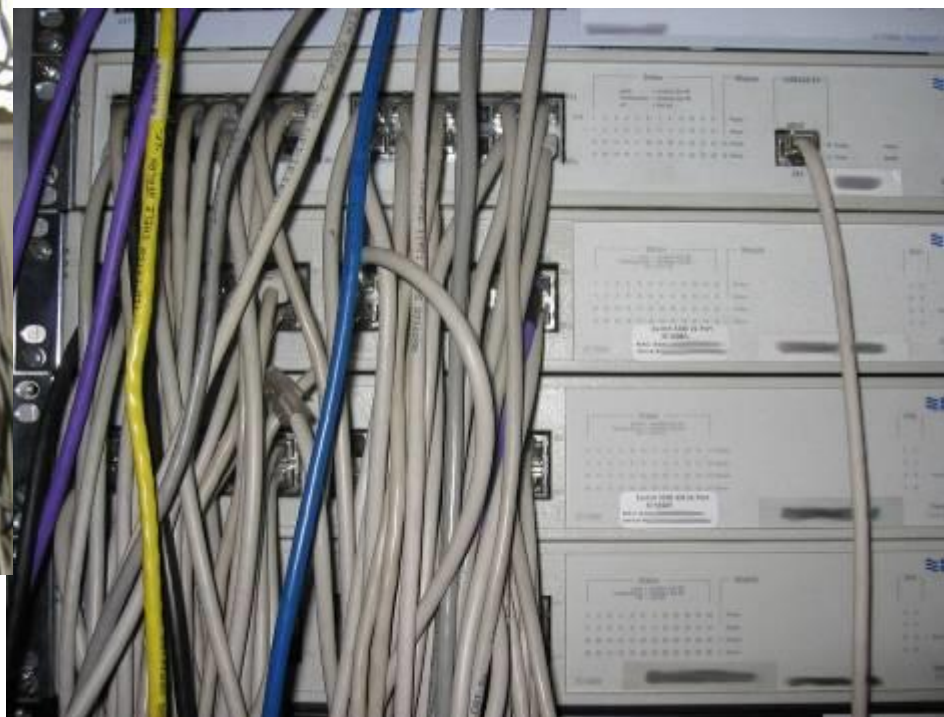
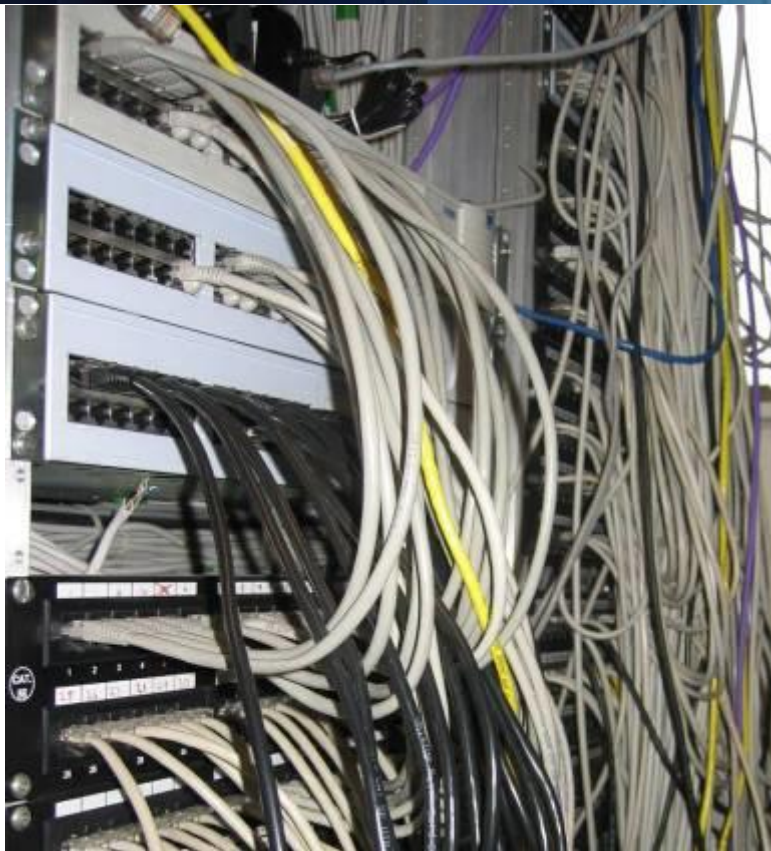


Switched Network

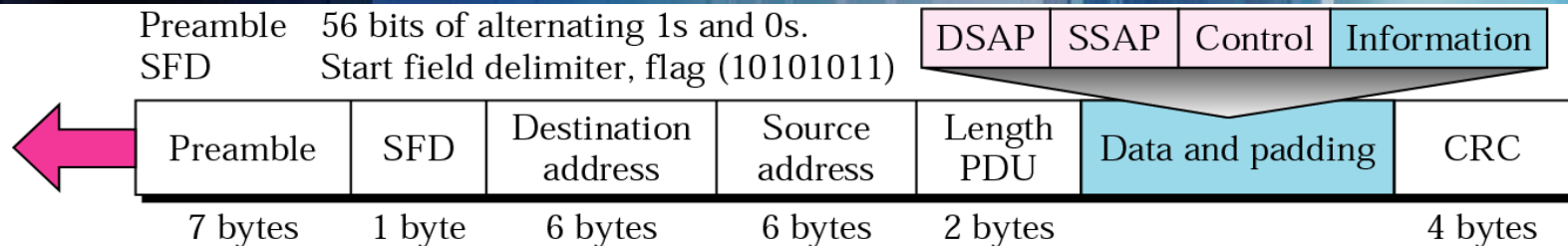




Switches in Comms Rooms



802.3 & 802.2 MAC Format



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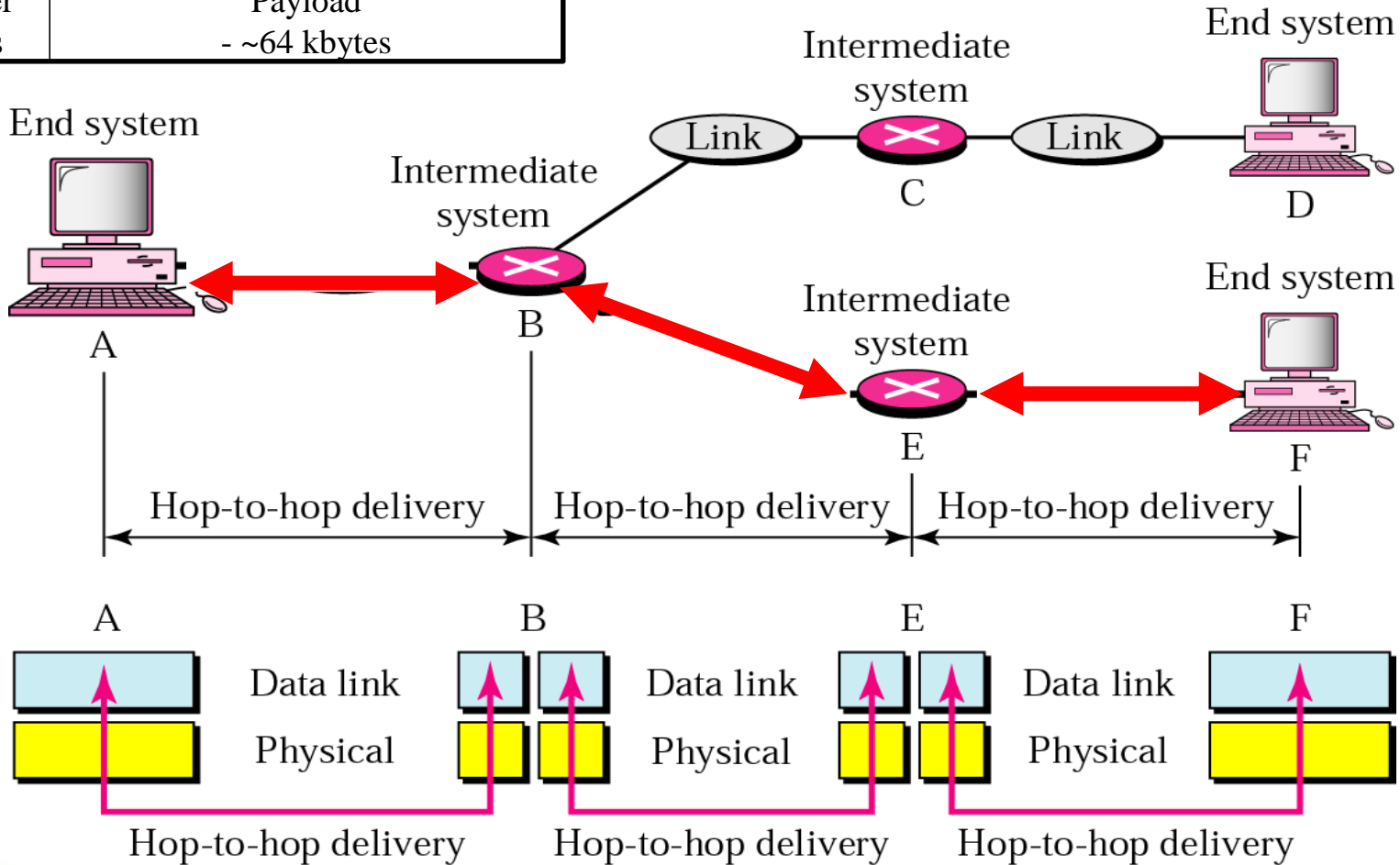
Summary: Ethernet

- Ethernet frame
 - Preamble to signal start of frame
 - MTU & minimum frame size
 - Addressing
- CSMA/CD
- Collision Domains
- Switched Networks

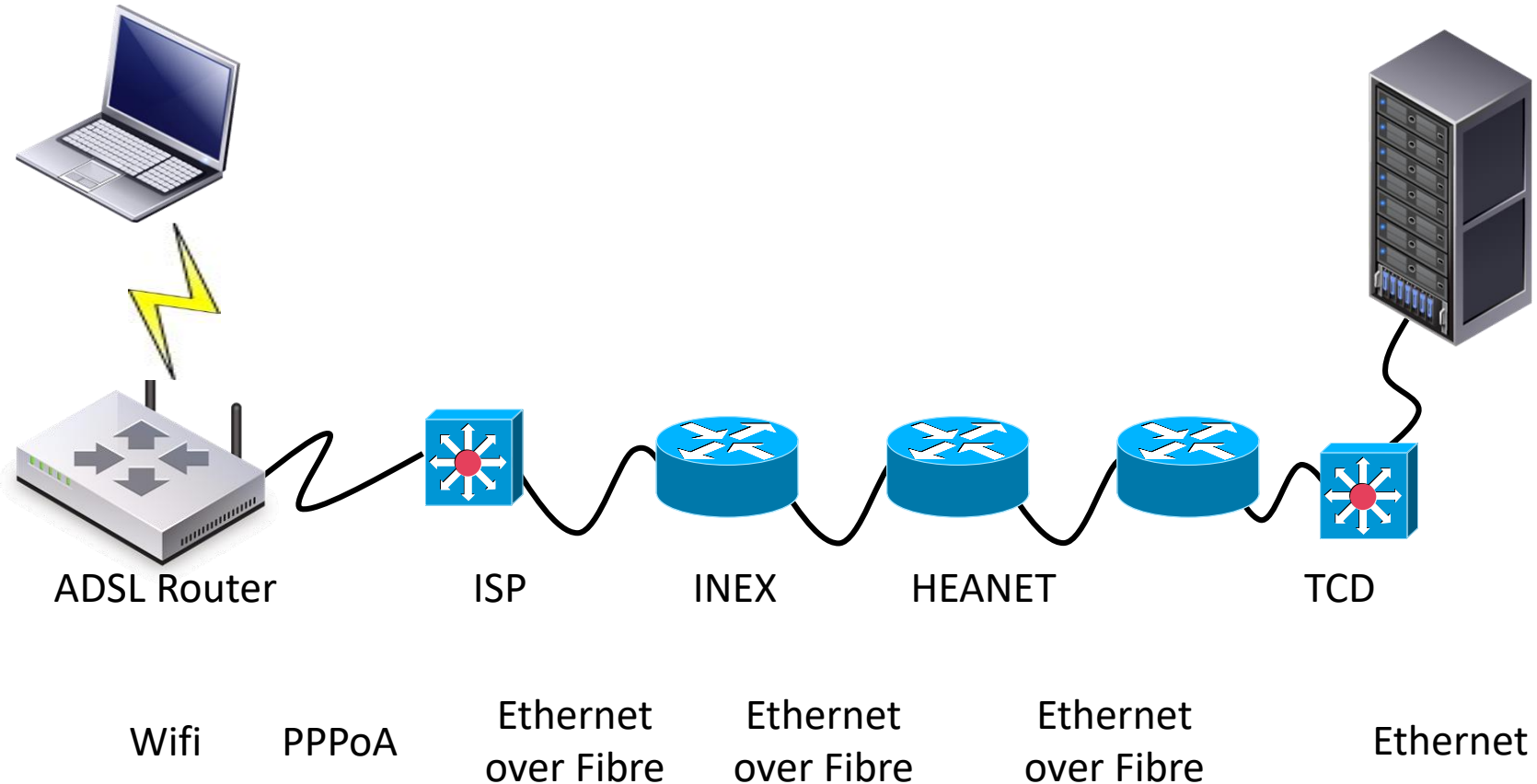
Link Layer

IP Packet

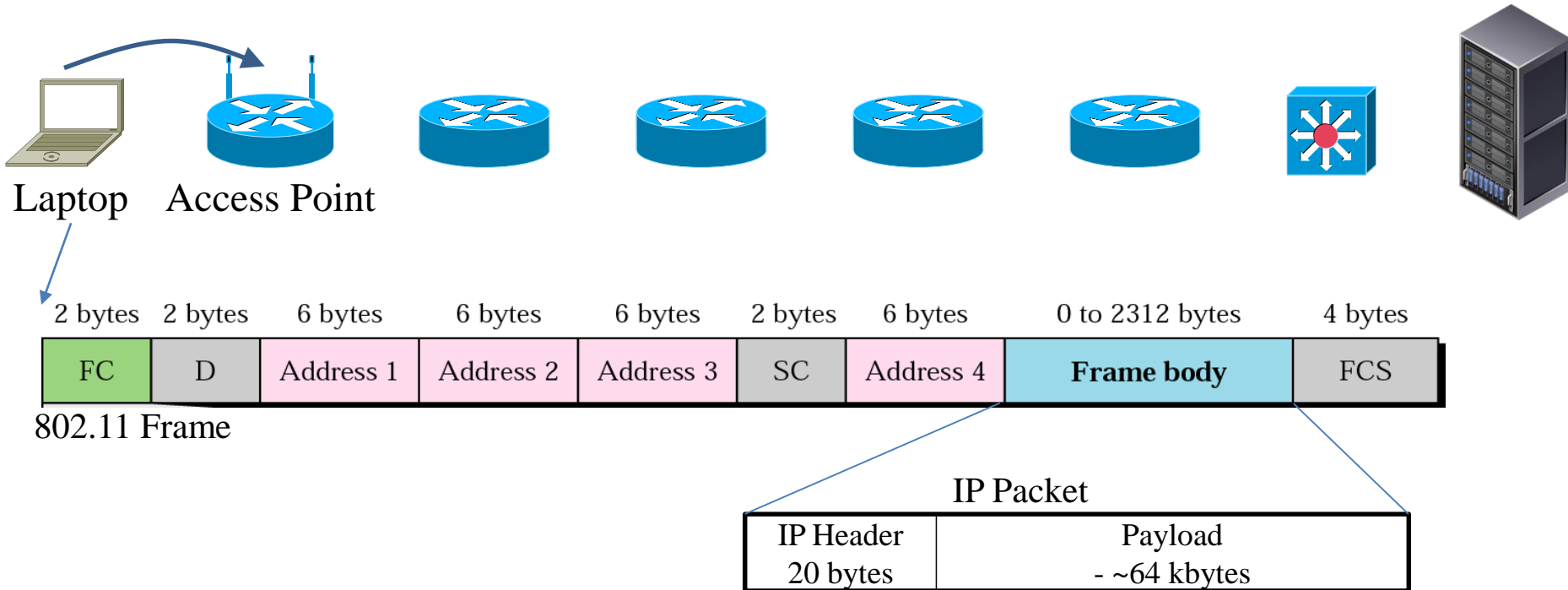
IP Header 20 bytes	Payload - ~64 kbytes
-----------------------	-------------------------



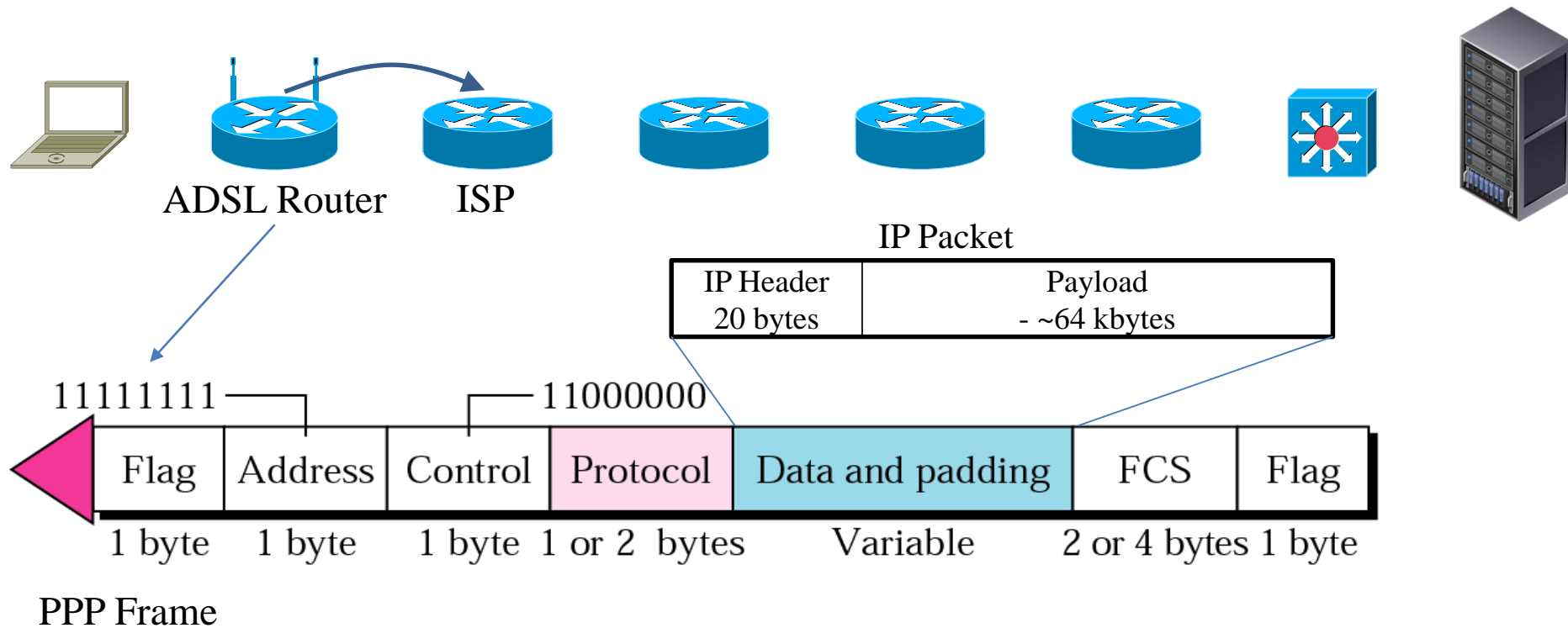
HTML Use Case



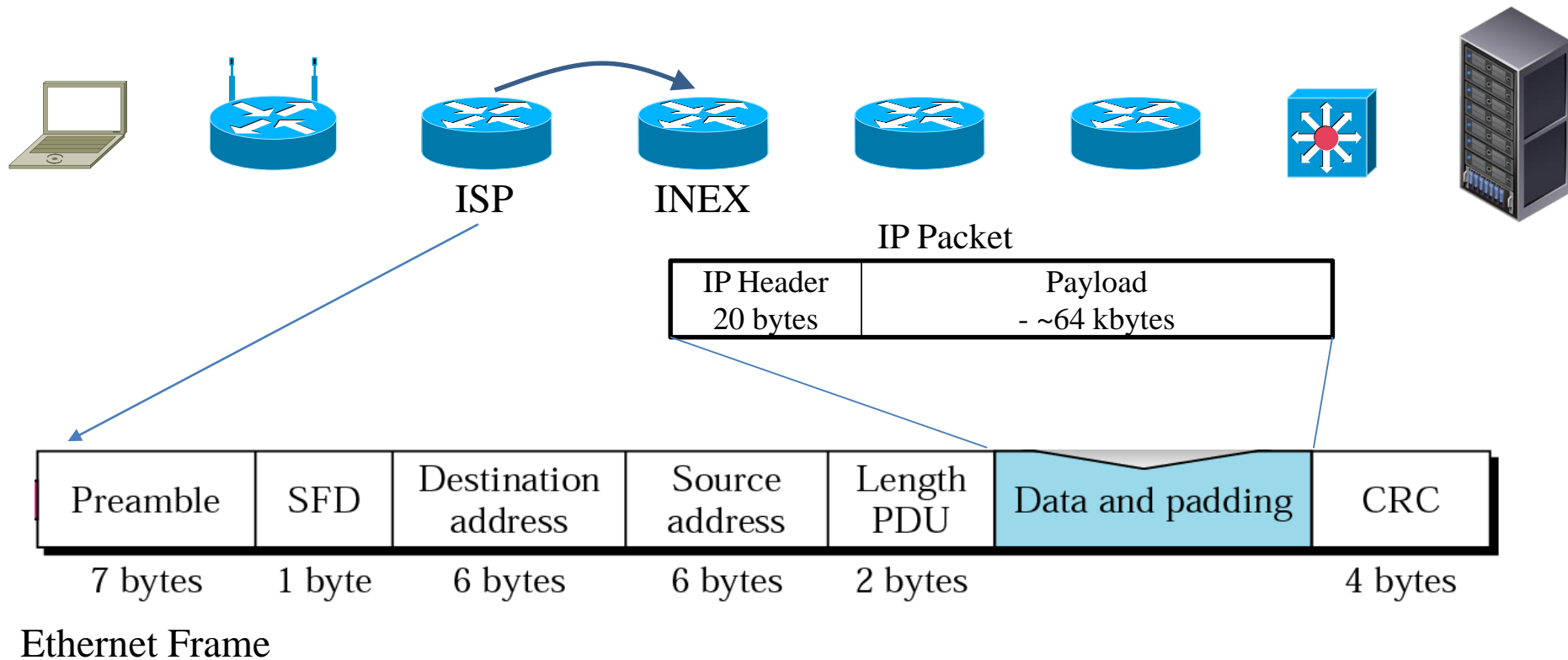
Wifi in Home Network



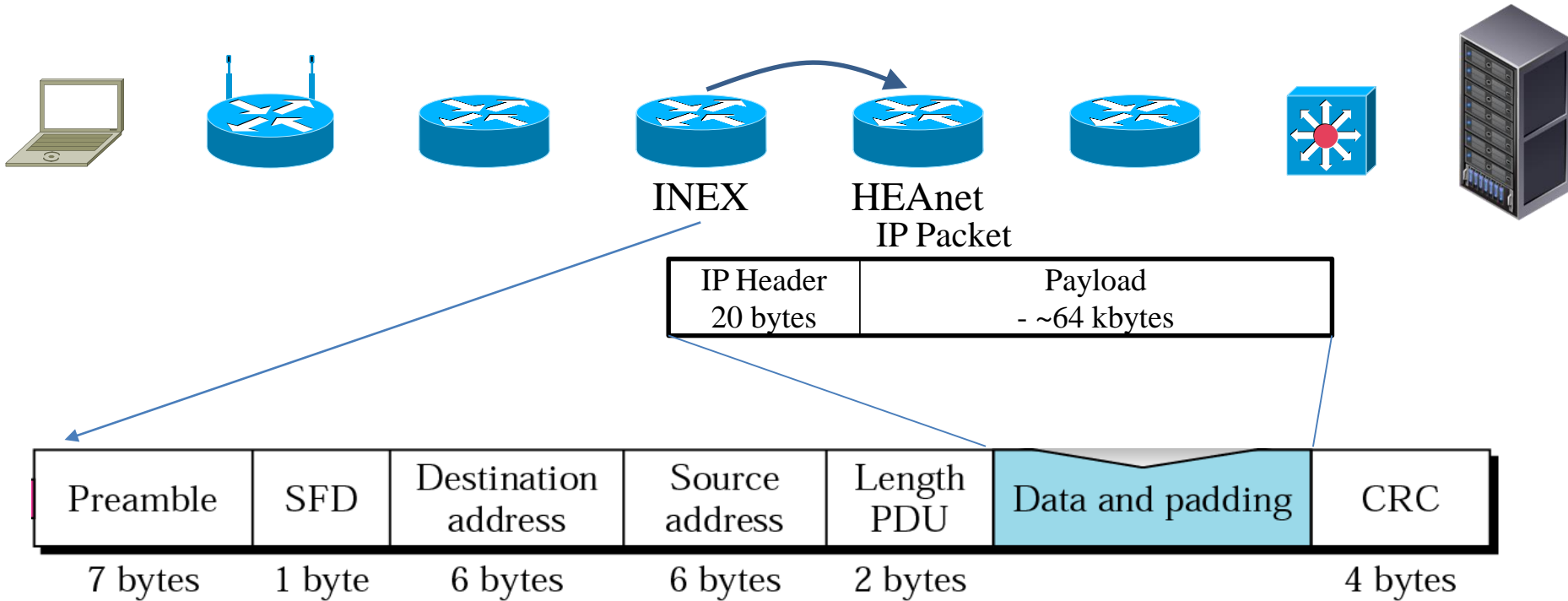
PPP to ISP



Ethernet over Fibre

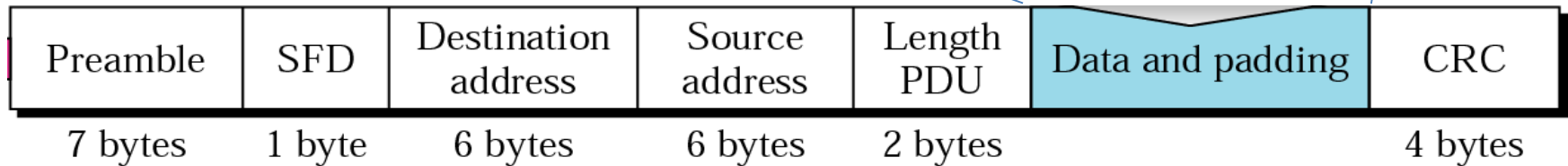
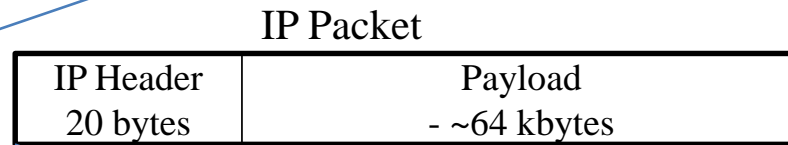
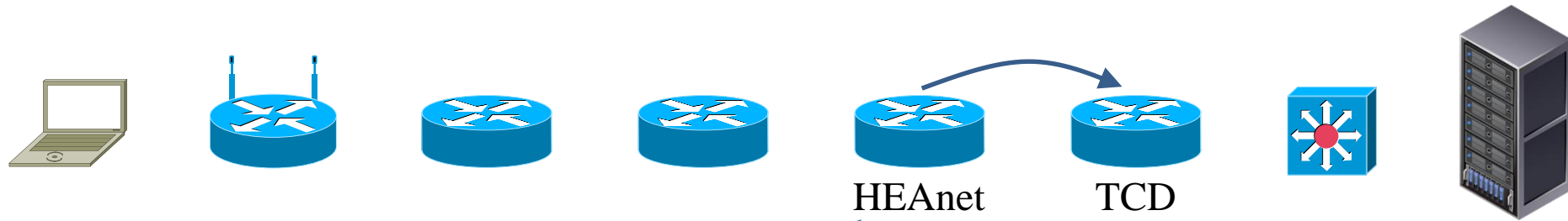


Ethernet over Fibre

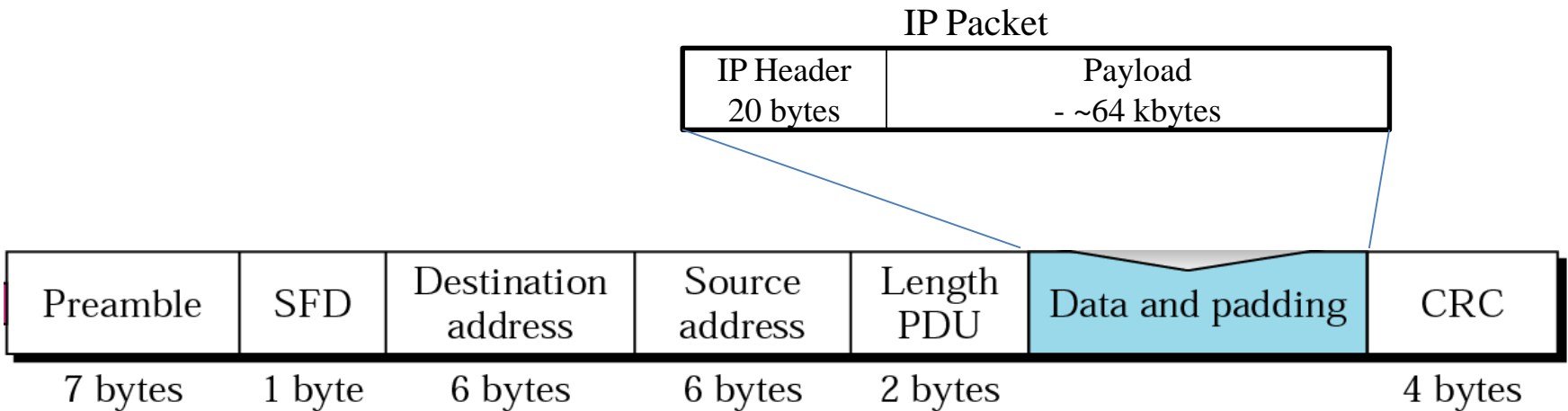
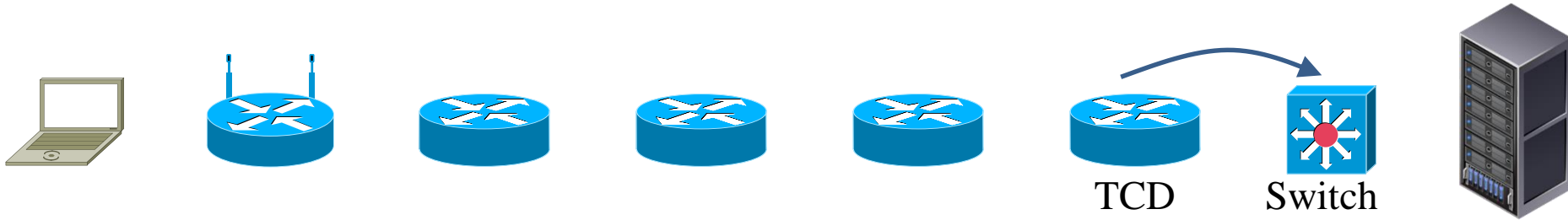


Ethernet Frame

Ethernet over Fibre

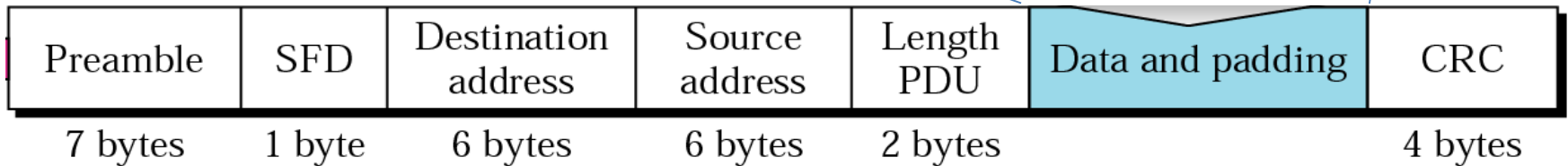
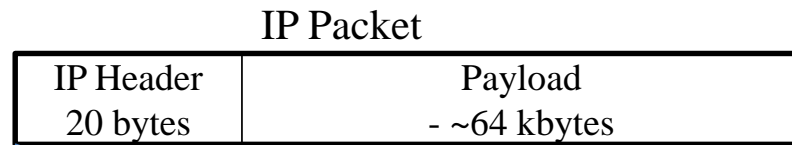
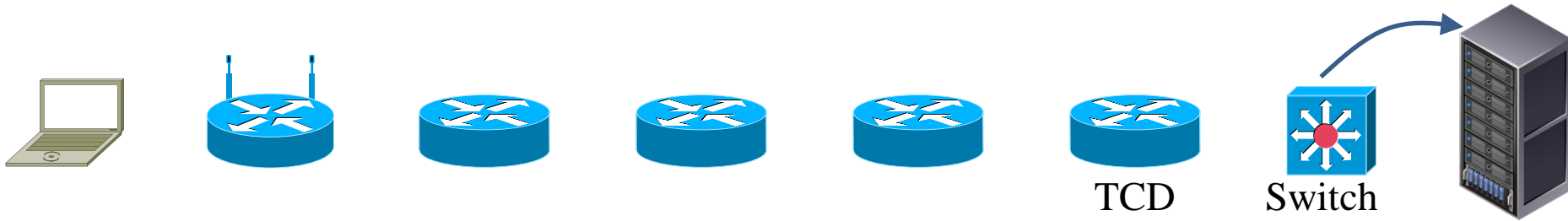


Ethernet



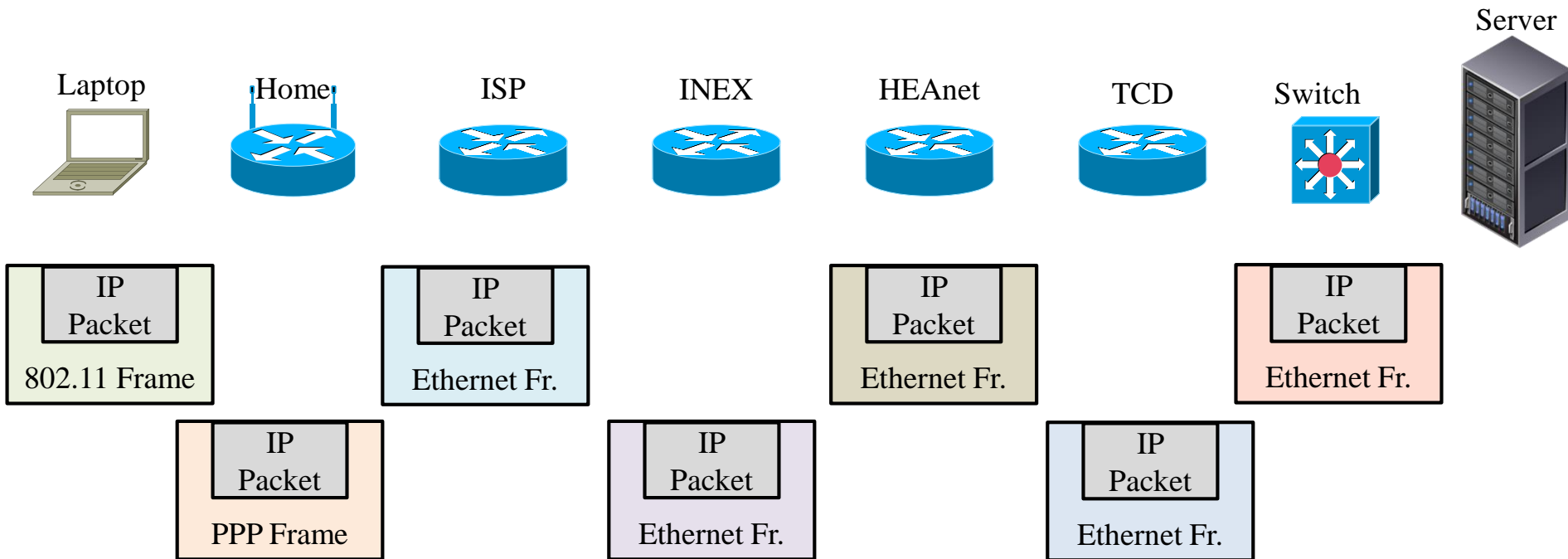
Ethernet Frame

Ethernet

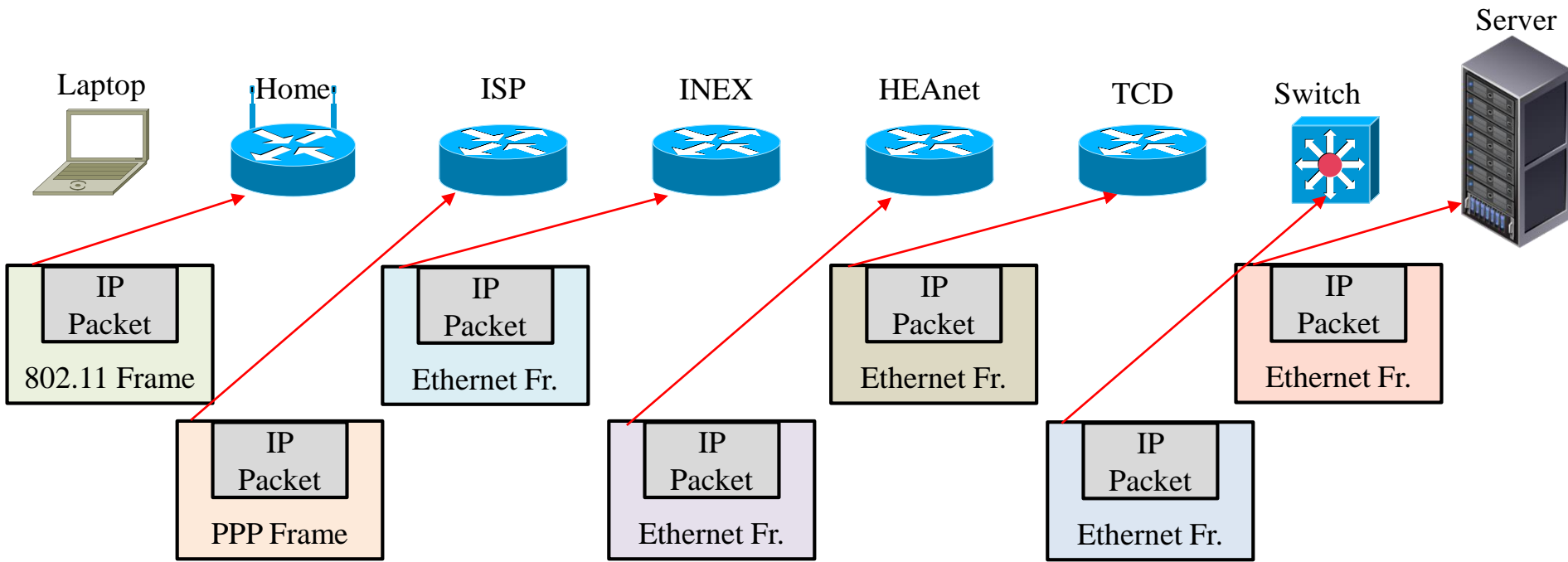


Ethernet Frame

Encapsulation



Addressing Next Hop



→ Addressed To

Assignment Discussion

- Sample Code
- Reports

File Input

```
String fname;
```

```
File file= null;
```

```
FileInputStream fin= null;
```

```
byte[] buffer= null;
```

```
int size;
```

```
fname= terminal.readString("Name of file: ");
```

Read filename

```
file= new File(fname);
```

Open file

```
buffer= new byte[(int) file.length()];
```

Reserve byte buffer

```
fin= new FileInputStream(file);
```

Initialize input stream

```
size= fin.read(buffer);
```

Read file content

Rest of File Input

```
if (size==-1) {  
    fin.close();  
    throw new Exception("Problem with File Access");  
}
```

```
terminal.println("File size: " + buffer.length);  
fcontent= new FileInfoContent(fname, size);  
terminal.println("Sending packet w/ name & length");  
packet= fcontent.toDatagramPacket();  
packet.setSocketAddress(dstAddress);  
socket.send(packet);  
terminal.println("Packet sent");  
this.wait();
```

```
fin.close();
```

End file access

Byte[] copying

```
DatagramPacket packet= null;
```

```
byte[] payload= null; byte[] header= null; byte[] buffer= null;
```

```
payload= (terminal.readString("String to send: ")).getBytes();
```

```
header= new byte[PacketContent.HEADERLENGTH];
```

```
buffer= new byte[header.length + payload.length];
```

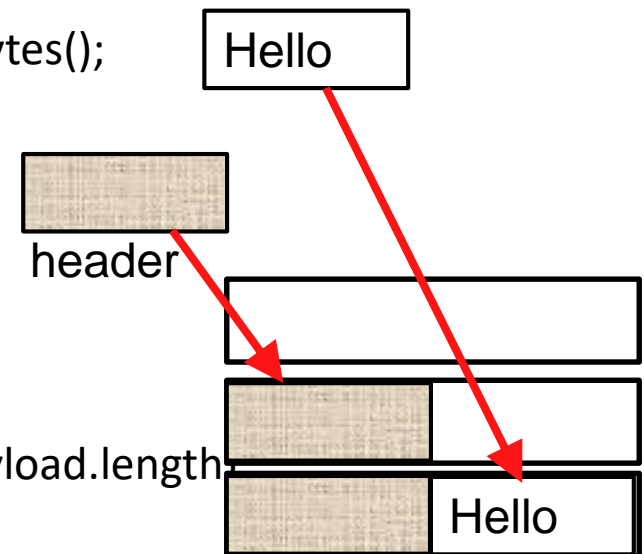
```
System.arraycopy(header, 0, buffer, 0, header.length);
```

```
System.arraycopy(payload, 0, buffer, header.length, payload.length);
```

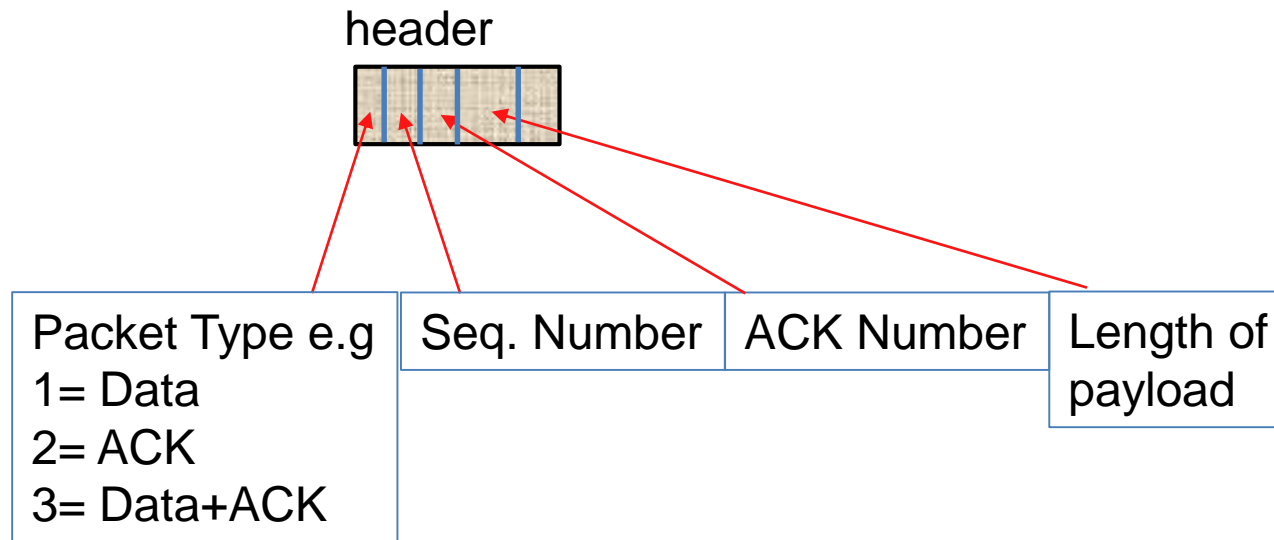
```
packet= new DatagramPacket(buffer, buffer.length, dstAddress);
```

```
socket.send(packet);
```

```
this.wait();
```



Example Header



tcd.lossy.DatagramSocket

```
package tcd.lossy;

public class DatagramSocket extends java.net.DatagramSocket {

    ...

    public void send(DatagramPacket arg0) throws IOException {
        if ((Math.random()*100) > noise) {
            super.send(arg0);
        }
        else {
            System.out.println("** Packet dropped");
        }
    }
}
```

“import tcd.lossy.DatagramSocket;” instead of “import java.net.DatagramSocket;”

Reports

- Stop&Wait
 - Explanation of your understanding of the mechanism
 - Explanation of your code
 - Reflection on your implementation
- Go-Back-N/Selective Repeat
 - Explanation of your understanding of the mechanism
 - Explanation of your code
 - Reflection on your implementation
- Reflection on Flow Control/on your understanding of Flow Control

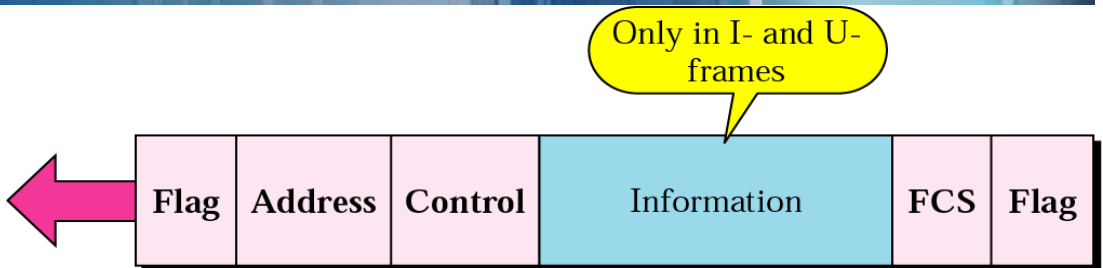


That's all
folks

Spare Slides

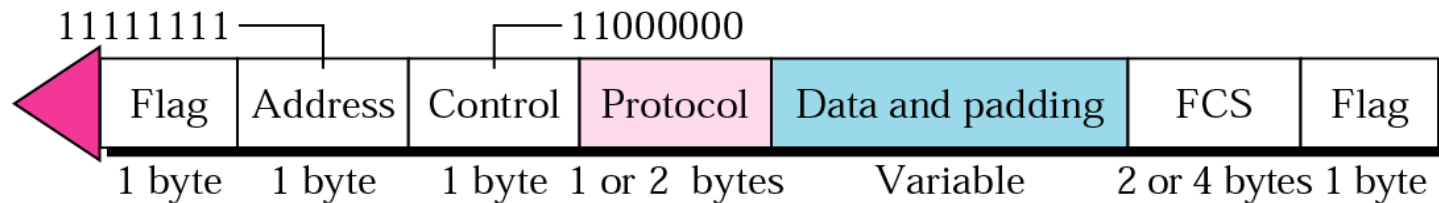
The following slides were omitted from the lecture to reserve time to discuss the assignment

HDLC Frame

- Flag= 01111110
 - Specifies beginning and end of frame
 - Address
 - Specifies secondary station as either sender or receiver
 - Control
 - Specifies type of frame and seq.&ack. number
 - Frame Check Sequence (FCS)
 - Either 16- or 32-bit CRC
- 

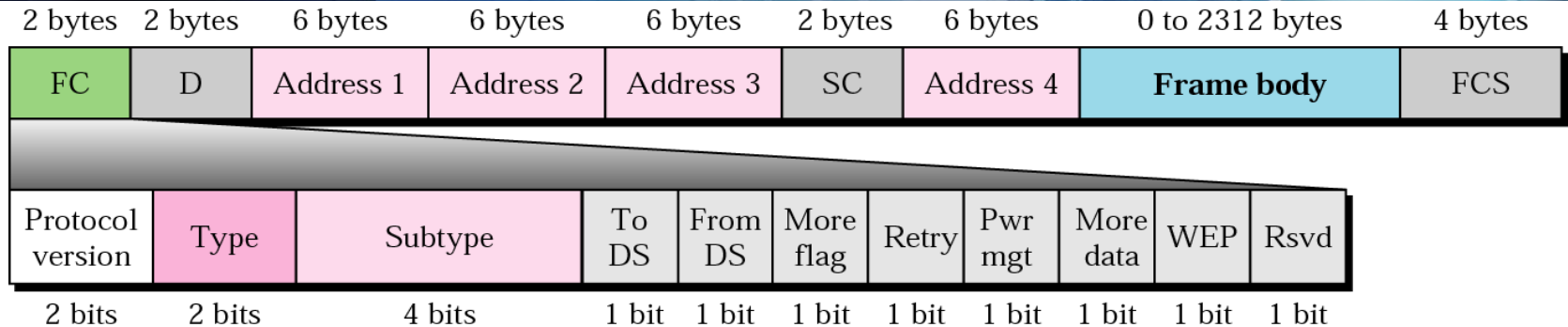
PPP Frame

■ Modified HDLC frame:



- Byte-oriented Protocol
 - Flag Byte: 01111110
 - Escape Byte: 01111101
- FCS: 16- or 32-bit CRC
 - $x^{16} + x^{12} + x^5 + 1$
 - 1 0001 0000 0010 0001 → 16 bits remainder ← 16-degree polynomial
 - $x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^8 + x^7 + x^5 + x^4 + x^2 + x + 1$

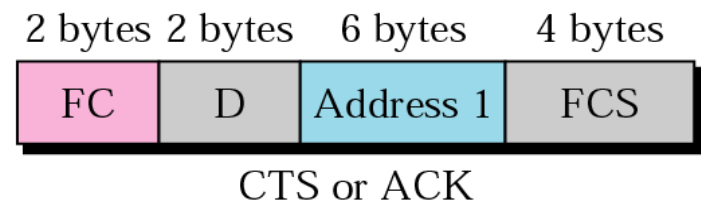
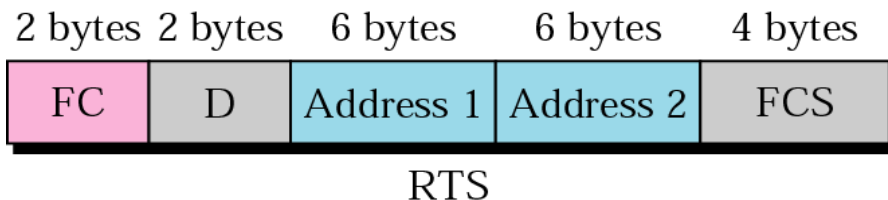
802.11 MAC Frame Format



Control Frames

Type: management (00), control (01), or data (10).

Subtype	Meaning
1011	Request to send (RTS)
1100	Clear to send (CTS)
1101	Acknowledgment (ACK)



802.11 Frames

- DSSS PLCP frame format

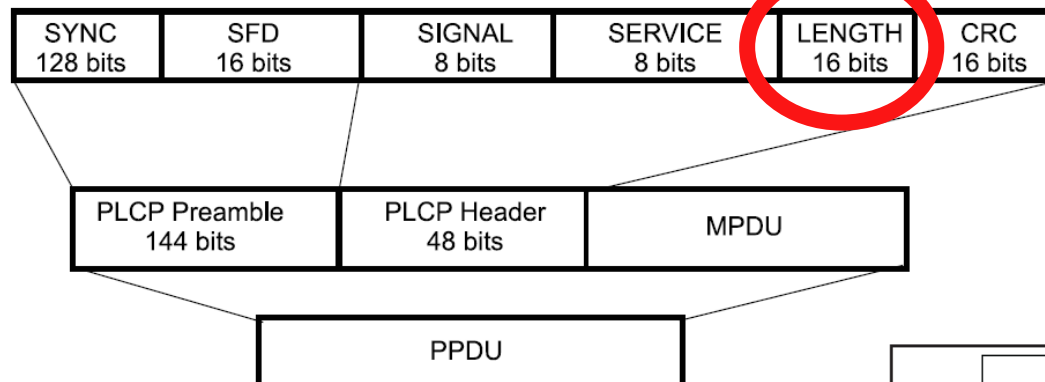


Figure 86—PLCP frame format

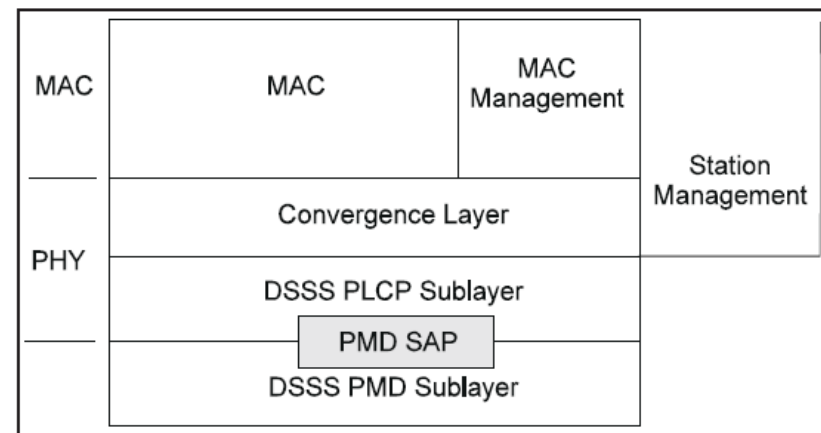
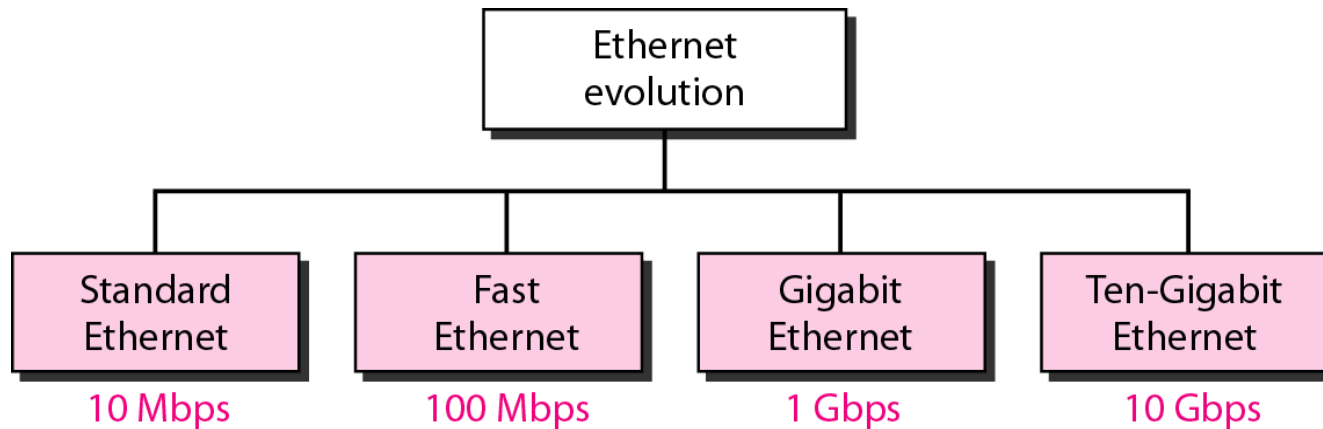


Figure 95—PMD layer reference model

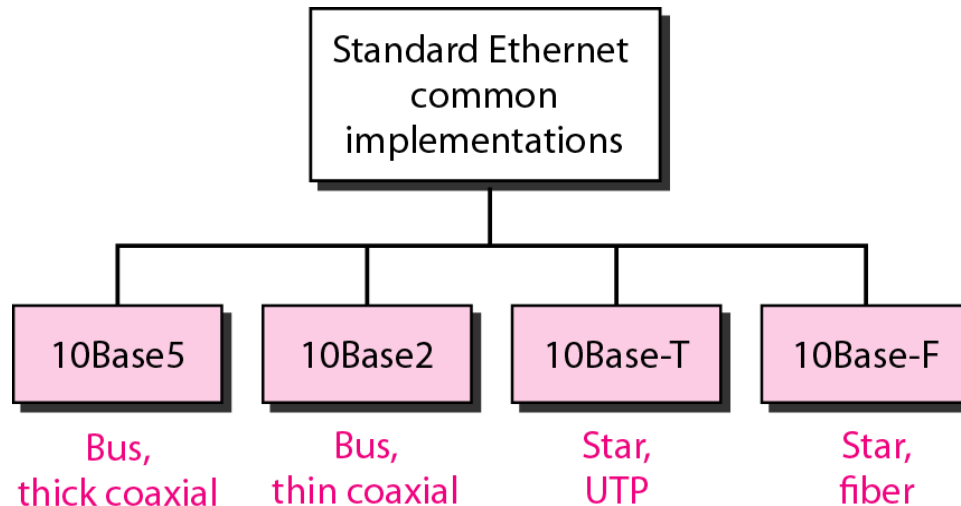
Evolution of Ethernet



- 1972/73 defined for coaxial cable
- Fast Ethernet used mainly unshielded twisted pair (UTP)
- Gigabit Ethernet common in desktops and laptops
- 10GB Ethernet used mainly for backbone

* Figure is courtesy of B. Forouzan

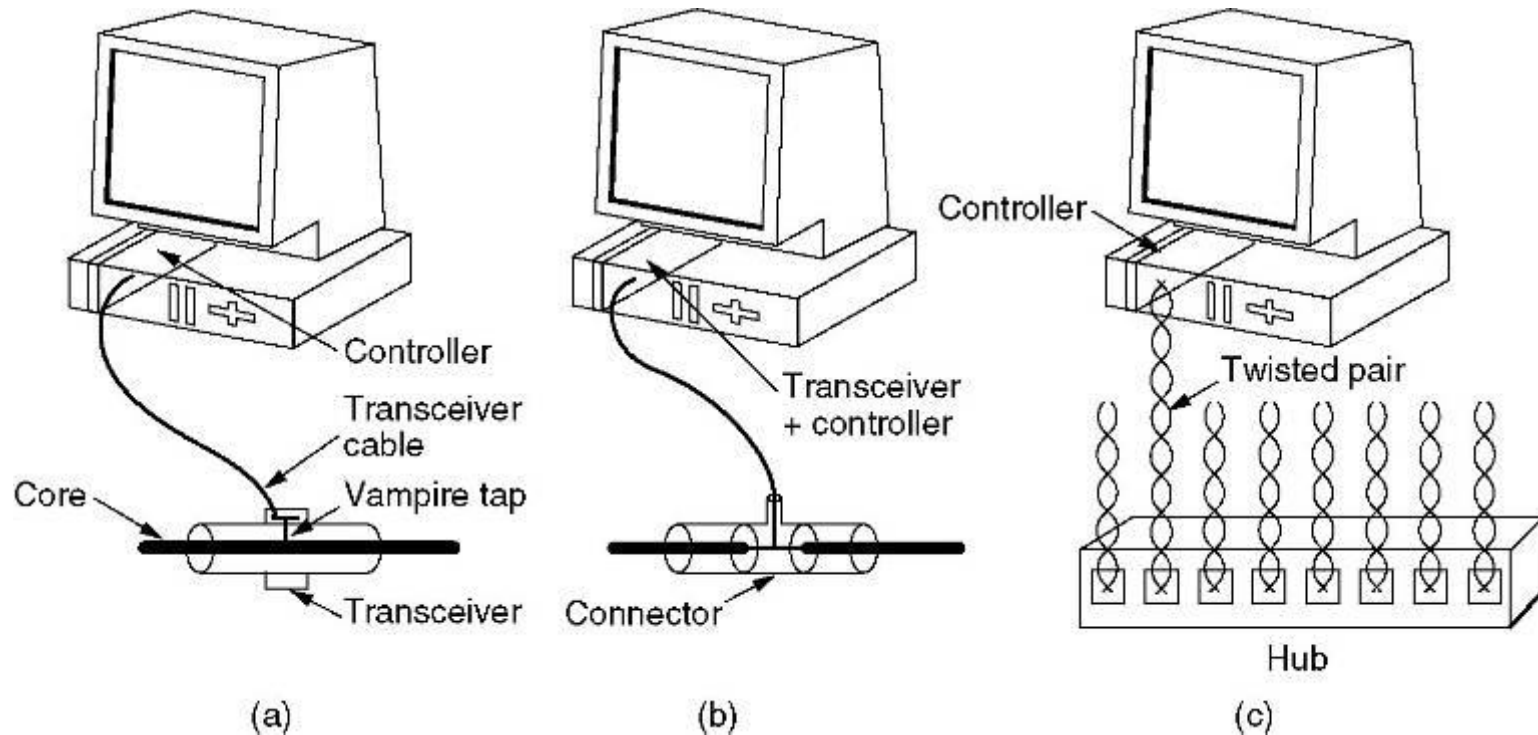
Types of Ethernet



Name	Cable	Max. seg.	Nodes/seg.	Advantages
10Base5	Thick coax	500 m	100	Original cable; now obsolete
10Base2	Thin coax	185 m	30	No hub needed
10Base-T	Twisted pair	100 m	1024	Cheapest system
10Base-F	Fiber optics	2000 m	1024	Best between buildings

* Figure is courtesy of B. Forouzan

Ethernet Cabling



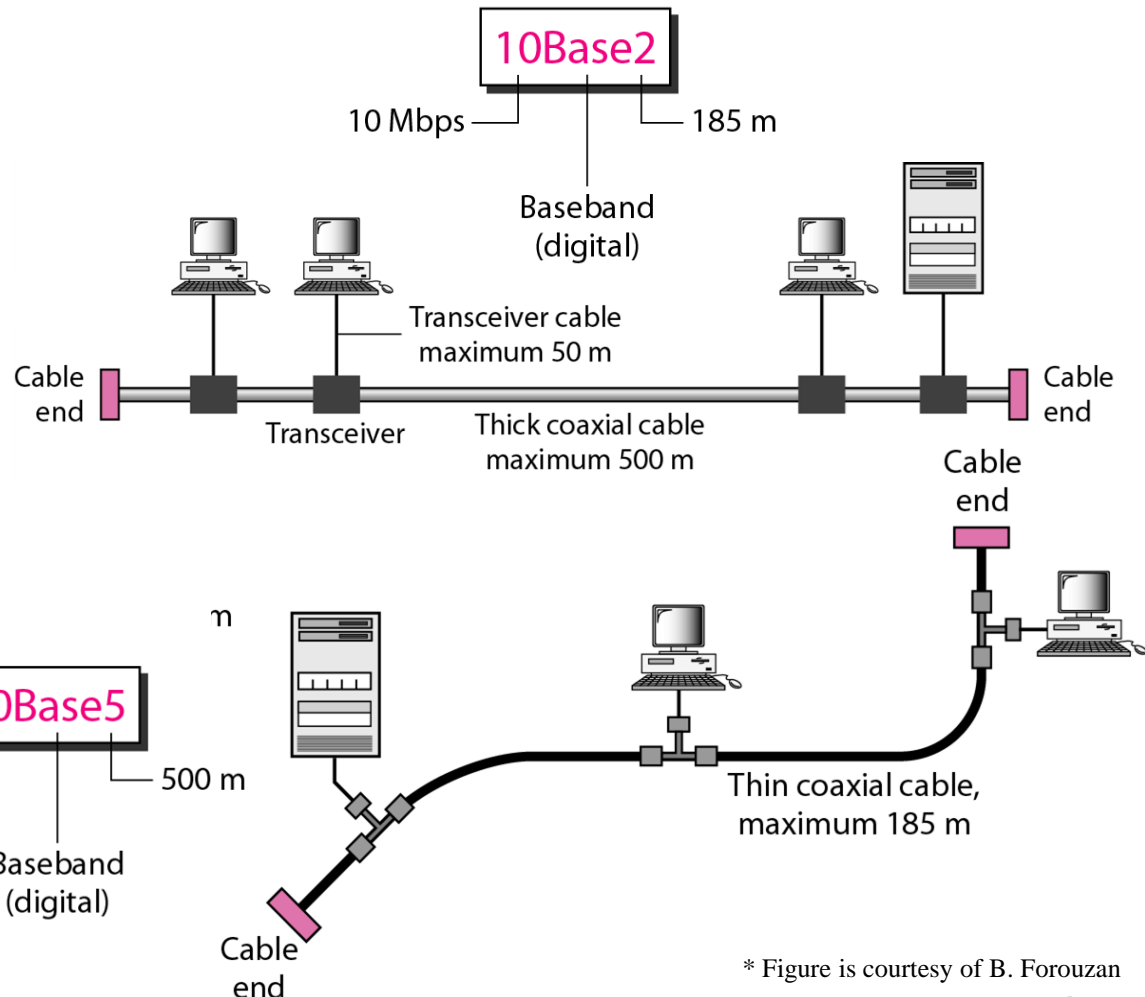
(a) 10Base5, (b) 10Base2, (c) 10Base-T.

10Base5 & 10Base2

- Signal travels over cable & is picked up by all stations

- Used as backbone technology

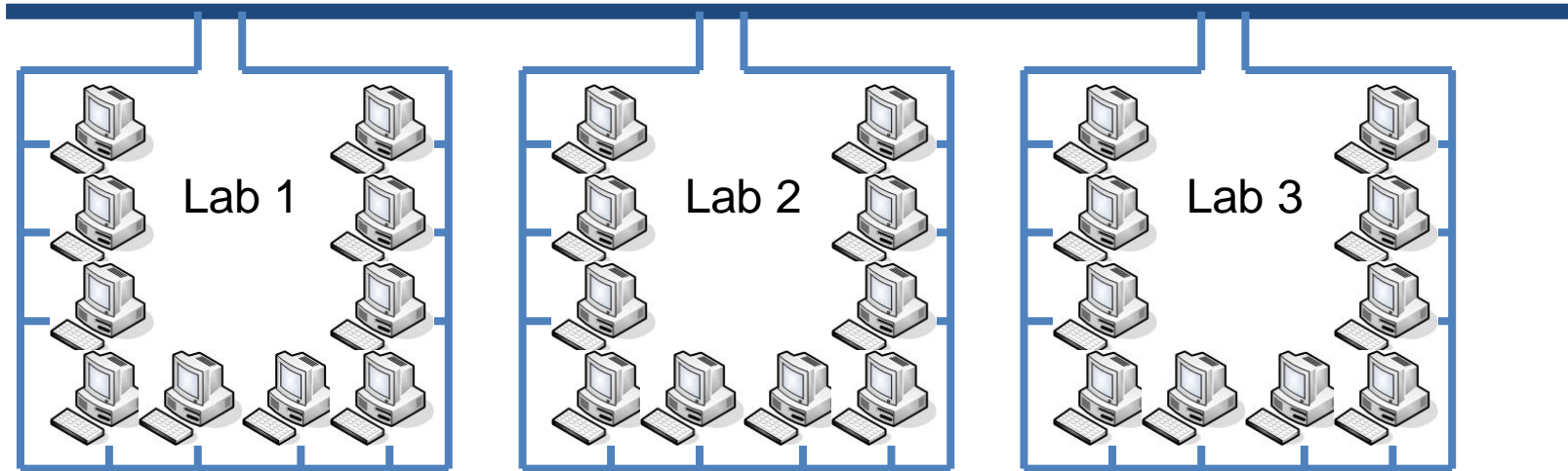
- 10Base5: Stations linked into coaxial cable



* Figure is courtesy of B. Forouzan

Common Configuration

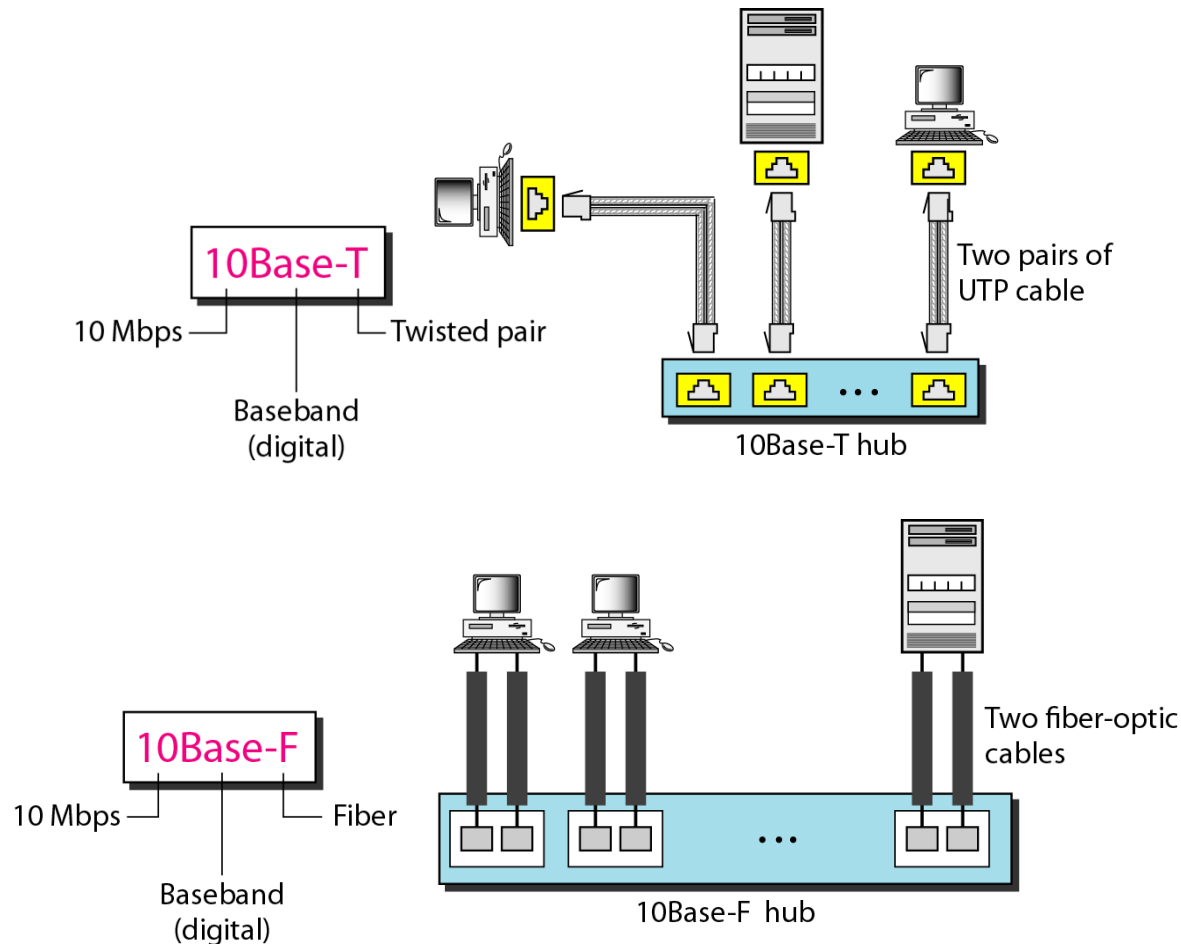
Backbone



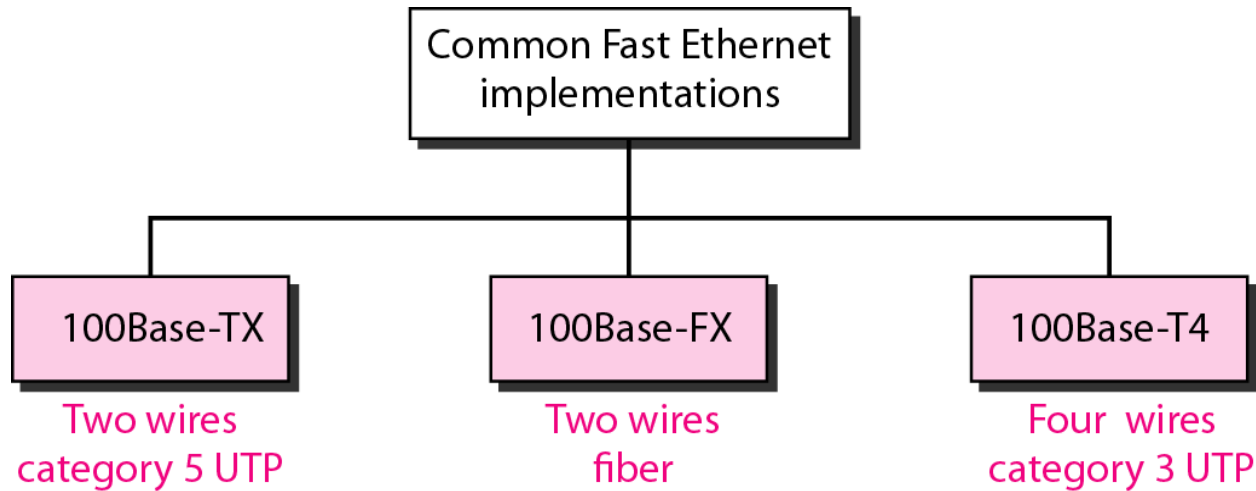
- Thick coax cable as backbone:
 - Inflexible, large segments, 500m
 - Called Thicknet
- Thin coax cable to desktop:
 - Flexible, short segments, 200m
 - Called Thinnet

10Base-T & 10Base-F

- Hub replicates traffic to connected stations
- Each station has its own connection to hub
- Every station hears all traffic!



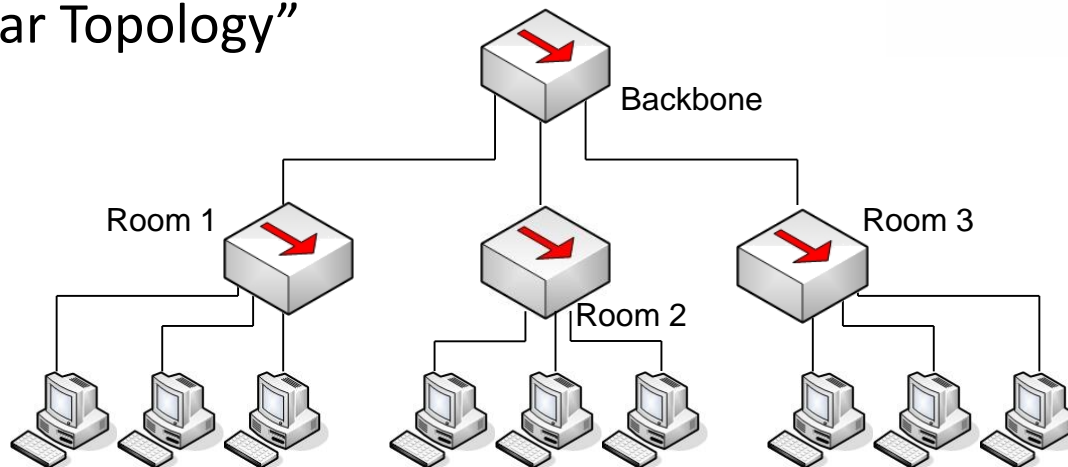
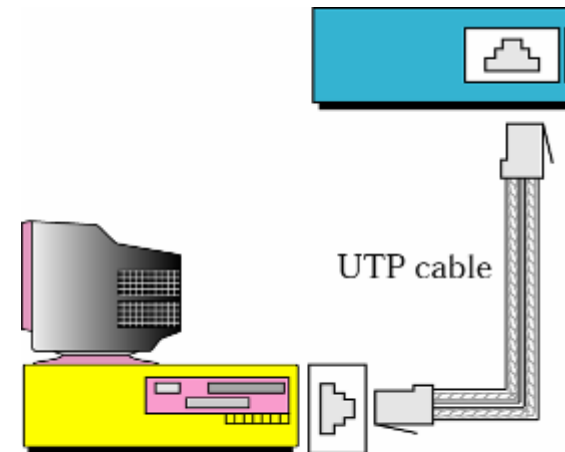
100Base-X



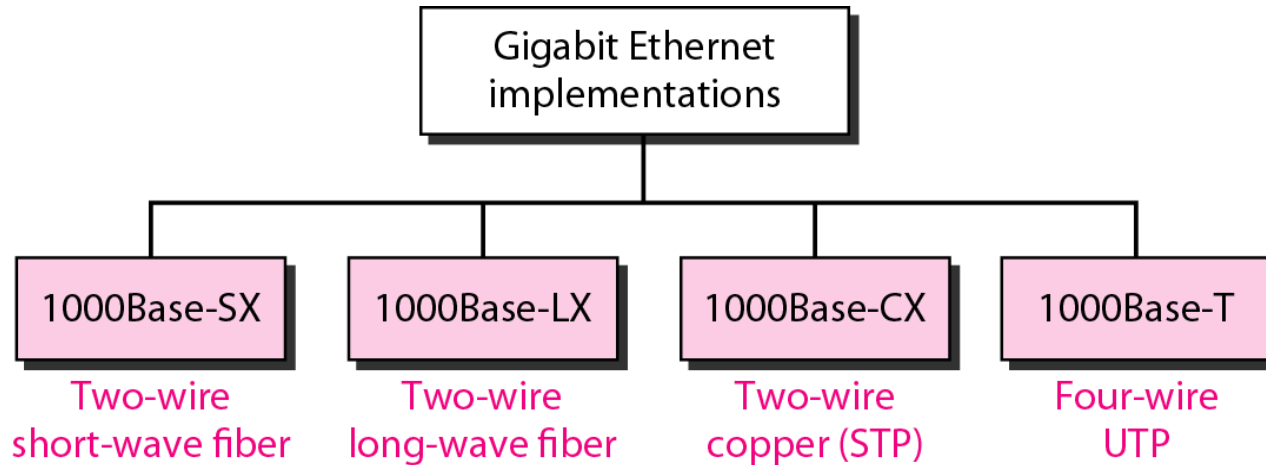
Name	Cable	Max. segment	Advantages
100Base-T4	Twisted pair	100 m	Uses category 3 UTP
100Base-TX	Twisted pair	100 m	Full duplex at 100 Mbps
100Base-FX	Fiber optics	2000 m	Full duplex at 100 Mbps; long runs

100Base-T

- 10/100 Mbps rate
 - latter called “Fast Ethernet”
- T stands for Twisted Pair
- Hub to which nodes are connected by twisted pair
 - “Star Topology”



Gigabit Ethernet



- Minimum frame length: 512 bytes

Ethernet Standards

Name	Cable	Max. seg.	Nodes/seg.	Advantages
10Base5	Thick coax	500 m	100	Original cable; now obsolete
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100Base-FX	Fiber optics	2000 m	Full duplex at 100 Mbps; long runs

Name	Cable	Max. segment	Advantages
1000Base-SX	Fiber optics	550 m	Multimode fiber (50, 62.5 microns)
1000Base-LX	Fiber optics	5000 m	Single (10 μ) or multimode (50, 62.5 μ)
1000Base-CX	2 Pairs of STP	25 m	Shielded twisted pair
1000Base-T	4 Pairs of UTP	100 m	Standard category 5 UTP

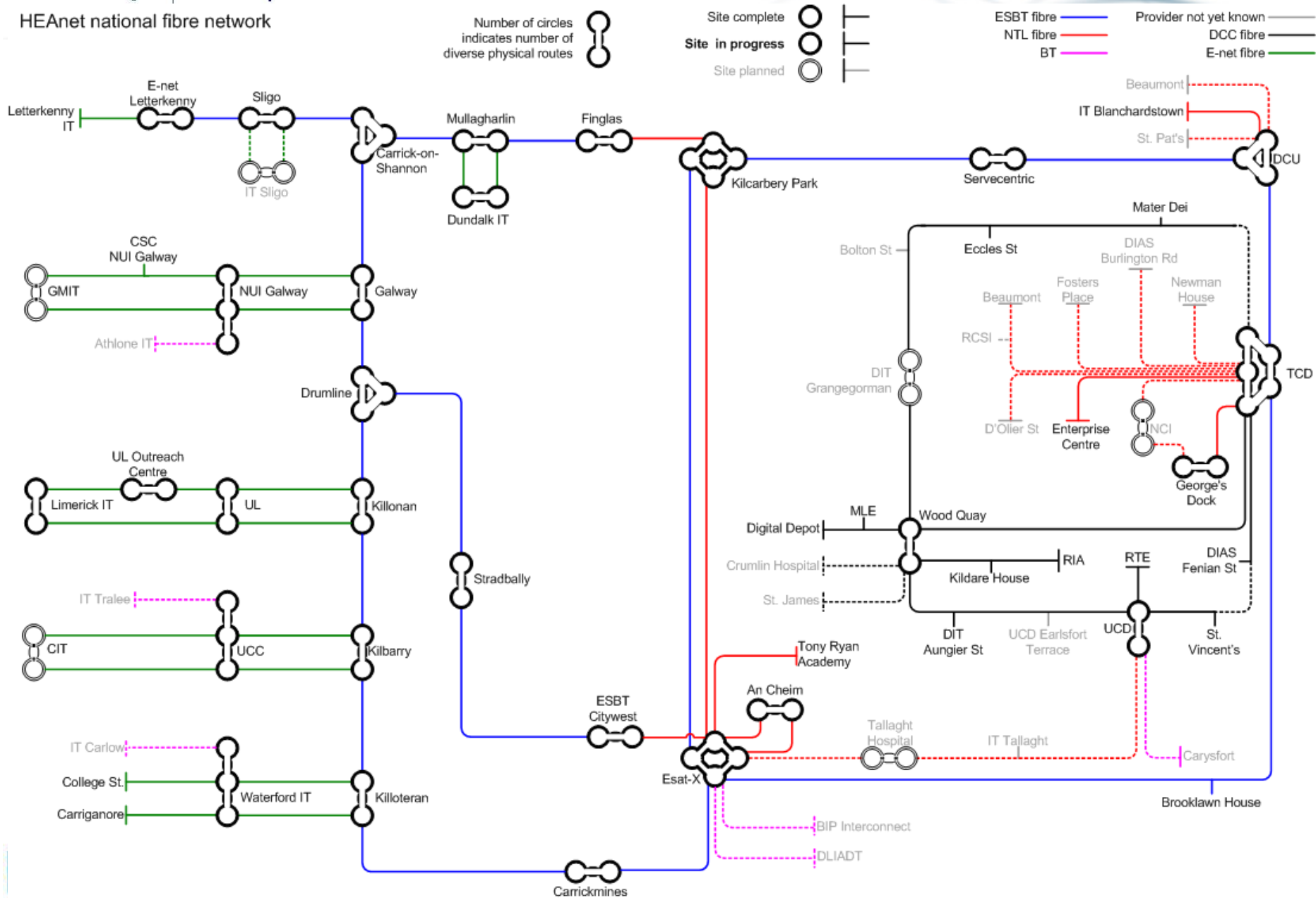
802.3ae 10GB-Ethernet

<i>Characteristics</i>	<i>10GBase-S</i>	<i>10GBase-L</i>	<i>10GBase-E</i>
Media	Short-wave 850-nm multimode	Long-wave 1310-nm single mode	Extended 1550-nm single mode
Maximum length	300 m	10 km	40 km

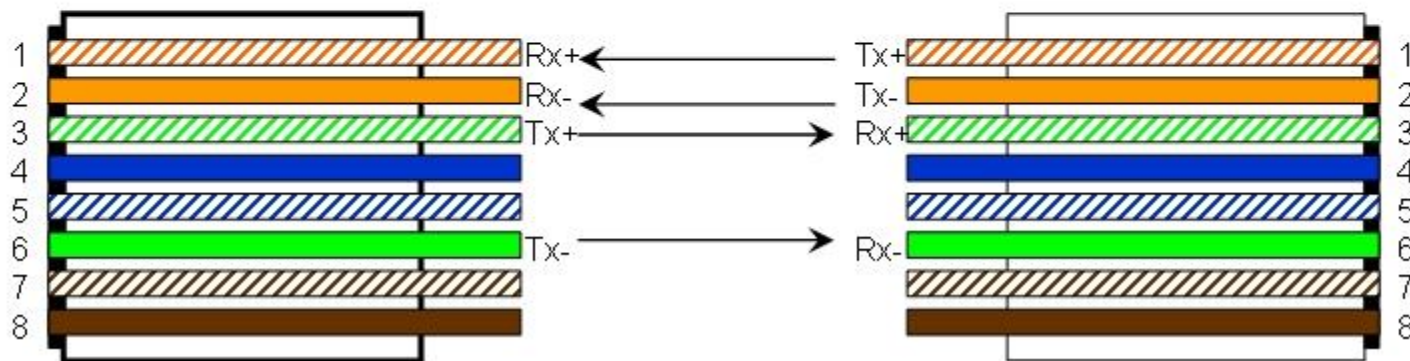
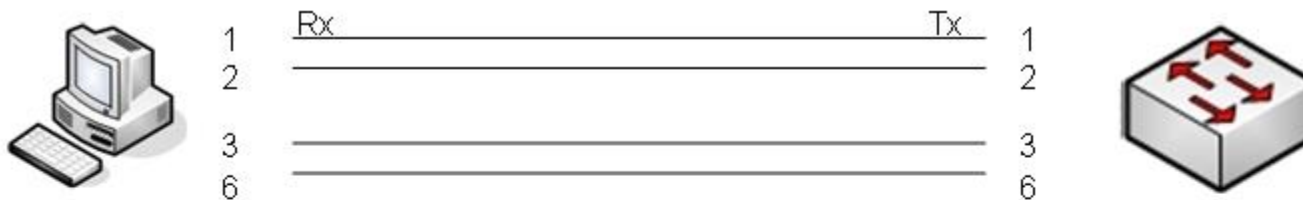
- Backbone technology
- Based on optical fibre

school of Computer Science & Statistics

HEAnet national fibre network

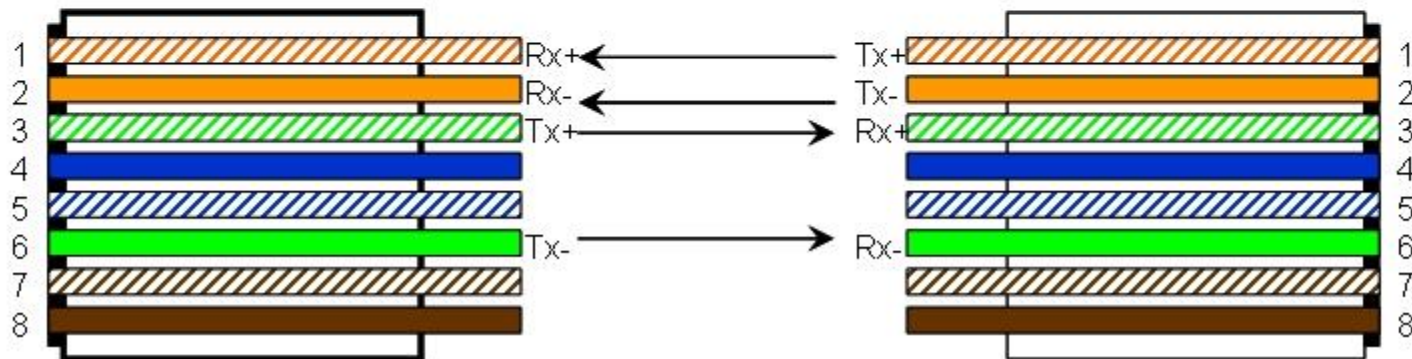
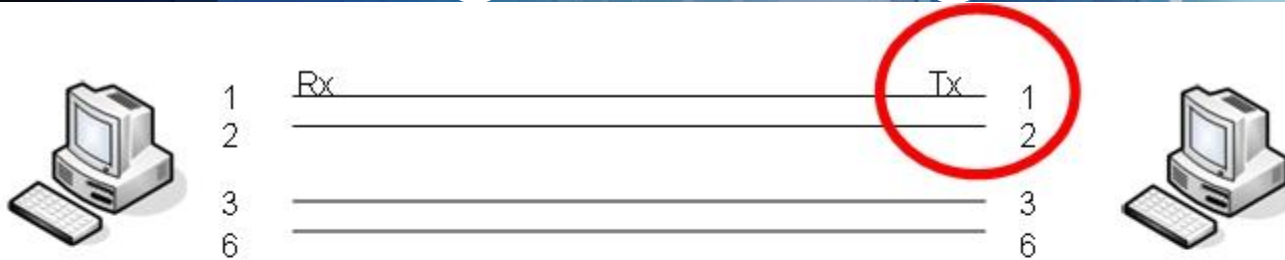


Straight Cabling & RJ45



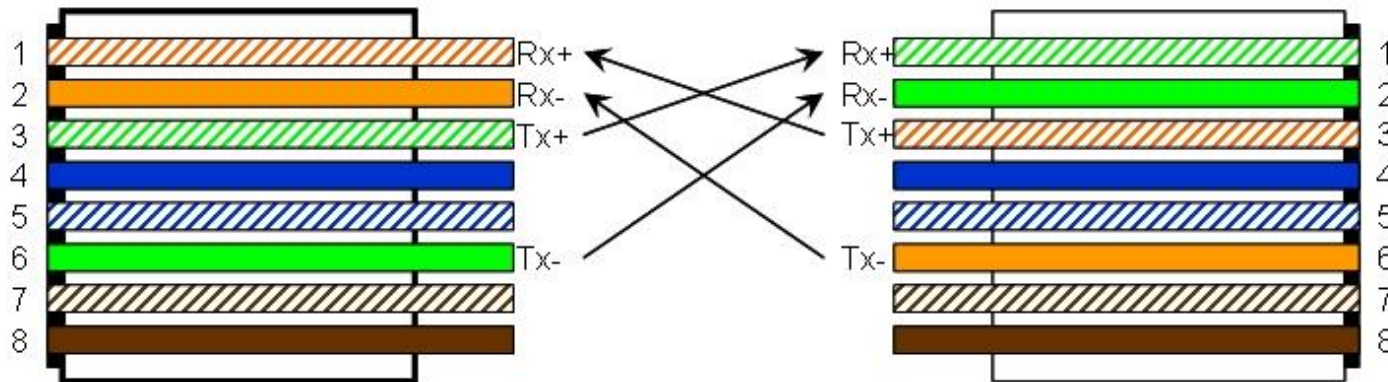
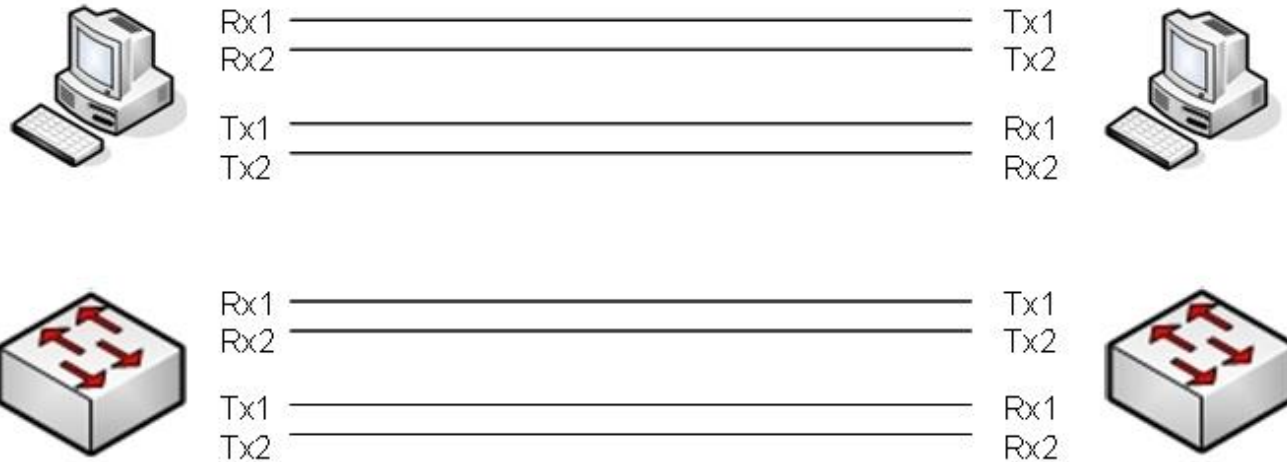
- Switch expects
 - Transmission from station on 3 & 6
 - Transmits on 1 & 2

Straight Cabling II



- Switch expects
 - Transmission from station on 3 & 6
 - Transmits on 1 & 2

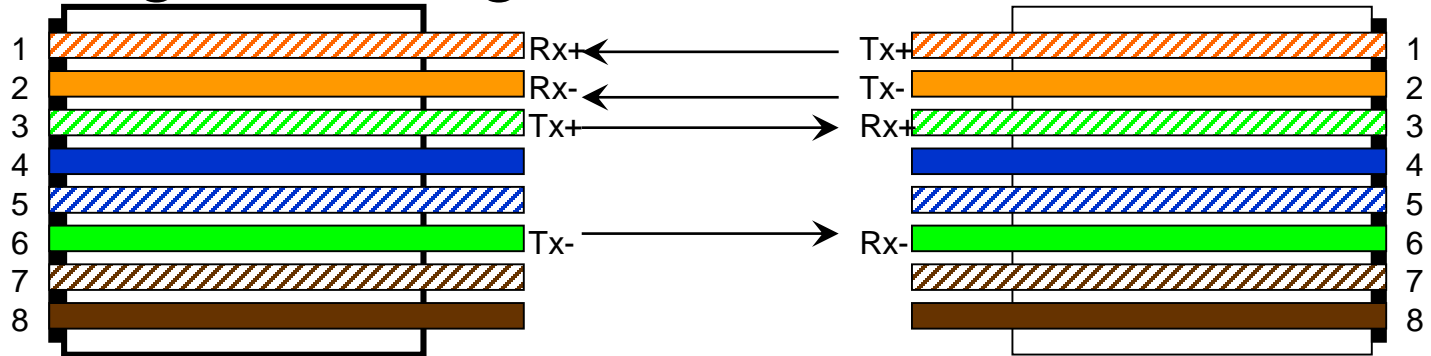
Crossover Cabling



- Direct connection of desktops & infrastructure equipment

RJ45 Cabling

■ Straight cabling:



■ Crossover cabling:

