CSCI 466: Networks

Link Layer

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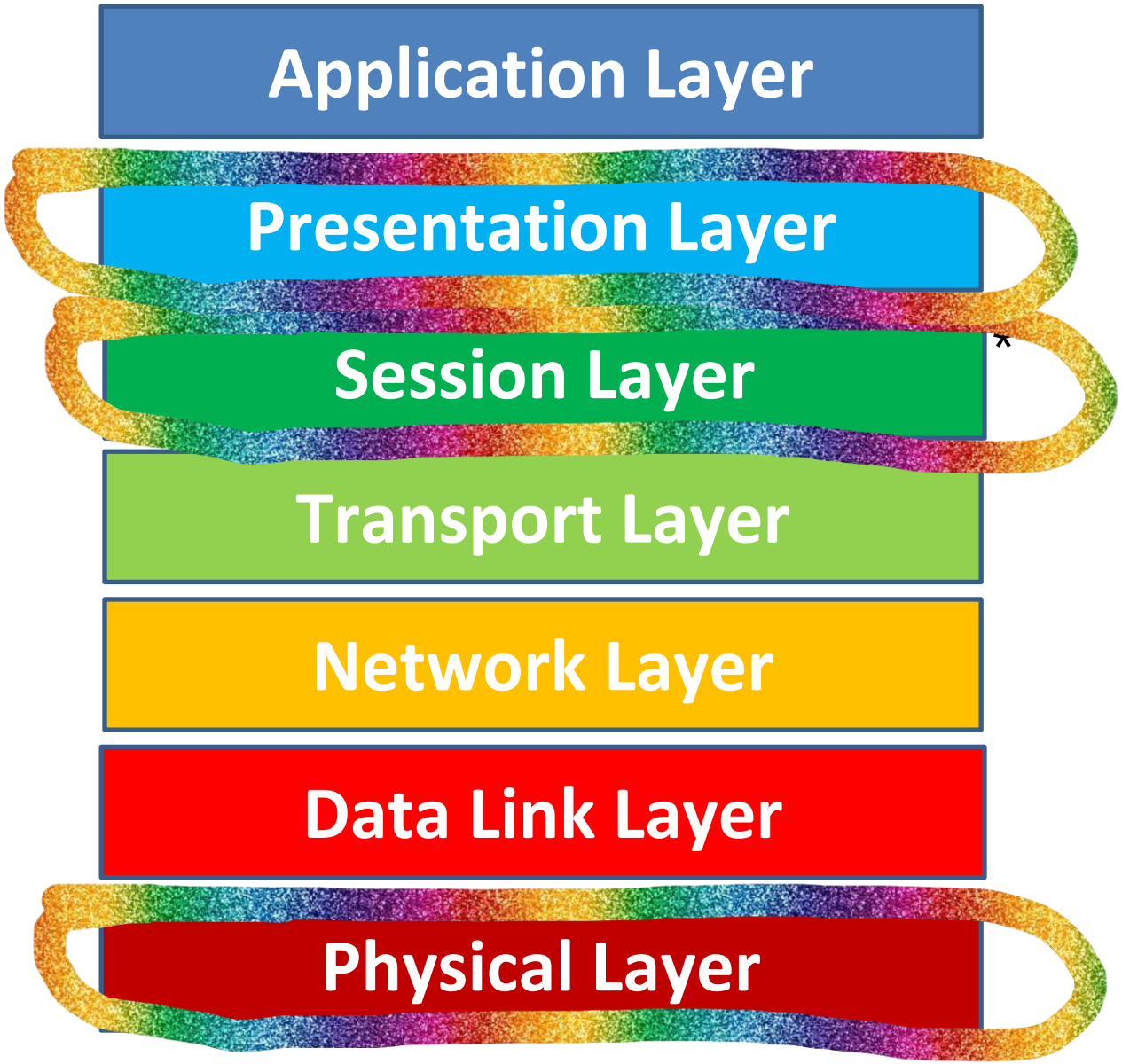
Fall 2022

Announcements

NO CLASS Friday 11/11

Lab 2 Posted Later today

OSI Model



Application Layer

Messages from Network Applications

Physical Layer

Bits being transmitted over a copper wire

**In the textbook, they condense it to a 5-layer model, but 7 layers is what is most used*

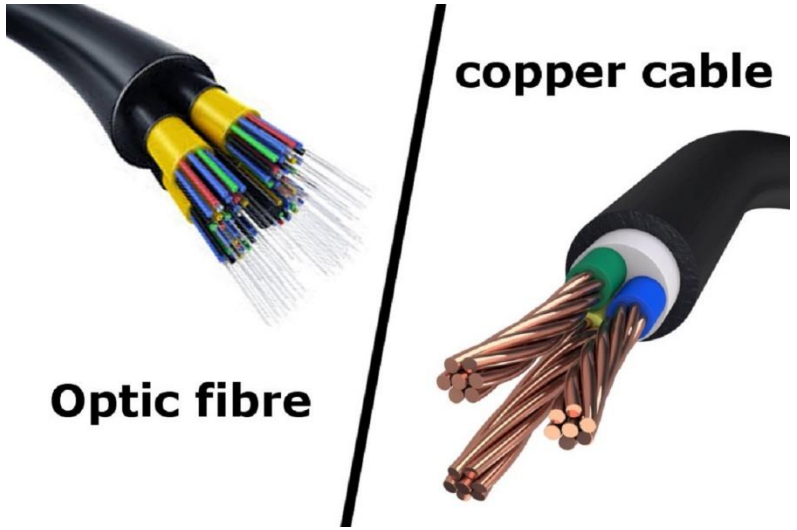
Physical Layer

0101011101010101010101111101000010101010101010101

Goal: To transmit N bits from a *transmitter* to a *receiver* over an analog channel in a timely manner and with low error

What types of medium?

Copper Wire
Optic Fiber
Radio Frequency / Through the air



Physical Layer

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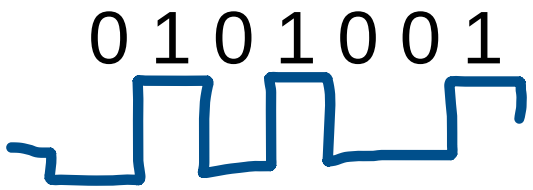
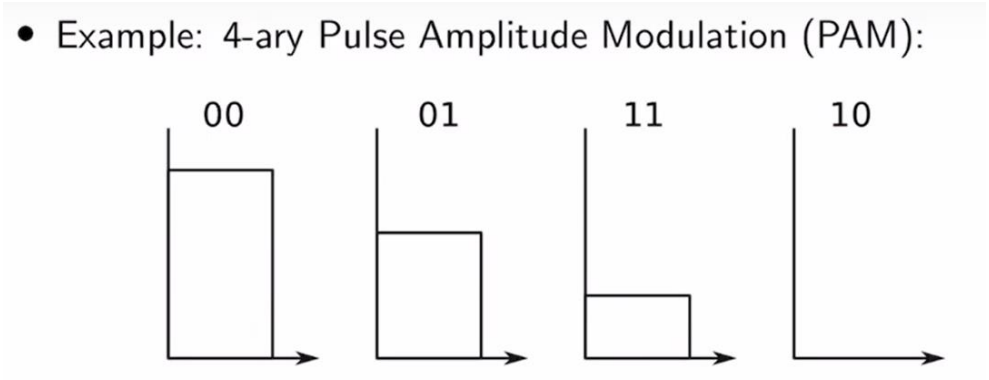
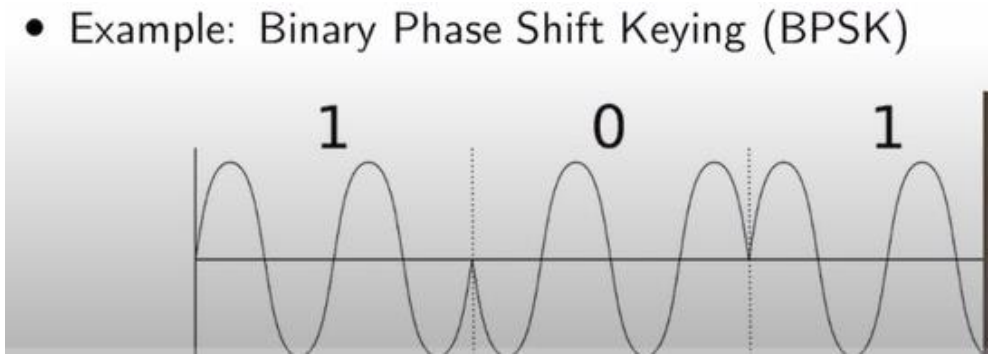
Ethernet Frame

Representing zeros and ones in the physical layer



0 = no electricity
1 = electricity





There are a lot of ways to represent 0/1s

Physical Layer

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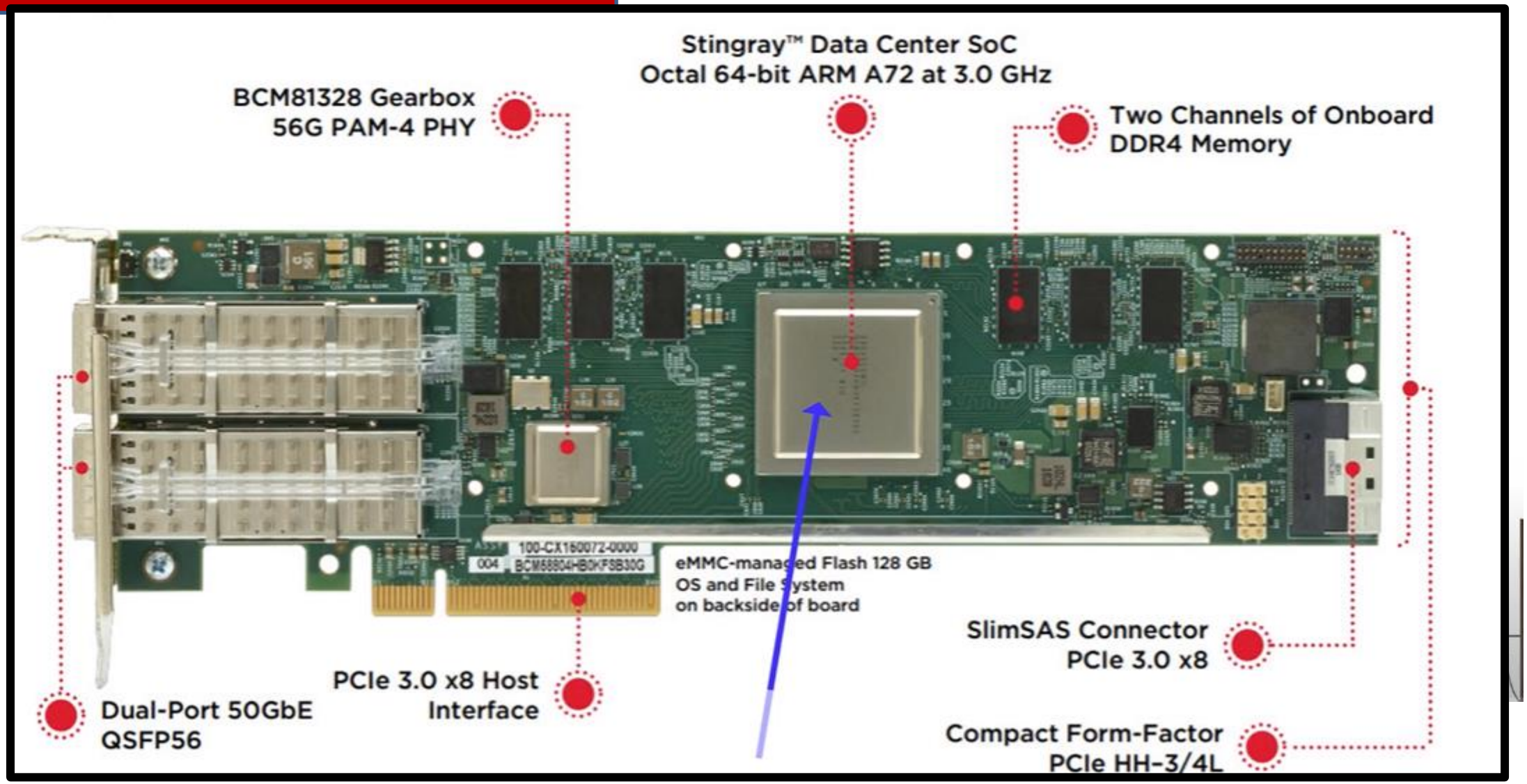
Ethernet Frame



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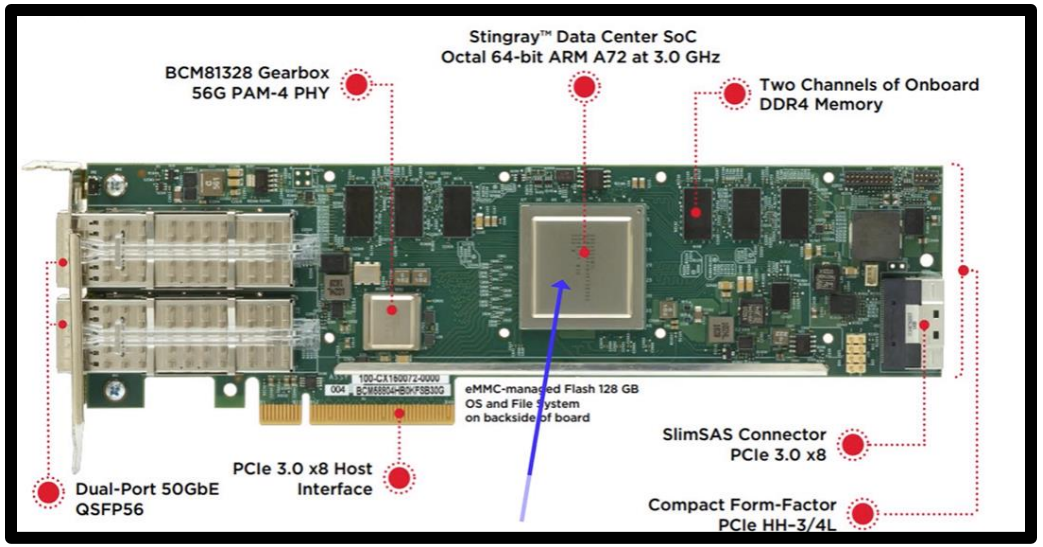
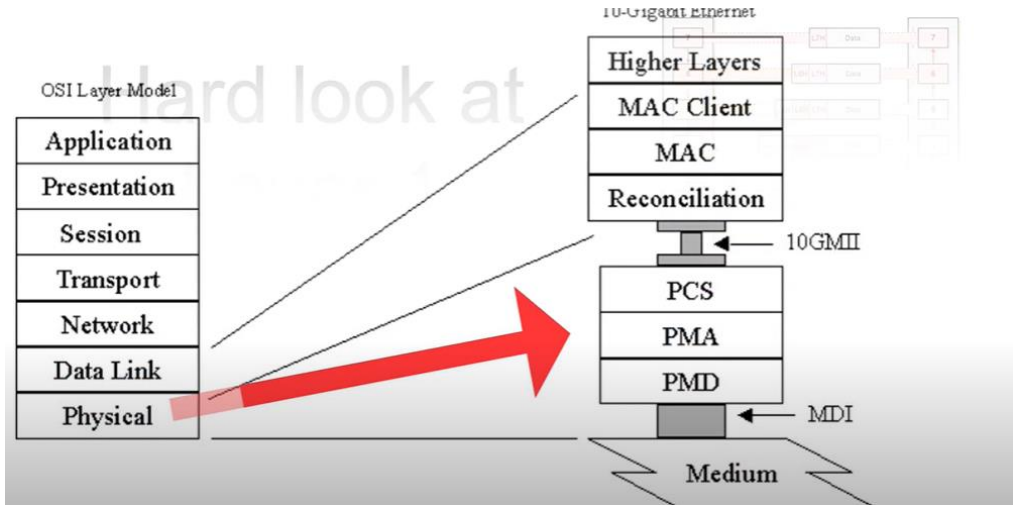




Physical Layer typically has three sub layers

PCS- Encoding the binary data
PMA- Parallel to serial or serial to parallel
PMD – Voltage amplifiers/LEDs/Lasers

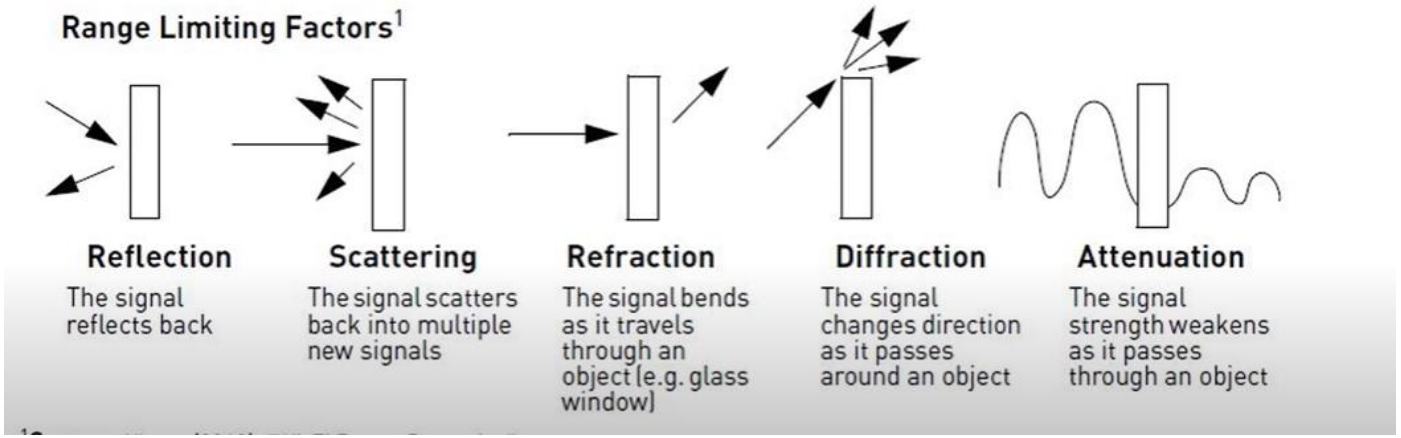
Physical Layer

0101011101010101010101111101000010101010101010101

Ethernet Frame

Noise and interference will corrupt the analog waveforms as they travel through the channel

Each analog channel has a probability ***p*** of bit error



Typical Values of ***p***?

A wireless link may have a raw ***p*** of 1e-3, with error correction, this can be improved to 1e-6
Fiber optic link may have ***p*** of 1e-12

That a very low probability!!!

Physical Layer

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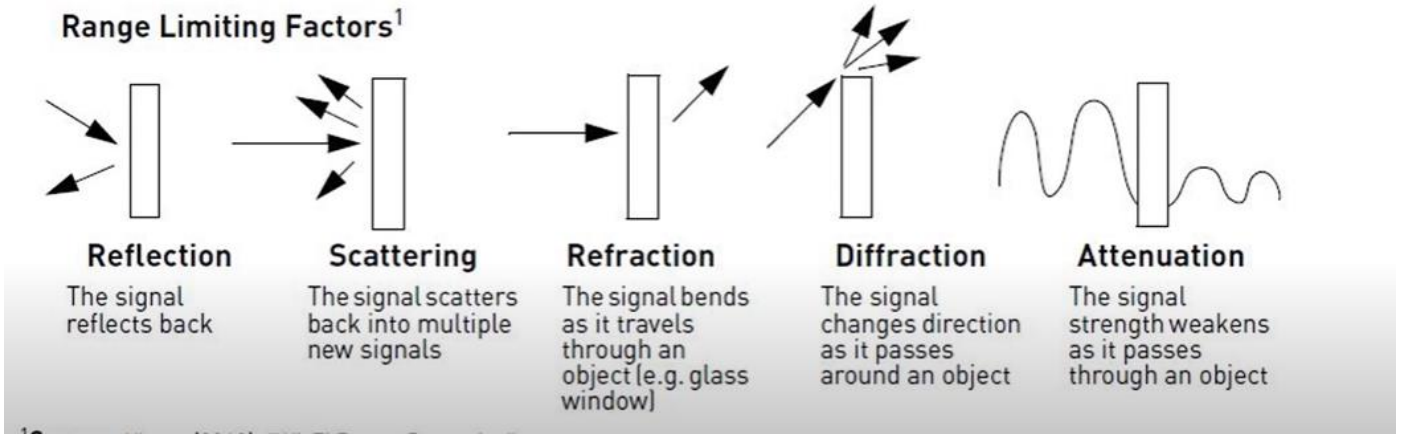

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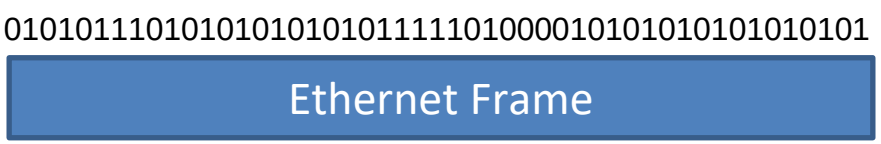
That a very low probability!!!

80 Mbs Wifi Link where ***p=1e-3*** means 4,800 bit errors every minute
10 Gbps fiber optic link where ***p=1e-12*** means 36 bit errors every hour

Physical Layer



Error Patterns

Frame transmitted: 10110
Error Pattern: 10001

Suppose through error correction in the link layer, we found that a bit error occurred on the first bit and last bit of our pattern

How to get the correct bit pattern of our frame?

Physical Layer

Error Patterns

Frame transmitted: 10110
Error Pattern: 10001

00111

Suppose through error correction in the link layer, we found that a bit error occurred on the first bit and last bit of our pattern

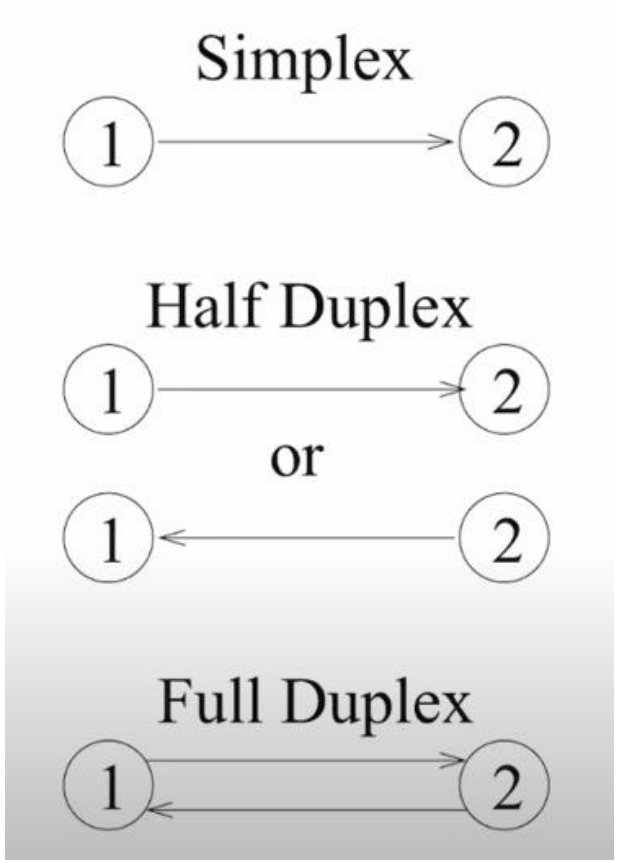
We can run the XOR operator to get the correct pattern back

Physical Layer

0101011101010101010101111101000010101010101010101

Ethernet Frame

Physical Layer Transmission



Session Layer

Traffic Control between Computers

Controls connections and connection information

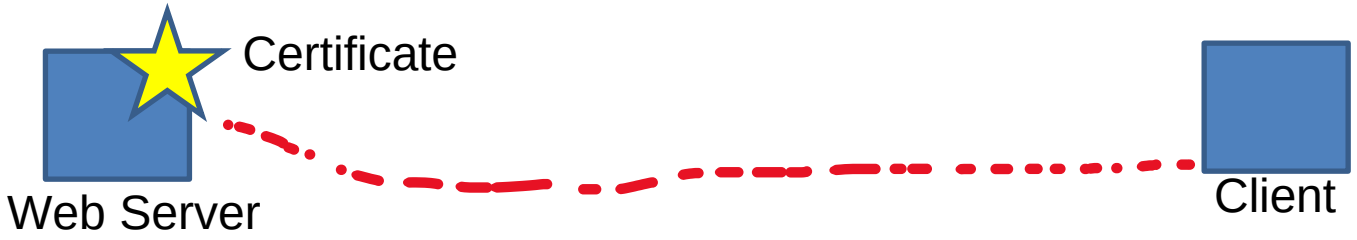
Establishes, manages, and terminates connections

Session Layer also makes sure separate files are downloaded correctly

- Authorization, and Authentication between endpoints happens here

Secure Sockets Layer (SSL)- protocol used to establish a safe, encrypted connection between a web application and web server

Establishes a digital **certificate** to verify a server's identify



No certificate? Cant do HTTP**S**

Before transmitting Data, your machine may do some SSL communication to verify or check the existence of a certificate

Presentation Layer

The layer that allows applications to interpret meanings of data

Three main jobs:
1. Translation

Formats data for proper compatibility between devices

- ASCII
- GIF
- JPG

Ensures the data is readable by receiving system

LETTER	ASCII VALUES	BINARY VALUES
A	65	01000001
C	67	01000011
D	68	01000100
E	69	01000101
F	70	01000110
G	71	01000111
H	72	01001000
I	73	01001001
J	74	01001010
K	75	01001011
L	76	01001100
M	77	01001101
N	78	01001110
O	79	01001111

Presentation Layer

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Three main jobs:
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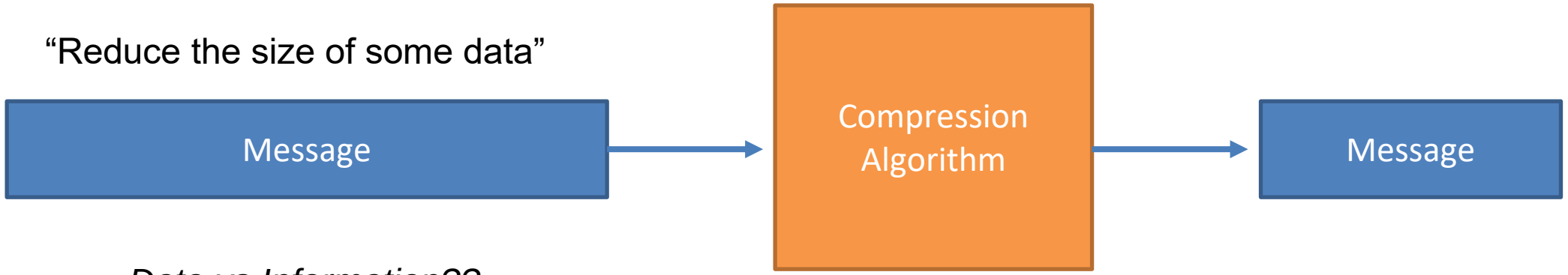
2. Compression

"Reduce the size of some data"



Data vs Information??

Type of compression:
1. **Lossy-** loses some of the original data during compression (is that ok?)
2. **Lossless-** doesn't remove data, instead it transforms it to reduce its size

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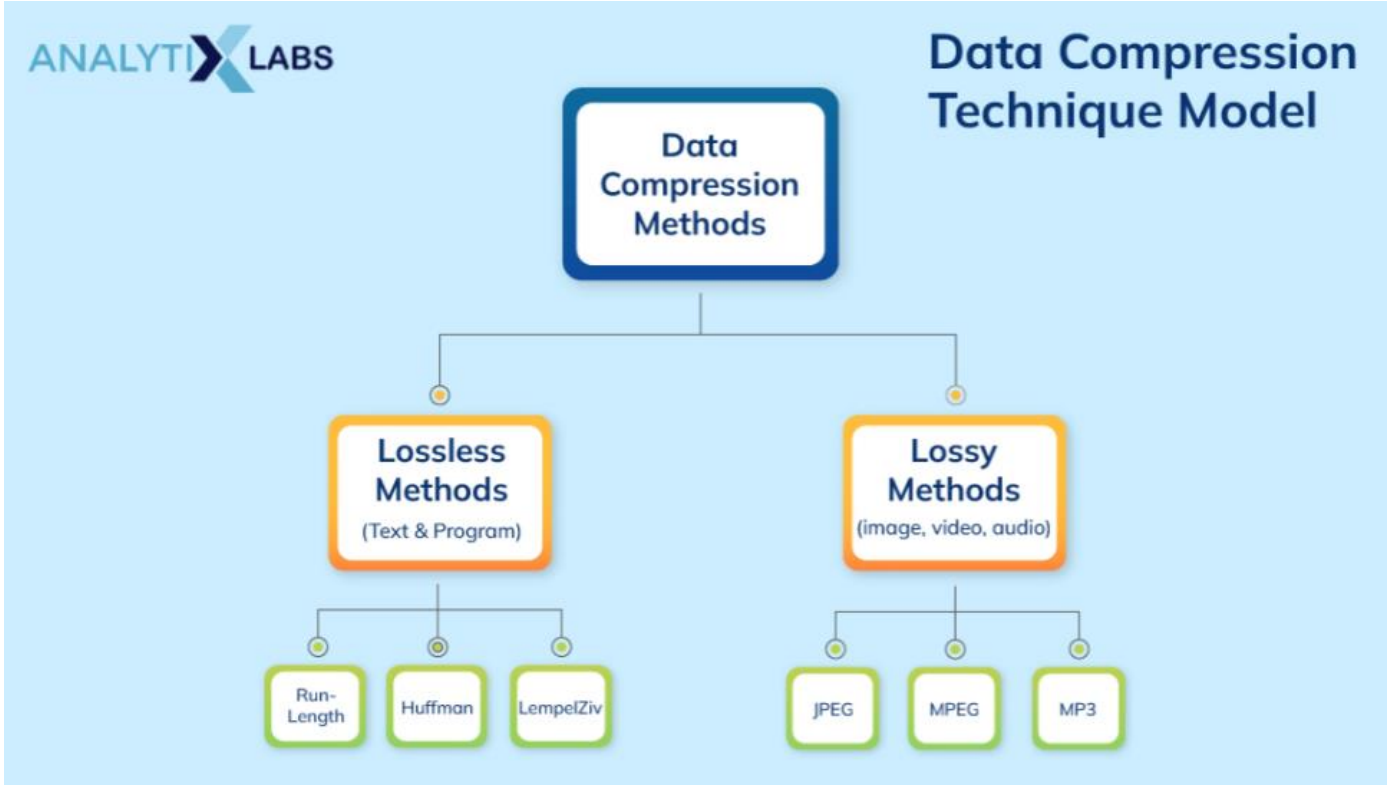

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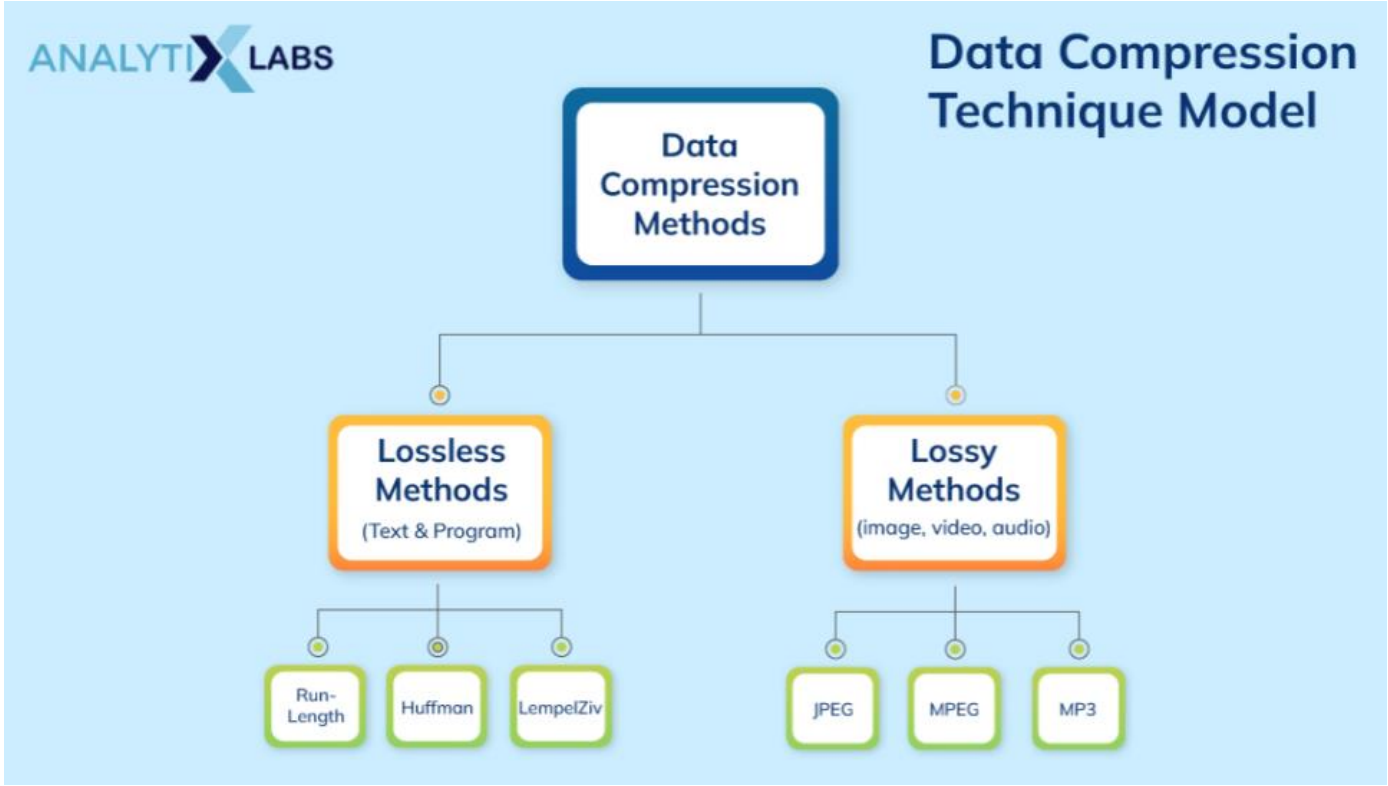

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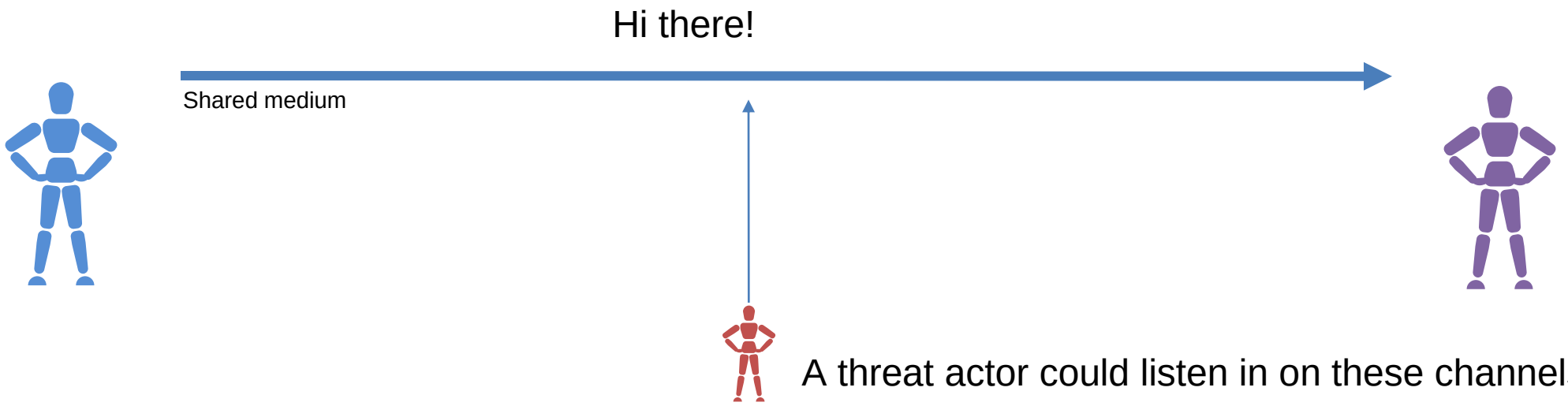
Encryption- securing communication between two endpoints (typically in the presence of an adversary)



Presentation Layer

The layer that allows applications to interpret meanings of data

Three main jobs:
1. Translation
2. Compression
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Hi there! Plaintext

Xb8yDD54zmbm/JFr
9phqTjMzKV98m88k
MYfvSqBoe+Q= Ciphertext

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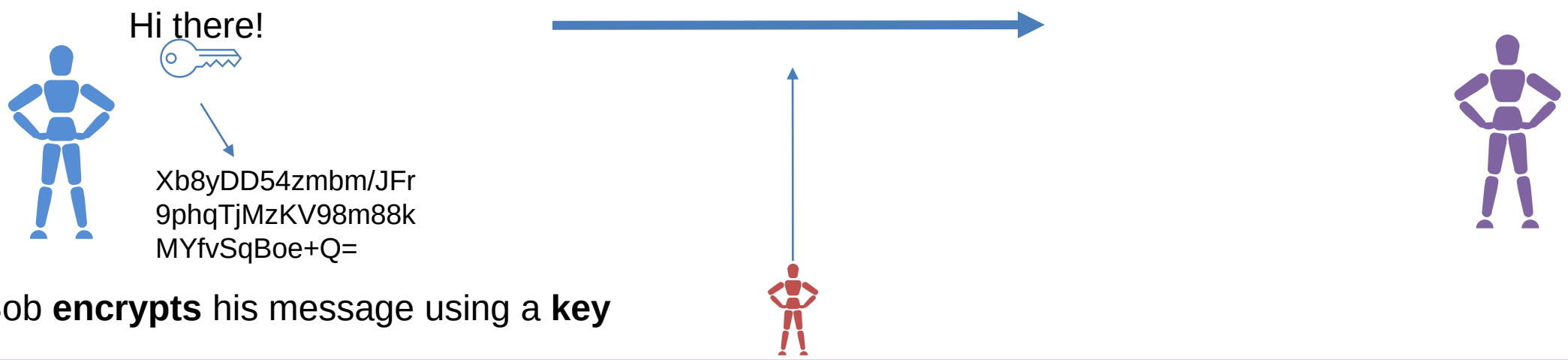

Bob **encrypts** his message using a **key**

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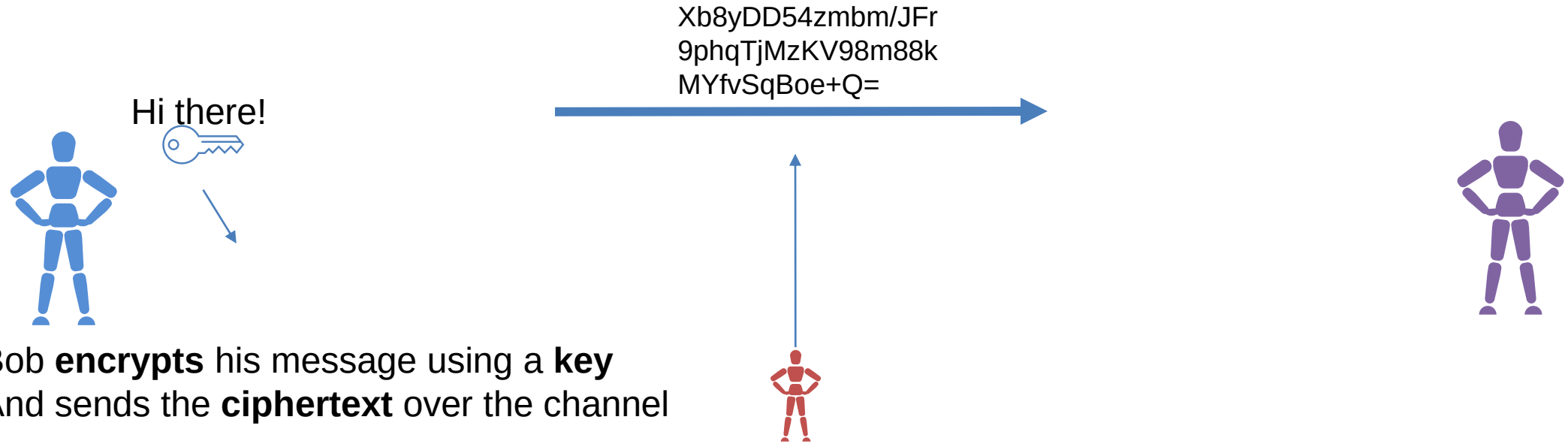

Bob **encrypts** his message using a **key**
And sends the **ciphertext** over the channel

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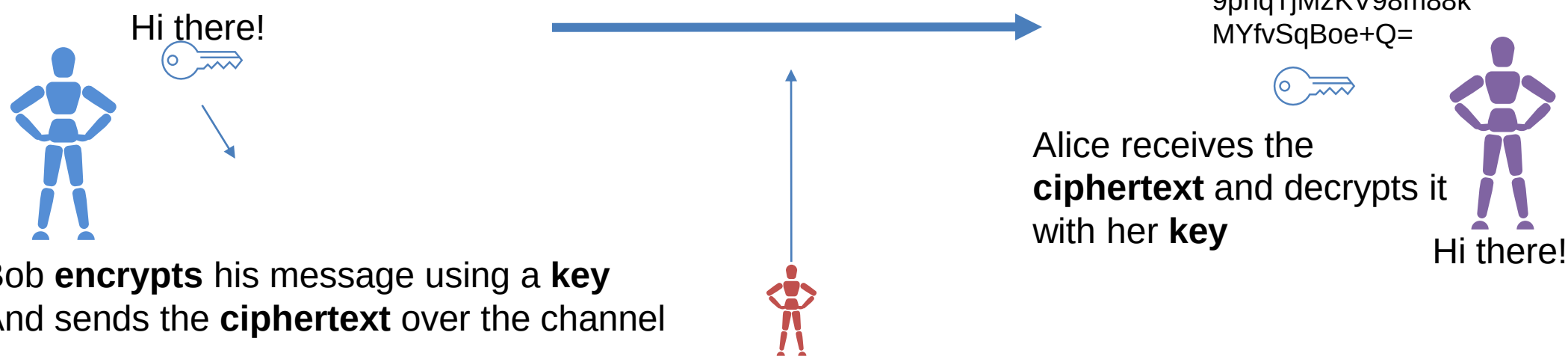

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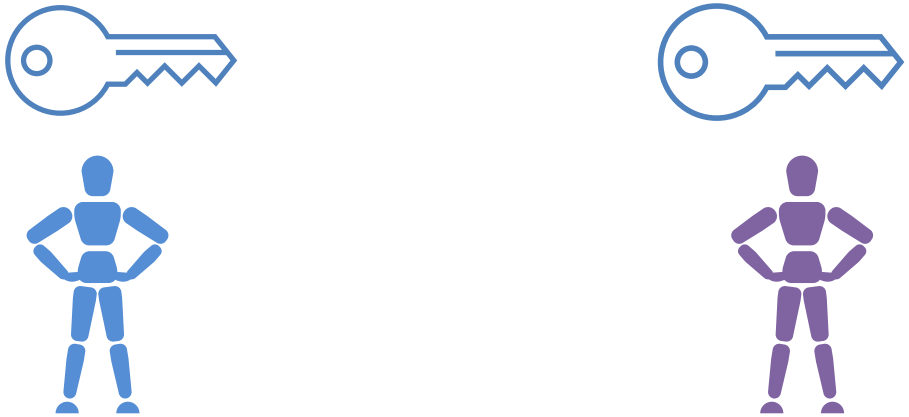

Symmetric Cryptography (Secret Key Encryption)-
Same set of keys are used

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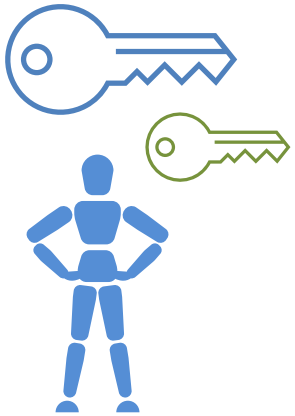

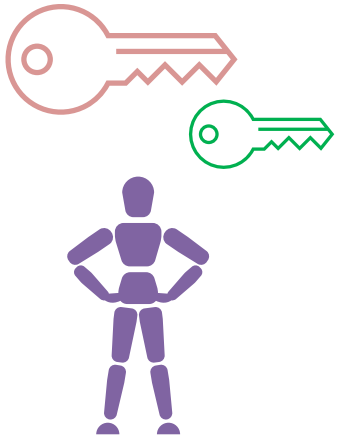

Asymmetric Cryptography (Public Key Encryption)-
Different set of keys are used

7	Application Layer	Human-computer interaction layer, where applications can access the network services
6	Presentation Layer	Ensures that data is in a usable format and is where data encryption occurs
5	Session Layer	Maintains connections and is responsible for controlling ports and sessions
4	Transport Layer	Transmits data using transmission protocols including TCP and UDP
3	Network Layer	Decides which physical path the data will take
2	Data Link Layer	Defines the format of data on the network
1	Physical Layer	Transmits raw bit stream over the physical medium

Next up:

Security
- Firewalls/Tunnels/VPNs
- Encryption
- Network Attacks and Defenses

Wireless Networks + Wifi