Physical Layer

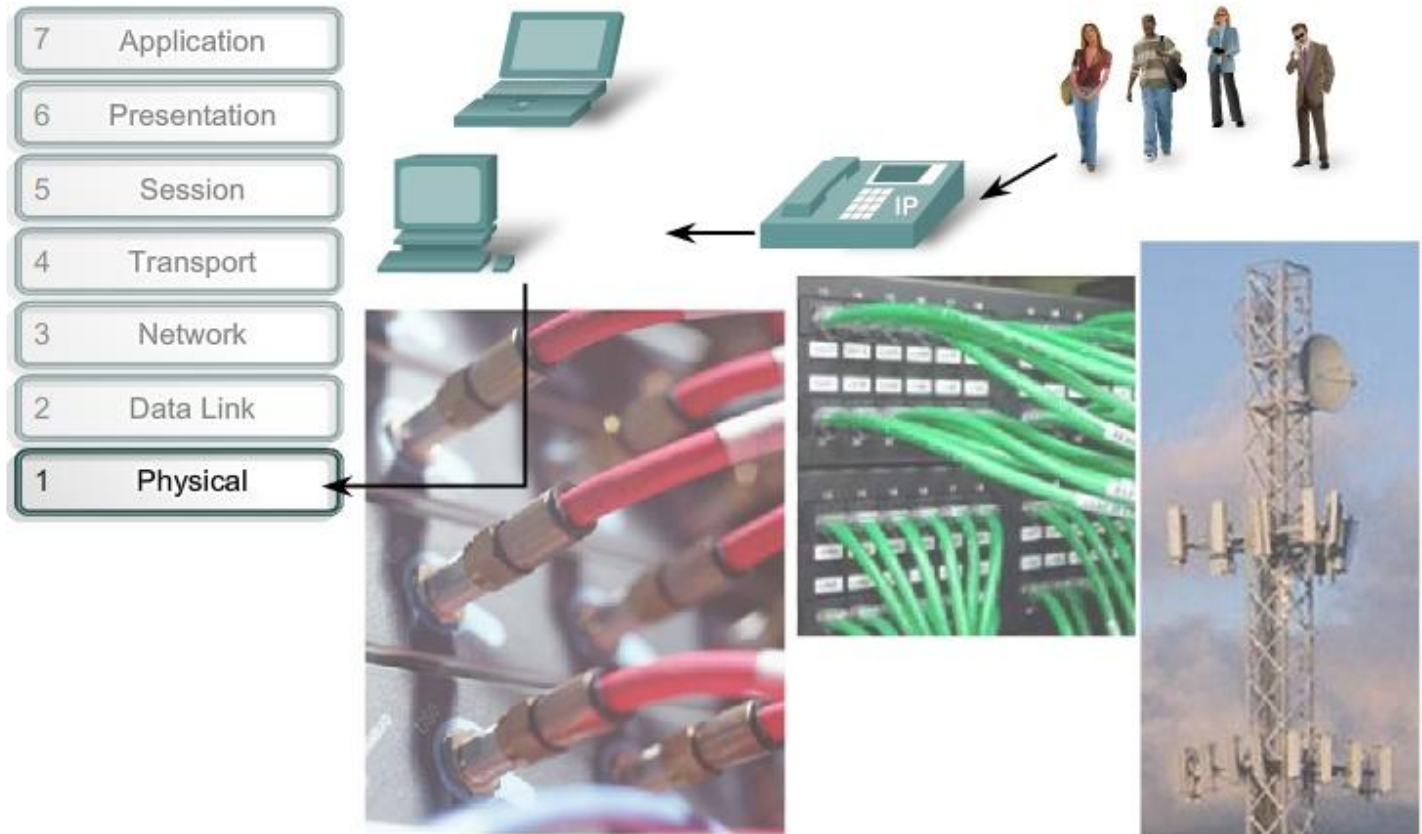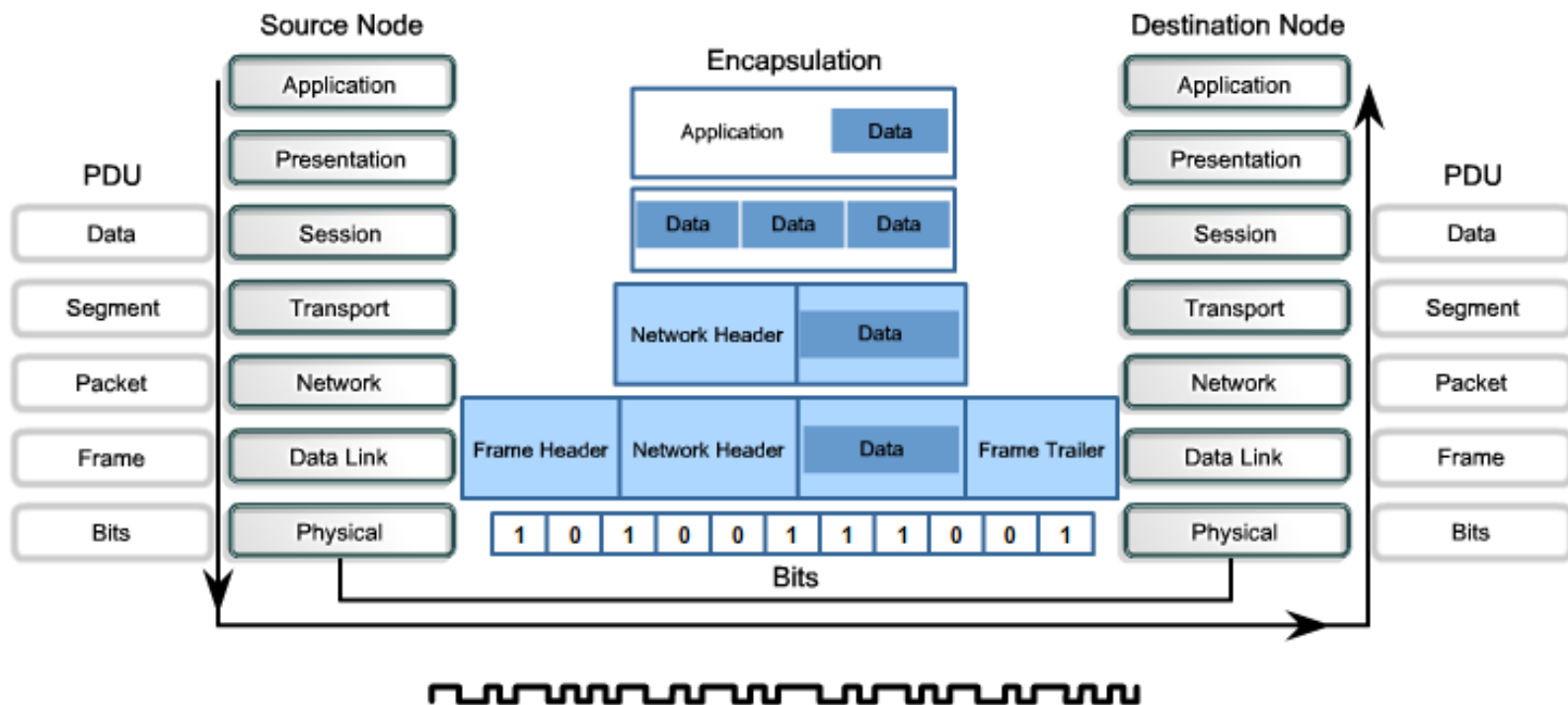| 7	Application
6	Presentation
5	Session
4	Transport
3	Network
2	Data Link
1	**Physical**

The Physical layer interconnects our data networks.

Physical Layer- Purpose

Transforming Human Network Communications to Bits

In diagrams, signals on the physical media are depicted by this line symbol.
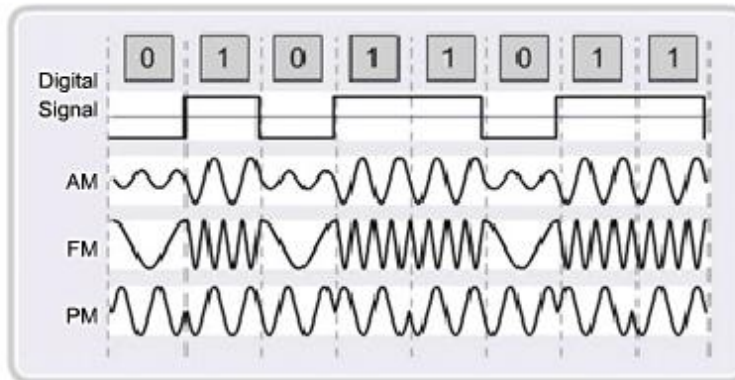
Physical Layer -Operation

Representations of Signals on the Physical Media

Sample electrical signals transmitted on copper cable
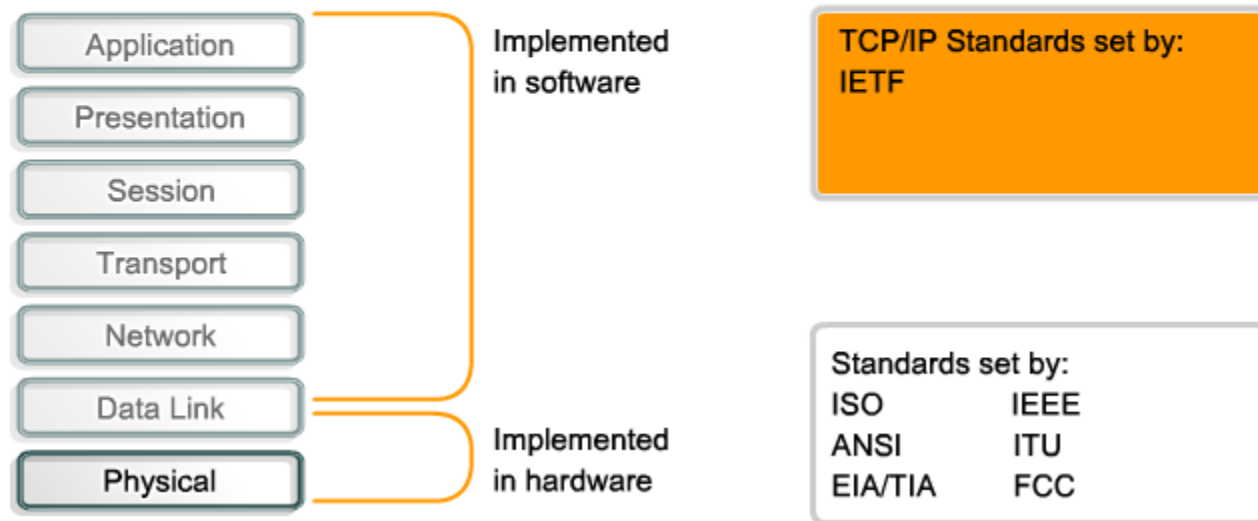
Representative light pulse fiber signals

Microwave (wireless) signals
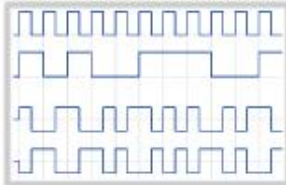
Physical Layer -Standards

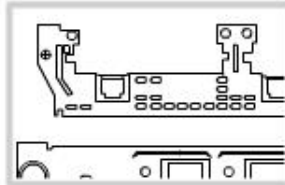Comparison of Physical Layer Standards and Upper Layer Standards

Physical Layer –Standards..

Standards for the Physical layer specify signal, connector, and cabling requirements.
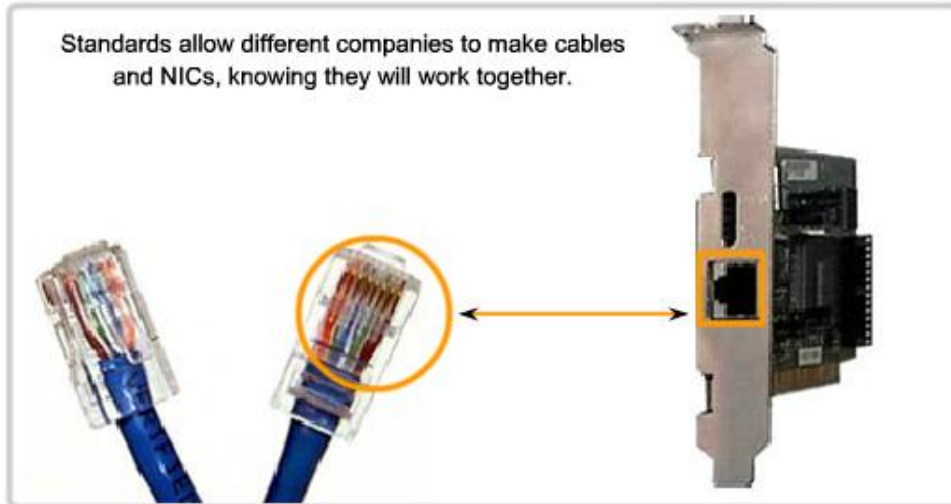
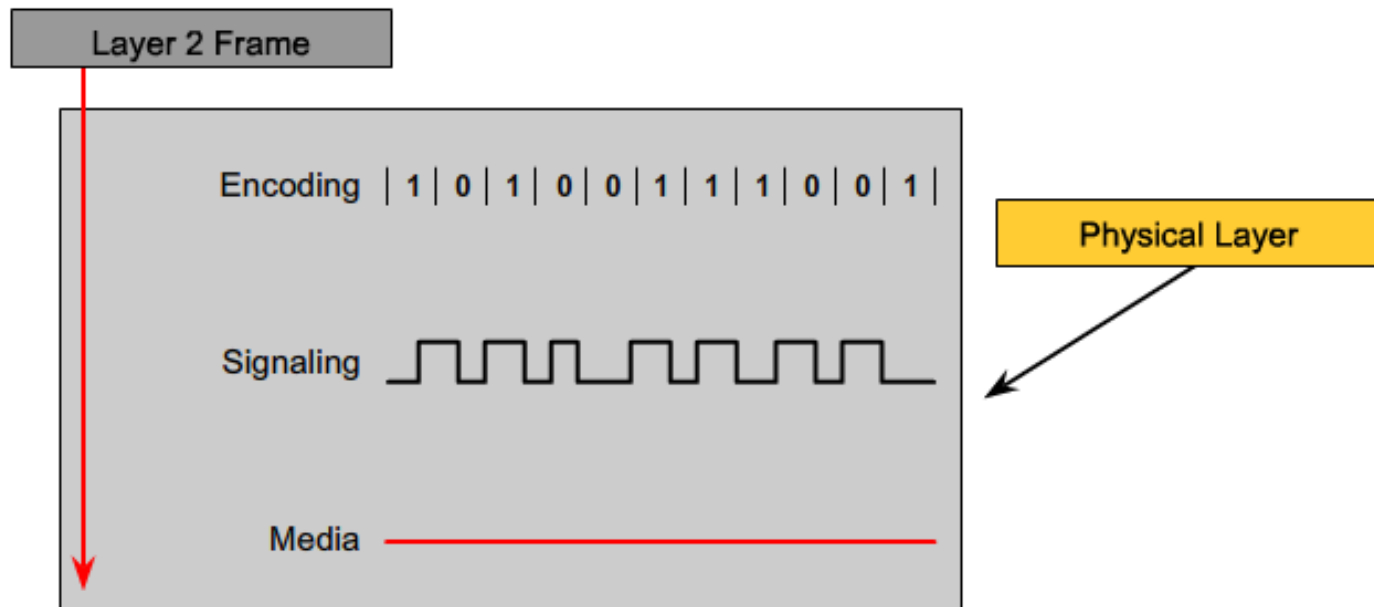| SIGNALS | CONNECTORS | CABLES |

Standards allow different companies to make cables and NICs, knowing they will work together.

Click to learn more.

Physical Layer fundamental Principles

Physical Layer Fundamental Principles

Layer 2 Frame

Encoding | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |

Signaling

Physical Layer

Media

Signaling Bit for the Medium

Ways to Represent a Signal on the Medium
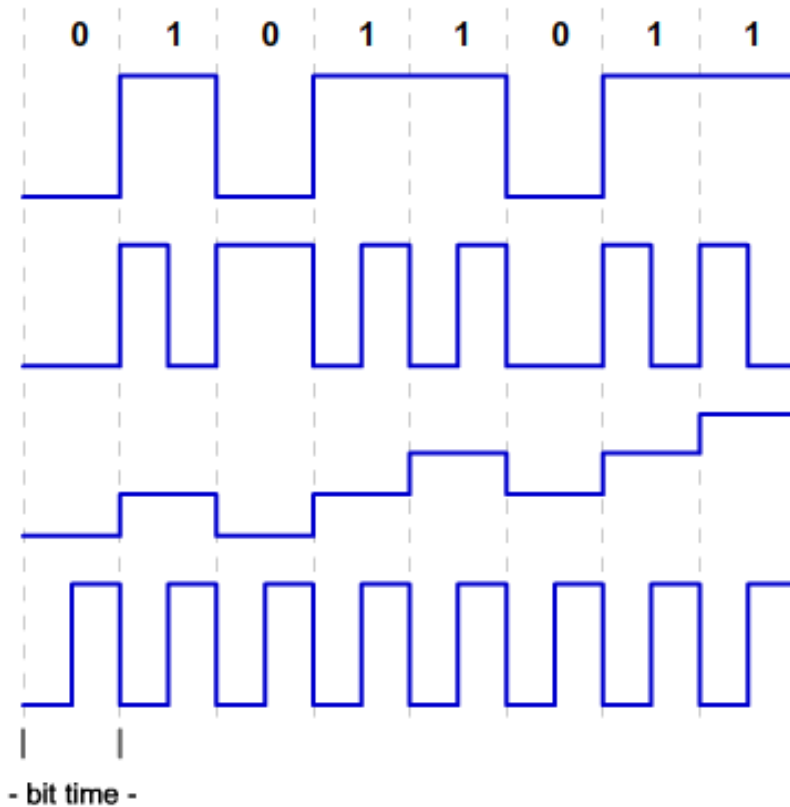
Signaling bits for the media

Signaling Bits for Transmission
Non Return to Zero (NRZ)

T = Bit-Time
A = Amplitude (height of pulses)

+ Volts

T

1   0   1   0   1

A

0 Volts
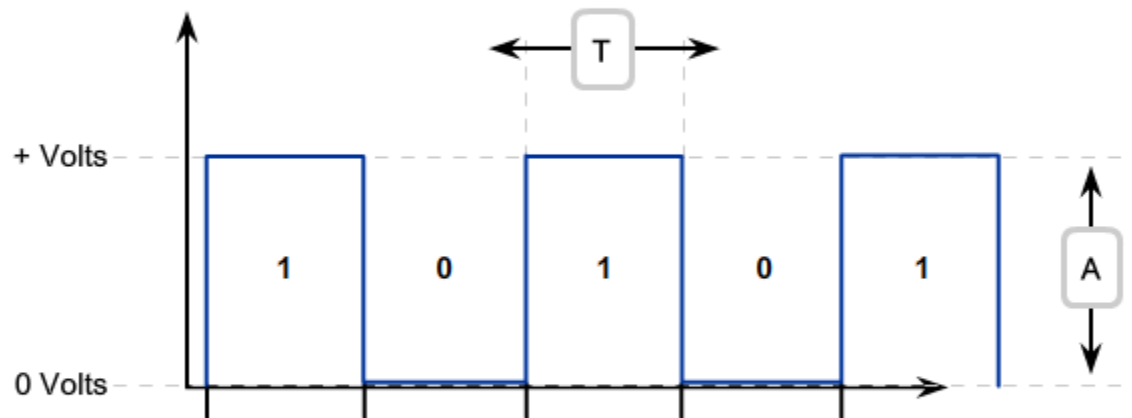
- Discrete pulses (not continuous)
- Can only have one of two states (1/0, on/off)
- Voltage jumps between levels

Signaling bits for the media…

Signaling Bits for Transmission
Manchester Encoding

Manchester Encoding uses the **change in signal level** in the middle of the bit time to represent the bits.
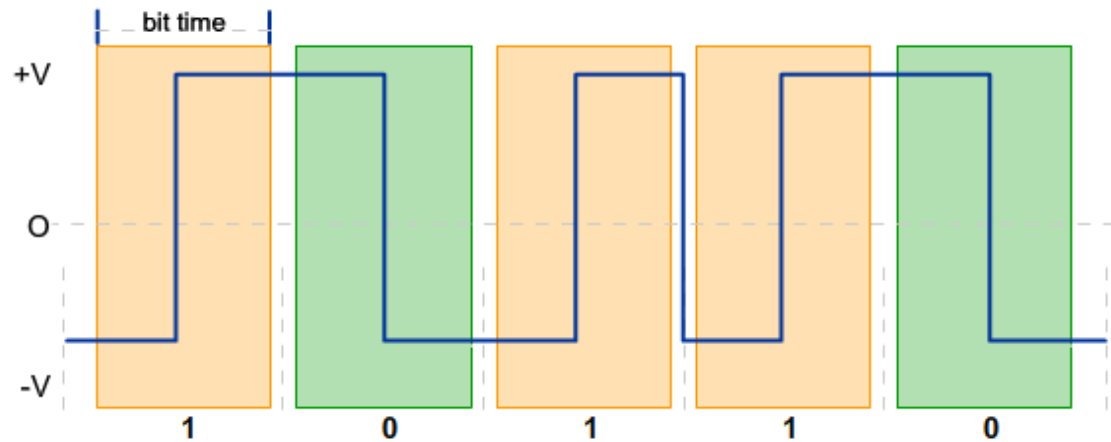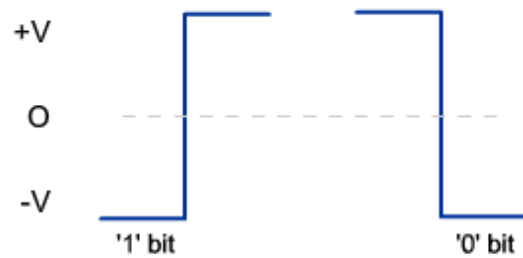
Encoding-Grouping bits

Recognizing Frame Signals

Encoding-Grouping bits...

Code Groups

| Data bits | 1 1 1 1 1 1 1 1 |

| Code symbol for data bits | 1 0 1 0 1 1 0 0 0 1 |

| Signaling onto media | |

Encoding-Grouping bits…

4B/5B Code Symbols

Data Codes

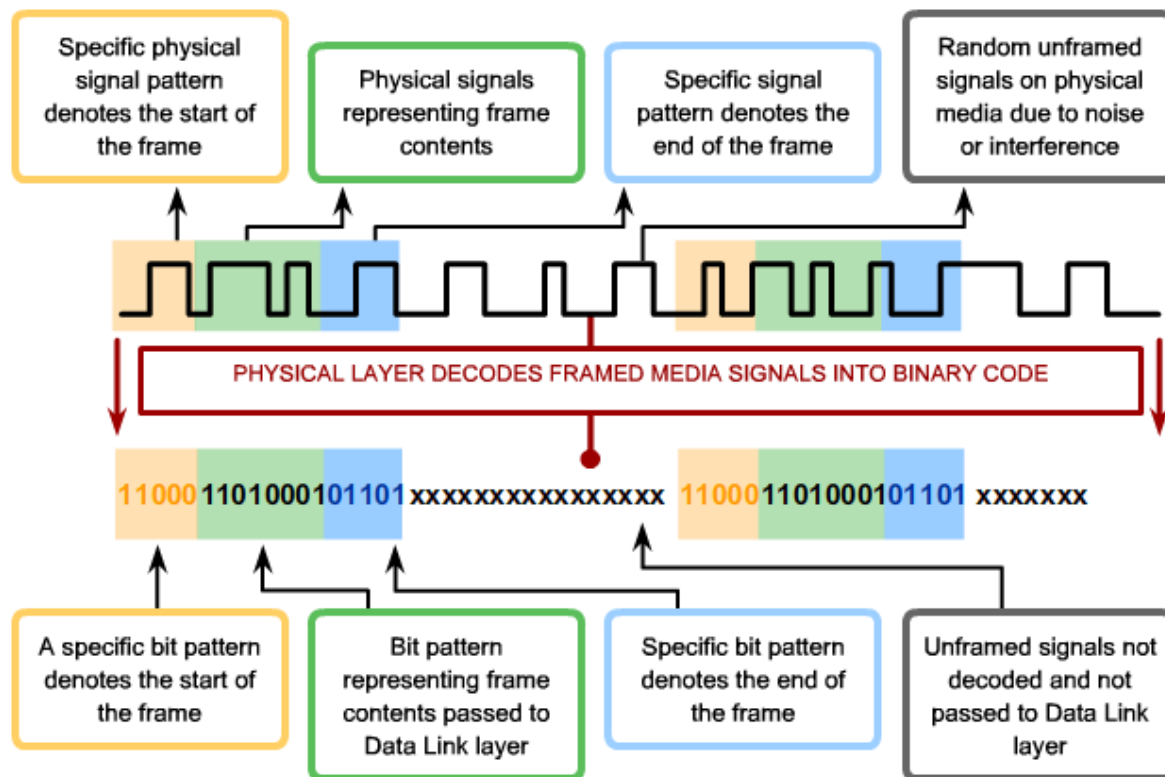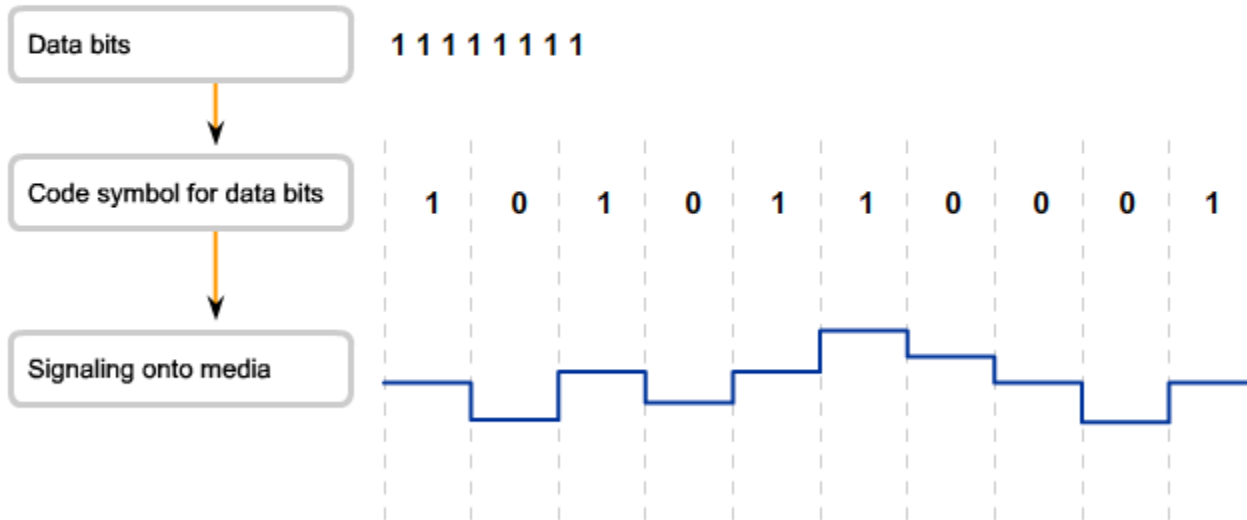| 4B Code	5B Symbol
0000	11110
0001	01001
0010	10100
0011	10101
0100	01010
0101	01011
0110	01110
0111	01111
1000	10010
1001	10011
1010	10110
1011	10111
1100	11010
1101	11011
1110	11100
1111	11101

Control and Invalid Codes

4B Code	5B Symbol
idle	11111
start of stream	11000
start of stream	10001
end of stream	01101
end of stream	00111
transmit error	00100
invalid	00000
invalid	00001
invalid	00010
invalid	00011
invalid	00100
invalid	00101
invalid	00110
invalid	01000
invalid	10000
invalid	11001

Data Carrying Capacity

Data Throughput and Goodput
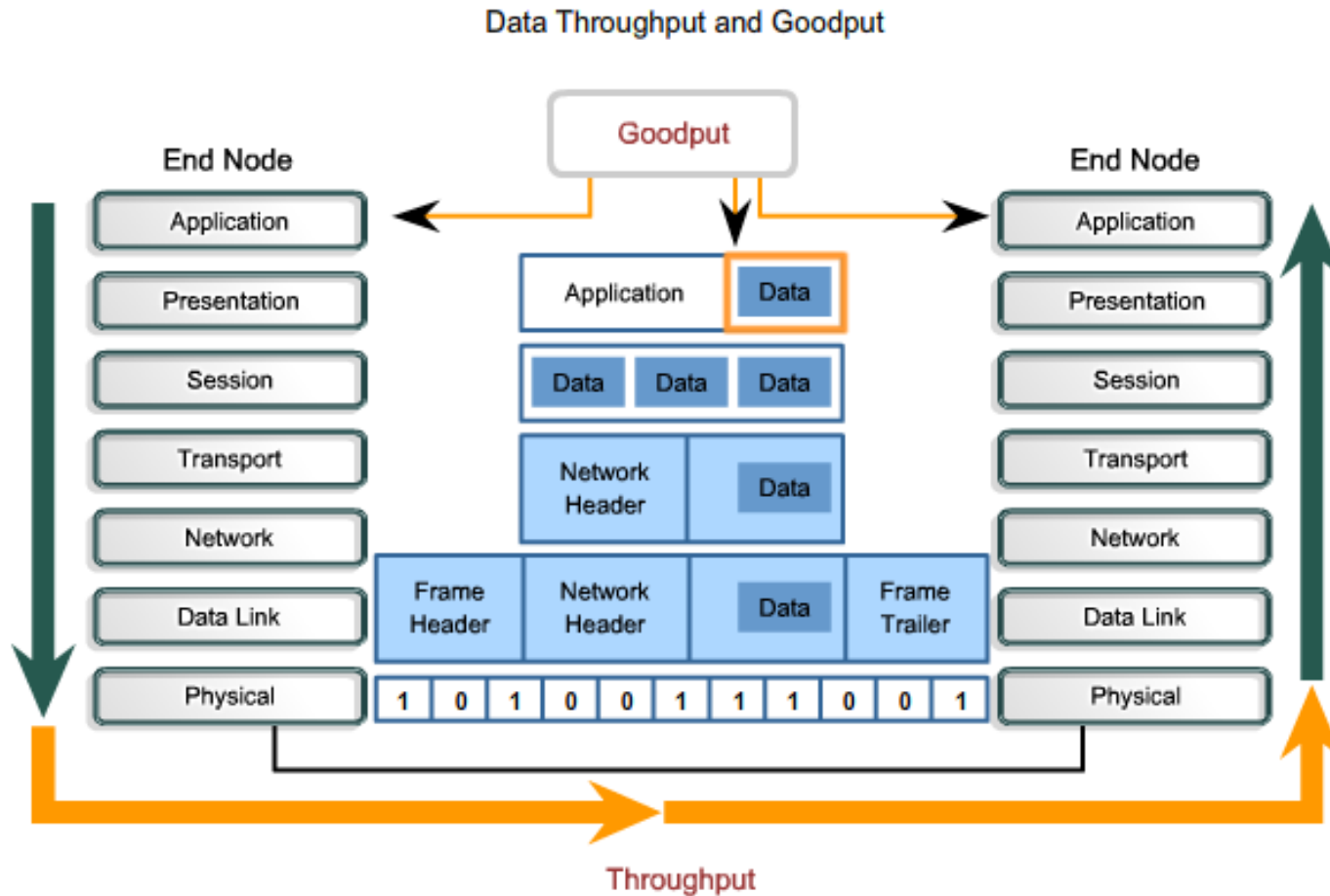
Data throughput is actual network performance. Goodput is a measure of the transfer of usable data after protocol overhead traffic has been removed.

Types of physical Media

Ethernet Media

	10BASE-T	100BASE-TX	100BASE-FX	1000BASE-CX	1000BASE-T	1000BASE-SX	1000BA
Media	EIA/TIA Category 3, 4, 5 UTP - four pair	EIA/TIA Category 5 UTP - two pair	50/62.5 m multi mode fiber	STP	EIA/TIA Category 5 (or greater) UTP, four pair	50/62.5 micron multimode fiber	50/62.5 multim or 9 mi single r fiber
Maximum Segment Length	100m (328 feet)	100m (328 feet)	2 km (6562 ft)	25 m (82 feet)	100 m (328 feet)	Up to 550 m (1,804 ft) depending on fiber used	550 m (MMF) (SMF)
Topology	Star	Star	Star	Star	Star	Star	Star
Connector	ISO 8877 (RJ-45)	ISO 8877 (RJ-45)		ISO 8877 (RJ-45)			

Wireless Media

Standards	Bluetooth 802.15	802.11 (a, b, g, n), HiperLAN 2	802, 11, MMDS, LMDS	GSM, GPRS, CDMA, 2.5- 3G
Speed	<1 Mbps	1 - 54+ Mbps	22 Mbps+	10- 384 Kbps
Range	Short	Medium	Medium - long	Long
Applications	Peer-to-peer device-to-device	Enterprise networks	Fixed, last mile access	PDAs, Mobile phones, Cellular access

Copper Media

Copper Media
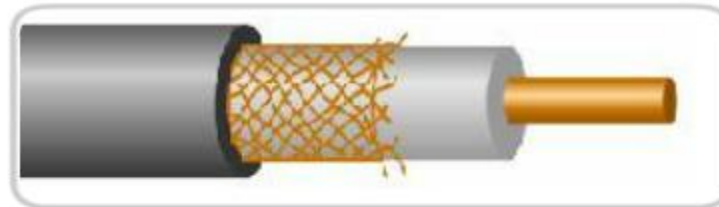
Coaxial cable
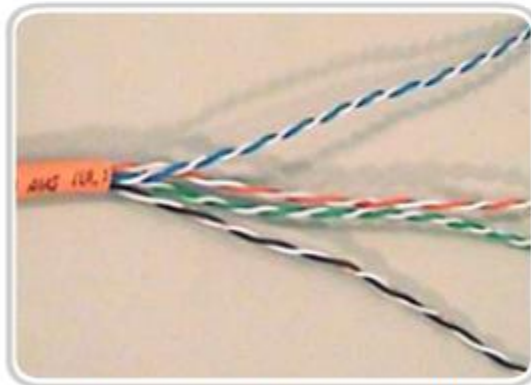
Unshielded twisted-pair cable

RJ-45 connections

Copper Media…

External Interference with Copper Media

Fluorescent lighting
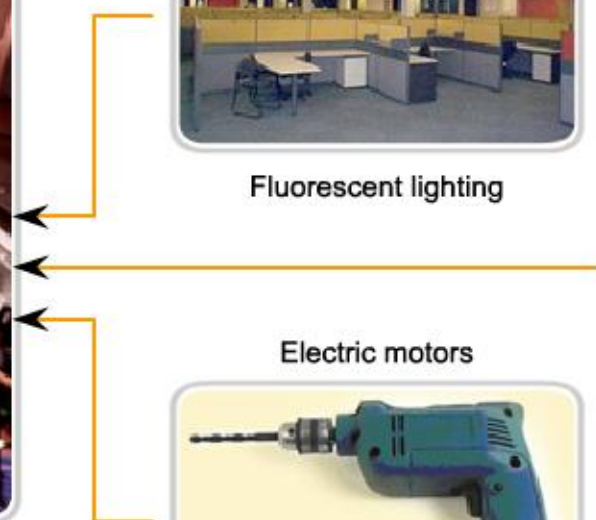
Electric motors

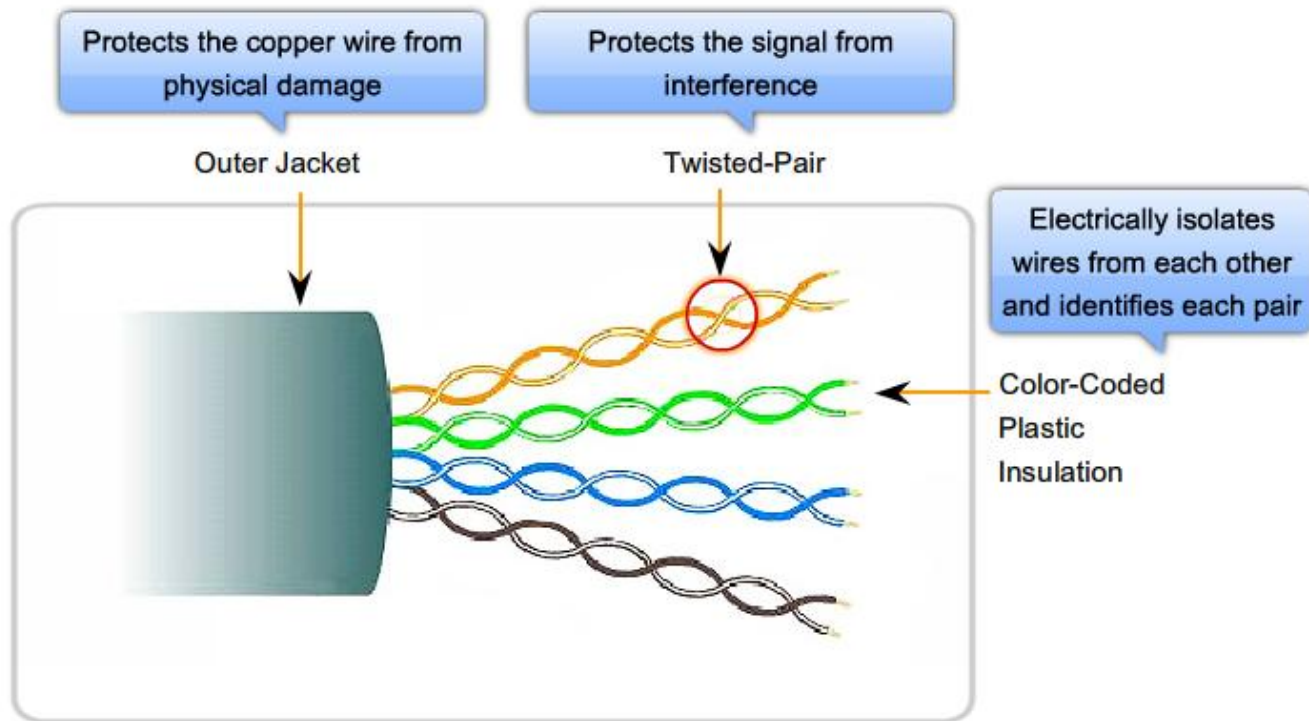Radio waves

Sources of interference to data
signals on copper media

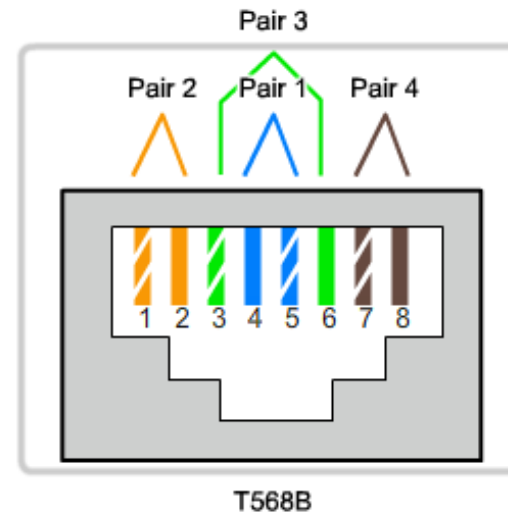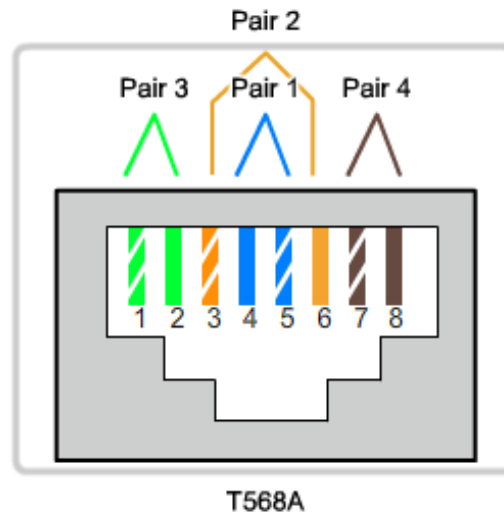# Unshielded Twisted-Pair (UTP) Cable

Unshielded Twisted-Pair (UTP) Cable

Unshielded Twisted-Pair (UTP) Cable…

Straight-through, Crossover, and Rollover Cable Types

Cable Type	Standard	Application
Ethernet Straight-through	Both ends T568A or both ends T568B	Connecting a network host to a network device such as a switch or hub.
Ethernet Crossover	One end T568A, other end T568B	Connecting two network hosts. Connecting two network intermediary devices (switch to switch, or router to router).
Rollover	Cisco proprietary	Connect a workstation serial port to a router console port, using an adapter.

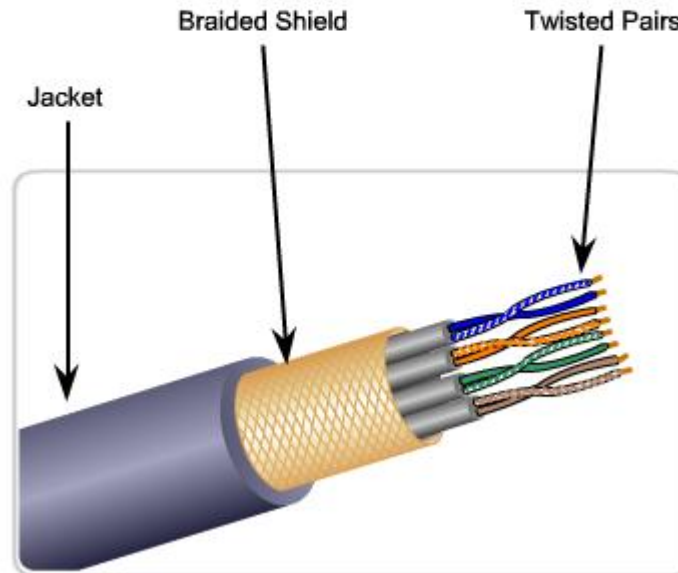T568A

T568B

Other Copper Cable

Coaxial Cable Design

Outer Jacket

Braided Copper Shielding

Copper Conductor

Plastic Insulation
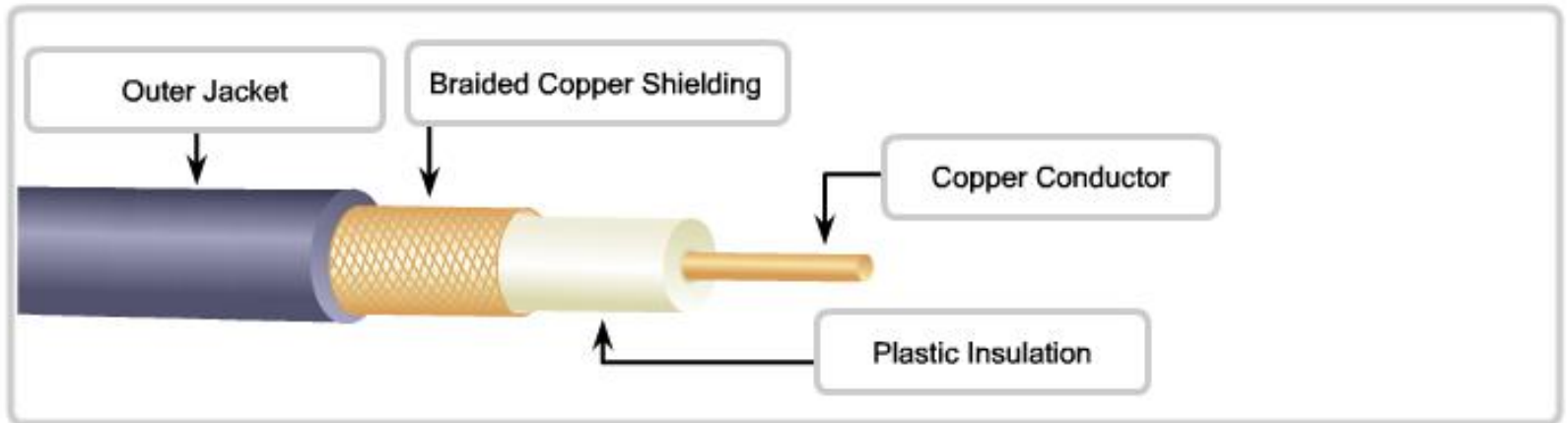
Coaxial Connectors

BNC

N type

F type

Shielded Twisted Pair (STP) Cable

Shielded Twisted-Pair (STP) Cable

Fiber Media

Fiber Media Cable Design

Strengthening Material (Aramid Yarn)
Buffer
Cladding
Core
Jacket (Typically PVC)

Jacket
Aramid Yarn
Buffer
Cladding
Core
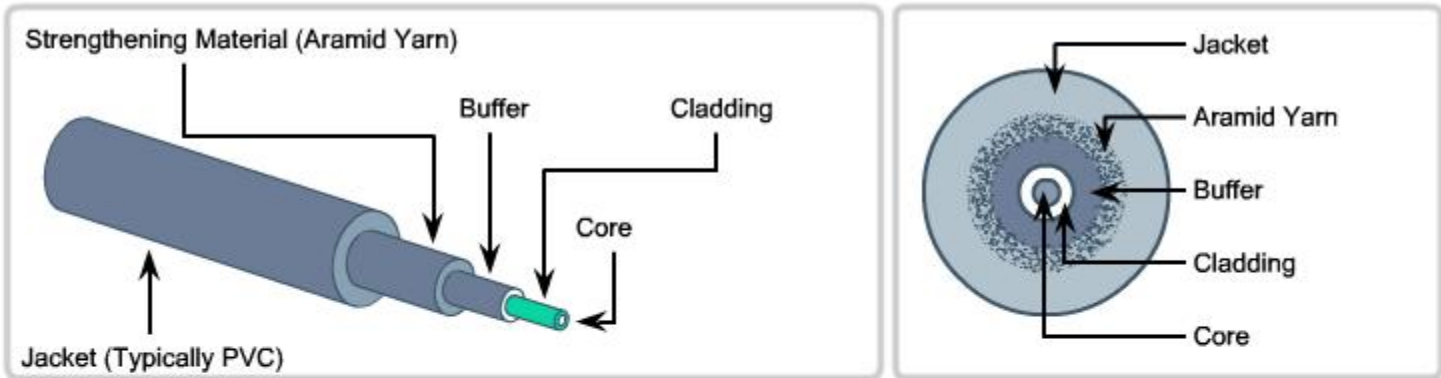
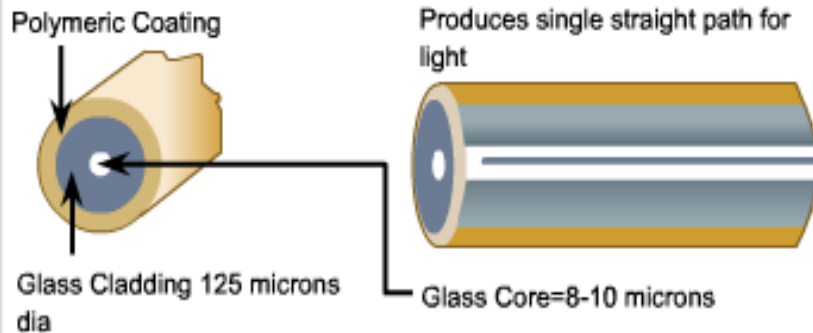Fiber Connectors

Fiber Media…

Fiber Media Cable Design

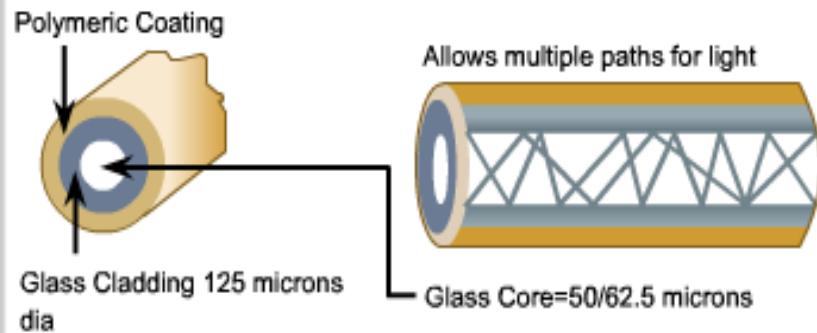Fiber provides full duplex communications with a
cable dedicated to each direction.

Fiber Media…

Fiber Media Modes

Single-Mode

Polymeric Coating

Glass Cladding 125 microns dia

Produces single straight path for light

Glass Core=8-10 microns

- Small core
- Less dispersion
- Suited for long distance applications (up to 100 km, 62,14 mi.)
- Uses lasers as the light source often within campus backbones for distance of several thousand meters

Multimode

Polymeric Coating

Glass Cladding 125 microns dia

Allows multiple paths for light

Glass Core=50/62.5 microns

- Larger core than single-mode cable (50 microns or greater)
- Allows greater dispersion and therefore, loss of signal
- Used for long distance appllication, but shorter than single-mode (up to ~2km, 6560 ft)
- Uses LEDs as the light source often within LANs or distances of a couple hundred meters within a campus network
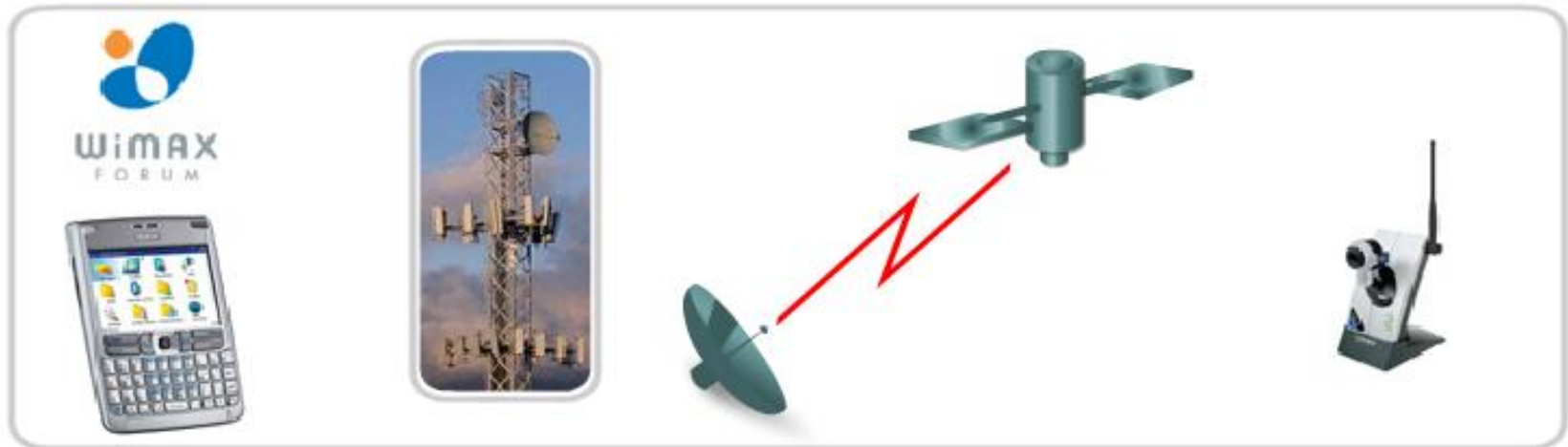
Wireless Media

Wireless Media Signals and Security
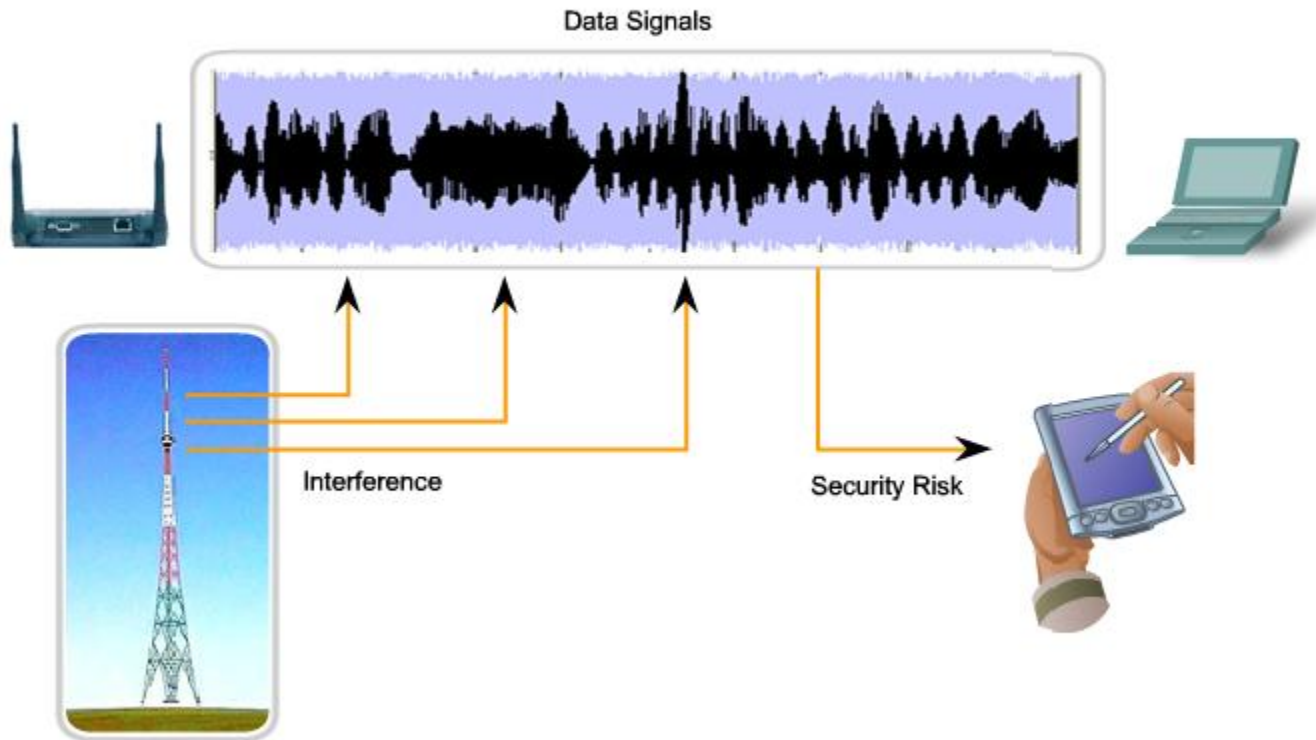
Types of Wireless Networks

Wireless Media Standards and Types

The Wireless LAN

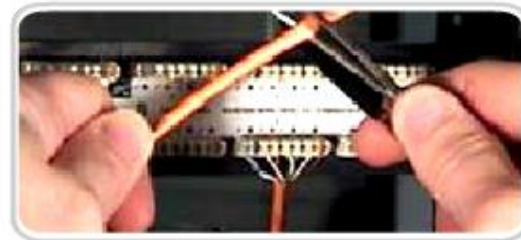WLAN Access Points and Adapters

Wireless Access Point

Wireless Adapters
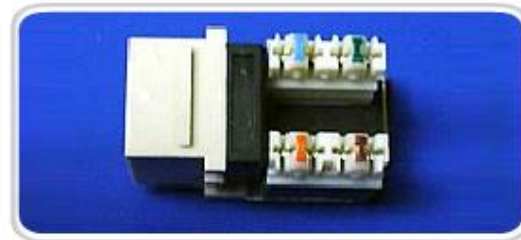
Media Connector

Copper Media Connectors

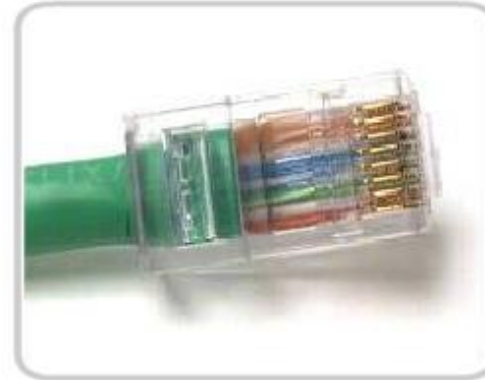

110 punch block

RJ-45 UTP Plugs

RJ-45 UTP Socket

Media Connector…

Copper Media Connectors
RJ-45 Termination

Bad connector - Wires are untwisted for too great a length.

Good connector - Wires are untwisted to the extent necessary to attach the connector.

Improper cable termination can impact transmission performance.

Media Connector…

Fiber Media Connectors

ST Connector

Straight Tip (ST) connector is widely used with multimode fiber

SC Connector

Subscriber Connector (SC) is widely used with single-mode fiber

Single-Mode (LC)

Single-Mode Lucent Connector (LC)

Multimode (LC)

Multimode LC Connector

Duplex Multimode (LC)

Duplex Multimode LC Connector

Summary

- Layer 1 of the OSI model is responsible for the physical interconnection of devices. Standards at this layer define the characteristics of the electrical, optical, and radio frequency representation of the bits that comprise Data Link layer frames to be transmitted. Bit values can be represented as electronic pulses, pulses of light, or changes in radio waves. Physical layer protocols encode the bits for transmission and decode them at the destination.

- Standards at this layer are also responsible for describing the physical, electrical, and mechanical characteristics of the physical media and connectors that interconnect network devices.

- Various media and Physical layer protocols have different data-carrying capacities. Raw data bandwidth is the theoretical upper limit of a bit transmission. Throughput and goodput are different measures of observed data transfer over a specific period of time.

The end