School of Advanced Technology

Networking Basics

Week 03
Physical Layer (OSI Layer 1)

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ALGONQUIN COLLEGE

Reference

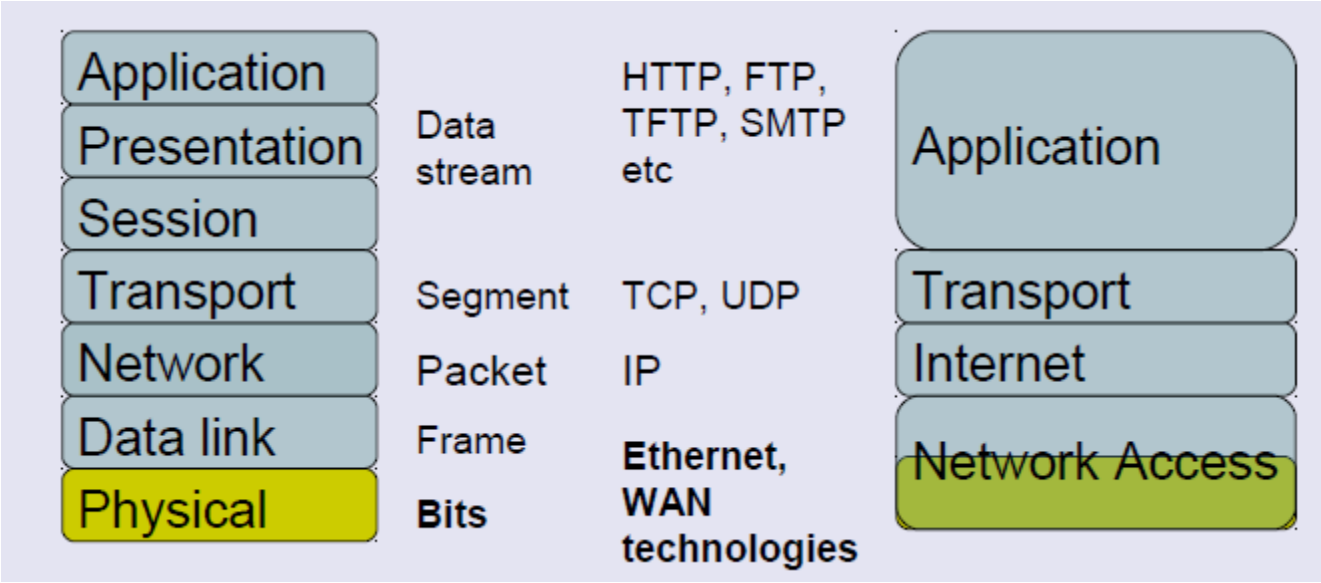
- Cisco Chapter 4
  - Sections 4.0, 4.1 & 4.2

Physical Layer Topics

- Protocol and services
- Encoding and signalling
- Characteristics of copper, fiber and wireless
- Describe use of copper, fiber and wireless media
- Bandwidth, Throughput and Goodput
- Units of speed

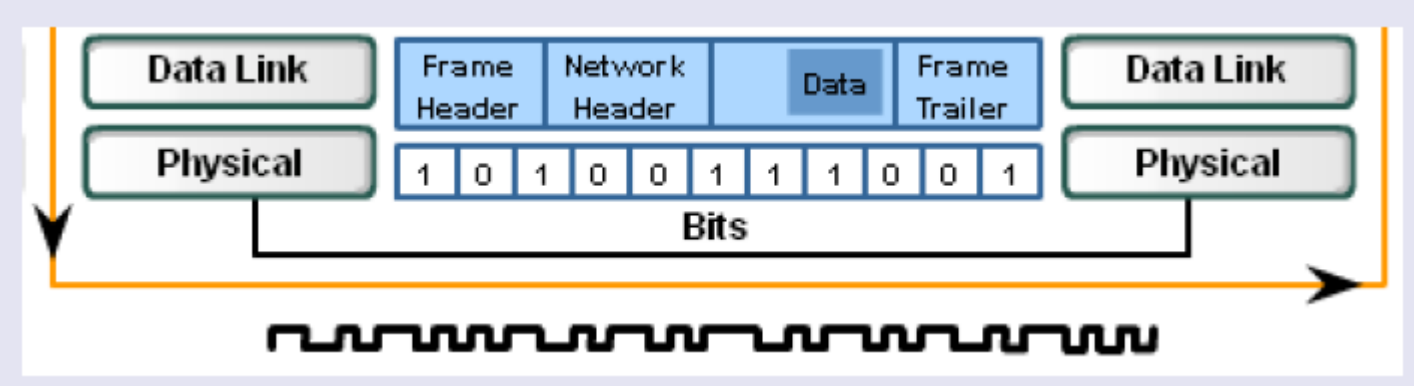
OSI Physical Layer

- OSI Model Layer 1
- Bottom part of the TCP/IP Network model



Physical Layer Tasks

- Takes frame from Data Link Layer
- Sees the frames as bits – no structure
- Represents the bits as signals to go on media



Standards

- Physical Layer standards define:
  - Physical and electrical properties of the media
  - Mechanical properties (materials, dimensions, pinouts) of the connectors and NICs
  - Bit representation by the signals
  - Definition of control information signals

Signalling

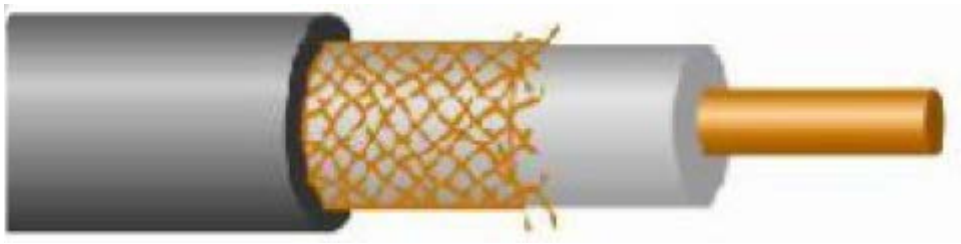
- Signalling
  - Concerned with how the 0s and 1s are represented on the media
- Encoding
  - Conditioning of the bit stream before the signalling step
    - e.g. Applies a coding like 4b/5b scheme to balance the 0s and 1s

Media

- Copper
  - Coaxial, UTP, STP
- Fiber
  - Multimode, Single mode
- Wireless

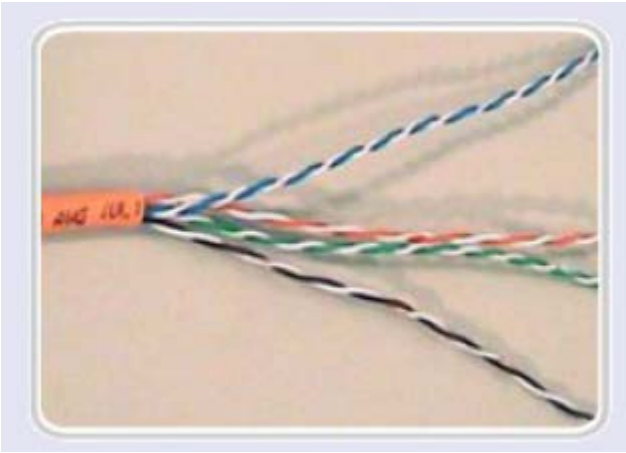
Coaxial cable

- Good for high frequency radio/video signals
- Used for antennas/aerials
- Used for cable TV and Internet connections, often now combined with fibre optic.
- Formerly used in Ethernet LANs – died out as UTP was cheaper and gave higher speeds



UTP Cable

- UTP (cat 3, 5, 5e, 6)
  - Low cost
  - Easy to install
  - Commonly used for Ethernet LANs



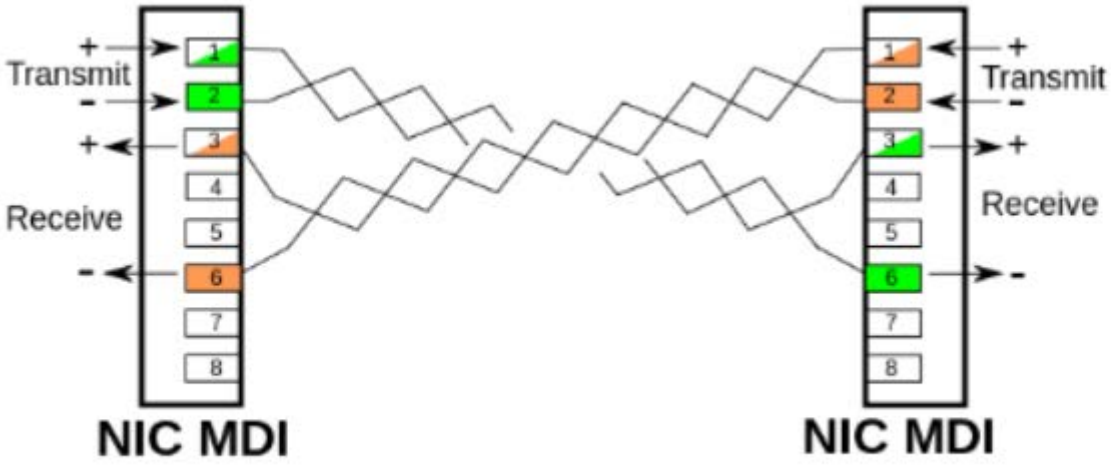
UTP Cable Types

- Cable Types
  - Straight through
    - Connect devices of different types
      - Any end device to switch or hub, switch to router
  - Crossover
    - Connect devices of same type
      - Hub or switch to switch or hub
      - Any end device to any end device
      - Any end device to router

Note:

Auto MDI-X

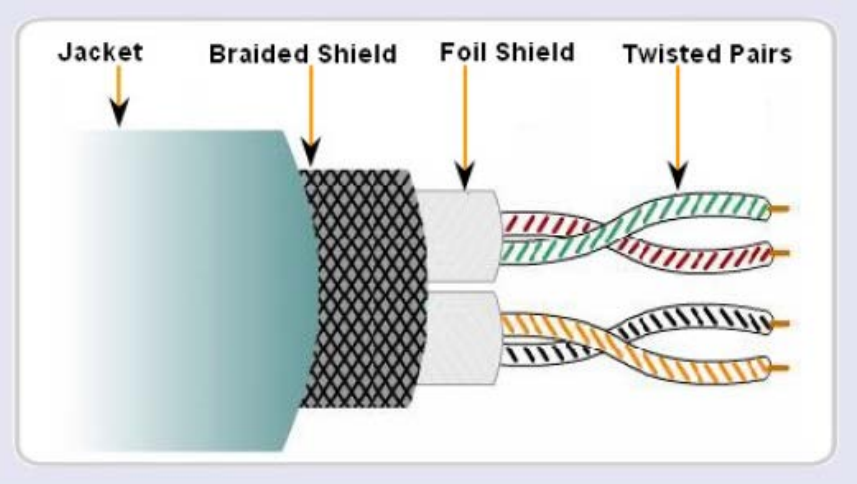
Use Case – MDI to MDI



(picture from wikipedia)

STP Cable

- Shielded Twisted Pair (STP)
  - Wires are shielded against noise
  - Much more expensive than UTP
  - Used for 10 Gbps Ethernet



Fibre Optic

- Uses light to signal 0s and 1s
- Two technologies
  - Single Mode $$$$$$
    - 100KMs
  - Multimode $$
    - Few KMs
- No RFI/EMI noise problems!
- Full duplex requires two fibre strands!

UTP or Fibre

Implementation Issues	UTP Cabling	Fiber-optic Cabling
Bandwidth supported	10 Mb/s – 10 Gb/s	10 Mb/s – 100 Gb/s
Distance	Relatively short (1 – 100 meters)	Relatively high (1 – 100,000 meters)
Immunity to EMI and RFI	Low	High (Completely immune)
Immunity to electrical hazards	Low	High (Completely immune)
Media and connector costs	Lowest	Highest
Installation skills required	Lowest	Highest
Safety precautions	Lowest	Highest

Wireless

- Electromagnetic signals at radio and microwave frequencies
- No cost of installing cables
- Hosts free to move around

- Interference from other wireless communications, cordless phones, fluorescent lights, microwave ovens…
- Building materials can block signals.
- Security is a major issue.

Wireless

- 802.11

Standard	Maximum Speed	Frequency	Backward Compatible
802.11a	54 Mb/s	5 GHz	No
802.11b	11 Mb/s	2.4 GHz	No
802.11g	54 Mb/s	2.4 GHz	802.11b
802.11n	600 Mb/s	2.4 GHz or 5 GHz	802.11a/b/g
802.11ac	1.3 Gb/s (1300 Mb/s)	2.4 GHz and 5 GHz	802.11a/b/g/n
802.11ad	7 Gb/s (7000 Mb/s)	2.4 GHz, 5 GHz, and 60 GHz	802.11a/b/g/n/ac

Measures of Speed

- Bandwidth (Physical layer)
  - The capacity of a medium to carry data is described as the raw data bandwidth of the media.
  - Measure at the physical layer
  - Speed under ideal conditions with no external factors
  - Usually what ISPs advertise

  - Measured in kilobits per second (kbps), megabits per second (Mbps), gigabit per second (Gbps).

- Throughput (Physical layer)
  - Measure of the transfer of bits across the media over a given period of time taking into account the external factors.
  - Measure at the physical layer
  - Speed at a given period in time affected by external conditions

  - In a multi-access topology such as Ethernet, nodes are competing for media access and its use. Therefore, the throughput of each node is degraded as usage of the media increases.

Measures of Speed

- Goodput (Application layer)
  - Measure of usable data transferred over a given period of time.
  - Measure at the application layer
  - Is equal to the
    - throughput minus overhead
  - Overhead includes
    - Connection establishment
    - Acknowledgements
    - Retransmits
    - Encapsulation
    - Decapsulation
    - etc
  - 50 MB file transferred with FTP in 10 seconds
    - What is the goodput?

Goodput < throughput < bandwidth

Unit of Speed

Bits per second	bps	1 bps = fundamental unit of bandwidth
Kilobits per second	kbps	1 kbps = 1,000 bps = 10^3 bps
Megabits per second	Mbps	1 Mbps = 1,000,000 bps = 10^6 bps
Gigabits per second	Gbps	1 Gbps = 1,000,000,000 bps = 10^9 bps
Terabits per second	Tbps	1 Tbps = 1,000,000,000,000 bps = 10^12 bps

The End!

Important Note

- Some slides copied from:
  - –Cisco Academy Slide set
  - –Online Cisco Curriculum