



NETWORKING FOR AVL TECHNICIANS

CFI Networking 101

What is a network?

- A network consists of two or more computers or devices that are linked in order to share resources, exchange files or allow electronic communication. The network devices (nodes) may be connected via cables (fiber optic or category) or wirelessly to a network switch.
- Types of Networks:
 - LAN – Local Area Network
 - WLAN – Wireless Local Area Network
 - WAN – Wide Area Network
- Examples of AVL networks (LANs) are:
 - Control Network
 - Audio mixer control
 - Video router control
 - Power amplifier control
 - Dedicated Media network
 - Dante network
 - sACN (Streaming ACN), ArtNet, and RDM for lighting
 - Video Streaming – Extron NAV, Crestron NVX, QSYS NV
 - Comms – Clearcom Helixnet

OSI Model

Layer 7 – Application (HTTP, FTP, SMTP, DNS)

Layer 6 – Presentation (JPEG, MPEG)

Layer 5 – Session (NFS, SMB)

Layer 4 – Transport (TCP, UDP)

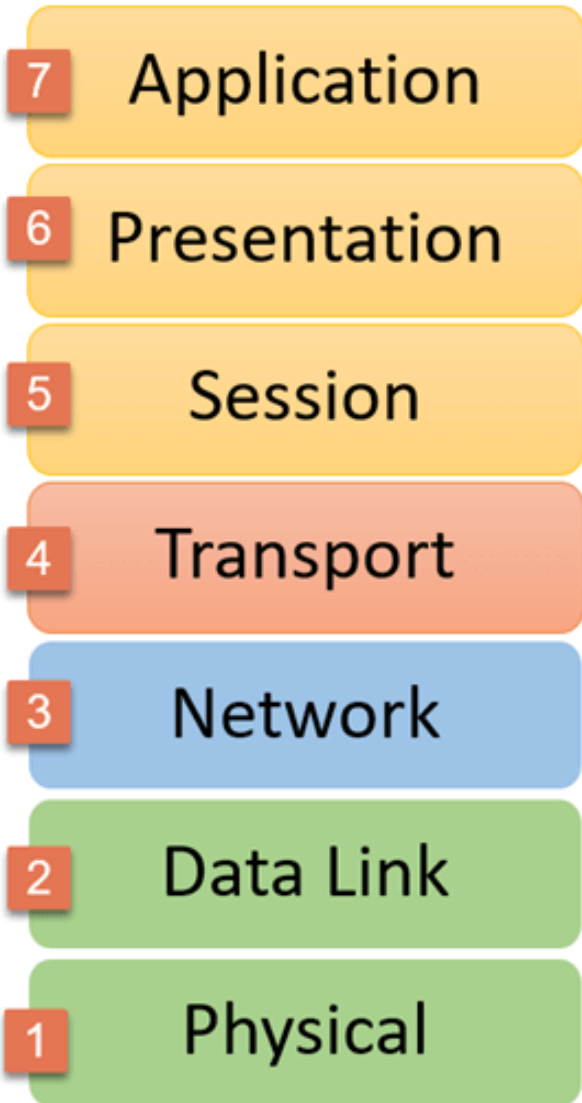
Layer 3 – Network (IPv4, IPv6)

Layer 2 – Data Link (ARP, CDP, STP)

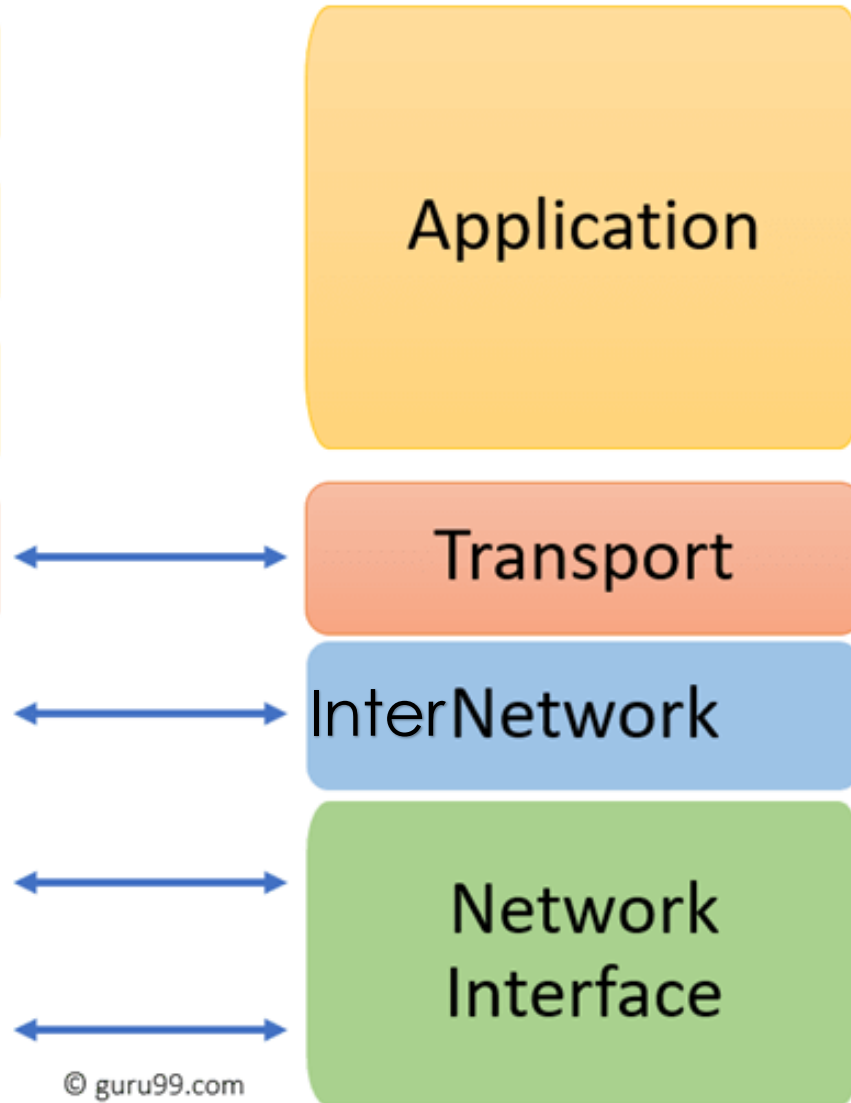
Layer 1 – Physical (100Base-TX, 1000Base-T)

The OSI Model (Open Systems Interconnection Model) is a conceptual framework used to describe the functions of a networking system. The OSI model characterizes computing functions into a universal set of rules and requirements in order to support interoperability between different products and software.

OSI Reference Model



TCP/IP Conceptual Layers



OSI vs. TCP/IP models

- Physical and Data Link layers combined in TCP/IP model
- Session Presentation and Application Layers combined in TCP/IP model

Layer 1 – Physical Layer

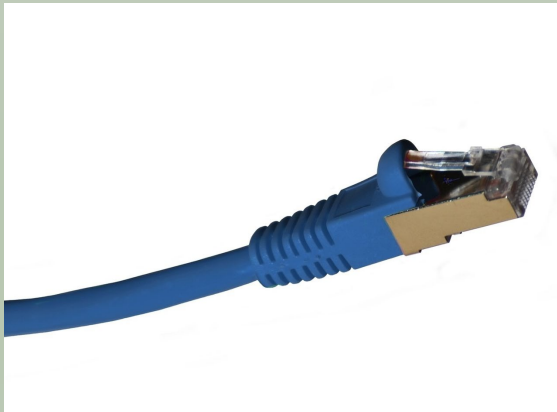
- Category Cable (UTP, STP)
 - 5e – up to 100 MHz, 100Mbps up to 1Gbps
 - 6 – up to 250Mhz, 1Gbps (10Gbps supported but only to 55 meters, 180 feet)
 - 6a – up to 500 Mhz, 10Gbps
 - 7a – up to 1000Mhz, 10Gbps - (screen shielded SSTP or screen foil shielded SFTP)
 - 8 – up to 2000 Mhz , 40 – 100Gbps (limit of 30 meters, 98 feet)
- 100 meters (330 feet)
- Connector – 8P8C “RJ45”
- POE (Power over Ethernet) - up to 12.95W
- POE+ up to 30W
- POE++ Type 3 up to 60W, Type 4 up to 100W
- Use STP for digital snake connections – AES50, SLink, DX, GigaAce
- UTP is fine to use with Dante

Category Cables and Connectors



UTP Cable

Unshielded twisted pair



STP Cable

Shielded Twisted Pair



Ethercon Connector

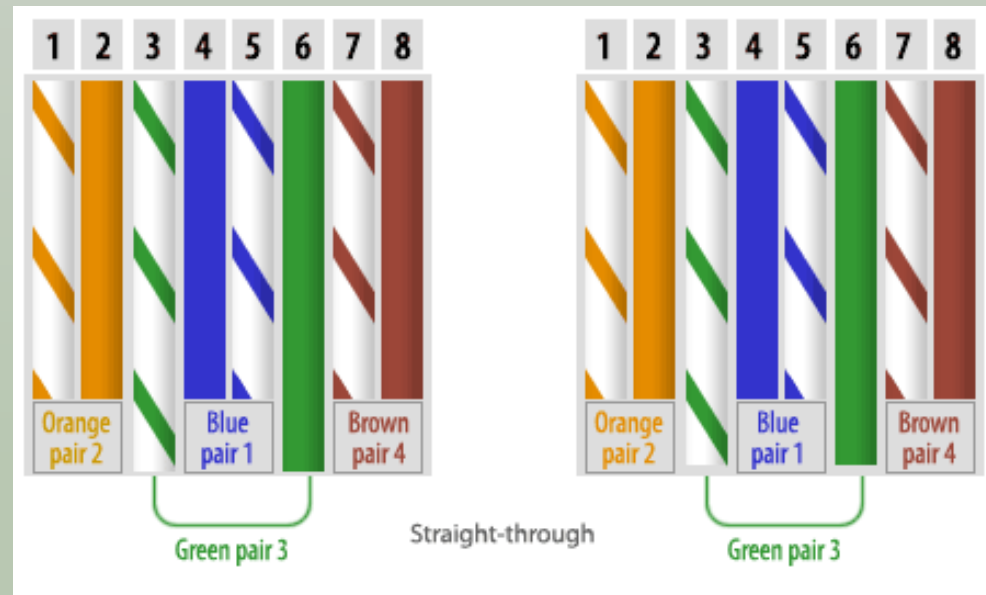
- Either UTP or STP cable
- Use STP Ethercon cables for digital snakes
- Locking connector XLR shell
- Remove tab on RJ45

Layer 1 – Physical Layer

Category Cable Wiring

- TIA/EIA 568B
- Standard in most places
- 568A swaps orange and green pairs
- 568A – 568B cable considered “crossover” cables
- 4 balanced pairs

568B wiring scheme



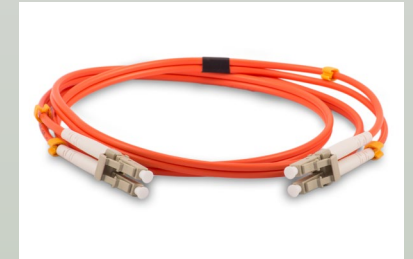
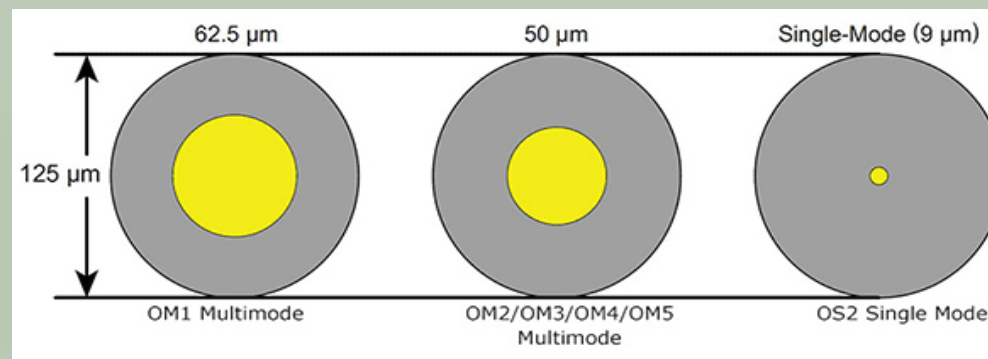
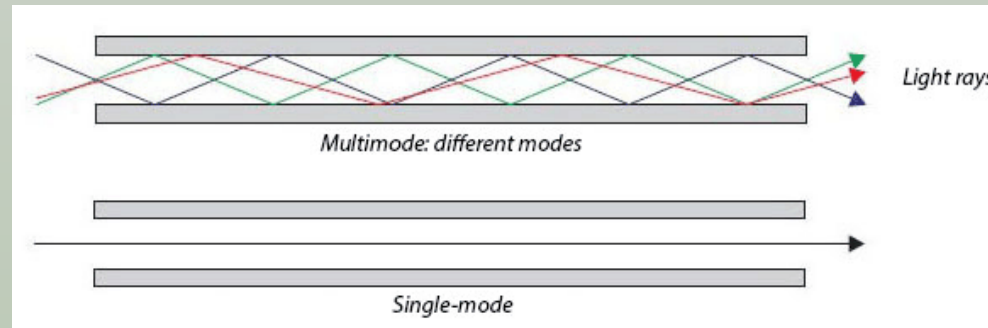
Tips for Category Cable

- Use strain relief
- Do not exceed bend radius of cable (4X diameter) it will cause signal attenuation or loss
- Be sure to remove the “tab” on the 8P8C “RJ45” connector that is used with an ethercon shell.
- Make sure wires reach end of 8P8C “RJ45” connector
- Test each cable for pin-to-pin continuity and bandwidth if test equipment allows
- Use stranded cable for patch cables and solid core for fixed wiring
- Remember cable length restrictions (330 ft) add a switch if you need to run a longer distance

Layer 1 – Physical Layer

Fiber Optic Cable

- Multimode
 - short range (400 meters – 1312 feet)
 - Inexpensive LED transmitters
 - Orange – 62.5 Micron (OM1)
 - Teal – 50 Micron (OM2, OM3, OM4)
 - Wavelengths 850 and 1300 nm
- Single Mode
 - long range (10 km – 32,080 feet)
 - Laser transmitters
 - Yellow (OS1, OS2)
 - Wavelengths 1310, 1383, 1550 nm



Multimode OM1



Multimode OM3



Singlemode OS2

Layer 1 – Physical Layer

Common Fiber Connector Types

- LC – Lucent Connector aka “little connector” used for neutrik opticalcon connectors
- SC – Subscriber Connector aka “Standard Connector” or “Square Connector”
- ST – Straight Tip Connector with bayonet style plug , think BNC



opticalcon



LC Connector



SC Connector



ST Connector

Common Fiber Interface Types

- GBIC – Gigabit Interface Converter
- SFP – short form-factor pluggable aka “mini GBIC”
- SFP+ - up to 10Gbps



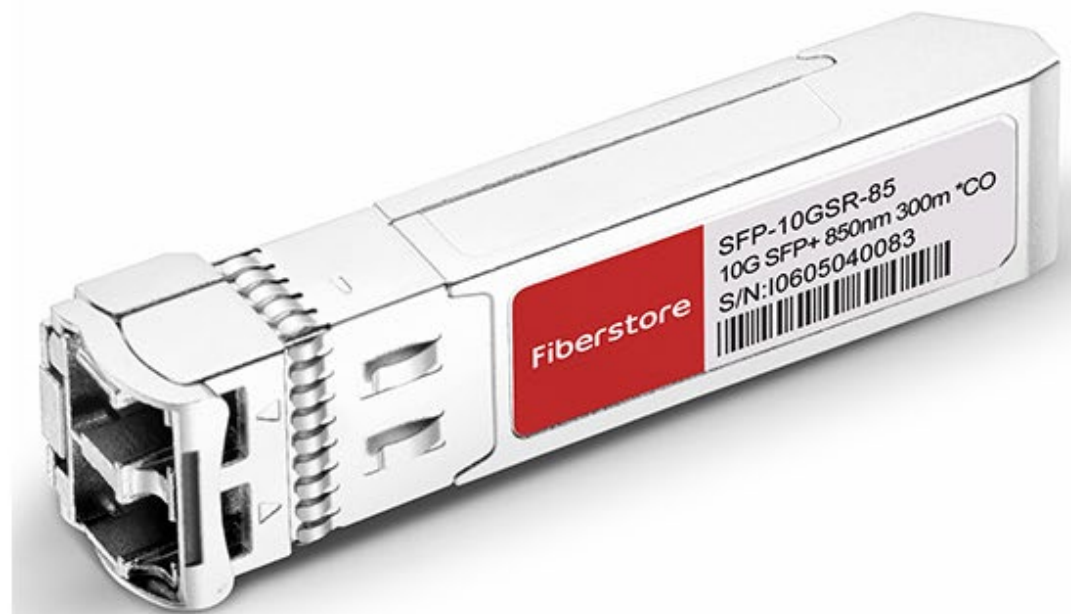
GBIC

SFP

Single or Multimode?



SFP



SFP+

Single or Multimode?



Tips for Fiber:

- Use strain relief
- Save the fiber connector caps and patch bay covers to re-use
- Don't store a fiber cable or SFP+ without the caps
 - Dust can disrupt a fiber connection
- Invest in an easy-to-use cleaner and fiber "wipes"
- NEVER look into a fiber connector that is connected to a device
 - The wavelengths are not visible to the human eye but are harmful.
- If testing a fiber connection with an led light, use your camera phone to "look" at the connector.
- Do not exceed the bend radius of fiber. (20x diameter) It will break or cause loss of signal
- Be careful when handling broken fiber, the glass core is very sharp
- Buy armored cable for use in the field

Layer 2 – Data Link Layer

- Switches and Nodes

- Network Nodes communicate by sending ethernet frames to another port on the switch or to a port on another switch within the same network (VLAN)

B4-0E-DE-68-E1-92

Intel Inc - NIC ID

- MAC Addresses

- 48 bit unique identifier for network card (NIC) and switchports
- 6 groups of hexadecimal digits (base 16 – 0-9 and A-F)
- B4-0E-DE-68-E1-92 (this laptops wifi NIC mac address)
- B40E.DE68.E192 (another format of mac address – used by switches)
- 1st 24 bits are manufacturer ID (OUI) , last 24 bits are unique to NIC
- ARP Command
 - arp-a command on PC displays current ip and mac address associations
 - Show arp command on switch shows what mac is associated with the specified IP address – 192.168.1.253

```
C:\Users\Chris Moody>arp -a
```

```
Interface: 192.168.1.131 --- 0x12
```

Internet Address	Physical Address	Type
192.168.1.1	60-38-e0-85-4e-e3	dynamic
192.168.1.109	a0-6a-44-d6-27-24	dynamic
192.168.1.255	ff-ff-ff-ff-ff-ff	static

```
FPL-9500-SV#show arp | i 192.168.1.253
```

```
Internet 192.168.1.253 7 a4bb.6d48.8d5f ARPA
```

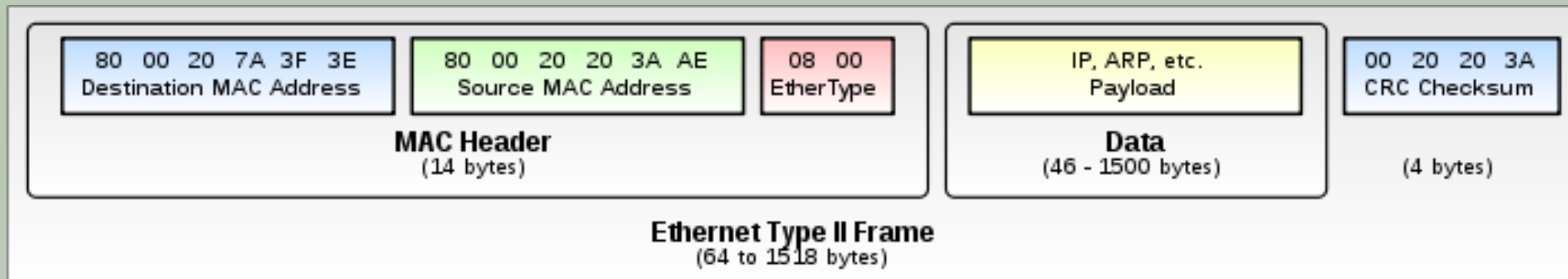
- Show Mac address-table command on switch shows which port the mac address ending in 8d5f is plugged into. Gigabit port 4 on the 3rd switch in the switchstack.

```
9200-Stk#show mac address-table | i 8d5f  
a4bb.6d48.8d5f DYNAMIC Gi3/0/4
```

Layer 2 – Data Link Layer

- Ethernet Frames

- Container for communication between network nodes
- Contain Source and Destination MAC Addresses
- Data Payload from further up the OSI Model (IP, etc.)
- Frame Check Sequence (CRC) error check
- IEEE 802.1Q tag, if present, is placed between the Source Address and the EtherType or Length fields.
 - The tag indicates if the frame is tagged or untagged as well as the QoS priority.
 - Tagged frames are “trunk” frames and indicate a switchport that passes traffic for multiple vlans (interswitch links)
 - Untagged “access” frames indicate a switchport that passes only traffic from a single vlan



Layer 2 – Data Link Layer

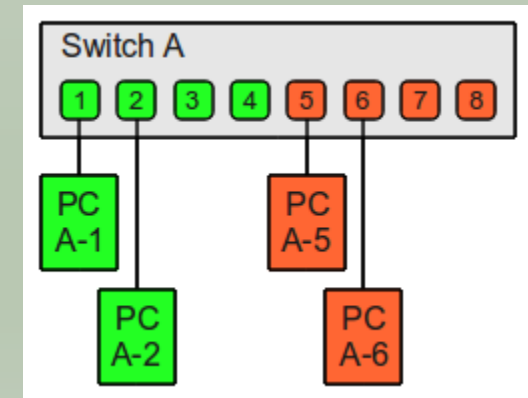
- Intra and Inter Switch Communication (within 1 network)
- Network nodes communicate with 1 network at a time
- VLANs – logical grouping of network nodes even if not connected to the same switch
 - Vlan allow ports in a switch to be subdivided into a logical network for ease of administration
 - Vlan cannot communicate data between each other natively
 - Trunk ports “tagged” ports keep vlan data separate
 - Trunk ports are typically used between switches
 - Access ports are typically used by network nodes (hosts)

In Switch A

Ports 1-4 are untagged access ports and part of a vlan

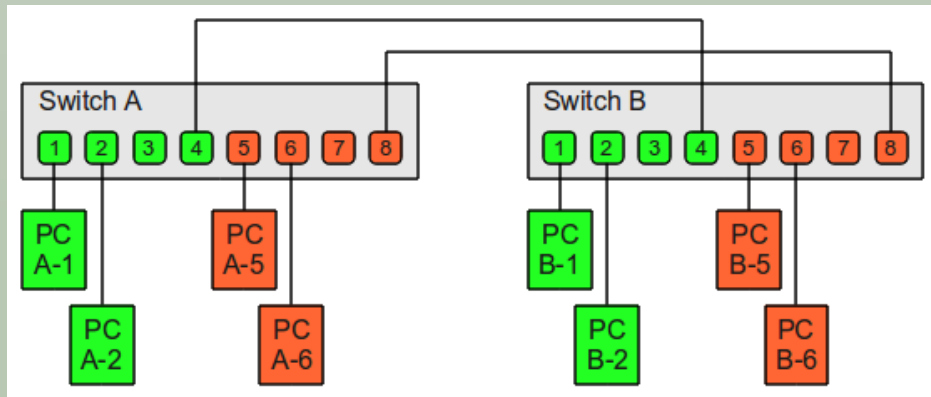
Ports 5-8 are untagged access ports and part of a different vlan

PC A-1 cannot communicate with PC A-5 at Layer 2. They are logically separated and can't communicate by Layer 2 protocols.

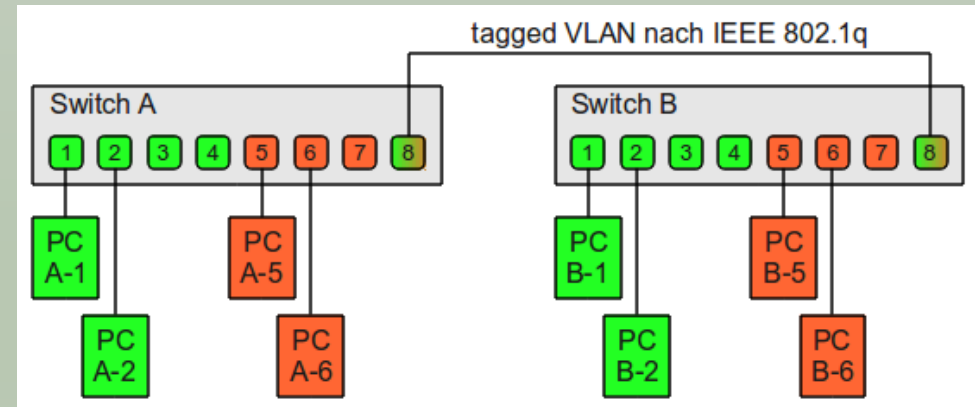


Layer 2 – Data Link Layer

Switch A and B only have access ports. Communication on the green VLAN occurs on port 4 between the switches. Similarly, port 8 connects the orange VLAN on each switch. PC A-1 can talk to PC B-1 via port 4 on the switches. PCA-1 cannot talk to PC B-5



Switches A and B have a “tagged” trunk port that allows vlan data to travel between the switches on port 8 but still keeps the green and orange vlan traffic separate. PCA-1 can talk to PC-B1 via port 8 on the switches. PC A-1 cannot talk to PC B-5



Thanks for joining us!

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