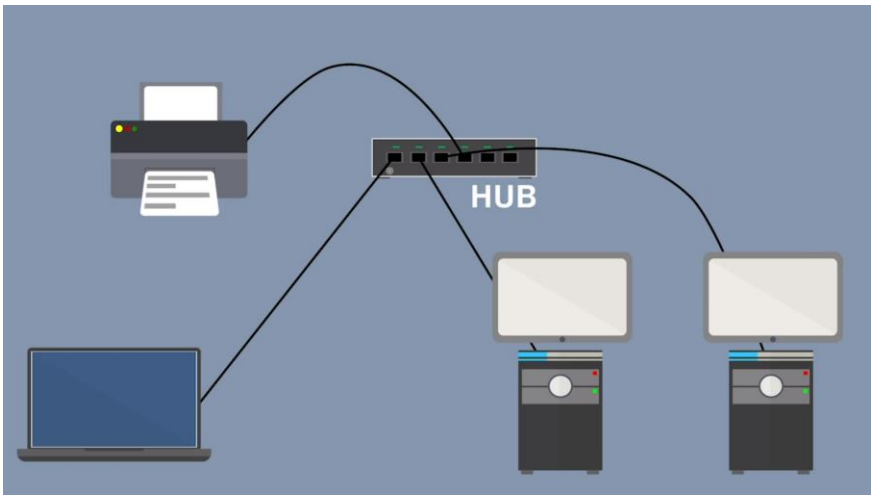
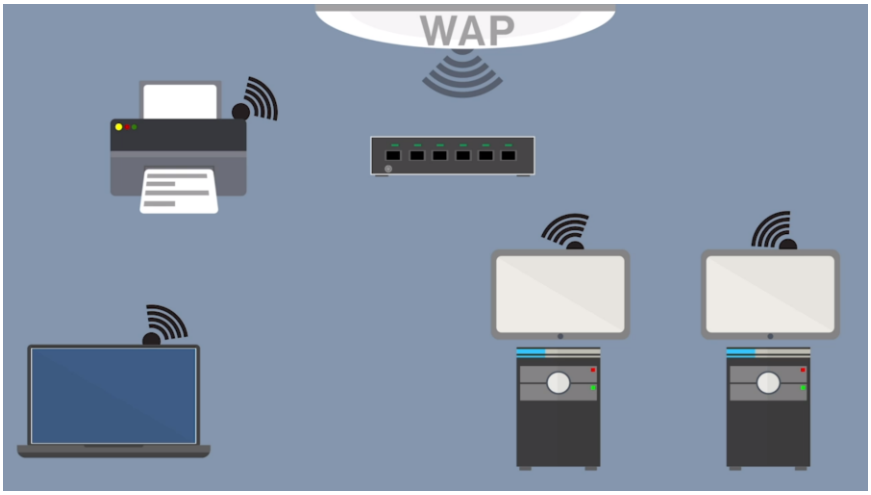
Introduction to Networking

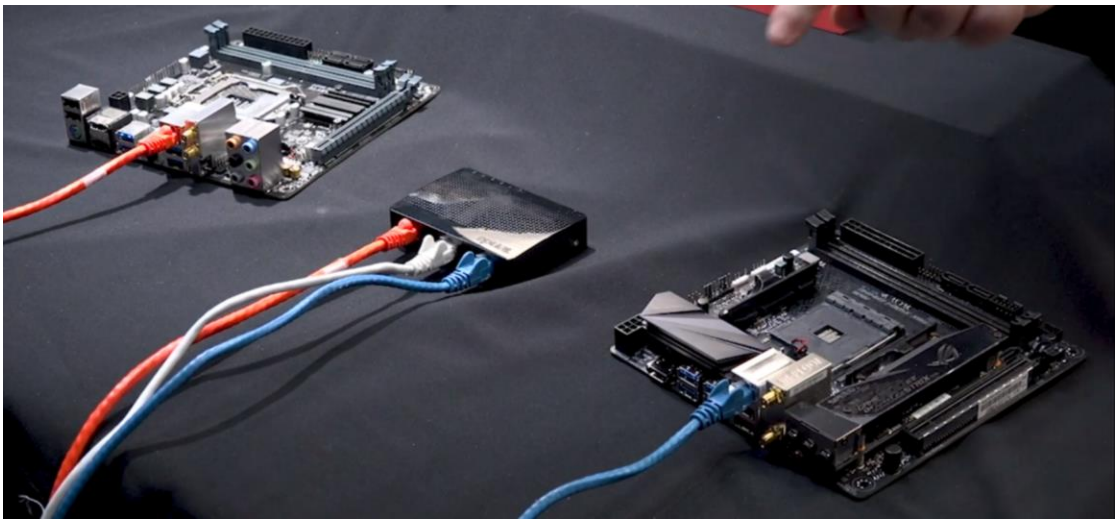
- LAN computers connect with Ethernet
. Ethernet frames standardized as 1500 bytes
- A MAC address uniquely identifies a host on a LAN
- Use ipconfig (Windows) or ifconfig (Linux) to view MAC





LAN (Local Area Network) - group of computers connected to share resources

Ethernet - Might be old, but still the most popular type of Networking
Defines - what kind of cabling we use;
type of Hubs; speeds; etc
You can only make your data in discrete chunks of 1500 bytes,
which is called a Frame



Very Simple Network Setup
2 Computers with Ethernet Connections connected to a Hub

MAC (Media Access Control) Address - Uniquely Identifies every system
on the Local Area Network

48 bit address which is always manifested as 12 hexadecimal characters
example: 00-14-22-01-23-45

Every Network Card gets a unique MAC Address
First 6 Characters - OEM ID

To find out your MAC Address -
Command Prompt
C:\Users\ryang>ipconfig /all
Scroll down to Ethernet Adapter Ethernet
Physical Address ← this is where your MAC Address will be!
Physical Address (burned in at the factory)
For MacOS or Linux, use the command ifconfig

Every time we send out a Frame,
instead of just the Data,
at the beginning we'll have the Destination MAC Address,
followed by the Source MAC Address

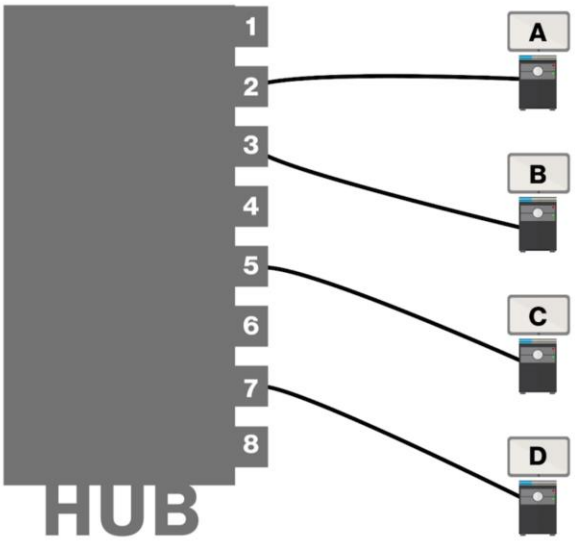
Destination MAC Address - get it to the correct computer
Source MAC Address - serves as a courtesy showing where it came from
incase they want to talk back to us
FCS (Frame Check Sequence) - nothing more than a checker
ensuring the data arrived in good order (End of the Ethernet Frame)

This is the basics of an Ethernet Frame

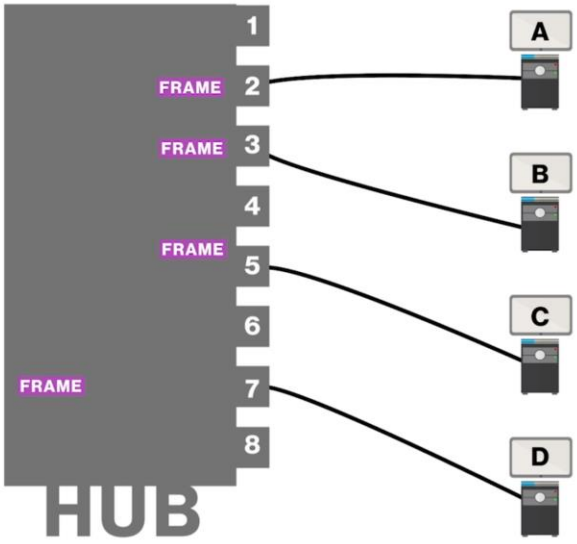
Hubs vs. Switches

- Hubs repeat all traffic on the LAN to all nodes
- Switches filter traffic based on MAC address
- Switches provide full bandwidth for all nodes

White Box on Top is a Hub, and the other 4 Boxes are Switches
Printed on the box it says, “Baseline Dual Speed Hub”
and the box under it says, “Switch 4400”



This 8 Port Hub is connected to these 4 computers (it doesn't matter where they get connected). We now have a Local Area Network!



If computer D wants to talk to computer A,
computer D sends a Frame into Port 7

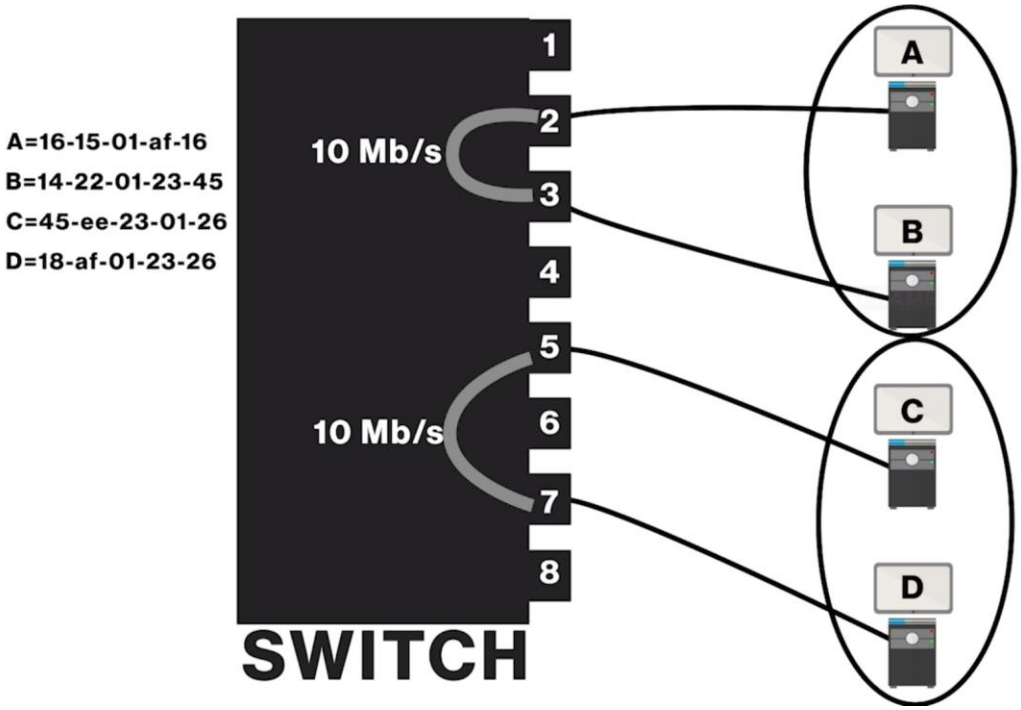
This box is a Repeater - it takes the signal that comes in
and it repeats it (makes a new copy),
and sends that signal back out where everyone is connected.
Everyone gets the conversation between D & A

Now, lets say A&B are talking, and C&D are talking
and this Hub has a max throughput of 10Mb/s.

These conversations have to share/split the throughput,
so both of these conversations are 5Mb/s.
Adding more computers would really slow things down.

Let's magically transform this Hub into a Switch

Switch will begin to collect MAC Addresses on an internal list.



The Frames can now be directly sent to the computer we want to send it to!!
and instead of having (2) 5 Mb/s conversations, we have (2) 10 Mb/s,
because nobody's trying to talk over the other conversation!

Switches work a LOT better than Hubs.
Nobody uses Hubs anymore!

Hubs - Repeats back on all of the Ports
Switch - is a Smart Repeater & only sends the data out to the proper destination
based on the MAC Address

Hexadecimal

- Hexadecimal (base 16) enables discussion of long strings of 1's and 0's
- Each hex Character represents 4 binary numbers (0000-1111)
- In hex, numbering goes 0-9, a-f, for 0-15

Hexadecimal - we use this short-hand nomenclature
so we don't have to write long strings of 1's & 0's

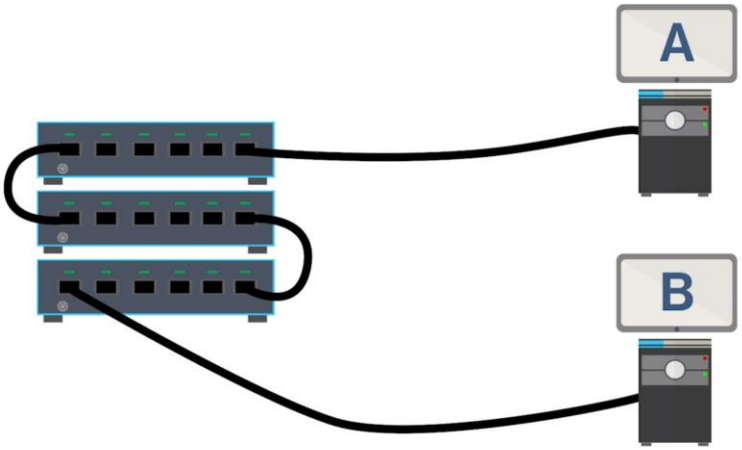
Every Hexadecimal character represents 4 binary values

So, how many bits long is this MAC Address?
40-8D-5C-1C-5A-50
Well, there are 12 characters x 4 binary values = 48 bits Address!

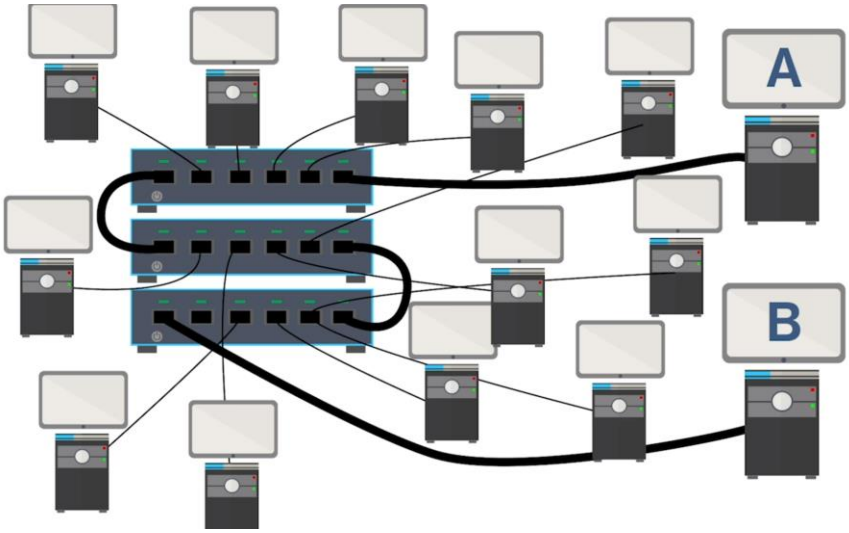
We get to represent this with ¼ of the info written on the screen!

WAN's and Routers

- Switches connect (up to 1024) computers in a LAN
- Routers connect multiple LANS together in a WAN
- Routers use logical addressing (IP addressing)
to determine local vs. remote traffic



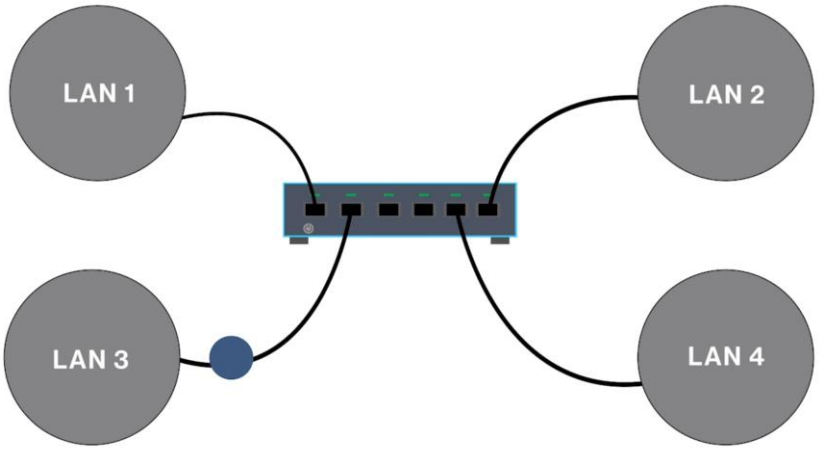
3 Switches daisy-chained together acting as 1 Switch, connecting 2 computers



This system is overloaded!

For a Local Area Network, 30-40 computers is standard max size
although Ethernet has a set standard of 1024 computers.

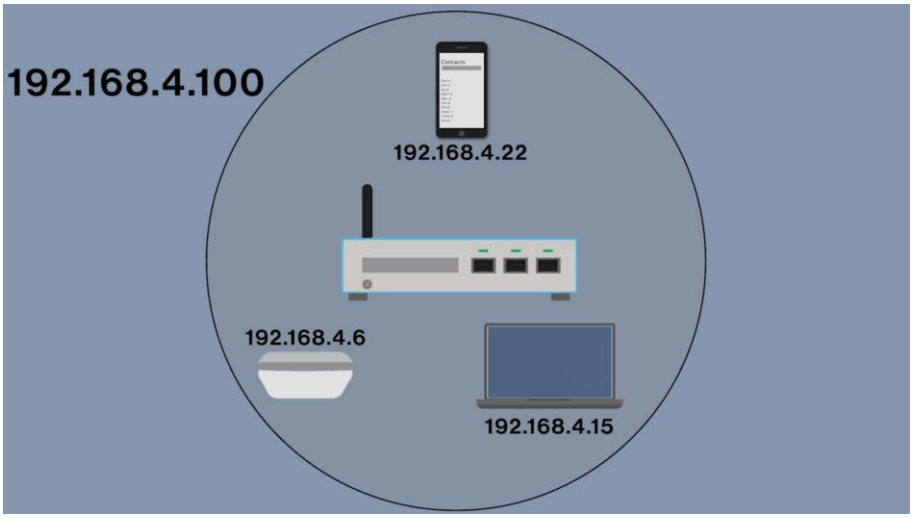
Wide Area Network (WAN) - widespread group of computers connected using long-distant technologies



LAN1 through LAN4 represent Local Area Networks of up to 30-40 computers
connected by a Router

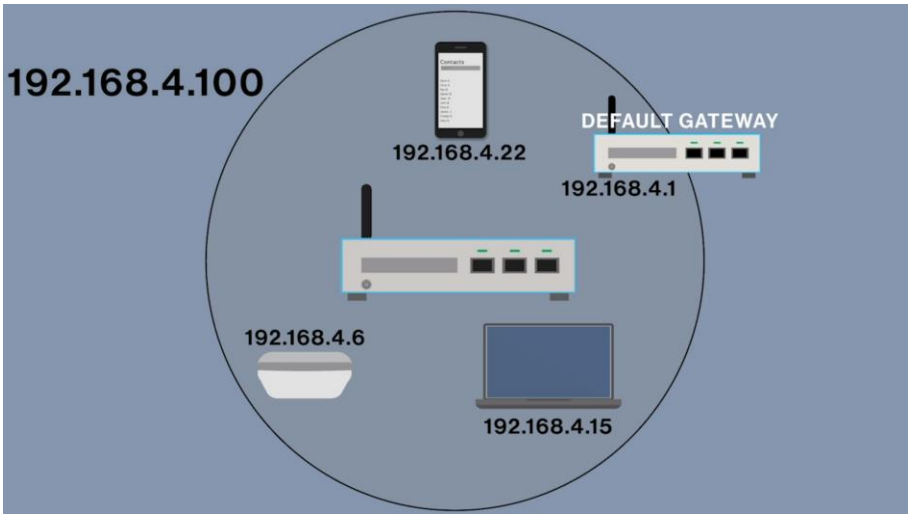
Logical Addressing connects each LAN to the Router

5 Port Switch & a Router look very similar



At your Home, you collectively have a LAN
connected by a Router with a built in Switch
with a Logical Addressing called an IP Addressing (# top left)

Every device within your LAN gets a unique Address
where the first 3 numbers are the same (192.168.4)
and the last number has to be unique

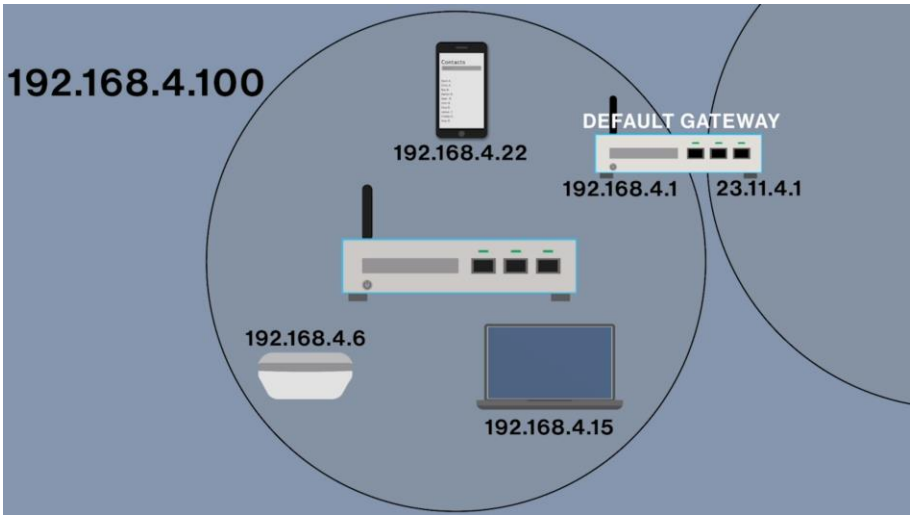


There's also a Router in our LAN, and by convention we give it a .1 Address

If any 2 computers want to talk to each other, they don't even use the IP Address.

They just use their MAC Addresses.

But if the computers want to talk to anybody
that doesn't have the Address 192.168.4,
they have to send it out to this Router called the Default Gateway



On the other side of this Router is a different IP Address
which is a separate LAN that is not ours!

Every computer on earth has 2 very different addresses
MAC (Physical) Address - for Local calls
Logical Address - based on numbering system called IP Addressing

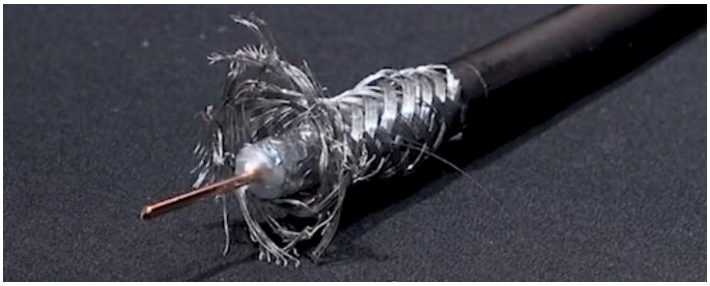
Cables and Connectors

- Coaxial cables use RG ratings and F-type connectors
- Most networks use twisted pair cabling
- Fiber optic cables use light, rather than electrical pulses
- Twisted pair cabling have different category (Cat) ratings

Wired connections are the backbone of what makes our Networking & Internet work

Ethernet - predominant Networking
Defines our Frames, how Network Cards work, and Cabling & Connectors used

10BaseT (10 Mbps Baseband Twisted Pair)
1000BaseT; 10GB Base T - as technology improves, our cabling changes



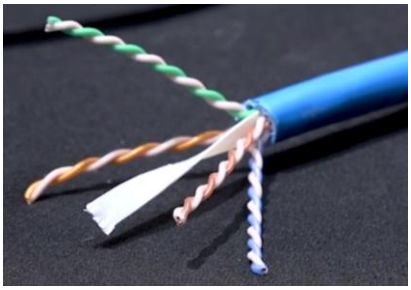
Coaxial Cable - the connectors are Axial
Center Piece with White Insulator
wrapped in an Outer Cladding which acts as a Signal Tool as well.

RG Ratings - printed on the cable

RG-58 - this *was* used in Networking; Thin Cable; (BNC Connector)

RG-59 & RG-6 - Cabling used for Video & Networking (F-Type Connectors)

Coaxial is great, but today we use Twisted Pair



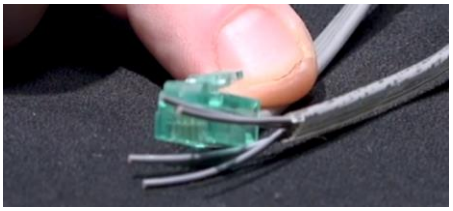
UTP (Unshielded Twisted Pair) - Notice there's No Metallic Foil (Unshielded)

4 Twisted Pairs (most common)

The twists help propagate the signal better.

If they weren't twisted, the distances we'd be able to run individual cables would be much shorter

These can run about 100 meters - from your switch to your computer



RJ-11 - Telephone Cable - 2 Twisted Pairs with 4 Contacts

RJ-45 - 4 Twisted Pairs with 8 Contacts

STP (Shielded Twisted Pair) - RJ-45 with Metallic Shielding for Protection

Fiber Optic Cable - Doesn't use electricity. It uses Light

Yellow strands on the left is Kevlar (same material used for bulletproof vests)

White Wire on the right is Cladding, which reflects

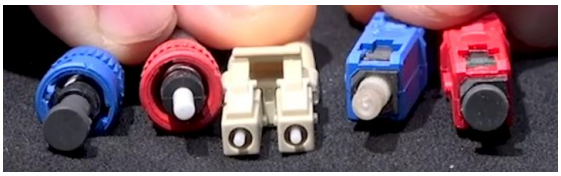
Inside the Cladding is a Hair-Thin Fiber Glass that propagates light signal

2 Ways to Propagate a Light Signal -

Multimode - Uses LED to propagate the signal

Typically what you see in a Network environment

Singlemode - Uses Lasers to propagate many kilometers



3 Types of Connectors (Notice they're all in Pairs)

With Fiber Optic, 1 Wire will Send, the other will Receive

Going back to Unshielded Twisted Pair -

Cat (category) Ratings - different types of Unshielded Twisted Pairs,

but designed to carry much more information

CAT 5 - designed for a 100 Mbps Network

CAT 5e - 1 Gbps

CAT 6 - 1 Gbps up to 100m and 10 Gbps up tp 55m

CAT 6a - 10 Gbps at 100m Segments

Memorize these!

Plenum Ratings - ability to Resist Fire (these cables are wrapped in plastic)

Plenum - area between dropped ceiling and floor

PVC (non-plenum) - The most burn-able there is (very cheap)

Riser Rating - this is mid-range fire resistant (used to go up floors)

Plenum Rating - much more resistant to fire

Always check your local building codes (most likely it'll be Plenum)

Crimping Cables

- Use a crimping tool to attach UTP cable to crimp (like RJ-45)
- Two standards: T568A and T568B
- Straight-through cable has same standard on each end
- Crossover cable has different standards on each end

Mike has in his car a 100ft piece of Unshielded Twisted Pair Cable for Network Testing

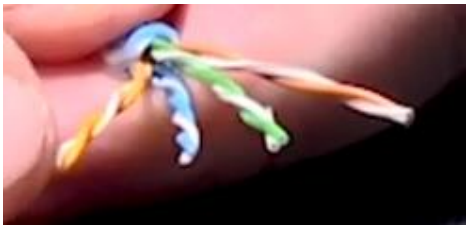
CAT 5e with a RJ-45 Crimp

Crimps also have a CAT Rating - make sure you have a CAT 5e Crimp!

Cable & Crimper Cutter

Cuts with a Razor, and Crimps RJ-45 & RJ-11

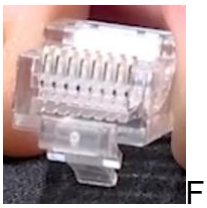
Cut away about an Inch of the Blue Jacket



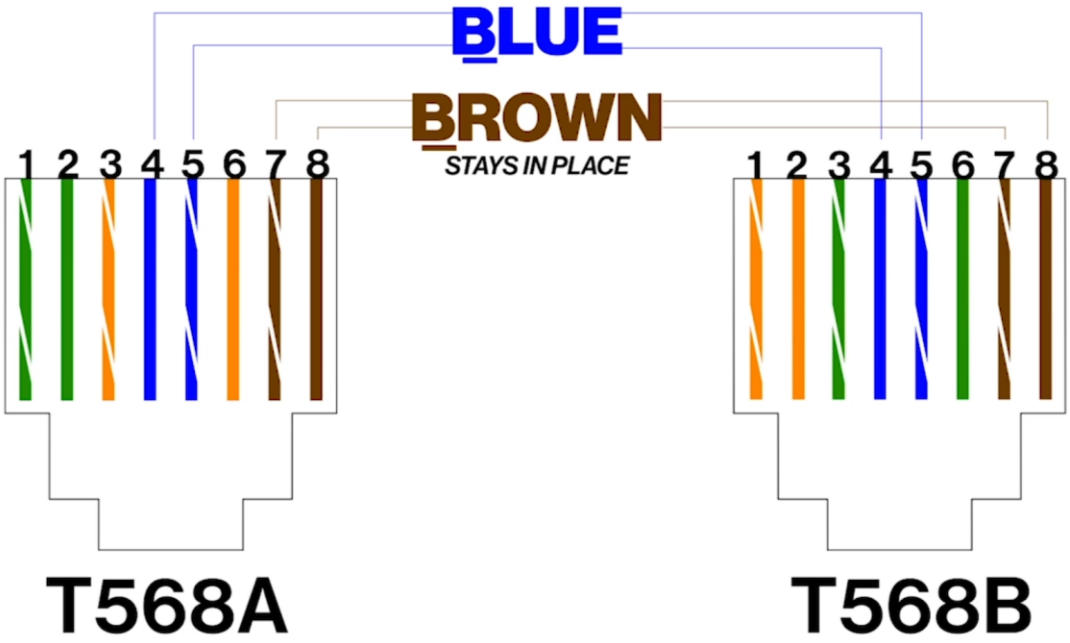
Twisted Pair Colors - Orange, Blue, Green, and Brown

These have to go into the Crimp in a very specific order

TIA 568A/TIA 568B - These 2 Standards define which wire we put into each crimp hole

 From Left to Right, the hole #’s are 8,7,6,5,4,3,2,1

You could imagine if you’re holding the crimp in a different orientation, the hole #’s would be 1,2,3,4,5,6,7,8



First - Notice the Pattern (White, Color, White, Color, White, Color, etc)

1&2 - Green 1&2 - Orange

4&5 - Always Blue 7&8 - Always Brown

 We can see that Mike’s preparing for a 568A Crimp, because he’s got the Green first (all the way on the right)

 Mike used Scissors to only expose ½ inch of wire, which will be shoved into the crimp

Use a Cable Checker to check for

1) Continuity - is it connected from 1 end to the other
2) Wire Map - wire orientation is correct on both ends

Straight-Through Cable - a cable that's wired properly
with 568A's on both sides, or 568B's on both sides

This Wire Map tells us
good Wire Map & good Continuity

This reading tells us we have bad continuity

Crossover Cable - one end wired 568A & other end wired 568B
Can be used to have 2 computers communicate with each other with no switch

Structured Cabling

- Horizontal runs from wall outlet to patch panel through walls/ceilings
- Use punchdown tool to connect cable to patch panel
- Use tone generator/tone probe to locate cables
- Use TDR for testing runs

Structured Cabling - methods of organizing cables in a network
for ease of repair and replacement. (Cables through the walls, not on the floors)

MDF (Main Distribution Frame) - this is where Structured Cabling starts
Typically in a closet/some room

Patch Panel

Horizontal Run

Switch

19 Inch Equipment Rack (Standard)

A Switch that's designed to be mounted in this rack is 19" Wide, and 1u High
aka a "1u Switch"

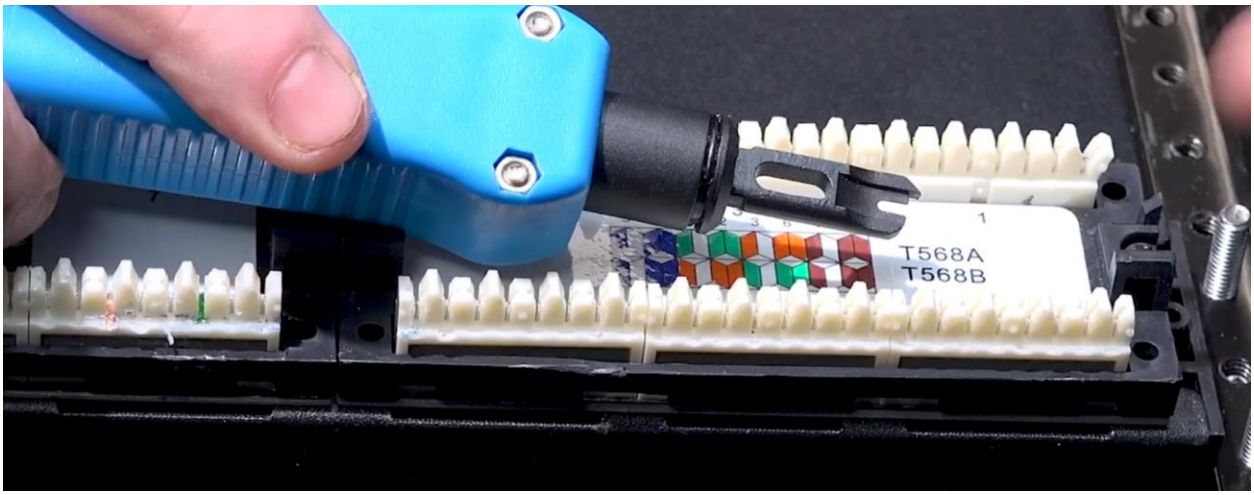
Horizontal Run - cabling that connects the equipment room to the work areas
which runs into the back of a Patch Panel

Boot - big extra rubber chunk

TIA Rules - Longest Run you can have is 90 meters
Ethernet - allows 100 meters

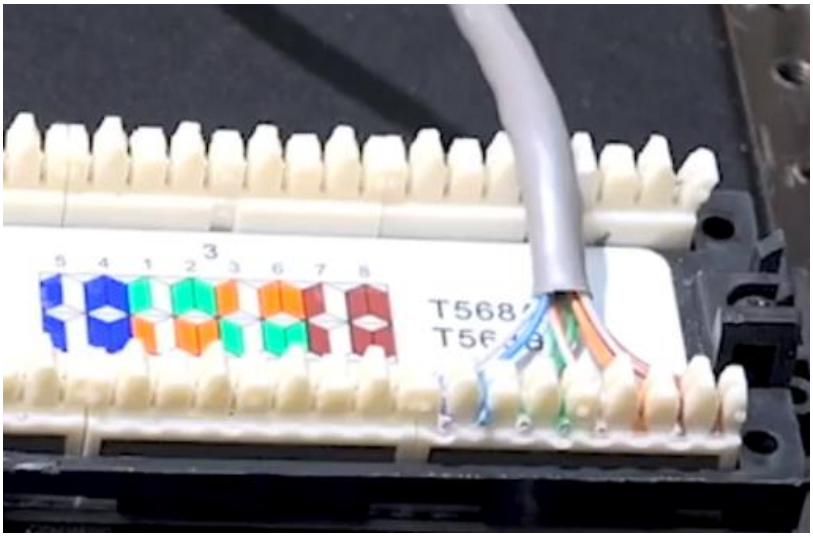
Large Patch Panel which is connecting the many Wall Outlets and to the Switch

Down below are also Server Systems (rack mounted computers providing file services)



Follow the 568A & 568B wire orientation on the back of the Patch Panel

May be different than what we've learned in the past, but this is what the panel wants



110 Punchdown Tool - That metal part that sticks out a little bit

always needs to be on the outside, never on the inside of the Patch Panel

Wire Map Testers will come with the main tester, and a remote tester,

so you can check for connectivity between the Patch Panel and the Wall Outlet

Fox (Tone Generator) and Hound (Tone Probe) - Used to locate cables

Fox makes a noise (gets plugged in), Hound finds the noise

If you're looking at an Outlet and having no idea where it is on the Patch Panel,

use the Fox and Hound to easily locate!

TDR (Time Domain Reflectometer) - uses speed of light to detect cable length
40m run, and now it's reading 20m
Great for seeing if there's a break in the wire in the walls,
which is the ultimate thing we don't want to see.

Different Types of Untwisted Shielded Pair -

Solid Core - Put into the Walls. Each one of the 8 wires is a solid piece of copper,
which carries electricity very well

Stranded - Used for the Patch Cables. Each of the 8 wires is stranded,
which makes it nice & flexible and it won't break

Network Card Troubleshooting

- Use Device Manager > NIC Properties for information/configuration
- Change duplex and wake-on LAN settings there
- Link lights show connectivity, activity, and (sometimes) speed

If you want an Individual Computer (Host) to connect to your Network,
it's going to need a Network Card

NIC (Network Interface Card) - RJ-45 Connector
Almost never just needing a simple card for this.
They're almost always built into the Mobo

If you are installing NIC, look for it in Device Manager under Network Adapters
Also, Right Click → Properties → Advanced
Speed & Duplex -
Full-Duplex - Talking & Listening at the Same Time
Half-Duplex - Situations where you might want this
such as using a Crossover Cable to connect 2 computers

Mike has rarely ever had to change this setting from
the default "Auto Negotiation"

Wake-On-LAN - Wakes up a computer if certain information comes in

Magic Packet - As an Admin wanting to distribute an update to all computers.
This update will include a Magic Packet, which wakes up these computers.

Properties → Power Management
"Allow this device to wake the computer"
"Only allow a magic packet to wake the computer"

When a Device is connected to a Switch,
you'll have Link Lights that will tell us……
1) Connected - will be steady on all the time
2) Speed Light - how fast am I running
3) Activity Light - will always be flickering

Connected & Speed Light are often the same light,
but the Speed Light is just a different color

These Link Lights are on the Switch and the back of your System

Checking Link Lights is always a good idea to check Network Connectivity
on your System & the Switch

I hope you’re enjoying this Notes Course.

I’d really appreciate it if you were to rate & review this course.

Thank you and keep up the good work!
Robert Mathisen