SEICHE 2022

Introduction to Arduino

Lesson 7/8– Grounding, ESD, Breadboards, Schematics, Resistors, Connecting LEDs

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Corporate Sponsor: DXC Technology

REMEMBER!

Immediately copy the latest lesson folder (Lesson9 today) from your USB flash drive to your hard drive where you previously copied the other flash drive files (probably Documents folder)

Lesson Plan Overview

Lesson 1 – Intro and Setup
[may require 2 classes]

- Introduction to class format
- Overview of lesson plan
- Presentation format (monitor, camera, screen, whiteboard)
- Inventory of Arduino kits
- Inventory of USB drives
- Installation of ESP32 serial port drivers (Windows only)
- Installation of Arduino software
- History of Computing

Lesson 2 and 3 – Laptop operation review

- Control panel/Settings location
- Home directories and folder hierarchy
- Arduino file locations
- Search functions
- Open questions and issues
- History of Computing redux

Lesson 4 and 5 – IDE essentials

- The boards manager
- Setting board type
- Installing Libraries
- Loading example sketches
- Finding and selecting the Arduino USB port
- Uploading a sketch to the microcontroller [Example Sketch#1]
- Basic Arduino sketch (program) structure
- Uploading your own sketch [Class Sketch #2]
- History of Telecommunications and Networking – Part 1

Lesson 6 – DC Electricity Basics and DMM Intro

- Quick review: DC vs AC electric currents
- DC current operation
- Voltage vs Amperage (current)
- Ohm's Law
- Series vs parallel circuits
- Introduction to basic DMM functions and usage
- Measuring voltage [DMM usage #1]
- History of Telecommunications and Networking – Part 2

Lesson 7 and 8 – Grounding, ESD, and Connecting LEDs

- Grounding
- The Phantom Menace of ESD
- Resistors!
- LED's [DMM usage #2, maybe]
- Powering LEDs – Ballast and dropping resistors
- Connecting LEDs to microcontrollers
- Parts of an Arduino Sketch
- ESP32 Specifications – Ampacity
- Let there be Light! – Class Sketch #2
- History of Telecommunications and Networking – Part 3

Lesson 9 – ESP32 External power sources [may require 2 classes]

- Capacitors!
- Microcontroller board power requirements
- Board power input options and grounding
- Components with different voltage requirements – level shifting
- External power circuit design
- Simplified serial communication protocols
- One-wire serial communication protocol
- Hardware vs software serial
- WS2812B and Neopixel connections – Class Sketch #3
- External device power design

Lesson 12 – Connecting LCD and Matrix Displays

- The SPI serial protocol
- SPI connections – Class Sketch #5
- SPI device external power design

Lesson 13 – Connecting sensors [Time permitting]

- Connecting buttons
- Connecting potentiometers and voltage dividers
- Reading buttons and debouncing
- Reading potentiometers

Lesson 14 – Connecting more sensors [Time permitting]

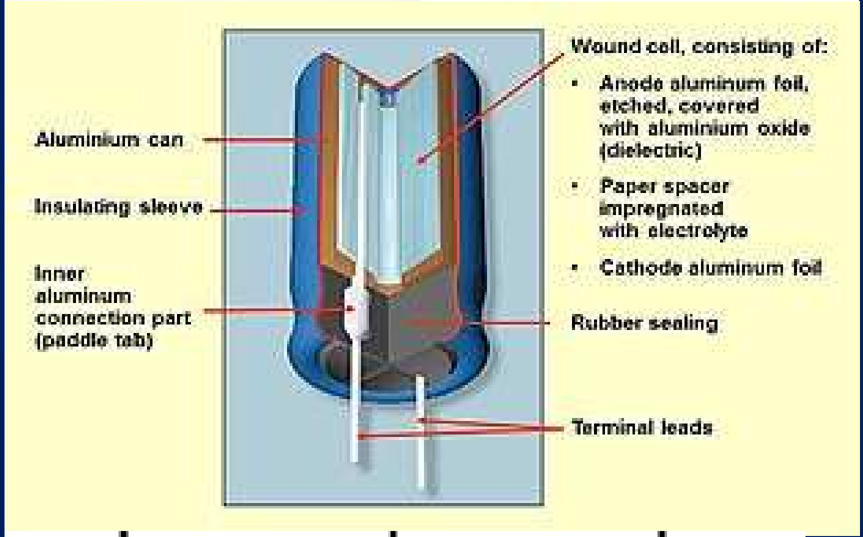
- Connecting I2C sensors and photoresistors
- Using ESP32 integral touch sensors

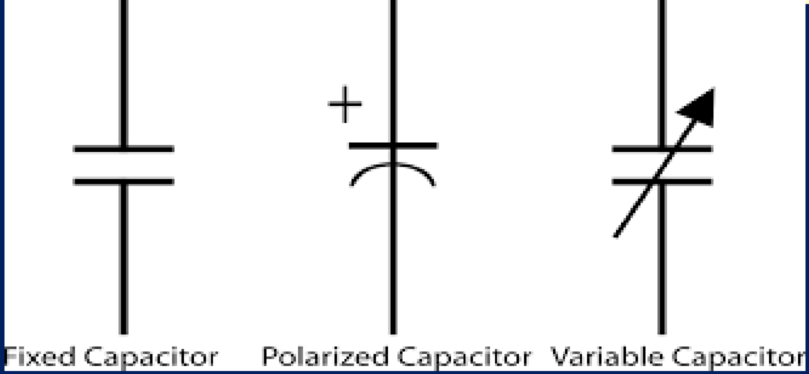
Lesson 9 – Smart LED Strips

- Capacitors!
- Board power input options and grounding
- External and USB Power
- Peripherals with different voltage requirements – level shifting
- External power circuit design
- WS2812B and Neopixel connections
- Class Sketch #3
- History of Telecommunications and Networking (Time Permitting)

Our Second Component – Capacitors

- A capacitor is a two-terminal, electrical component. Along with resistors and inductors, they are one of the most fundamental passive components we use. You would have to look very hard to find a circuit which didn't have a capacitor in it. [Sparkfun]
- What makes capacitors special is their ability to store energy; they're like a fully charged electric battery. Caps, as we usually refer to them, have all sorts of critical applications in circuits. Common applications include local energy storage, voltage spike suppression, and complex signal filtering. [Sparkfun]
- Capacitors come in two varieties, polarized and non-polarized. Polarized capacitors have specific leads for positive and negative electrical connections.
- Most polarized capacitors are electrolytic. An electrolytic capacitor is a polarized capacitor whose anode or positive plate is made of a metal that forms an insulating oxide layer through anodization. Due to their very thin dielectric oxide layer and enlarged anode surface, electrolytic capacitors have a much higher capacitance-voltage (CV) product per unit volume than ceramic capacitors or film capacitors, and so can have large capacitance values. [Wikipedia]


Aluminium can
Insulating sleeve
Inner aluminum connection part (paddle tab)
Wound cell, consisting of:
Anode aluminum foil, etched, covered with aluminium oxide (dielectric)
Paper spacer impregnated with electrolyte
Cathode aluminum foil
Rubber sealing
Terminal leads



Capacitors are critical components, pervasive in electronic devices

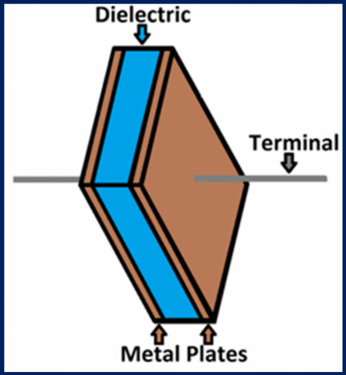
Capacitors - Measurement

Each capacitor is built to have a specific amount of capacitance. The capacitance of a capacitor tells you how much charge it can store, more capacitance means more capacity to store charge. The standard unit of capacitance is called the farad, which is abbreviated F.

It turns out that a farad is a lot of capacitance, even 0.001F (1 milifarad -- 1mF) is a big capacitor. Usually you'll see capacitors rated in the pico- (10-12) to microfarad (10-6) range.

When you get into the farad to kilofarad range of capacitance, you start talking about special caps called super or ultra-capacitors.

[Sparkfun]



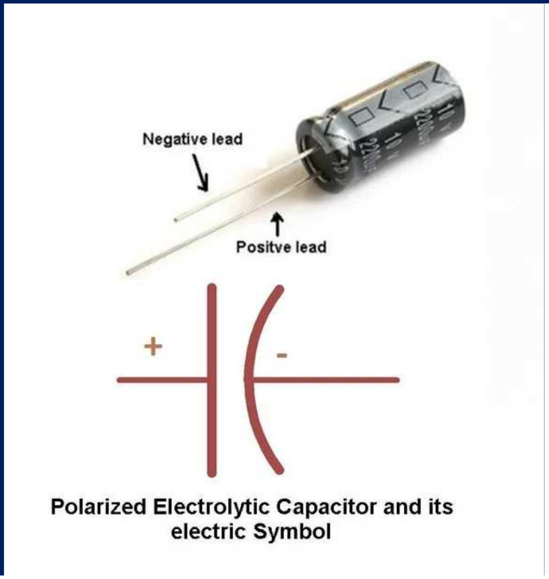
Prefix Name	Abbreviation	Weight	Equivalent Farads
Picofarad	pF	10^{-12}	0.000000000001 F
Nanofarad	nF	10^{-9}	0.000000001 F
Microfarad	µF	10^{-6}	0.000001 F
Milifarad	mF	10^{-3}	0.001 F
Kilofarad	kF	10^{3}	1000 F

Capacitors - Operation

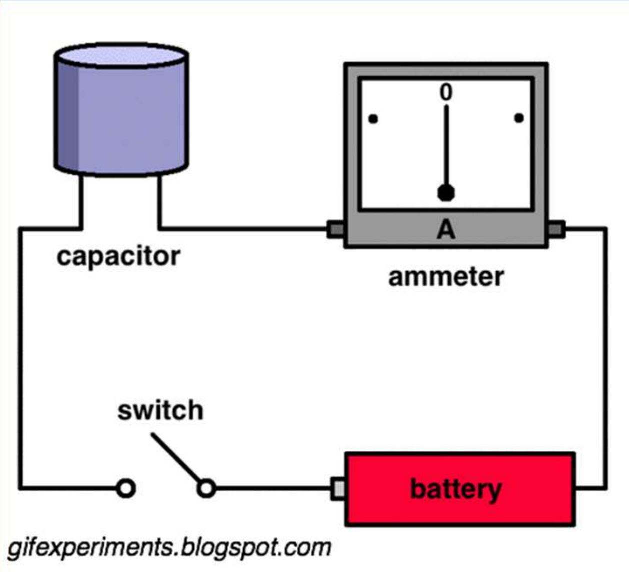
When positive and negative charges coalesce on the capacitor plates, the capacitor becomes charged. A capacitor can retain its electric field -- hold its charge -- because the positive and negative charges on each of the plates attract each other but never reach each other.

At some point the capacitor plates will be so full of charges that they just can't accept any more. There are enough negative charges on one plate that they can repel any others that try to join. This is where the capacitance (farads) of a capacitor comes into play, which tells you the maximum amount of charge the cap can store.

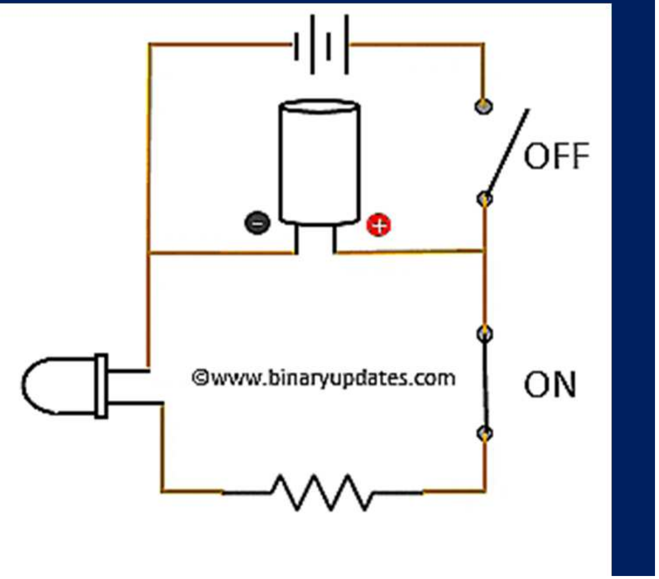
If a path in the circuit is created, which allows the charges to find another path to each other, they'll leave the capacitor, and it will discharge.
[Sparkfun]



Polarized Electrolytic Capacitor and its electric Symbol



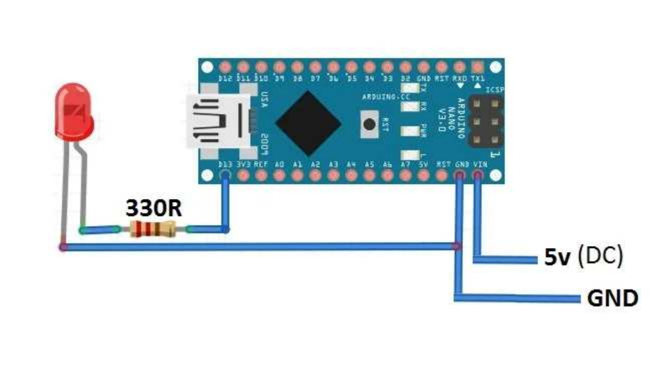
gifexperiments.blogspot.com

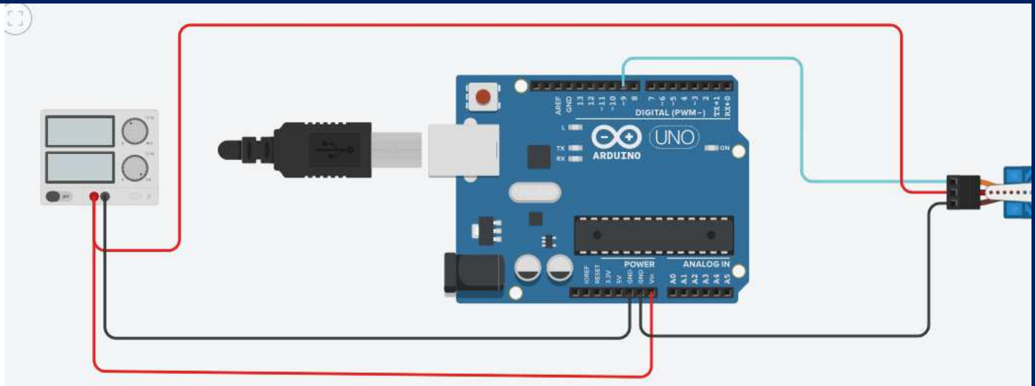


©www.binaryupdates.com

Board Power Input Options And Grounding

- All boards can be powered externally, without USB connected.
- Some boards, such as the Arduino Uno, have an external power connector right on the board.
- For other boards, things can get more complicated
- The #1 rule in all cases is that ALL DEVICES MUST SHARE A COMMON GROUND (RAIL).
- Failure to provide common ground can, and probably will, cause component damage
- It is very dangerous to connect USB power and external power rails together. Damage and even fire can result.





External and USB Power

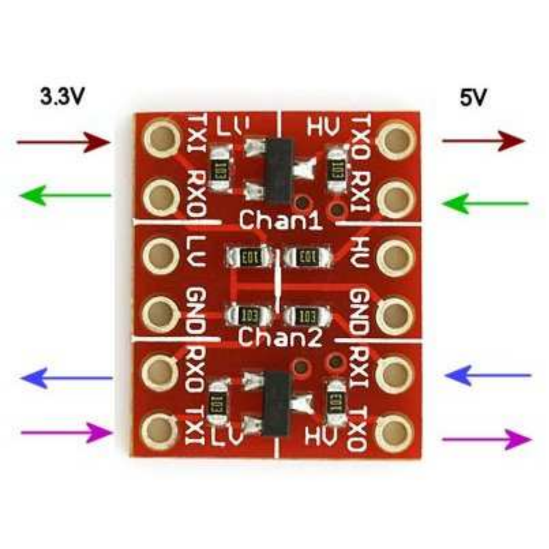
- Connecting USB and external power at the same time will frequently fry a board. This is especially true for the ESP-32, which uses lower capacity power regulation as it uses 3VDC.
- The easiest solution is (obviously) to only have one plugged in at a time.
- BEWARE!: As previously noted, when on USB power many boards will still supply 4.2VDC from the USB connector to the 5 volt rail. This allows peripherals to operate on USB power.
- That’s not a problem for low current devices, but quantities of Neopixels will burn out the regulator, the laptop’s USB chip, *or both*.
- The solution to this problem is to place a diode in-line between the 5 volt rail and the board’s input power pin.
- The diode prevents power from “flowing back” from USB power to the peripherals.

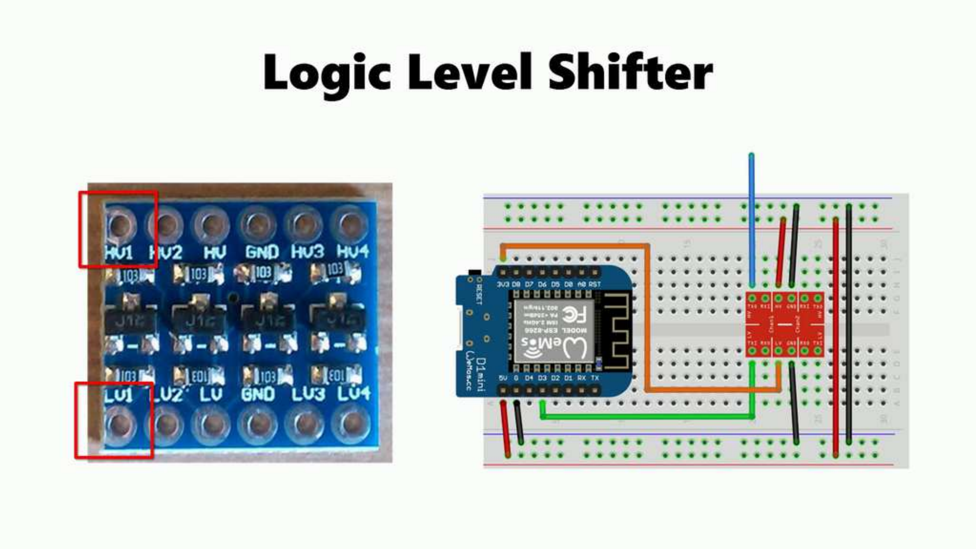
Different Voltage Requirements

- Not all peripherals will run at the same voltage as the microprocessor board you are using
- This results in different signal level tolerances. Not the power rails, *but the control signals themselves* operate at different voltages.
- Transmitting a 5 volt signal into a 3.3 volt device will damage or destroy the receiving device. This is as true for SPI as it is for traditional RS-232C TTL serial connections.
- Transmitting a 3 volt signal into a 5 volt device *sometimes* works. It depends on how well designed the receiving device is.
- The best-practice solution to this problem is to use devices called level shifters. Level shifters provide voltage translation between the two different signal levels.

Level Shifters

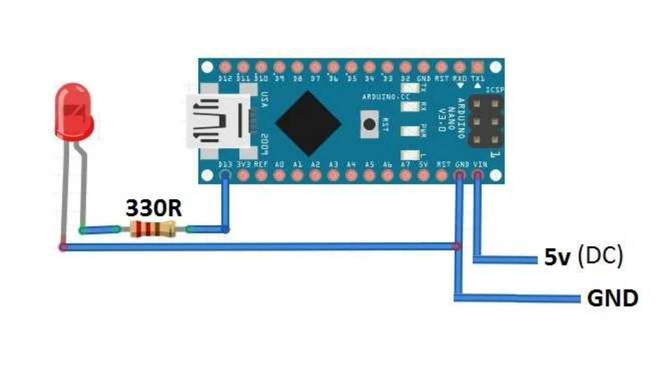
- Level shifters provide bidirectional translation of logical signal voltages between different digital peripherals and devices
- For instance, if you needed to connect a 3.3V microcontroller to a 5V real time clock (RTC), you would use a level shifter on the SPI or I2C serial connections
- Nearly all level shifters are for 5 VDC and 3.3VDC translation
- Level shifters are not self powered; they must have external power connections to the higher voltage (5V) rail

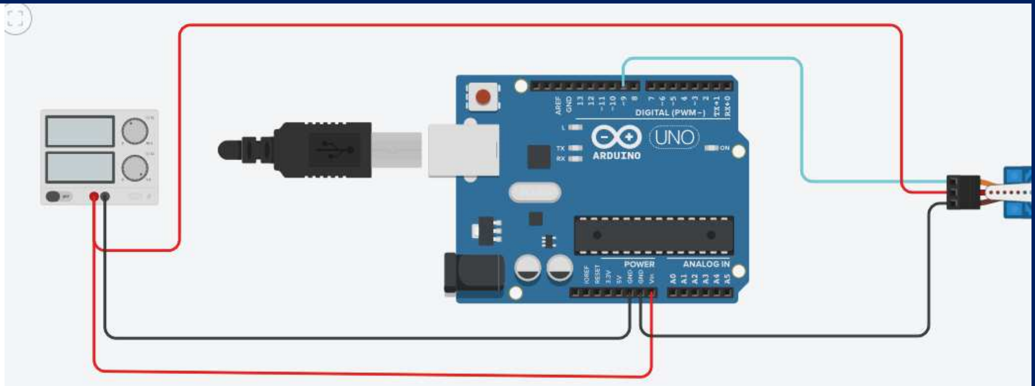




External Power Circuit Design

- All microcontroller boards have a range of external input power they will accept
- Not all boards have direct USB interfaces
- External power should be applied to the board’s external power input pin. This is usually shown on the board pinout
- The Heltec Wifi Kit 32 accepts power on the 5V pin
- The maximum external power a Heltec will accept is six (6) volts.
- **Always maintain common grounding between all components, peripherals, and devices!**



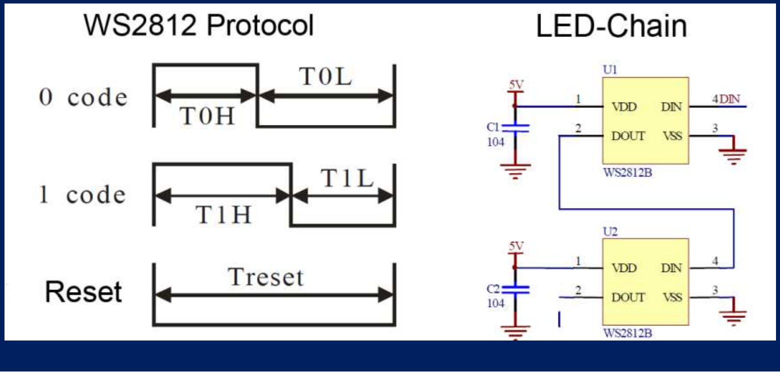


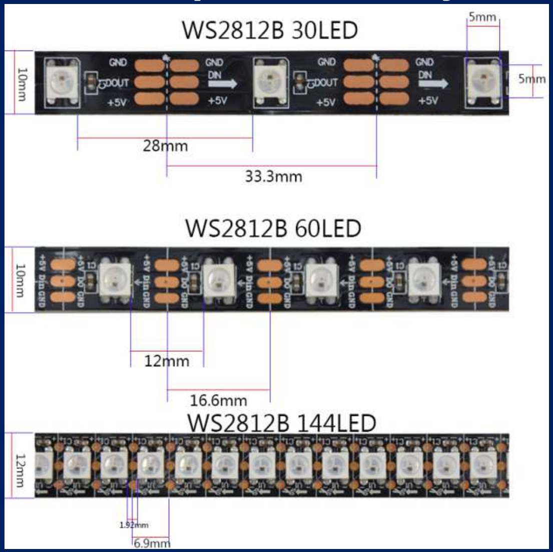
The WS2812B LED aka Neopixel

- The WS2812B is an (integrated) chip and 5050 package (flat, square) RGB LED
- An RGB LED can display 24 bits of color (0-255 red, 0-255 green, 0-255 blue)
- There are RGB LED controllers other than the WS2812B; discussion of those is outside the scope of our class
- “Neopixel” is a proprietary marketing term used by Adafruit Industries for their line of products based on the WS2812B
- RGB LEDs, and their chipsets, can be designed to run at 5VDC and 12VDC
- The chips of “Smart” LEDs make them individually controllable
- Control is by means of a one-wire transmit-only serial data protocol; the signal is directional with an input and an output for each pixel. Usually daisy-chained.

This is the WS2812B chip

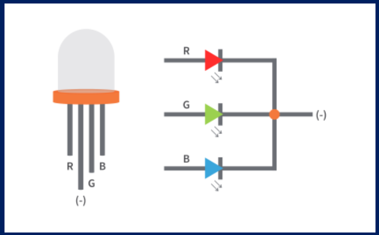
5050 RGB LED package





Types of WS2812B Strips

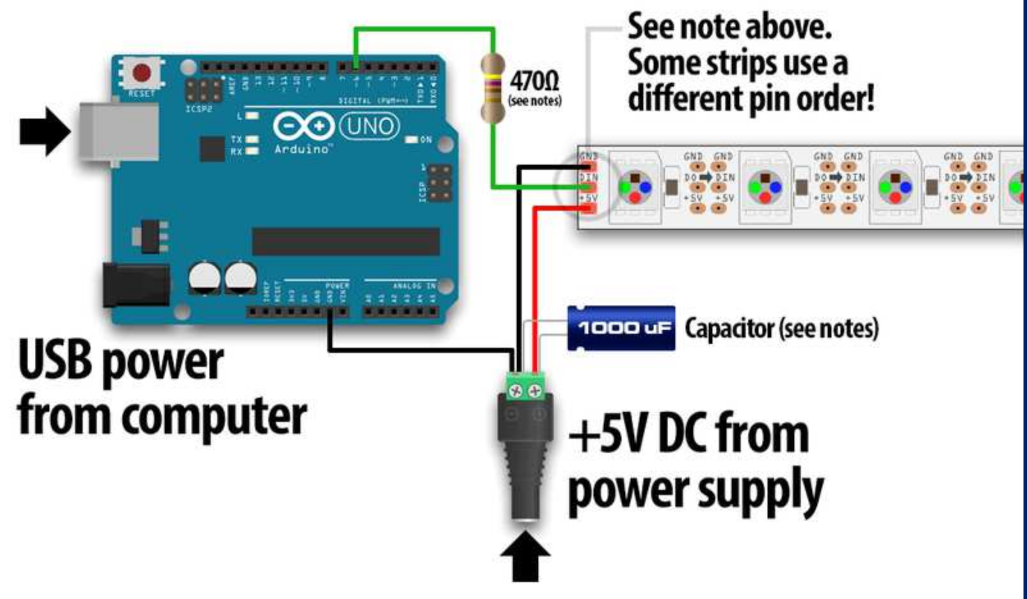
PIXELS ARE DIRECTIONAL!!!



“Traditional” RGB LED (5mm package)

External Power and WS2812B Neopixels

- RGB LEDs of any kind draw *LOTS* of current. 20mA per LED x 3 LEDs = 60 mA of current as a general power budget. *THAT'S PER LED.*
- More than 5 Neopixels will overload most 500mA board power regulators.
- The solution to this problem is to use external power for the LED strip.
- When the external power is 12 or 5 volts and the microcontroller is 3 volts things get very tricky indeed
- It's OK to send 5V to the board input power pin and the LEDs simultaneously
- It's generally NOT OK to connect USB power *at the same time*
- *Level shifting may be required for the serial data line (Data IN) to the Neopixels. This is entirely dependent on the pixel type. YMMV!*



The ability to SAFELY connect USB power and external power at the same time **depends on the board!!!**

Most boards will attempt to power peripheral devices *using USB power*
There is no sanity checking of this action

Trying to power numbers of Neopixels from *any* board will overload the onboard regulator

Wiring an ESP32 and Neopixels

From your Arduino kits:

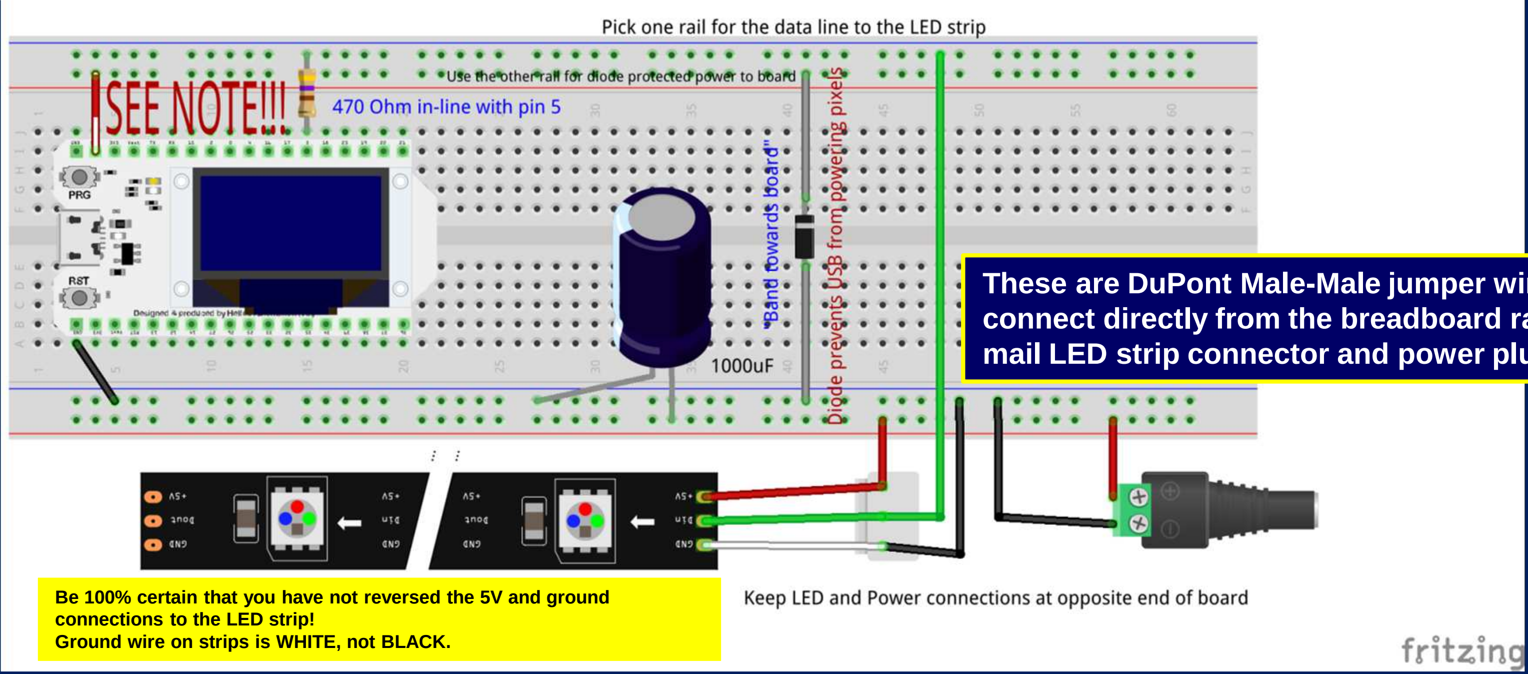
- Green power plug adapter
- 1000uF capacitor
- WS2812B LED strip
- One (1) general purpose diode
- Male-Male DuPont jumpers as required

In spite of extensive pre-testing of the *design*, it turns out that our LED strips are an off-brand that will *probably* not operate without level shifters. These will be supplied in the next class.

Wire your breadboard up to look like this:

NEVER connect USB and external power without the in-line diode. Something will go terribly wrong otherwise.

The 1000uF capacitors are loose in the large plastic boxes in your kits



Pick one rail for the data line to the LED strip

Use the other rail for diode protected power to board

470 Ohm in-line with pin 5

"Band towards board"

Diode prevents USB from powering pixels

These are DuPont Male-Male jumper wires that connect directly from the breadboard rails to the mail LED strip connector and power plug.

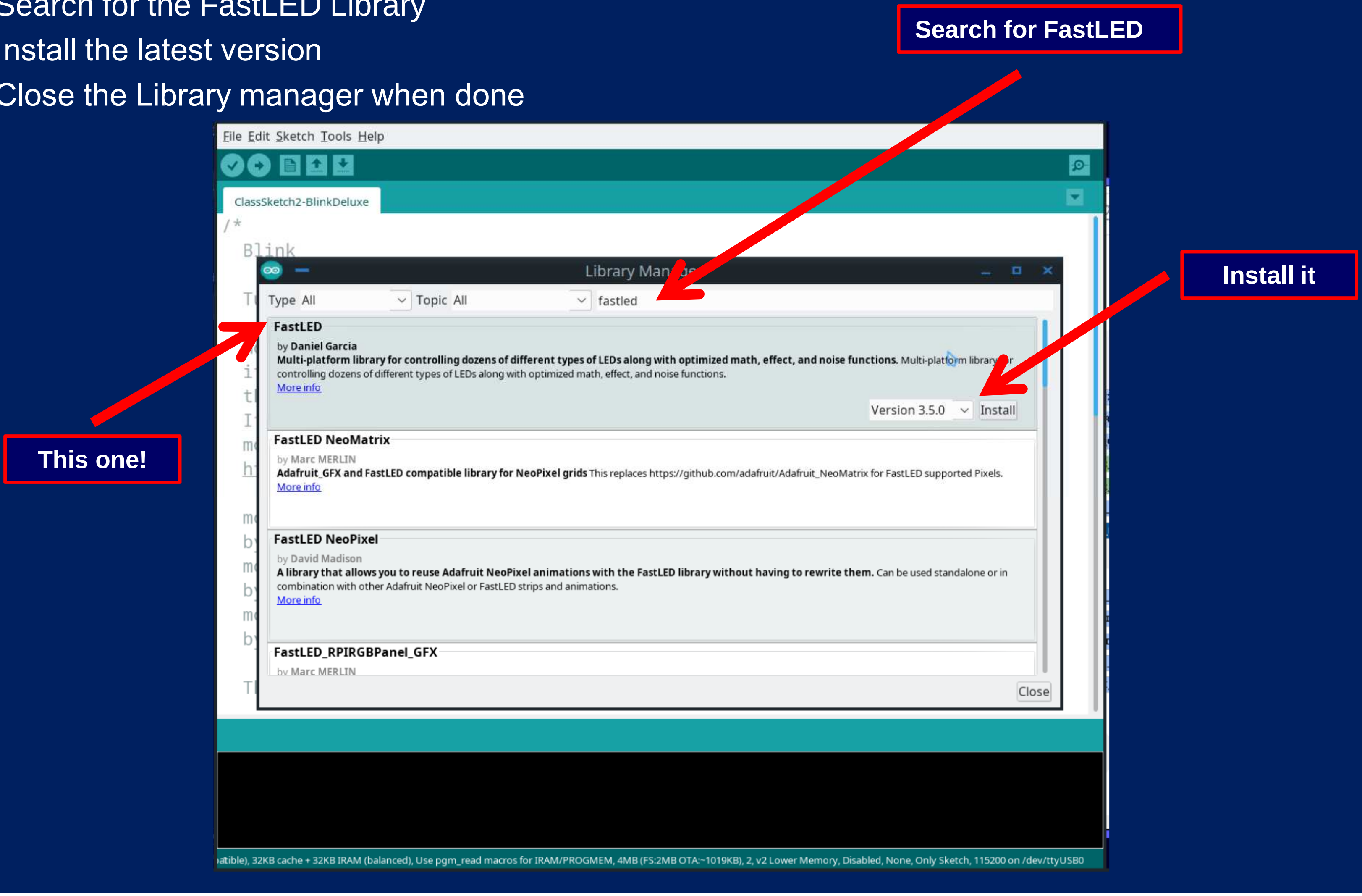
Be 100% certain that you have not reversed the 5V and ground connections to the LED strip!
Ground wire on strips is WHITE, not BLACK.

Keep LED and Power connections at opposite end of board

Have your instructor check all work before applying power to anything!

The FastLED Library

- Find the Arduino sketch in your Lesson 9 folder (which you copied from your USB drives, right?) named “ClassSketch3-V2” and open it in the Arduino IDE (double clicking the [.ino] file is easiest)
- Open the Library manager (Tools-Manage Libraries)
- Search for the FastLED Library
- Install the latest version
- Close the Library manager when done



FastLED

by **Daniel Garcia**

Multi-platform library for controlling dozens of different types of LEDs along with optimized math, effect, and noise functions. Multi-platform library for controlling dozens of different types of LEDs along with optimized math, effect, and noise functions.

More info

FastLED NeoMatrix

by Marc MERLIN

Adafruit_GFX and FastLED compatible library for NeoPixel grids This replaces https://github.com/adafruit/Adafruit_NeoMatrix for FastLED supported Pixels.

More info

FastLED NeoPixel

by David Madison

A library that allows you to reuse Adafruit NeoPixel animations with the FastLED library without having to rewrite them. Can be used standalone or in combination with other Adafruit NeoPixel or FastLED strips and animations.

More info

FastLED_RPIRGBPanel_GFX

by Marc MERLIN

```
atible), 32KB cache + 32KB IRAM (balanced), Use pgm_read macros for IRAM/PROGMEM, 4MB (FS:2MB OTA:~1019KB), 2, v2 Lower Memory, Disabled, None, Only Sketch, 115200 on /dev/ttyUSB0
```

Let There Be Light Redux

- Leave the IDE open and your ClassSketch3-V2 open
- Connect your board to your laptop using USB cable (board end first, then the laptop end!) LEAVE EXTERNAL 5V POWER DISCONNECTED!!!
- Remember to set your board type and port speed! (Change speed if initial upload fails!)
- Upload the sketch! ➔ (this also validates it first)
- **Disconnect USB!!!**
- **Connect the external 5VDC power supply**
- Did it work? Enjoy the light show!☺
- It didn’t work? Now we get to troubleshoot!🔧😎

See what happens if you change “RAINBOW true” to “RAINBOW false” in your sketch. Remember to reupload after modifications!

Anatomy of a sketch

```
#include <FastLED.h>

// How many leds in your strip?
#define NUM_LEDS 30
// Which pin is the pixel DIN line connected to?
#define DATA_PIN 5
#define LED_TYPE WS2812B
#define COLOR_ORDER GRB
#define BRIGHTNESS 30

#define RAINBOW true
```

These are actually *macro* definitions, and not *variable* declaration. Macros are substituted wherever they appear. More on that next semester.

Setup section excerpt

```
Setup()
{
  delay(3000);
  FastLED.addLeds<LED_TYPE, DATA_PIN, COLOR_ORDER>(leds, NUM_LEDS);
FastLED.setBrightness(BRIGHTNESS);
}



void loop()
{

  if (RAINBOW)
  {
    fill_rainbow(leds,NUM_LEDS,i++,1);
    FastLED.show();
  }
…
```

What happens if you change the RAINBOW def to false?

History of Telecommunications Part 2

- Local Area Networks (LANs)
- Wide Area Networks (WANs)
- Wireless LAN (WiFi)
- Cellular Voice Networks
- Cellular data networks
- The Internet - Overview

THE INTERNET AGE

Much like the industrial revolution, the Internet revolution has changed the way people live, shop, socialize and work, and the way companies operate. In the run-up to the 20th anniversary of the 9 August 1995 listing of Netscape's shares on Nasdaq, Mint lists the important landmarks in the evolution of the Internet as we know it today, with special emphasis on India.

1958: The US establishes the Defense Advanced Research Projects Agency (Darpa) in response to the USSR's launch of Sputnik during the Cold War.

1961: Leonard Kleinrock at the Massachusetts Institute of Technology (MIT) publishes the first paper on packet-switching theory—a theory that comes into use later for sending data through the Web.

Leonard Kleinrock

1962: J.C.R. Licklider of the MIT proposes the concept of a "Galactic Network", similar in concept to today's Internet. Licklider is chosen to head Darpa's research efforts.

1965: Computers TX-2 in MIT and Q-32 in California are connected via a telephone network. With the first wide-area computer network comes the realization that time-sharing works well, although not over telephone networks (circuit switching), but through packet switching.

1967: Lawrence G. Roberts of MIT goes to Darpa, comes up with his plan for Arpanet and publishes it. MIT (1961-67), RAND Corp. (1962-65) and the National Physical Laboratory (NPL), the UK (1964-67), all research in parallel about packet switching without the knowledge of each other's work.

1968: BBN Technologies wins a contract to build the first network switch. Bolt Beranek and Newman (BBN) was a group set up by former MIT professors and headed by Frank Heart.

1969: Four different nodes in different universities in California and Utah are connected—the University of Utah, the University of California at Santa Barbara, Stanford and the University of California, Los Angeles (UCLA). Charley Kline of UCLA sends the first Arpanet transmission to Bill Duvall of Stanford. He attempts to send "LOGIN", but the system crashes before he can reach "G". Only "LO" reaches.

Charley Kline

1970: Packet-switched network Mark I is built to serve the NPL in the UK. Developed by Donald Davies, a Welshman and a colleague of Alan Turing while at NPL in the late 1940s.

Graphic: Mohsin Shaikh/Mint

1972: First program devoted to electronic mail (email) is created by Ray Tomlinson at BBN. The concept of 'name@destination' is created. Network Control Protocol (NCP) is also introduced to allow computers running on the same network to communicate with each other. First [illegible] a test message [illegible] [illegible] "QWERTYUIOP".

1973: Vinton Cerf from Stanford and Bob Kahn from Darpa begin work developing TCP/IP [illegible]. The [illegible] networks [illegible] heavily influenced by the French packet-switching network CYCLADES, which was decommissioned in 1981.

1974: Kahn and Cerf refer to the system as the Internet for the first time.

1976: The Ethernet is developed by Robert M. Metcalfe. It's a way of connecting computers together in a local area network (LAN).

- [illegible] the US [illegible] consortium of [illegible] the Internet beyond the US.
- Queen Elizabeth II sends out an email from England promoting a new programming language developed by the British ministry of defence via Arpanet. Her username: HME2 (Her Majesty, Elizabeth II).
- AT&T Bell Labs develops UUCP (Unix-to-Unix Copy) and UNIX.

1979: USENET, the first news group network, is developed.

- International Business Machines Corp. (IBM) introduces BITNET to work on emails and listserv systems.

1981: The National Science Foundation (NSF) releases CSNET 56. Allows computers to network without being connected to government networks.

1983: TCP/IP becomes the standard for Internet protocol. For this reason, 1 January 1983 is celebrated as the unofficial birthday of the Internet.

- Domain Name System is introduced to allow domain names to automatically be assigned an IP number.

1984: The number of hosts crosses 1,000. MCI Communications creates T1 lines for faster transportation of information over the Internet.

1989: The number of hosts crosses 100,000. Traffic rises and plans are to find a new replacement for the T1 lines.

- The first link is established between Australia and NSFNET via Hawaii on 23 June. Australia was limited to USENET up until then.
- Arapnet is decommissioned.

1990: Advanced Network and Services (ANS) develops the T3 line for faster speeds.

- A hypertext system is created and implemented by Tim Berners-Lee while working for CERN (European Organization for Nuclear Research).
- Archie, the first search engine, is created at McGill University, Canada. Archie's developer Peter Deutsch insists it is short for "archiver" and has nothing to do with the comic strip [illegible]

1991: The US gives the nod to commercial enterprises to take off on the Internet; the first item to be purchased on the Internet was a Pizza [illegible]

- CERN releases the World Wide Web publicly on 6 August.

1993: The [illegible] (ISOC) is chartered.

- The number of hosts breaks 1 million.

[illegible] provides general services, a [illegible] directory.

- The first Web browser, Mosaic, created by the National Center for Supercomputing Applications, is released. Mosaic later becomes Netscape. Erwise, a browser developed by Finnish students, was created a year earlier, but discontinued due to a lack of funding.

[illegible] The first [illegible] is opened. First Virtual [illegible] Bank went online two years earlier.

- Yahoo is founded as Jerry Yang and David Filo's guide to the World Wide Web (WWW). It is incorporated a year [illegible]

1995: [illegible] become the second most popular service.

- Registration of domains is no longer free; NSF sells them for an annual fee of $50 apiece.
- Netscape launches its initial public offering (IPO) on Nasdaq; the stock's [illegible]
- Rajesh Jain launches IndiaWorld Communications.
- Videsh Sanchar Nigam Ltd (VSNL) launches India's first full Internet service.
- Satyam Infoway is founded.

1996: WWW browser wars waged, mainly between Microsoft Corp. and Netscape.

- Internet service providers (ISPs) begin appearing, such as Sprint and MCI.
- Nokia releases the first cellphone with Internet access—Nokia 9000 Communicator—in Finland via two local networks.
- Ajit Balakrishnan launches Rediff.com.
- Several Indian newspapers set up websites.

1997: Sanjeev Bhikchandani launches Naukri.com, a jobs portal.

- Pradeep Kar's Micromedia holds the first Internet World exhibition.

1998: Satyam Infoway becomes India's first private ISP.

- Netscape releases the source code for Navigator.
- [illegible] for Assigned Names and Numbers (Icann) is created to [illegible]

1999: Satyam Infoway acquires IndiaWorld for ₹499 crore.

- Ashish Dhawan and Raj Kondur launch Chrysalis Capital, a venture capital fund.
- Wireless technology called 802.11b, more commonly referred to as Wi-Fi, is standardized.

2000: The dotcom bubble bursts, numerically, on 10 March. The Nasdaq Composite index peaks at 5,048.62.

- Avnish Bajaj and Suvir Sujan launch auction site Baazee.com.
- Deep Kalra launches MakeMyTrip.com.
- India's Parliament passes the Information Technology Act.
- Rediff lists on Nasdaq.
- Spectranet launches broadband services.

2001: Blackberry releases the first Internet cellphone in the US—Blackberry 957—with "push email".

- Indian Railways allows online booking of tickets through Irctc.com.

2003: The French ministry of culture bans the use of the word "email" by government ministries, adopts the use of the more French sounding "courriel".

- Airtel launches broadband services in India.

2004: Web 2.0 rises in popularity. Tim O'Reilly and MediaLive host the first Web 2.0 conference.

- Mydoom, the fastest spreading email computer worm, is released. An estimated one in 12 emails is infected.
- India approves broadband policy.
- eBay buys Baazee for $50 million.
- Mark Zuckerberg launches Facebook.
- Google launches social networking site Orkut.

Mark Zuckerberg

2005: YouTube is launched.

- Dot in sites are launched.
- Estonia offers Internet voting nationally for local elections.

2006: The number of Internet websites reaches more than 92 million.

- Twitter is launched.
- Info Edge (India) Ltd, the parent company of Naukri.com, files for an IPO.
- Zimbabwe's Internet access is almost completely cut off. Intelsat cuts service for non-payment of dues.
- Internet2 announces plans for the launch of a brand new nationwide network. Aims to boost capacity from 10gbps to 100gbps.

2007: Sachin Bansal and Binny Bansal start Flipkart.

- Google News launches Hindi service.

2008: Google index reaches one trillion URLs.

- Apple launches its first iPhone in India, almost a year after its global launch.
- Google releases the Chrome Web browser.
- Nasa successfully tests the first deep-space communications network modelled on the Internet.
- Dozens of space images are transmitted to and from a Nasa science spacecraft located more than 32 million km from Earth.

2009: Icann gains autonomy from the US government. Opens up applications for internationalized domain names.

- Kickstarter is founded in April. Crowdfunding becomes popular with start-ups.

2010: The first tweet from space: astronaut T.J. Creamer tweets from aboard the International Space Station.

- WikiLeaks collaborates with media organizations to release US diplomatic cables.
- Snapdeal is started as a daily deals platform.
- 3G and broadband wireless access spectrum auctioned (in India).
- The number of registered domains reaches 200 million.
- Photo sharing evolves with the launch of Pinterest and Instagram.

T.J. Creamer

2011: The number of Internet users reaches two billion.

- Number portability is launched in India.
- Microsoft buys Skype for $8.5 billion.
- The Stop Online Piracy Act (SOPA) is introduced in the US by Republican Representative Lamar S. Smith.
- iPad enters the India market.

2012: Facebook files for an IPO. It also reaches one billion monthly active users (604 million on mobile).

- Icann begins accepting applications for new generic top-level domains.
- Amazon becomes the largest hosting location with 118,000 Web-facing computers.
- Twitter passes 200 million active users (December), and 500 million tweets per day (October).
- Nasa's Curiosity Rover checks in on Mars using the mobile application FourSquare.
- The Gangnam Style video on YouTube reaches one billion views.

2013: Twitter files for an IPO.

- Former US Central Intelligence Agency (CIA) employee and National Security Agency (NSA) contractor Edward Snowden leaks classified documents to media organizations.
- Netflix and YouTube account for over 50% of Internet traffic measured by bytes.
- The number of Internet hosts surpasses one billion.

2014: The number of Web servers surpasses one billion.

- Google shuts social networking site Orkut.
- Facebook buys WhatsApp for $19 billion.
- A European Union court orders Google to honour "requests to be forgotten"; 12,000 requests are submitted on the first day after this.
- Icann domain auction sales fetch more than $32 million.

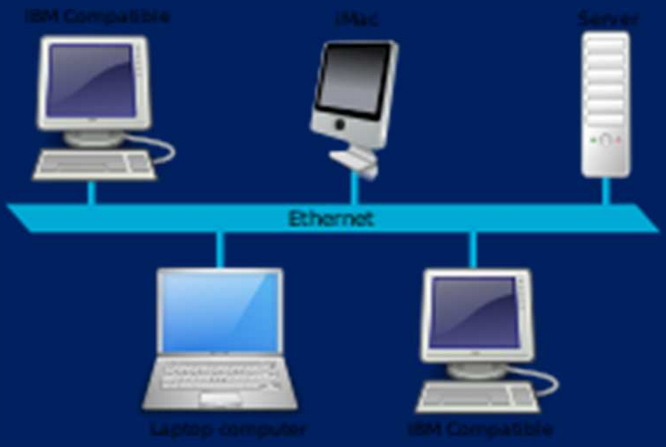
2015: A debate on network neutrality garners public attention after Airtel announced in December 2014 that it plans to to levy additional charges for making voice calls from its network using services such as WhatsApp and Skype.

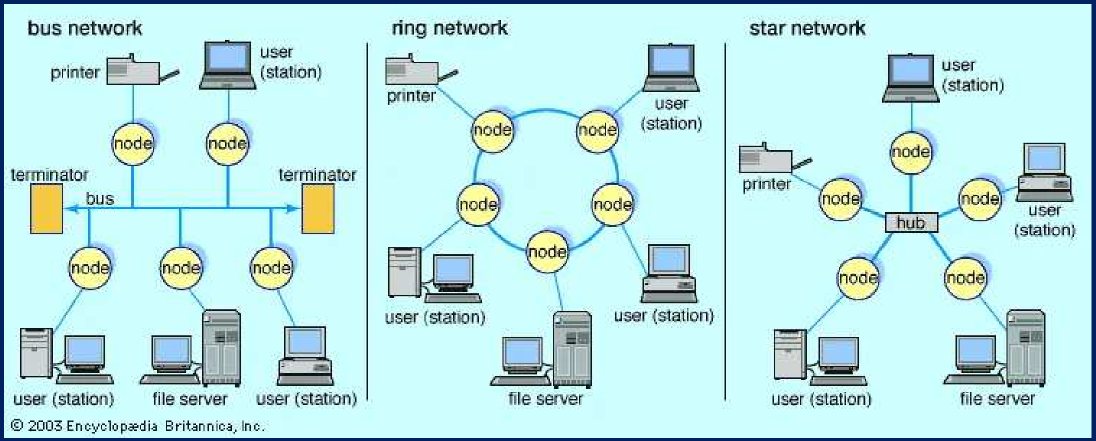
- In March, the Telecom Regulatory Authority of India releases a formal consultation paper on a regulatory framework for Over-the-top (OTT) services, seeking comments from the public. The consultation paper is criticized for being one-sided and having confusing statements.

Source: ISOC, Zakon.org, Mint research

Local Area Networks

- A local area network (LAN) is a group of computers and peripheral devices that share a common communications line or wireless link to a server within a distinct geographic area. A local area network may serve as few as two or three users in a home office or thousands of users in a corporation's central office.
  Source: TechTarget
- Regardless of size, a LAN's single defining characteristic is that it connects devices that are in a single, limited area. Source: Cisco Systems
- TL;DR a LAN is a group of computers in a single physical location connected together with physical cabling to allow exchange of data





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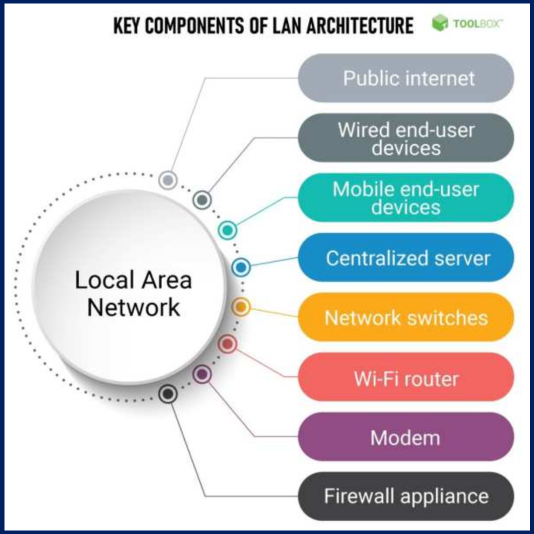
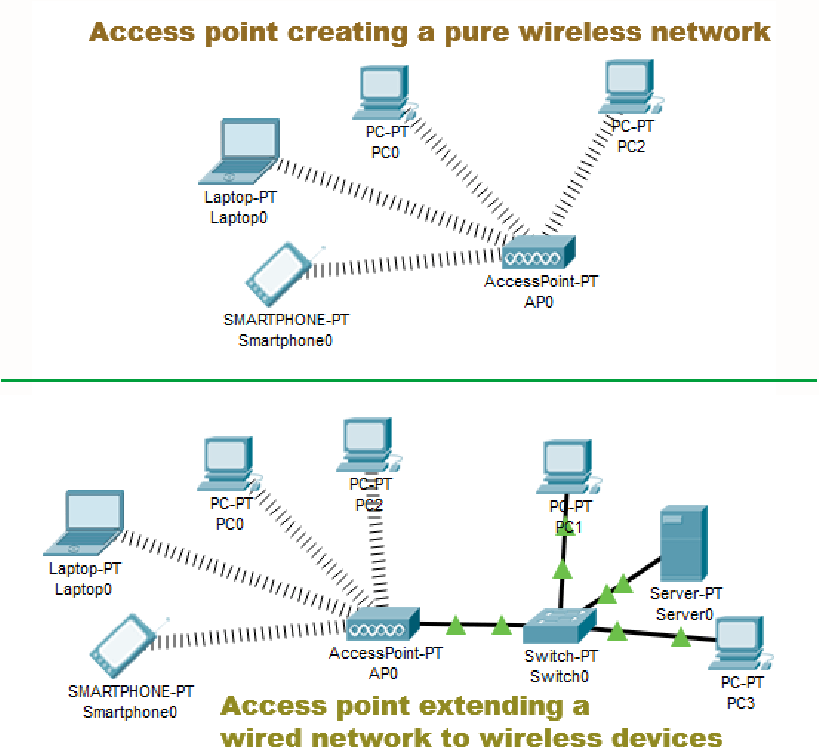
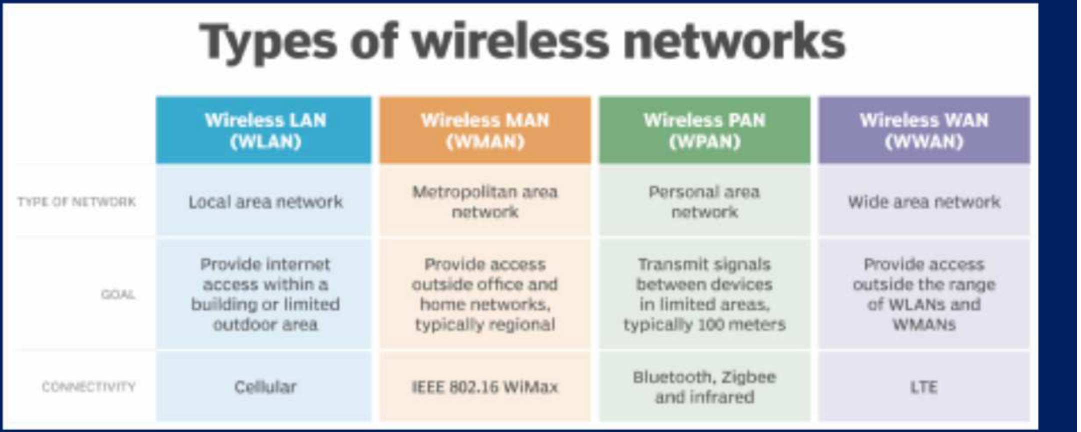


Wireless LAN (WiFi)

- WLAN/Wi-Fi is a family of wireless network protocols, based on the IEEE 802.11 family of standards, which are commonly used for local area networking of devices and Internet access, allowing nearby digital devices to exchange data by radio waves. These are the most widely used computer networks in the world, used globally in home and small office networks to link desktop and laptop computers, tablet computers, smartphones, smart TVs, printers, and smart speakers together and to a wireless router to connect them to the Internet, and in wireless access points in public places like coffee shops, hotels, libraries and airports to provide the public Internet access for mobile devices. Source: Wikipedia
- WLAN is the wireless technology used to connect computers, tablets, smartphones and other devices to the internet. Wi-Fi is the radio signal sent from a wireless router to a nearby device, which translates the signal into data you can see and use. Source: Verizon


Access point creating a pure wireless network

Access point extending a wired network to wireless devices

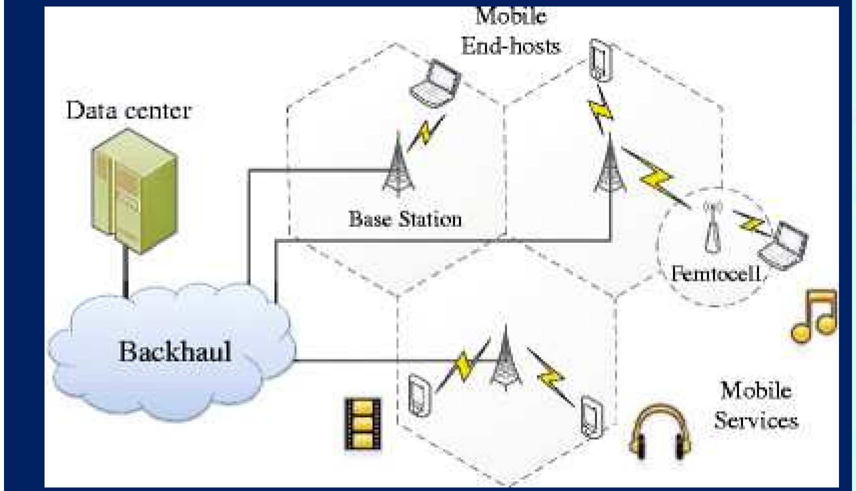


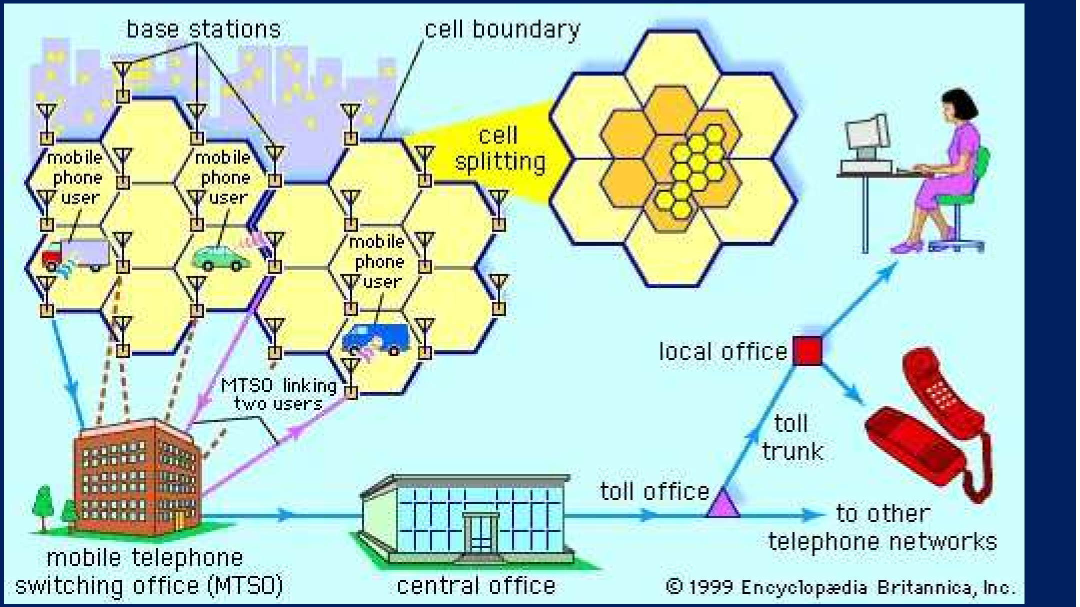
Types of wireless networks

	Wireless LAN (WLAN)	Wireless MAN (WMAN)	Wireless PAN (WPAN)	Wireless WAN (WWAN)
TYPE OF NETWORK	Local area network	Metropolitan area network	Personal area network	Wide area network
GOAL	Provide internet access within a building or limited outdoor area	Provide access outside office and home networks, typically regional	Transmit signals between devices in limited areas, typically 100 meters	Provide access outside the range of WLANs and WMANs
CONNECTIVITY	Cellular	IEEE 802.16 WiMax	Bluetooth, Zigbee and infrared	LTE

Cellular Voice Networks

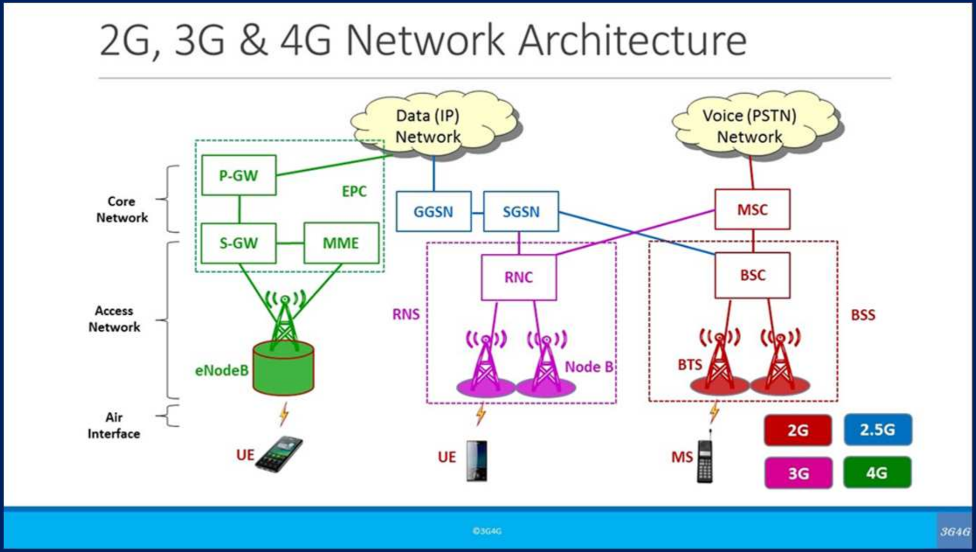
- A cellular network or mobile network is a communication network where the link to and from end nodes is wireless. The network is distributed over land areas called "cells", each served by at least one fixed-location transceiver (typically three cell sites or base transceiver stations). These base stations provide the cell with the network coverage which can be used for transmission of voice, data, and other types of content. A cell typically uses a different set of frequencies from neighboring cells, to avoid interference and provide guaranteed service quality within each cell. When joined together, these cells provide radio coverage over a wide geographic area. Source: Wikipedia
- Cellular networks can be designed to carry voice, data, or both. The earliest cellular networks were voice networks, connecting back to the PSTN (Public Switched Telephone Network).

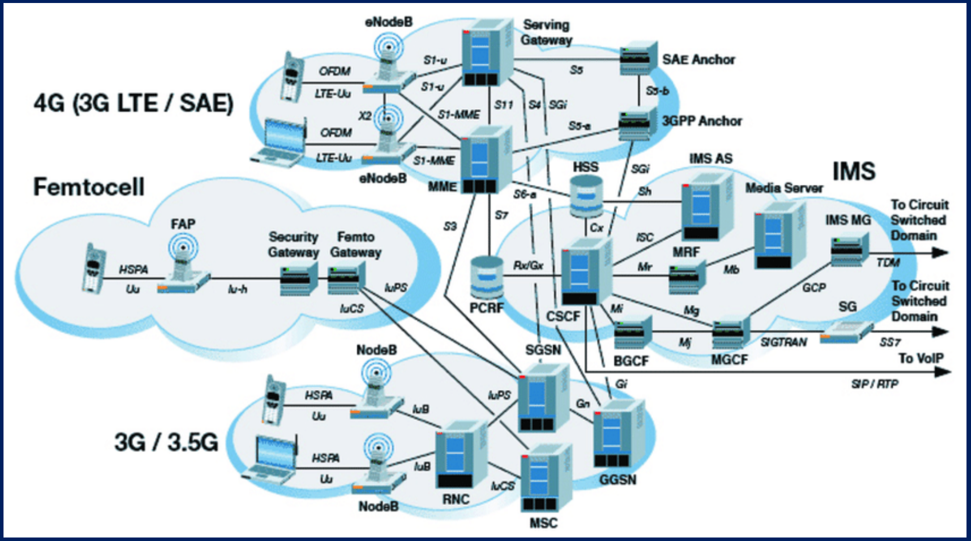




Cellular Data Networks

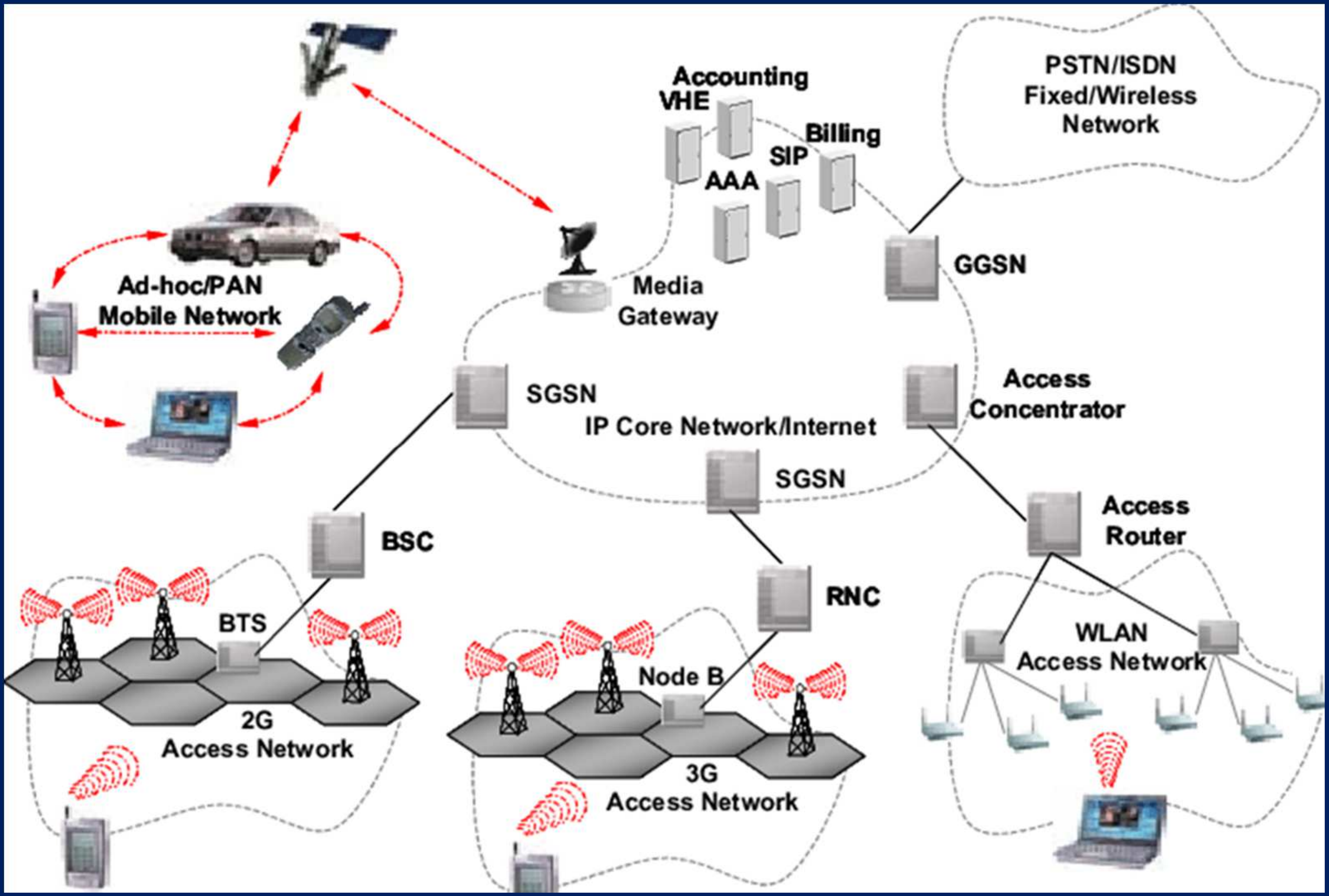
- Cellular Network Data is a *data* connection from the cellular device to the cell site. LTE (4G), 3G and 1X are types of cellular network data connections. Data sessions include, but are not limited to, browsing the Internet such as Google, streaming music, videos and movies, sending and receiving emails, sending and receiving MMS messages, hotspot hosting and application use. While connected to the cellular data network, data usage will pull from the current data plan.
- As with all communications between two computers, "data" refers to information encoded into a bitstream of binary numbers. The method used for encoding varies by network layer, device, and communications protocol.





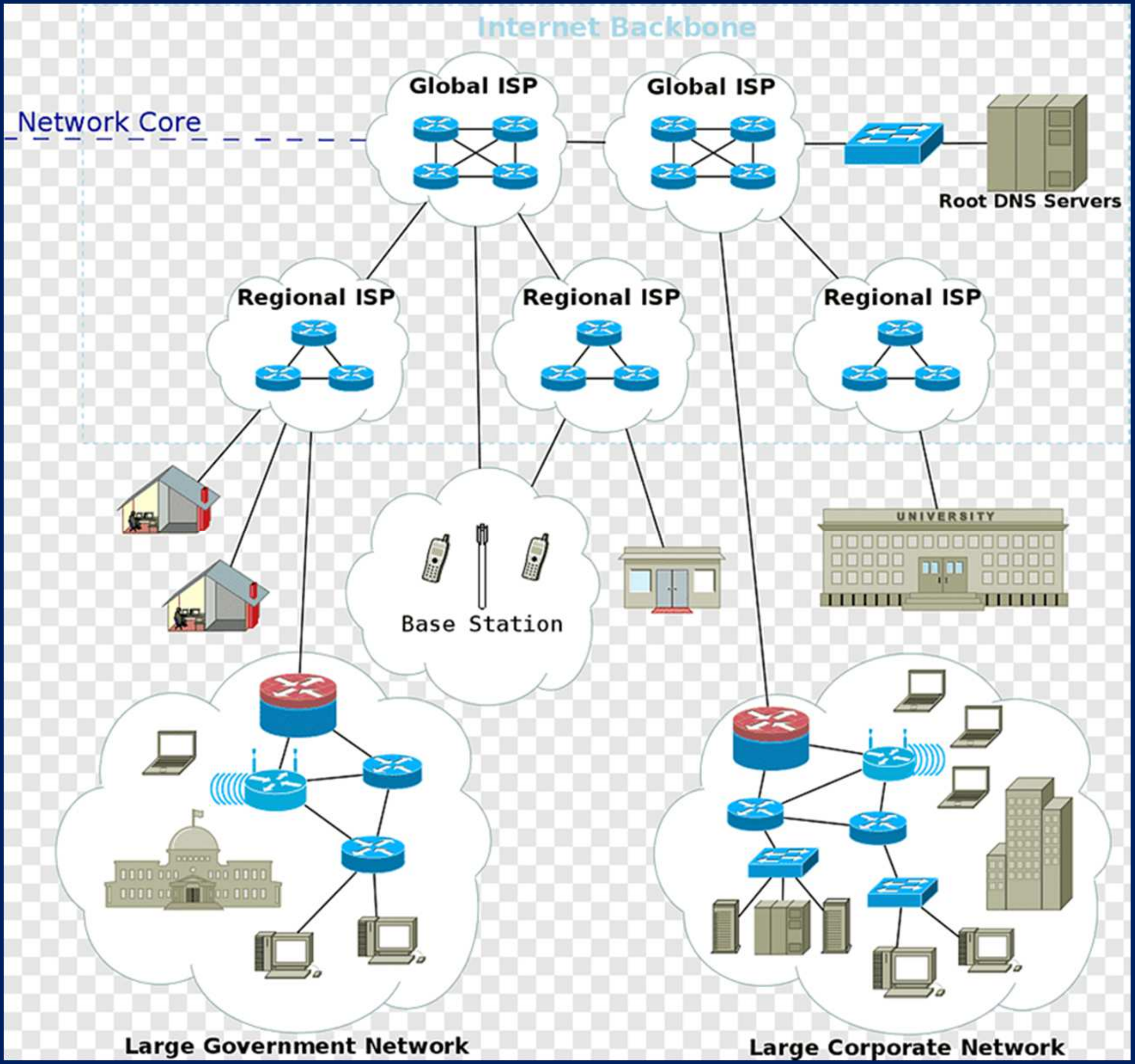
WiFi and Cellular

- WiFi connects to a local router, cellular data connects to a remote router
- WiFi has a limited range, cellular data does not



The Internet - Architecture

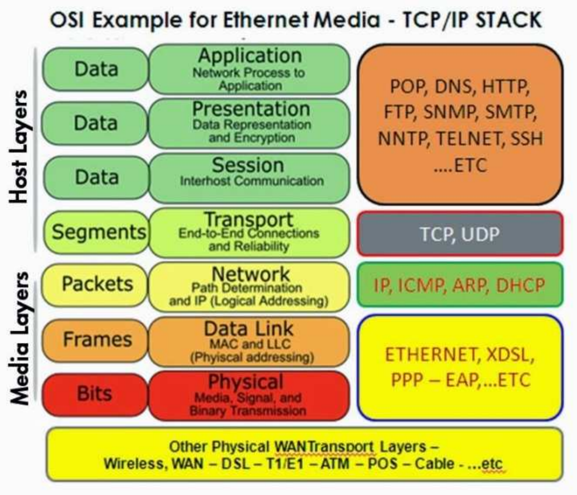
- The Internet is a "network of networks" used to connect many many LANs and WANs together
- Originally the Internet was owned and operated by the US DoD and NSF
- Public connectivity became available in 1992 from a company called PSI



The OSI/ISO Layered Network Model

- In a Quora post asking about the purpose of the OSI model, Vikram Kumar answered this way:
- “The purpose of the OSI reference model is to guide vendors and developers so the digital communication products and software programs they create will interoperate, and to facilitate clear comparisons among communications tools.”
- While some people may argue that the OSI model is obsolete (due to its conceptual nature) and less important than the four layers of the TCP/IP model, Kumar says that “it is difficult to read about networking technology today without seeing references to the OSI model and its layers, because the model’s structure helps to frame discussions of protocols and contrast various technologies.”
- If you can understand the OSI model and its layers, you can also then understand which protocols and devices can interoperate with each other when new technologies are developed and explained.

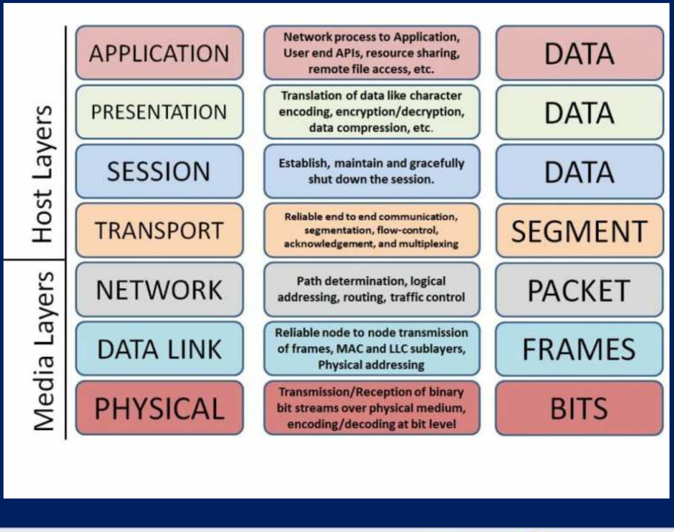
Source: Network World



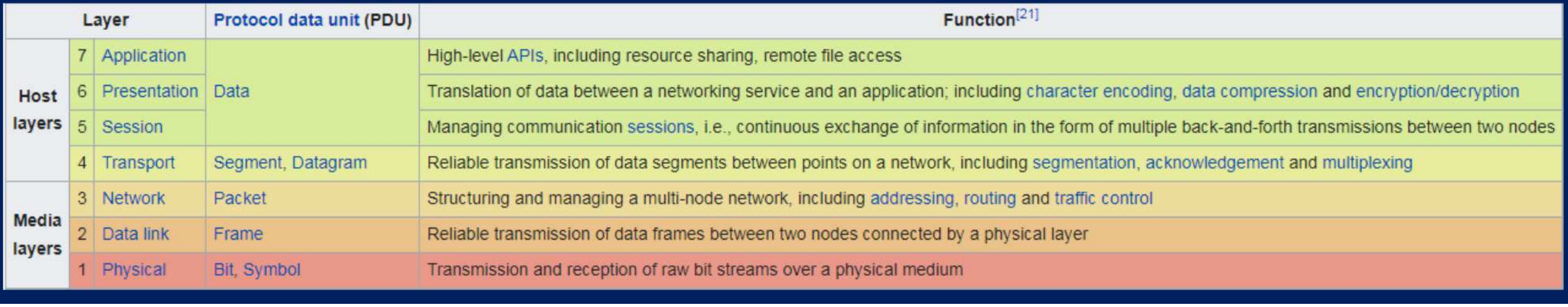
OSI Example for Ethernet Media - TCP/IP STACK

Host Layers	Data	Application Network Process to Application	POP, DNS, HTTP, FTP, SNMP, SMTP, NNTP, TELNET, SSH ....ETC
	Data	Presentation Data Representation and Encryption	
	Data	Session Interhost Communication	
	Segments	Transport End-to-End Connections and Reliability	TCP, UDP
Media Layers	Packets	Network Path Determination and IP (Logical Addressing)	IP, ICMP, ARP, DHCP
	Frames	Data Link MAC and LLC (Phyiscal addressing)	ETHERNET, XDSL, PPP – EAP,...ETC
	Bits	Physical Media, Signal, and Binary Transmission	

Other Physical WANTransport Layers – Wireless, WAN – DSL – T1/E1 – ATM – POS – Cable - ...etc



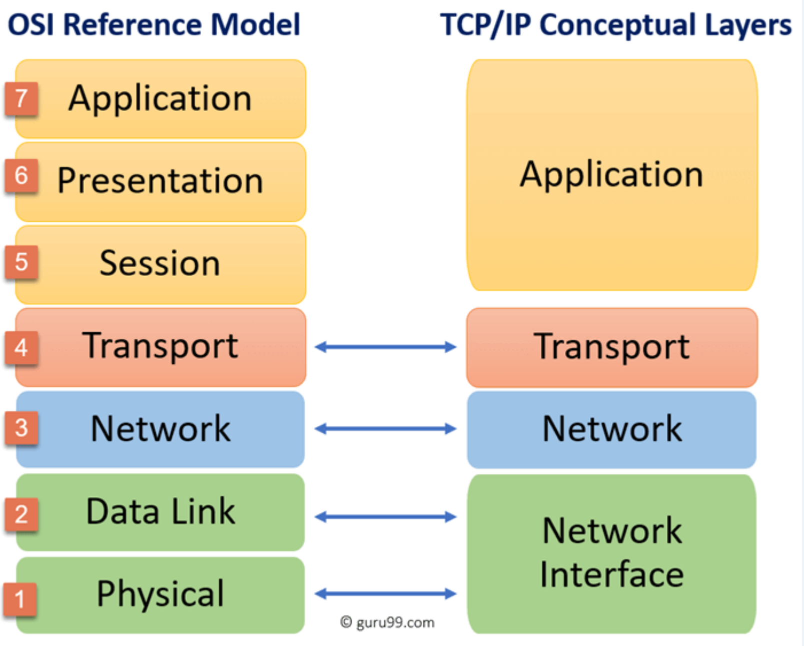
Host Layers	APPLICATION	Network process to Application, User end APIs, resource sharing, remote file access, etc.	DATA
	PRESENTATION	Translation of data like character encoding, encryption/decryption, data compression, etc.	DATA
	SESSION	Establish, maintain and gracefully shut down the session.	DATA
	TRANSPORT	Reliable end to end communication, segmentation, flow-control, acknowledgement, and multiplexing	SEGMENT
Media Layers	NETWORK	Path determination, logical addressing, routing, traffic control	PACKET
	DATA LINK	Reliable node to node transmission of frames, MAC and LLC sublayers, Physical addressing	FRAMES
	PHYSICAL	Transmission/Reception of binary bit streams over physical medium, encoding/decoding at bit level	BITS



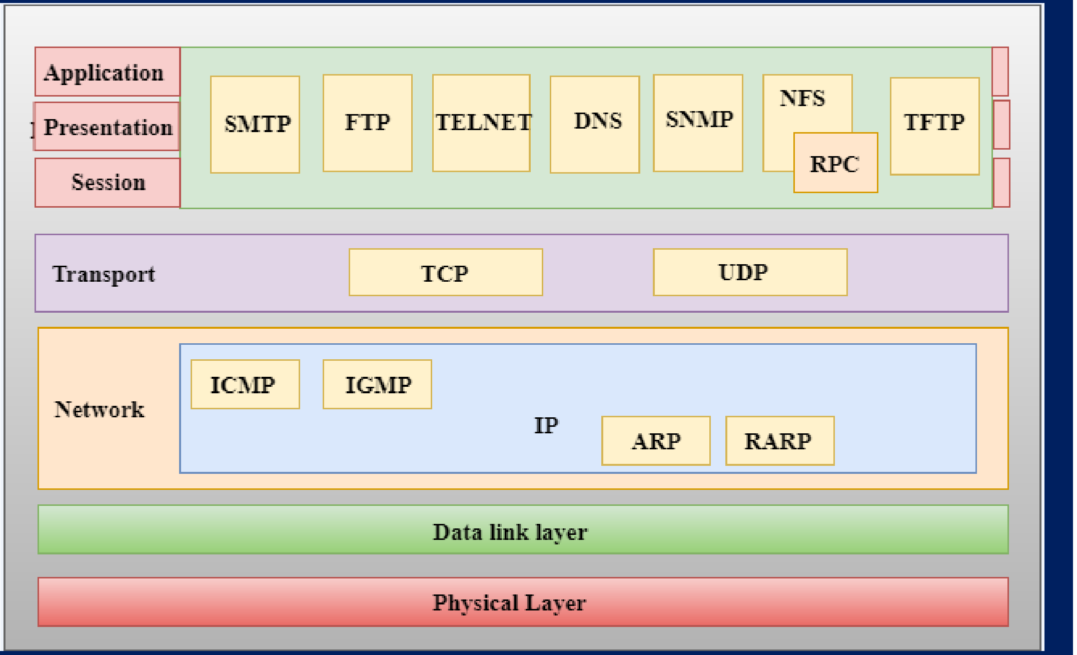
Layer			Protocol data unit (PDU)	Function[21]
Host layers	7	Application	Data	High-level APIs, including resource sharing, remote file access
	6	Presentation		Translation of data between a networking service and an application; including character encoding, data compression and encryption/decryption
	5	Session		Managing communication sessions, i.e., continuous exchange of information in the form of multiple back-and-forth transmissions between two nodes
	4	Transport	Segment, Datagram	Reliable transmission of data segments between points on a network, including segmentation, acknowledgement and multiplexing
Media layers	3	Network	Packet	Structuring and managing a multi-node network, including addressing, routing and traffic control
	2	Data link	Frame	Reliable transmission of data frames between two nodes connected by a physical layer
	1	Physical	Bit, Symbol	Transmission and reception of raw bit streams over a physical medium

ISO/OSI vs The TCP/IP Model

- TCP/IP is the data interchange protocol used by the Internet for computer-to-computer (host-to-host) communications
- It only loosely follows the formal OSI/ISO reference model
- Many consider TCP/IP to be a separate model, but this is not entirely true
- We will not be studying TCP/IP in depth, but it is important to know that it exists and is the underlying protocol used in all web comms



Accurate



Inaccurate

Formal End of Lesson 7

In next week's exciting episode

- Microcontroller board power requirements
- Board power input options and grounding
- Components with different voltage requirements – level shifting
- External power circuit design
- Connecting and using transistors
- Pulse width modulation and signal generation
- Connecting and using buzzers – Class Sketch #3

Don't forget to return your USB drives!