Introduction to Home Networking and Residential Routers

Basic Networking Knowledge, Router Functions, Setup, and Maintenance

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SCA Advanced Computer Topics
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Topics

- Basic Network Terminology
  - LAN/WAN/IP Address/DHCP/DNS/SSID/ISP/MAC Address/POE/WPS
- Typical residential network components and their functions
  - Modems
  - Routers
  - Switches
  - Wireless Access Points
- Installation
- Common/Recommended Settings and Maintenance

LAN – Local Area Network

- A network of computers or connected devices within a small area (example: your home)
- All of the devices that use your ISP (Internet Service Provider) connection are part of your LAN
- Devices on your LAN typically can communicate with each other without needing an internet connection

WAN – Wide Area Network

- The global network of computers, i.e.: “the Internet”
- The servers and services directly addressable with a “public” IP address

Cable Modem – Modulate/Demodulate

Changes the method of transporting data to/from a TV cable line to/from an Ethernet line

IP – Internet Protocol Address

- Written as 4 decimal numbers, each varying from 0 to 255, separated by periods
- Your WAN IP address is sometimes called your "public" ip address
- Your LAN IP address is sometimes called your "private" ip address
- Your public address is assigned by your ISP and may occasionally change whenever you reset or reboot your cable modem

98.160.237.27

192.168.1.12

MAC Address – Media Access Control Address

- A hardwired unique identifier for every network interface
- A single device having multiple network interfaces has a separate MAC address for each of those interfaces
- Your cable modem MAC address must be “registered” to your ISP account for them to allow connection to their network

DHCP – Dynamic Host Configuration Protocol

DHCP is the automated process by which a network-connected device may acquire an IP address and other network information

Hello everyone, if there is a DHCP Server listening, I'd like to be assigned an IP address on the network. My MAC ID is 0040363FB9C9

MAC ID 0040363FB9C9, we've assigned you IP address 98.160.237.27, you can use it for a 96 hour period.

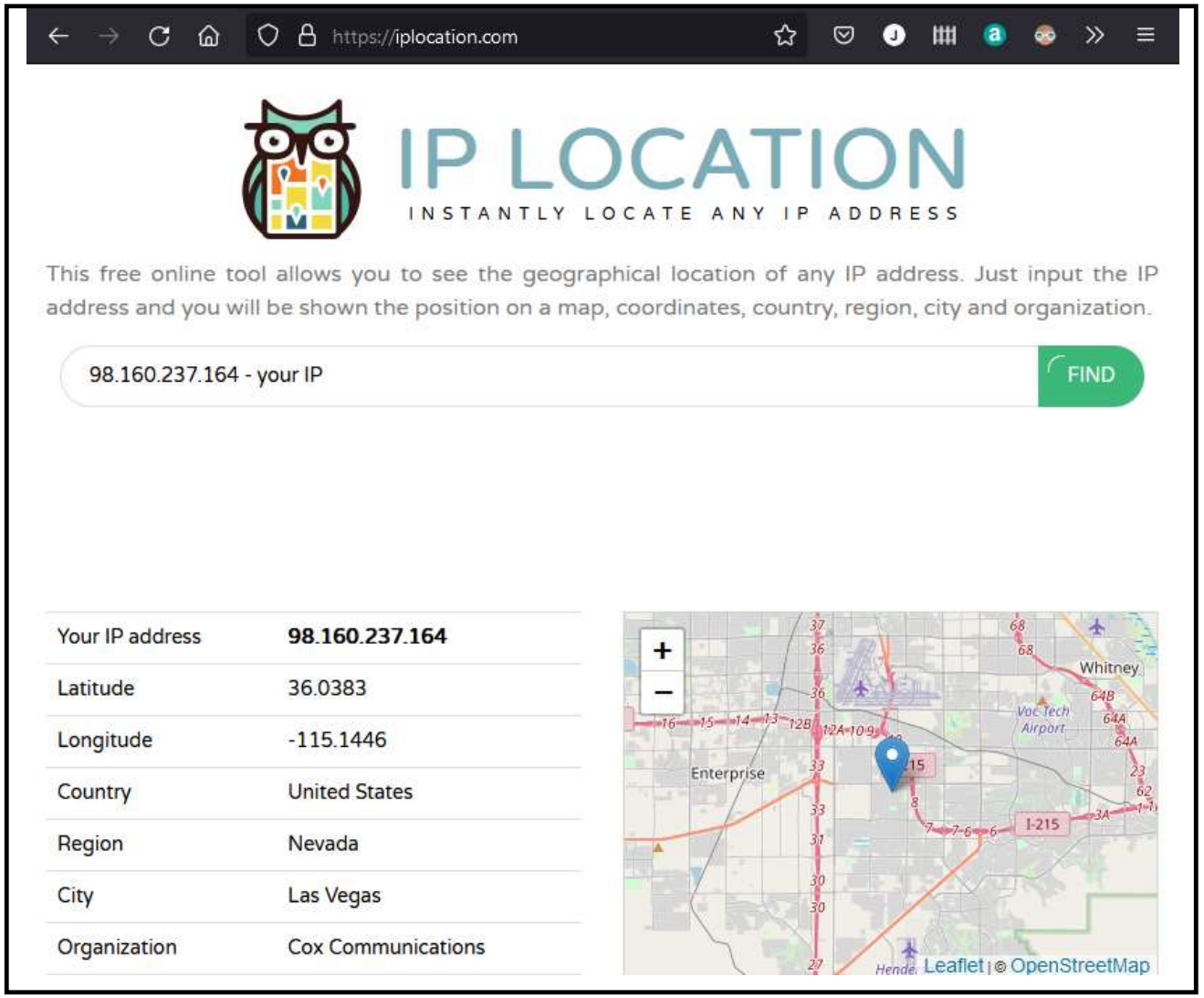
Thanks, I'll take it.

How is your public IP address used?

- Gives you a “phone number” on the public internet
- Unique for a specific duration
- Used to direct a response back to you for any requests made
- Part of it identifies your ISP, and part of it identifies your specific cable modem
- May be used by web sites you visit to approximate your location
- In combination with data from your ISP, may be used to uniquely identify your cable modem at a specific point in time
- An IP address without a domain name association is like having an “unlisted” phone number

Exercise: open a browser on any device and navigate to https://iplocation.com

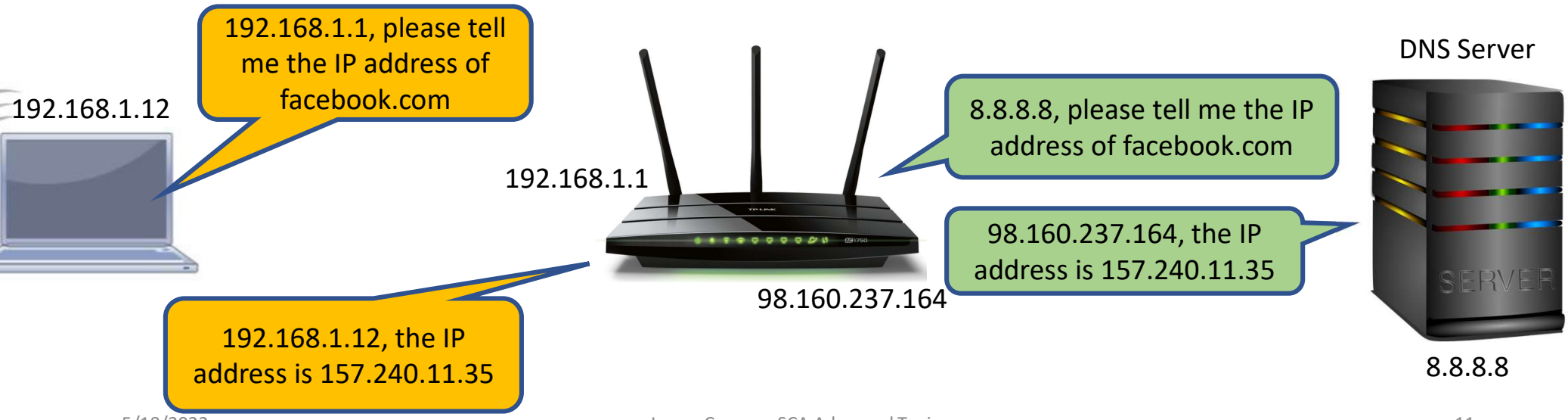
Here's a result you may get from a device connected to Cox Communications within SCA



DNS – Domain Name System

DNS is the “phonebook” of the Internet

- DNS is the process of looking up a domain name, like google.com or facebook.com, and providing their IP address



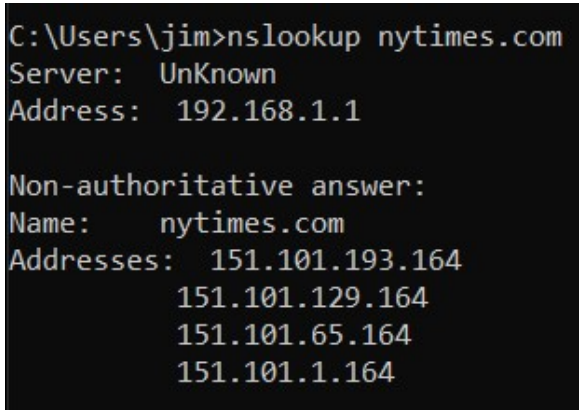
Exercise: nslookup nytimes.com

On Windows 11:

1. Start menu
2. Search/open “cmd”
3. nslookup nytimes.com

On Mac OS X:

1. Finder
2. Applications, terminal.app
3. nslookup nytimes.com



What Does a Router Do?

- Connects to the WAN using the public address provided to the Cable Modem
- Acts as a “firewall”
- A physical analogy is being a “receptionist” for network data

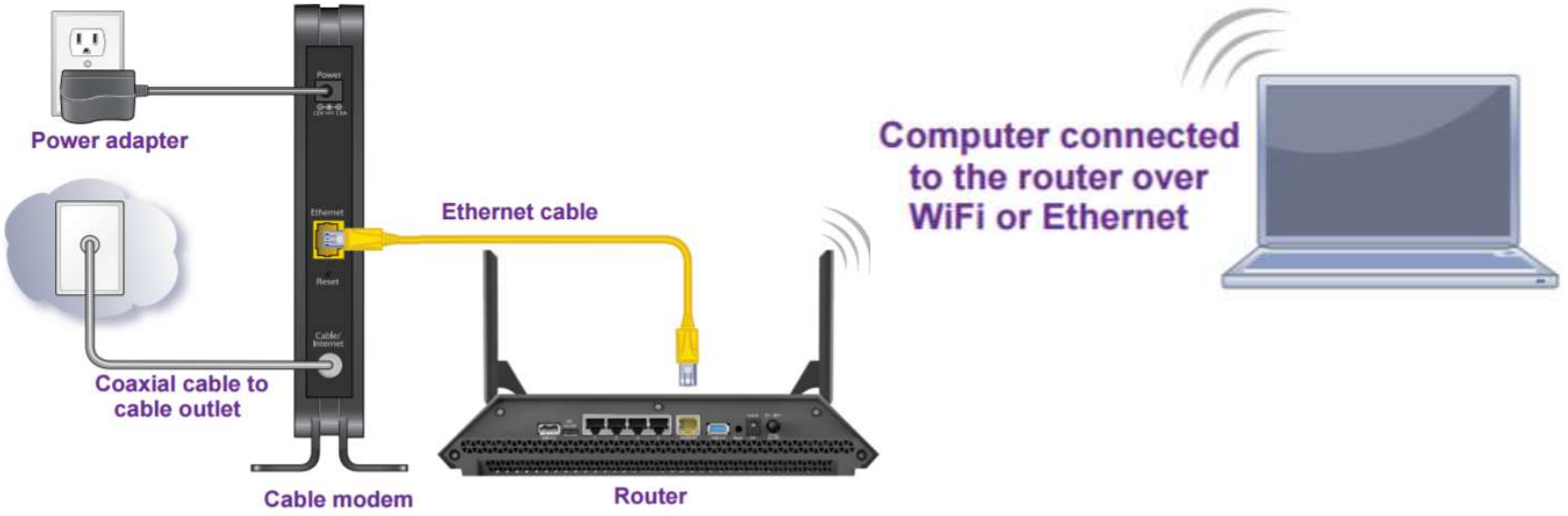
- Acts as a DHCP and DNS server to devices connected on the LAN side
- May have other features, such as device blocking, ad blocking, data usage tracking, parental controls, etc.
- May also be called a “gateway”

Router Setup Steps

1. Connect Ethernet Port on Cable Modem to WAN Port on Router
2. Connect a computer to one of the wired LAN Ports
3. Update Router firmware
4. Change Router admin password and save with a password manager
5. Change your DNS servers
6. Optionally Setup E-mail Notifications, logging, ad-blocker, network drive, etc.

Cable Modem/Router/Laptop Wiring

1. Connect the cable modem Ethernet to the Router's WAN port
2. Connect the laptop to one of the Router's LAN ports



Laptop adapters for Ethernet

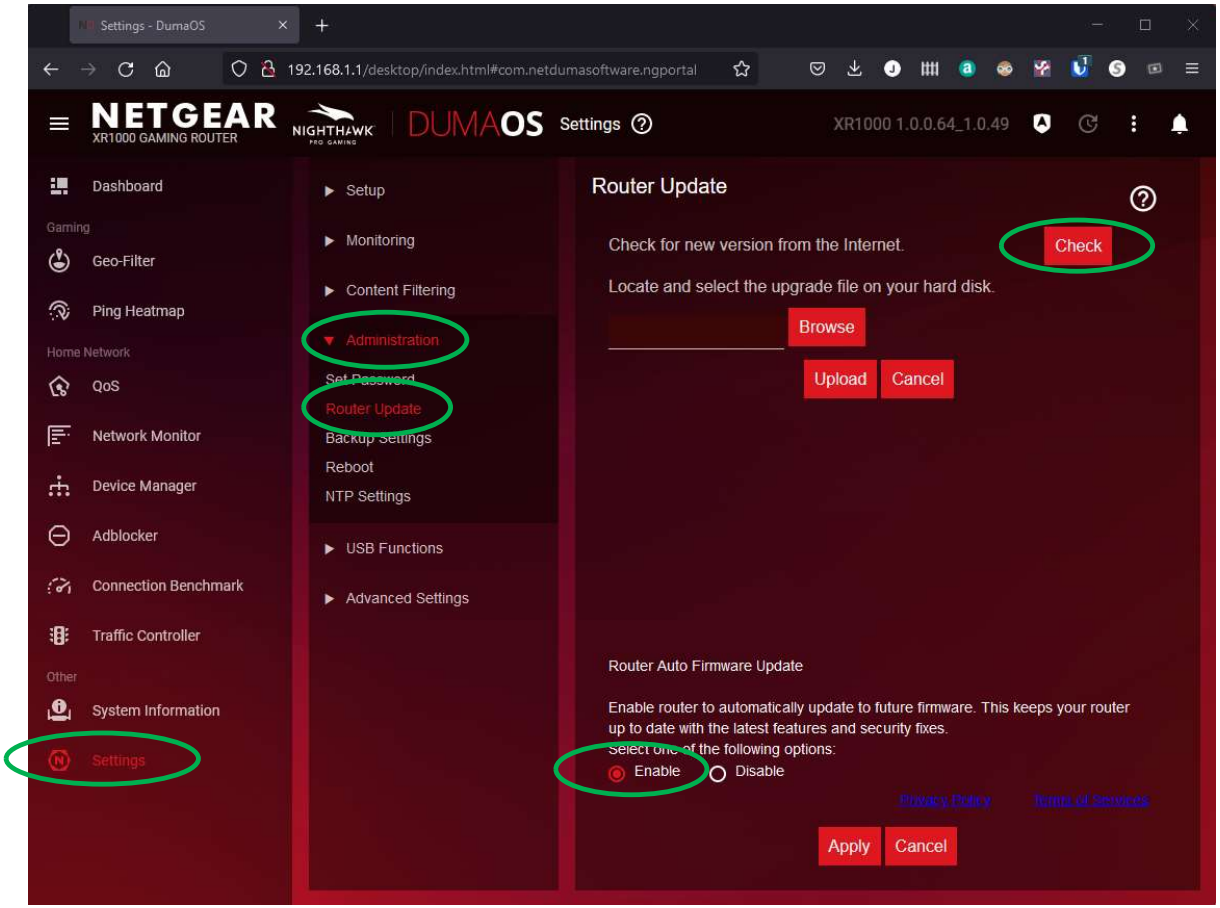
~$20 on Amazon.com

Log into the Router's Web interface

- Browse to the router's Web Page using the web address and credentials on a sticker under the router
- Routers may provide a phone app to configure basic functions, but re-connection will be required when you change Wi-Fi settings
- Note the extremely secure administrative credentials required

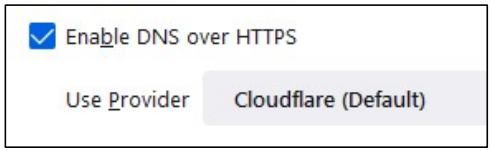
Get the latest Firmware

- While logged into the web interface of the router, navigate as required to the router firmware update page
- Settings…
- Administration…
- Router Update…
- Enable automatic updates…
- Check right now



Specify your DNS Servers

- For improved privacy, performance, and reliability, pick your DNS servers rather than the default ones provided by your ISP
- Online search can provide alternatives
- Some browsers may default to “encrypted” DNS, where they directly choose their DNS server

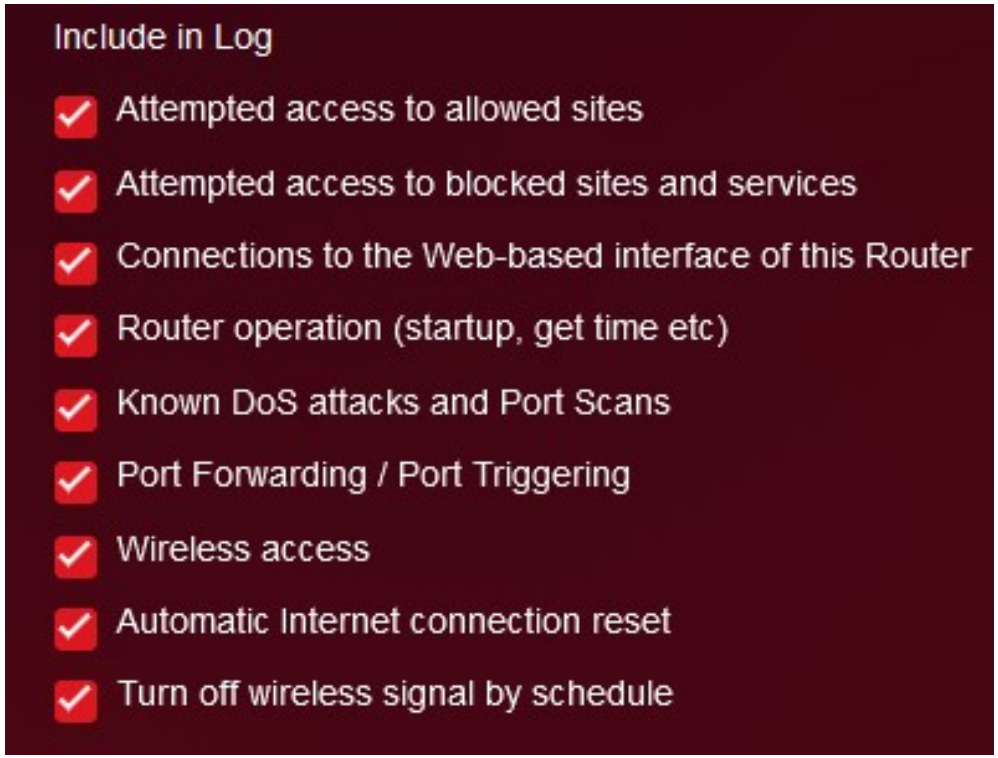


Best Free & Public DNS Servers		
Provider	**Primary DNS**	**Secondary DNS**
Google	8.8.8.8	8.8.4.4
Quad9	9.9.9.9	149.112.112.112
OpenDNS Home	208.67.222.222	208.67.220.220
Cloudflare	1.1.1.1	1.0.0.1
CleanBrowsing	185.228.168.9	185.228.169.9
Alternate DNS	76.76.19.19	76.223.122.150
AdGuard DNS	94.140.14.14	94.140.15.15

Source: https://www.lifewire.com/free-and-public-dns-servers-2626062

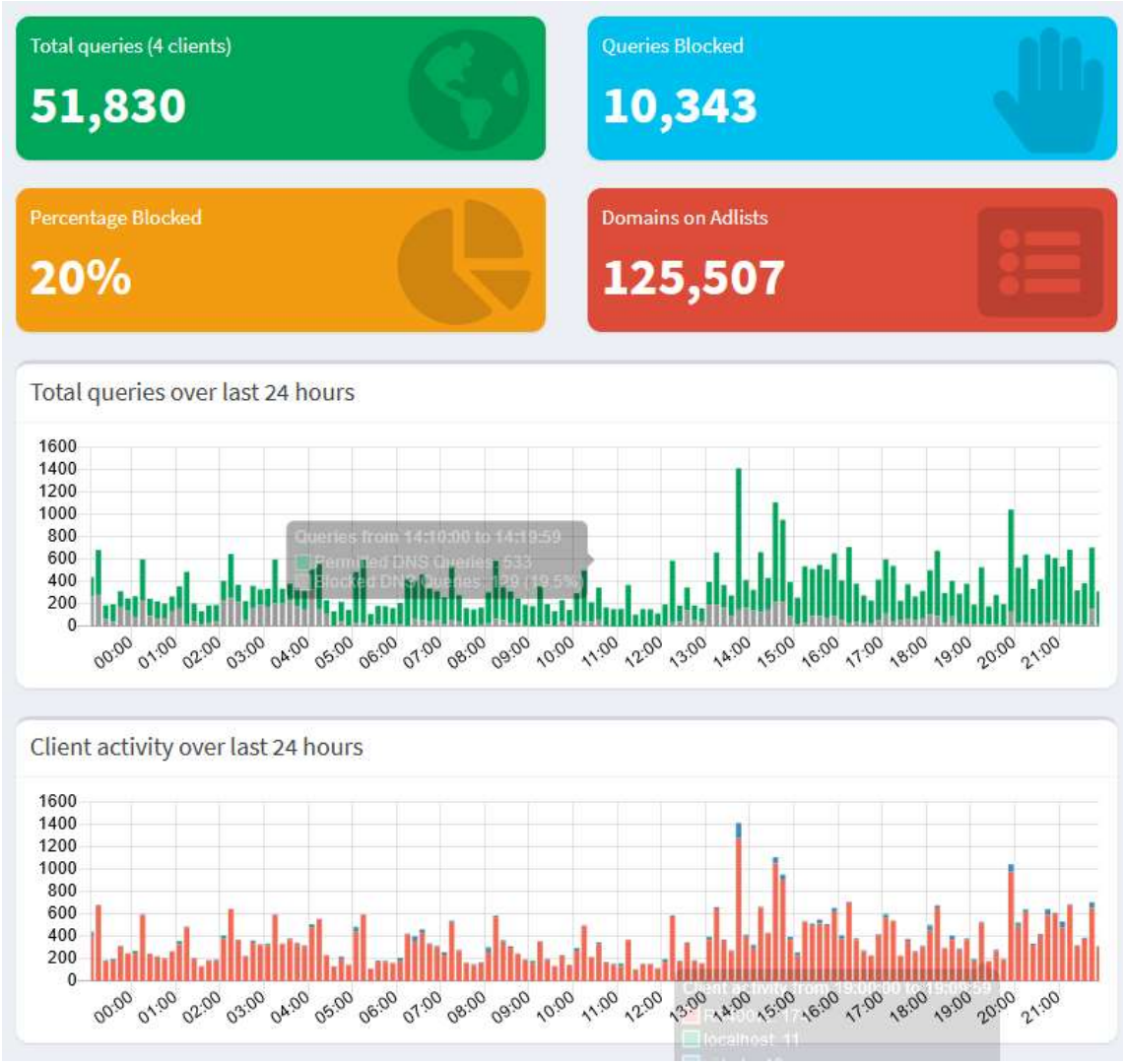
Configure E-mail Notifications from Router

- Most modern routers provide a way to notify you via e-mail of interesting events being seen by the router
- Some e-mail providers may require special setup to accept e-mail sent by your router
- Gmail users with 2-factor authentication will need an “app password” to use in the router
- You can be periodically e-mailed a log with a choice of information to include



Configure Ad-Blocker

- DNS lookup requests for ads and tracking-related sites can typically be 15-30% of the total queries from devices on your network
- Router ad-blockers do their job by discarding any DNS queries to known ad/tracking sites



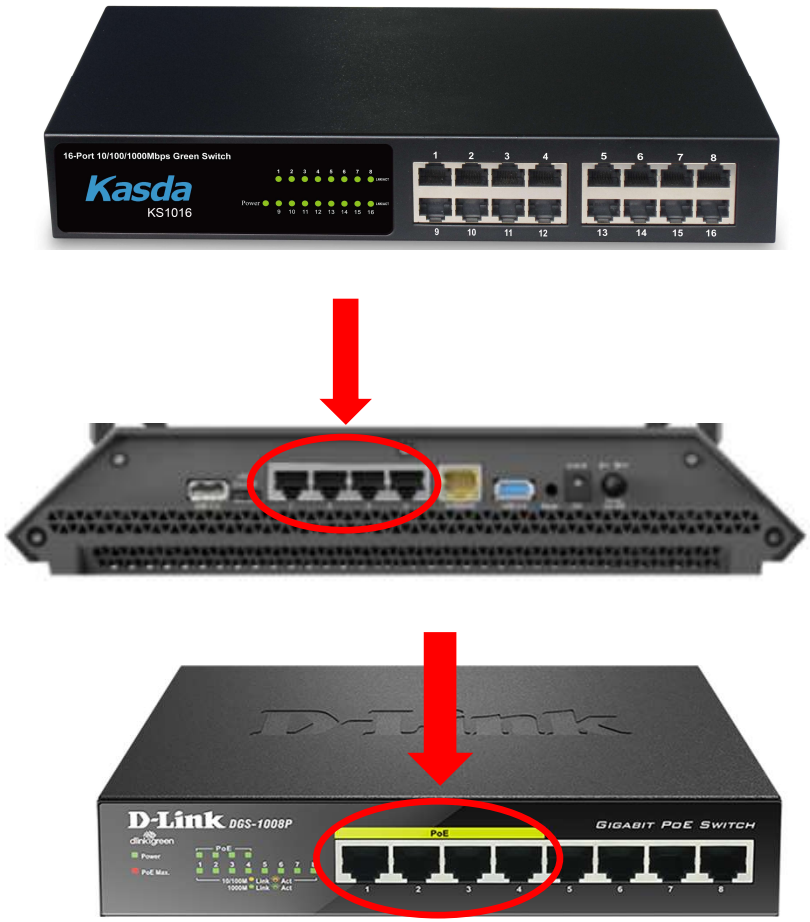
Configure a shared network drive

1. Plug a USB drive into the router
2. Log into the router admin page
3. For Netgear routers, under “Settings”, “USB Functions”, “ReadySHARE Storage”
4. Enable “Network Neighborhood/MacShare”, link defaults to \\readyshare
5. Under Windows 11 File Explorer, right-click “This PC”, “Show More Options”, “Map Network Drive”, “\\readyshare\USB_Storage”

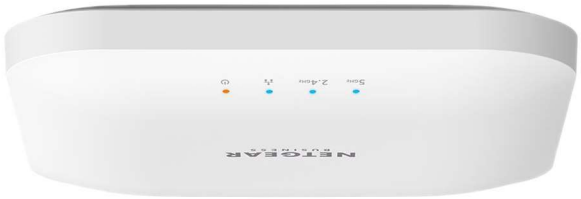
Switches

Extend the number of wired network connections on your LAN

- A four port switch is often integrated with routers
- Some switches provide POE (Power Over Ethernet) to allow some network devices (such as cameras and wireless access points) to be powered through the Ethernet wire



Wi-Fi Access Point



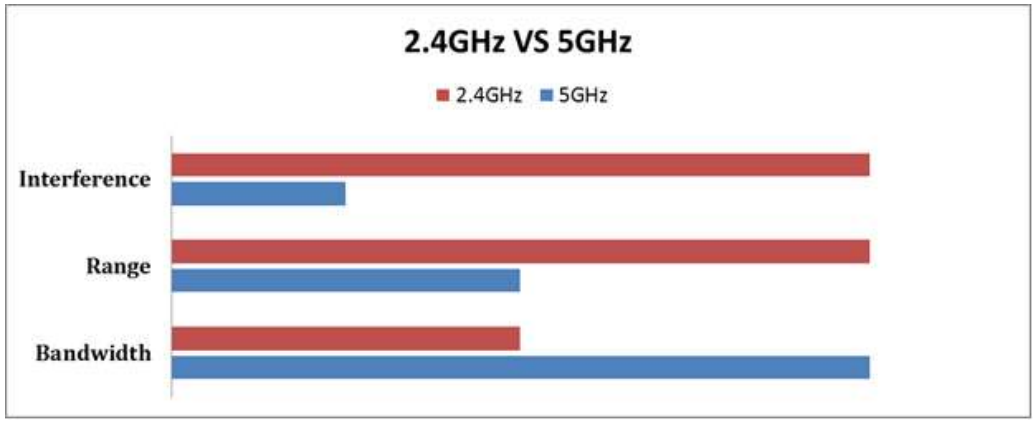
A Wi-Fi Access Point (AP) is a device which provides Wi-Fi connectivity to your LAN

- Wired somewhere to your LAN, or often integrated with a router (“wireless router”)
- Good placement important for best coverage and speeds
- Coverage can be improved with extenders or mesh devices
- Often powered by POE

Wi-Fi 2.4GHz vs. 5GHz

These bands are used for Wi-Fi access

- 2.4GHz provides wider coverage at slower speeds
- 2.4GHz band has more interference than 5GHz
- 5GHz provides faster speeds with a smaller coverage area



Wi-Fi Standards Comparison

Wi-Fi Generations

Generation	IEEE Standard	Maximum Linkrate (Mbit/s)	Adopted	Radio Frequency (GHz)[38]
Wi-Fi 7	802.11be	40000	TBA	2.4/5/6
Wi-Fi 6E	802.11ax	600 to 9608	2020	2.4/5/6
Wi-Fi 6			2019	2.4/5
Wi-Fi 5	802.11ac	433 to 6933	2014	5
Wi-Fi 4	802.11n	72 to 600	2008	2.4/5
(Wi-Fi 3*)	802.11g	6 to 54	2003	2.4
(Wi-Fi 2*)	802.11a	6 to 54	1999	5
(Wi-Fi 1*)	802.11b	1 to 11	1999	2.4
(Wi-Fi 0*)	802.11	1 to 2	1997	2.4
*: (Wi-Fi 0, 1, 2, 3, are unbranded common usage.[39][40])				

Source: Wikipedia

Any new purchases of a residential wireless device should be at least Wi-Fi 6 generation

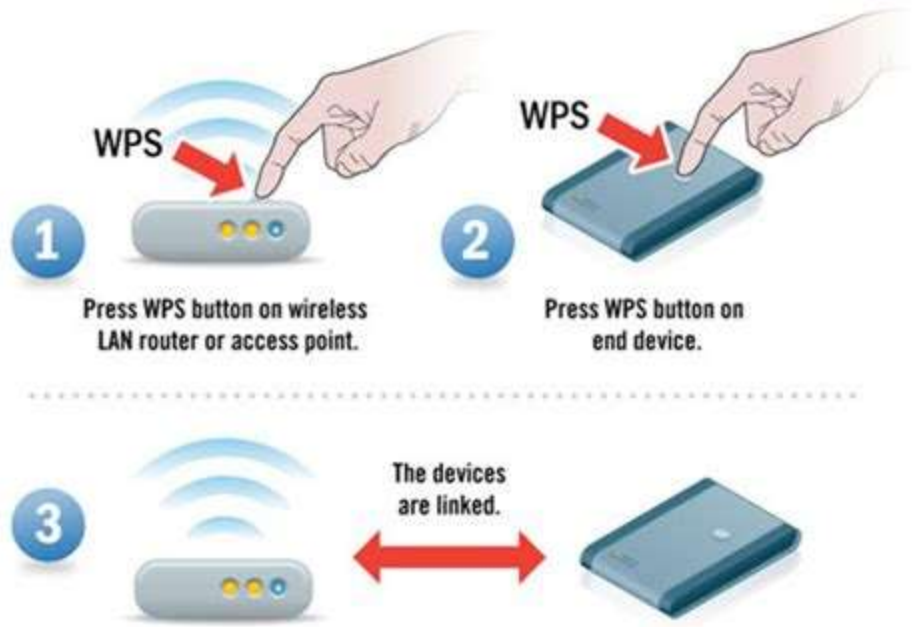
SSID – Service Set Identifier

A very fancy acronym for the name of a Wi-Fi connection

- You can choose NOT to “broadcast” the SSID for additional network security
- 32 Character Limit
- Case sensitive
- No spaces

WPS (Wi-Fi Protected Setup)

- Provides an easy way to connect devices to a Wi-Fi access point
- **Recommended to DISABLE due to security issues**
- Not available on Apple devices



Wi-Fi Setup

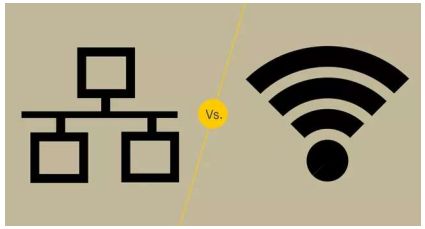
Log in to your wireless access point web page from a wired computer:

- Disable WPS
- Choose an easy (for you) to remember SSID
- Choose to broadcast your SSID or not
- Choose which bands to use: 2.4GHz, 5GHz, or both

Wi-Fi Setup (con’t)

- Pick the most secure encryption method available: WPA2 or WPA3
- Generate and save a good password using a password manager
- Choose whether to provide a guest network, then repeat setting all the previous options for the guest network
- Choose whether to allow the guest network connected devices to communicate with other devices on your network

Wired vs. Wireless?



Wired

- Better, consistent connection speeds
- No configuration involved
- Improved Security
- Device must be located near a network jack/switch/router

Wireless

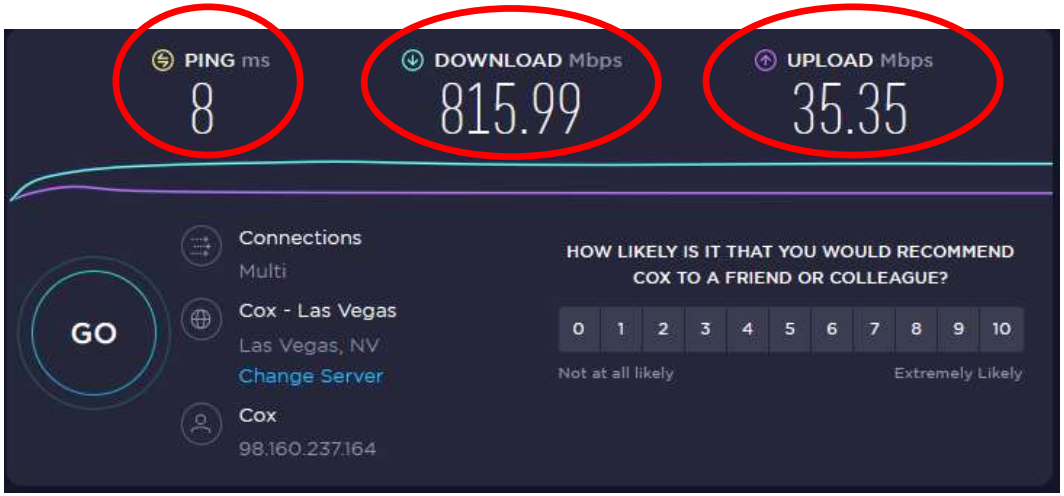
- Connection speed inconsistent and subject to location
- SSID, password must be configured at each device
- Reduced security
- Convenient, device can be located anywhere within range

Recommendations:

- If the device is stationary and near a jack/switch/router, wire it.
- If the device and access point support Wi-Fi 6, 5GHz, and they are close, use wireless
- Anything else, run a speedtest to see if the difference matters enough

Checking WAN network performance

- Run an internet speedtest from a device https://speedtest.net
- Ping: round trip delay for a tiny amount of data
- Download: Speed that data can come from the internet to your device
- Upload: Speed that data can be sent to the internet



Download speed of 815.99 Mbps (Megabits per second)
Divide by 8 for MBps (Megabytes per second) = 102 MBps

What did you Learn?

- How to hook up a cable modem
- How to hook up and configure a router and wireless access point
- How to update firmware in a router
- How to choose a good wireless access point location
- How to configure DNS, DHCP, Wi-Fi, with good encryption
- Tradeoffs between wired and wireless
- Tradeoffs between 2.4GHz and 5GHz wireless connections

Vocabulary

IP Address, LAN, WAN, MAC Address, Modem, Router, Switch, DNS, DHCP, POE, WPS, SSID, Wi-Fi Standards

https://iplocation.com using an “anonymous” browser or a VPN