



University of Colorado
Boulder

Learning Session:

Home Networking 101



<https://oit.colorado.edu/covid-19-resources>

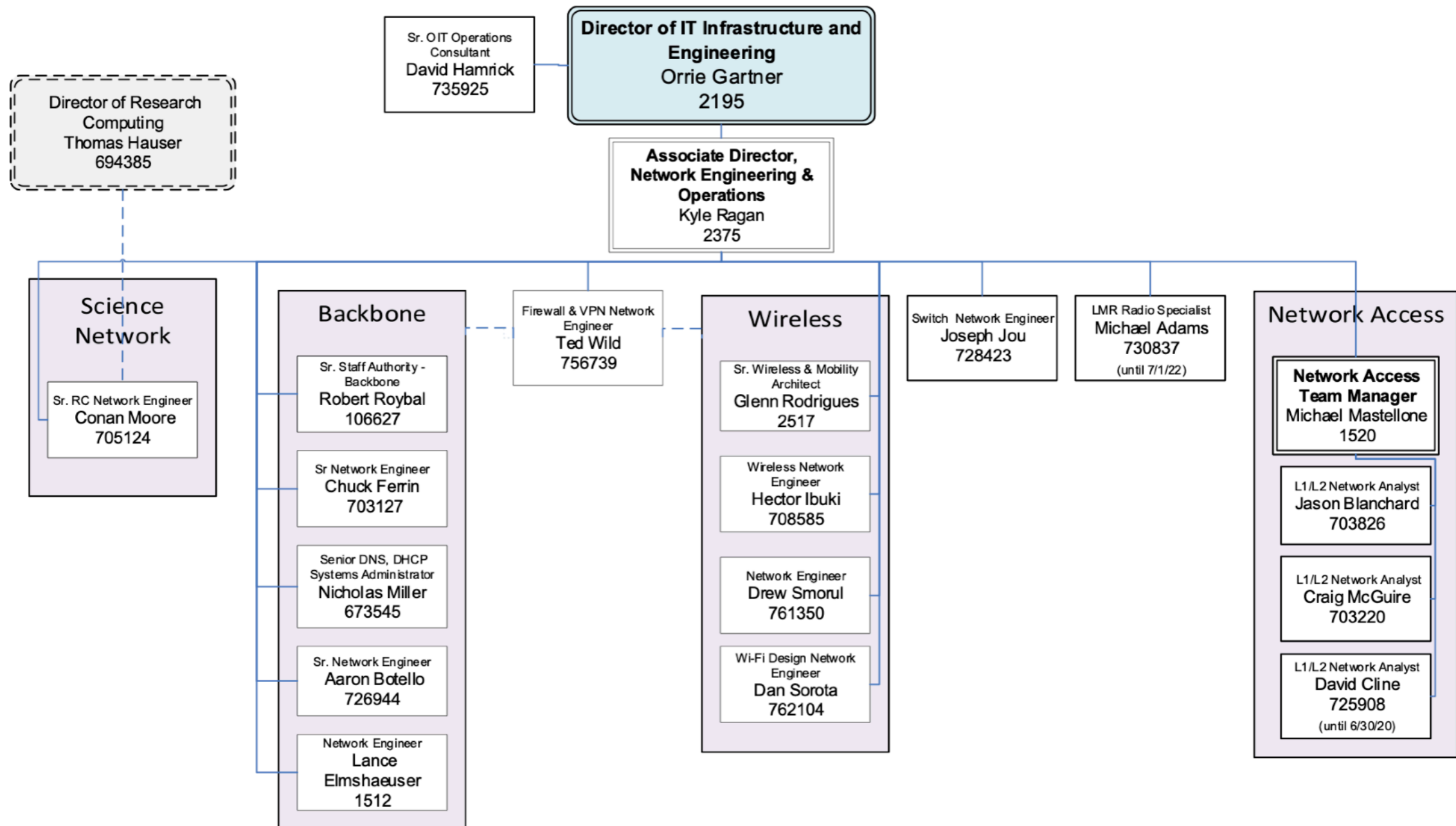
The screenshot shows a web browser displaying the COVID-19 Resources page. The browser's address bar shows the URL <https://oit.colorado.edu/covid-19-resources>. The page header includes the University of Colorado Boulder logo and the Office of Information Technology name. A navigation menu contains links for Services, Software & Hardware, Accounts, Support, About OIT, and COVID-19 Resources (which is highlighted). A secondary menu includes Hours, Social, and Login. A left sidebar features a Feedback button and a list of COVID-19 Resources: Academic Technology Resources, Instruction Modes & Technology Mapping, Remote Guidance for Students, Resources for Working Remotely, Instructor Laptops Project, OIT-Provided Peripherals for Fall 2020, and Fall 2020 Technology Request. Below this is a section for Fall 2020 News with a link to IT services & support. The main content area is titled "COVID-19 Resources" and includes a "Last Updated: 09/09/2020" timestamp. It has sub-sections for UPDATES, REMOTE RESOURCES, SUPPORT, and FAQ. The "REMOTE RESOURCES" section is active, showing "IT for Academic Continuity" with a paragraph of text and a link to the "CU Boulder COVID-19 Website". Below this is "Resources for Teaching, Learning, and Working Remotely", which is divided into "Teaching" and "Learning" categories. The "Teaching" category lists "Academic Technology Resources for Fall 2020" and the "Learning" category lists "Remote Learning Guidance for Students".







Network, Engineering, and Operations



Agenda

What is an ISP?

Connectivity Types & Terminology

Broadband Speeds

Do I need a VPN?

The More You Know ★

Wireless Technologies and Terms

Demonstration

Q&A (if time allows)



An **Internet service provider (ISP)** is an organization that provides services for accessing, using, or participating in the Internet. Internet service providers can be organized in various forms, such as **commercial**, community-owned, non-profit, or otherwise privately owned.

https://en.wikipedia.org/wiki/Internet_service_provider





Broadband Types

DSL



VS

Cable



VS

Fiber



Mobile Broadband

- Mobile Hotspots
- Tethering
- 4th Generation LTE
- 5th Generation





Key Takeaways

- There are tons of ISP choices.
- Understanding and selecting the right “last mile” option.
- If possible, avoid Cellular and DSL options.



Bandwidth, at a basic level, is the total download rate of your internet service - i.e. the fastest that you'll be able to download information or data to your computer or internet-connected device.

Mbps vs. MBps

- Mbps = megabits per second.
 - Download/upload speed.
- MBps = megabytes per second.
 - Related to file size.



Activity	Minimum Download Speed
Streaming SD Music	<0.5 Mbps
Browsing, email, and social media	1 Mbps
Streaming SD video	3 - 4 Mbps
Streaming HD video	5 - 8 Mbps
Streaming 4K video	15 - 25 Mbps
Online multiplayer games	4 Mbps
Video calls	6 Mbps

<https://www.fcc.gov/consumers/guides/broadband-speed-guide?kbid=120594>



<https://www.fcc.gov/consumers/guides/broadband-speed-guide?kbid=120594>

Home / Consumer / Consumer Guides /

Broadband Speed Guide

[Español](#) | [繁體中文](#) | [Tagalog](#) | [Tiếng Việt](#) | [한국어](#)

Compare typical online activities with the minimum download speed (Megabits per second, or Mbps) needed for adequate performance for each application. Additional speed may enhance performance. Speeds are based on running one activity at a time.

For household broadband needs, use our [Household Broadband Guide](#) to compare minimum Mbps needs for light, moderate and high household use with one, two, three or four devices at a time (such as a laptop, tablet or game console).

For more information on broadband speeds, see our [Measuring Broadband America report](#).

These numbers are rough guidelines and are not based on surveys or experiments conducted by the FCC. You should use your best judgment when choosing your broadband service.

Activity	Minimum Download Speed (Mbps)
General Usage	
General Browsing and Email	1
Streaming Online Radio	Less than 0.5
VoIP Calls	Less than 0.5
Student	5 - 25

Speed Comparison

	File Size	1Mbps	5Mbps	10Mbps	20Mbps	100Mbps	1000Mbps
4 Minute Song	4MB	30s	5s	3s	1.5s	.3s	.03s
5 Minute Video	30MB	3m	40s	26s	13s	2.5s	.2s
9 Hour AudioBook	110 MB	10m	2m	1.5m	46s	9.2s	0.9s
45 Minute HD show	600 MB	1h	15m	8.5m	4m	50s	5s

***All estimates from fastmetrics.com



Zoom Requirements

Meetings

1:1 video calling

- 600kbps (up/down) for high quality video
- 1.2 Mbps (up/down) for 720p HD video
- Receiving 1080p HD video requires 1.8 Mbps (up/down)
- Sending 1080p HD video requires 1.8 Mbps (up/down)



For group video calling

- 800kbps/1.0Mbps (up/down) for high quality video
- For gallery view and/or 720p HD video: 1.5Mbps/1.5Mbps (up/down)
- Receiving 1080p HD video requires 2.5mbps (up/down)
- Sending 1080p HD video requires 3.0 Mbps (up/down)

Other

- For screen sharing only (no video thumbnail): 50-75kbps
- For screen sharing with video thumbnail: 50-150kbps
- For audio VoiP: 60-80kbps
- For Zoom Phone: 60-100kbps



Bandwidth Planning

- Types and number of devices?
- What online services are being used?
- Bandwidth requirements for those services and apps?
- How many people are living with you?



More Users = More Mbps

	1-3	4-8	8-10	10
Light Usage	5-10 Mbps	15 Mbps	25 Mbps	50 Mbps
Moderate Usage	15 Mbps	25 Mbps	50 Mbps	100 Mbps
High Usage	25 Mbps	50 Mbps	100 Mbps	150 Mbps
Very High Usage	50 Mbps	100 Mbps	150 Mbps	200+ Mbps



Putting it all together...

- **Mbps:** How fast a file is downloaded to your device, and how fast one can be uploaded to the internet.
- **MBps:** file size. The larger it is, the longer it will take to download or upload from or to the internet.
- **A general rule:** the more Mbps you have, the faster your music, videos, webpages, etc will load. The opposite is true, too.





Key Takeaways

When figuring out your bandwidth needs, one must consider?

- Mbps is not the same as MBps but they must both be understood to determine bandwidth needs.
- Understand your internet usage based on the applications and protocols used.
- The more Mbps in your plan will equal faster download speeds.
- The more people you have in a household will increase bandwidth requirements.



ISP Recommendations

- Pick the right service tier.
- Pick the right for you “last mile” type.
- Cellular carriers are only good for one user at a time.
- 5G coverage is expanding but not everywhere yet.
- DSL is only recommended, if no other option is available.

Best Options

Cable



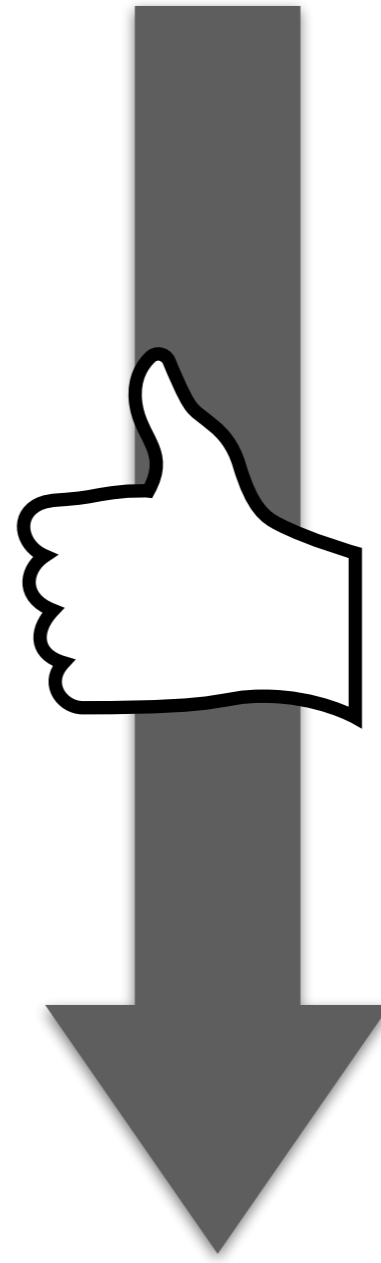
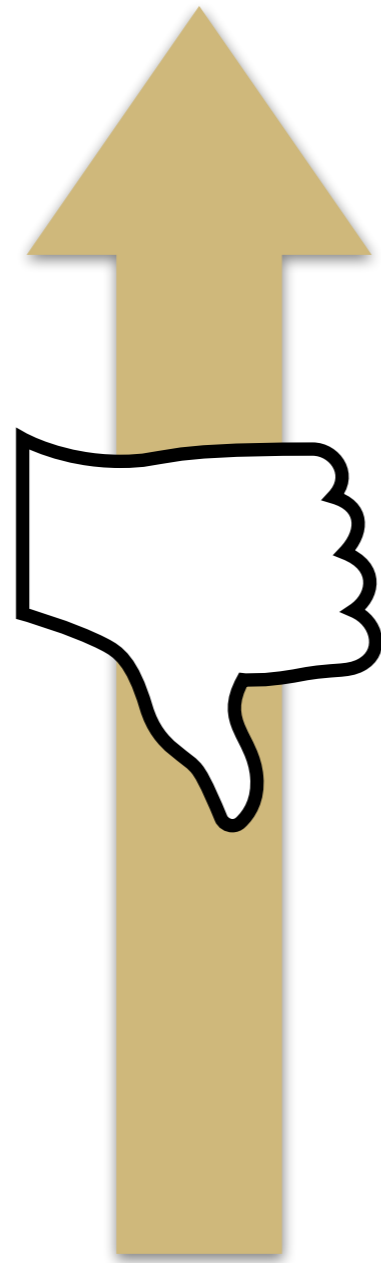
Fiber



OR

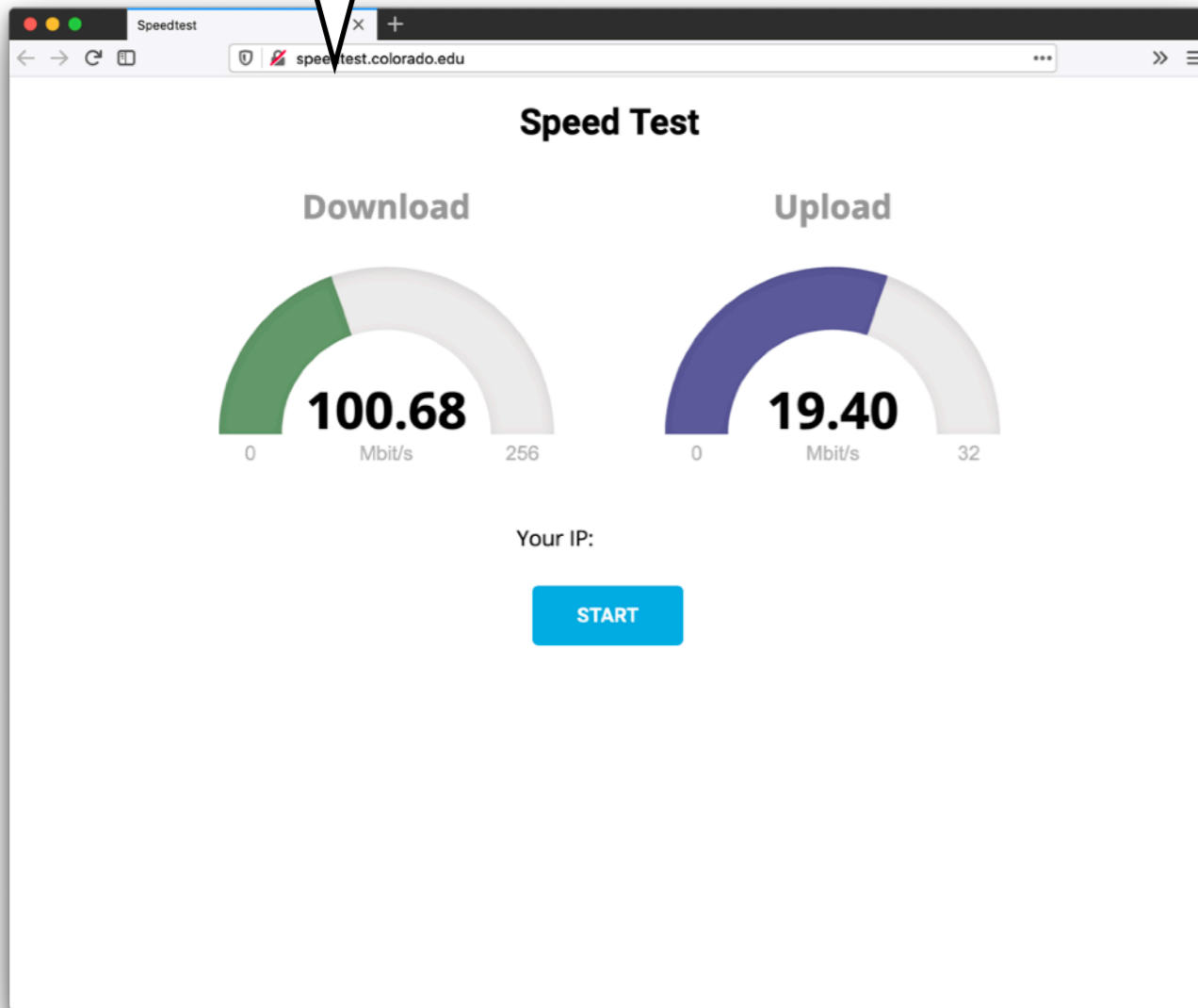


Upload & Download

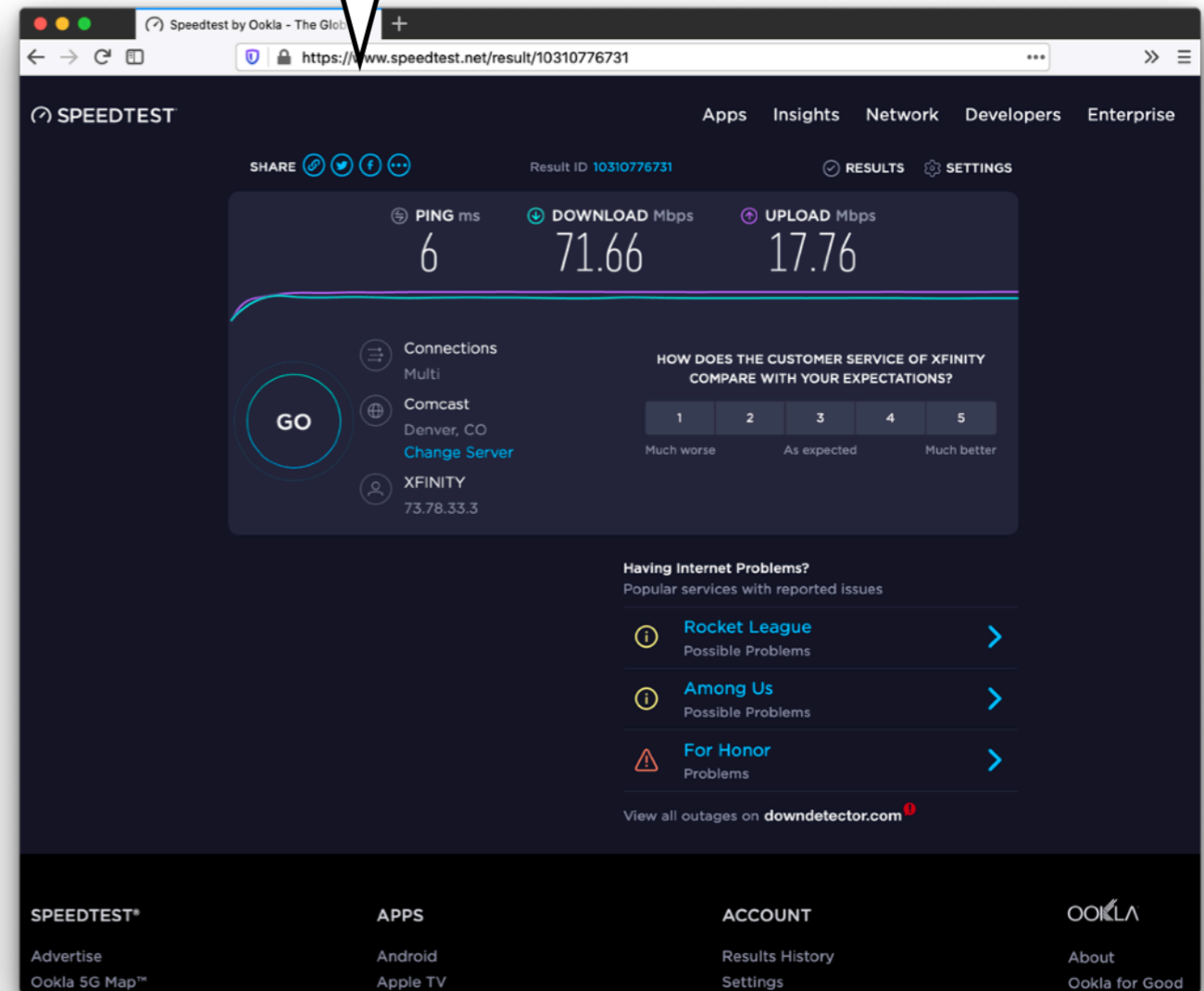


Speed Tests

speedtest.colorado.edu



speedtest.net



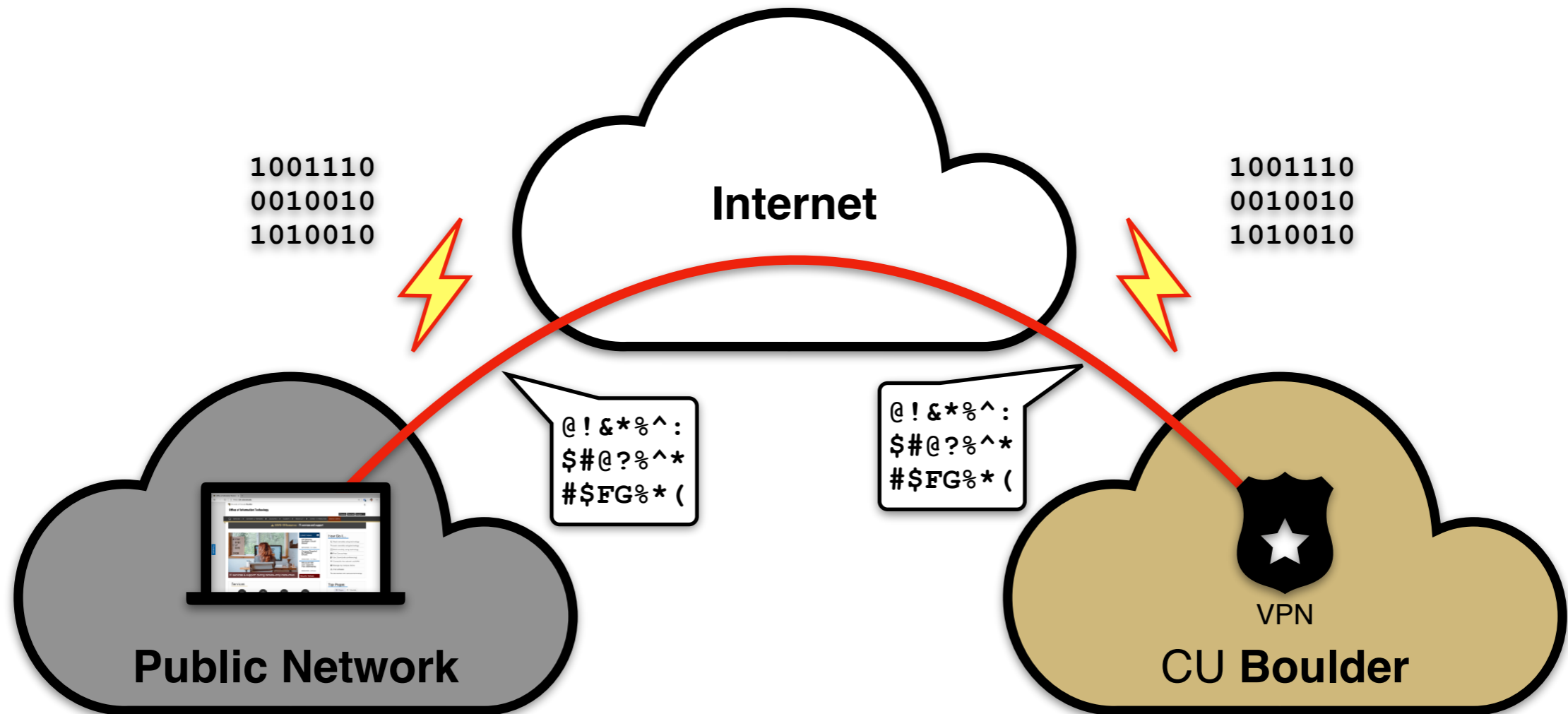


Key Takeaways

- The more people you have in your household the higher the bandwidth need.
- Best and most cost-effective options for most homes will be Cable or Fiber.
- Plans that range from the 50Mbps to 150Mbps range should be enough for most homes.
- Understanding upload verses download speeds and how this can affect your perceived speed.
- Using a Speed Test site helps to determine your current speeds.



Virtual Private Network





Do you need to get to...

- Access CU Boulder's file servers like UCB Files
- CIFS, NFS file sharing
- Access CU System administrative tools from off-campus like HCM and CU-SIS
- Access the Cisco VOIP Phone Self Care Portal
- Access specific library databases





Key Takeaways

- VPNs are very secure way of assessing important and confidential files or services.
- In most cases, a VPN may not be needed unless special access is required.
- VPNs can cause overhead and slow down your speed on slower ISP services like DSL and Cellular.

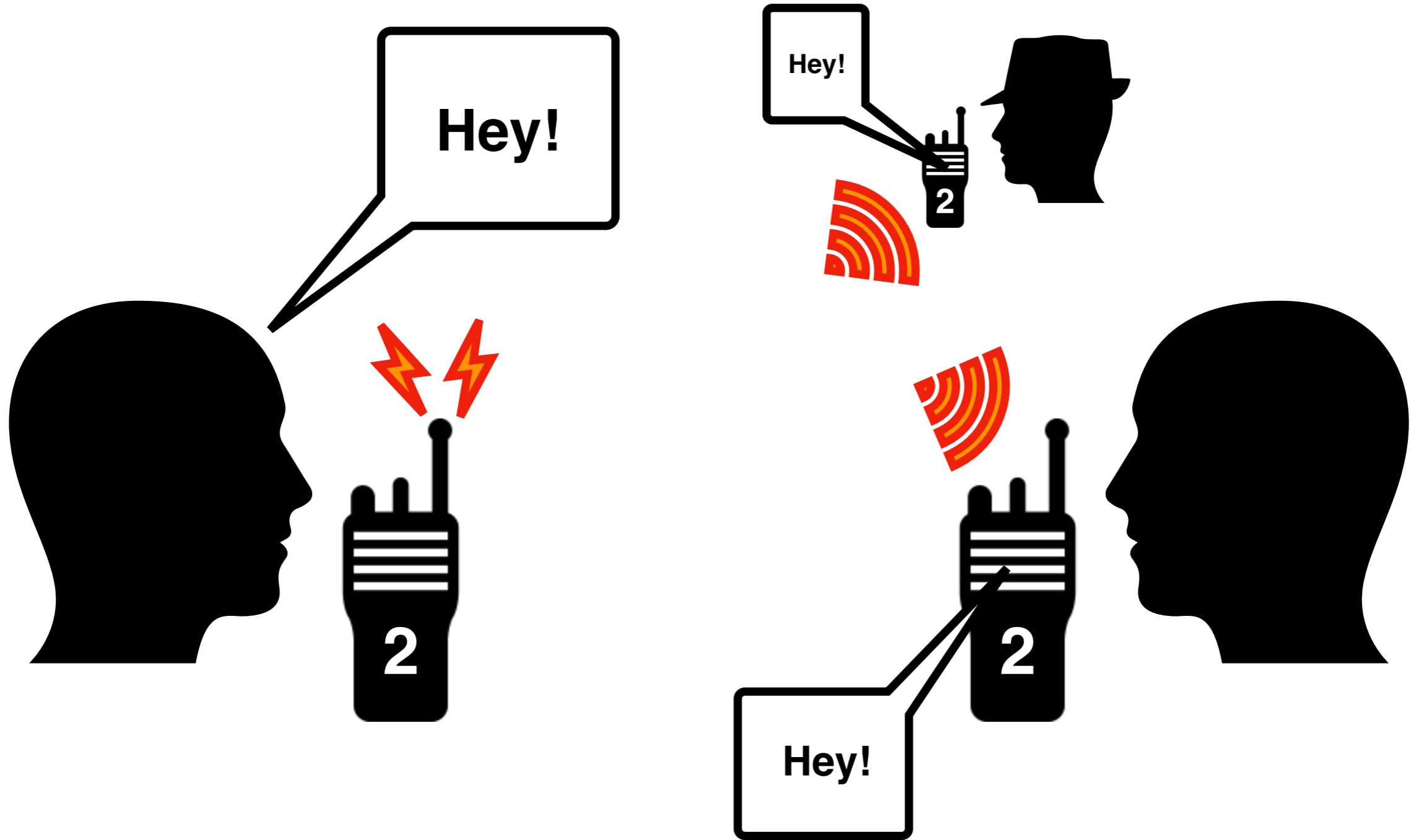


Questions

The More You Know



Office of Information Technology
UNIVERSITY OF COLORADO BOULDER



Passwords

- Make sure you change the default password
- Password should have at least 8 characters of alpha-numeric, letters, numbers, and capitalization



Encryption

```
[Calculated window size: 32768]
[Window size scaling factor: -1 (unknown)]
Checksum: 0x4adc [unverified]
[Checksum Status: Unverified]
Urgent pointer: 0
▶ Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps
▶ [SEQ/ACK analysis]
▶ [Timestamps]
TCP payload (37 bytes)
▼ Transport Layer Security
  ▼ TLSv1.2 Record Layer: Application Data Protocol: http-over-tls
    Content Type: Application Data (23)
    Version: TLS 1.2 (0x0303)
    Length: 32
    Encrypted Application Data: 0f167adbf21235e270274b03bbd76668df8473734d8bbb33...
0000 a4 83 e7 6e 03 1f 8c 5b f0 bb e3 3a 08 00 45 20  ...n... [ ...:..E
0010 00 59 86 fd 00 00 f0 06 3b 37 c6 3b 37 26 0a 00  .Y..... ;7.;7&..
0020 00 e9 01 bb c1 68 db cf ee 96 f1 d1 ed 24 80 18  .....h... ..$.
0030 80 00 4a dc 00 00 01 01 08 0a e3 d8 93 ed 00 00  ..J.....
0040 00 00 17 03 03 00 20 0f 16 7a db f2 12 35 e2 70  ..... .z...5.p
0050 27 4b 03 bb d7 66 68 df 84 73 73 4d 8b bb 33 45  'K...fh. .ssM..3E
0060 32 d5 98 95 c8 82 e8 2.....
```



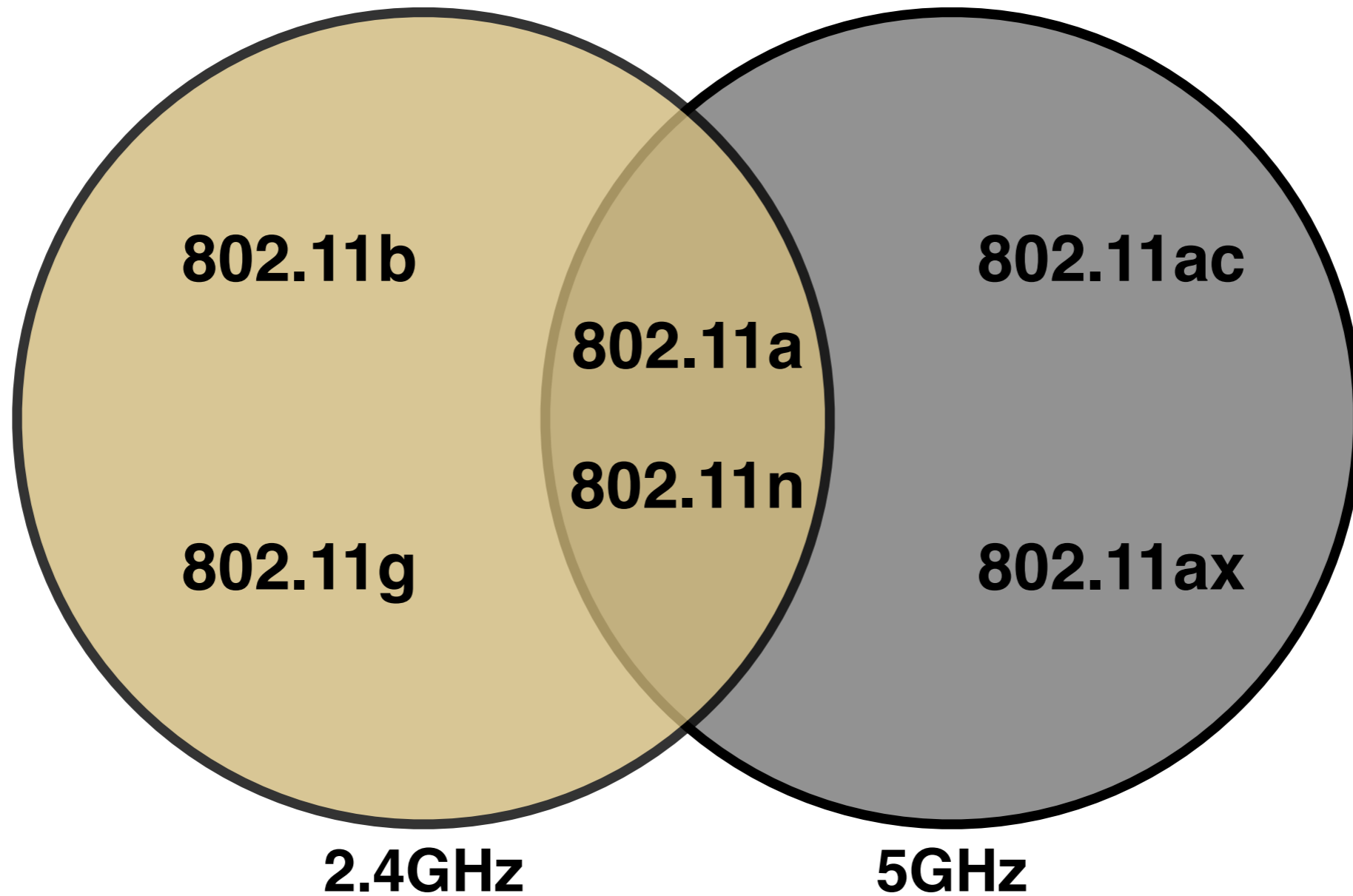
Key Takeaways

- Wireless networks communicate on frequencies that are publicly open.
- Interference can happen when two wireless networks talk on the same channel.
- Please make sure to change the default password on your wireless router.



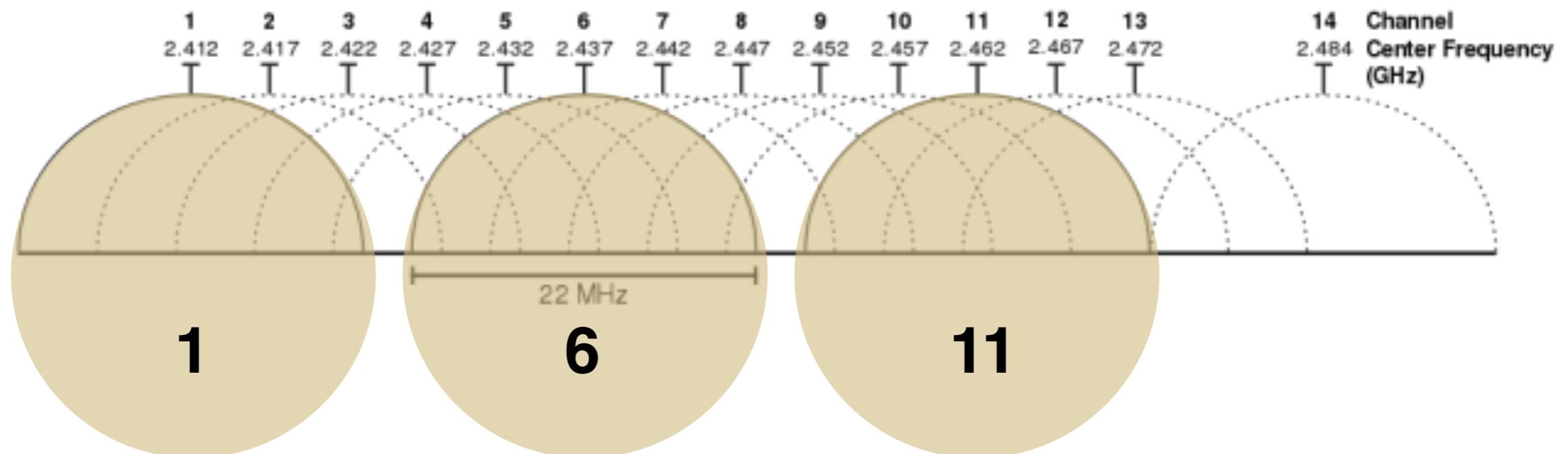


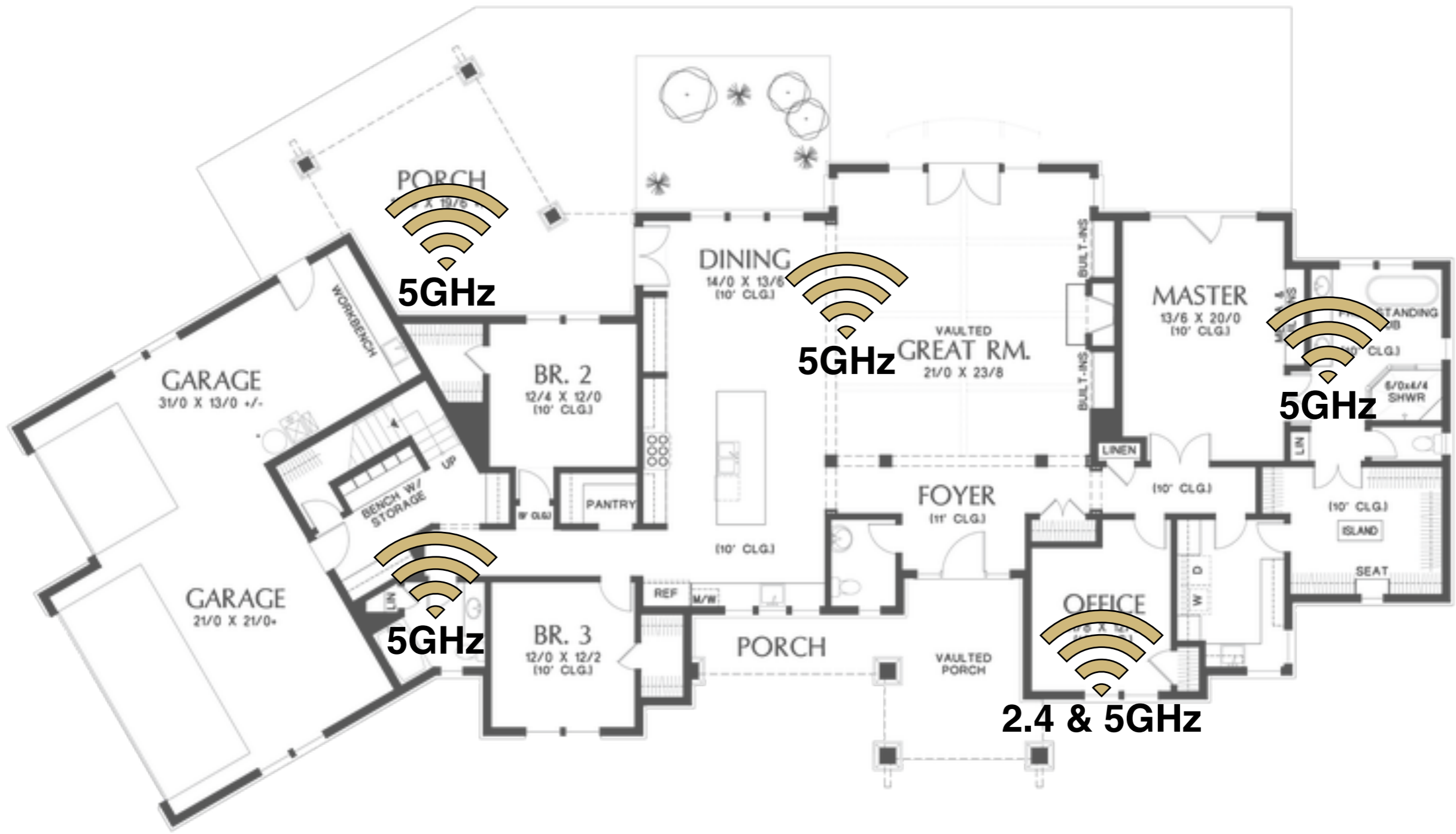
2.4GHz & 5GHz



2.4GHz

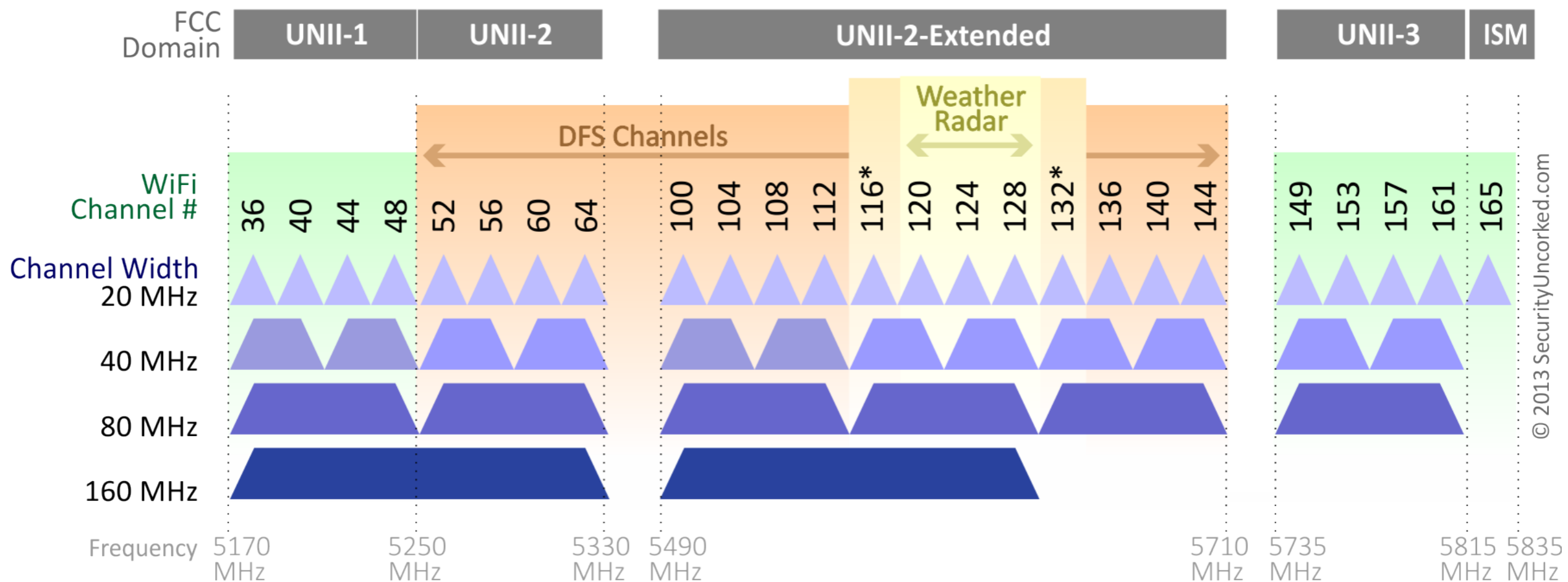
13 channels available but only **3** are **usable** because of overlap.





5GHz

802.11ac Channel Allocation (N America)



*Channels 116 and 132 are Doppler Radar channels that may be used in some cases.

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**You are only
as fast as
your
slowest link.**



So sayeth the Network Wizard





Key Takeaways

- Wireless networks work in the 2.4 or 5GHz range.
- 2.4GHz is legacy and slower than 5GHz but penetrates through walls better and the signal can travel farther. Has only 3 usable channels.
- 5GHz is newer and faster than 2.4GHz but has a harder time extending and penetrating the signal. Has many more channels which can be beneficial in apartments or in crowded neighborhoods.
- 5GHz gives you the ability to combine channels to increase the speed of your internal network.
- You are only as fast as your slowest link.



Demonstration

Questions



**Thanks for
attending!**



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