Learning Session: Home Networking 101
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.

LAST MILE
Broadband Types

- DSL
- Cable
- Fiber

VS
VS
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.
<table>
<thead>
<tr>
<th>Activity</th>
<th>Minimum Download Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Streaming SD Music</td>
<td>&lt;0.5 Mbps</td>
</tr>
<tr>
<td>Browsing, email, and social media</td>
<td>1 Mbps</td>
</tr>
<tr>
<td>Streaming SD video</td>
<td>3 - 4 Mbps</td>
</tr>
<tr>
<td>Streaming HD video</td>
<td>5 - 8 Mbps</td>
</tr>
<tr>
<td>Streaming 4K video</td>
<td>15 - 25 Mbps</td>
</tr>
<tr>
<td>Online multiplayer games</td>
<td>4 Mbps</td>
</tr>
<tr>
<td>Video calls</td>
<td>6 Mbps</td>
</tr>
</tbody>
</table>

Broadband Speed Guide

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

<table>
<thead>
<tr>
<th>Activity</th>
<th>Minimum Download Speed (Mbps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Usage</td>
<td></td>
</tr>
<tr>
<td>General Browsing and Email</td>
<td>1</td>
</tr>
<tr>
<td>Streaming Online Radio</td>
<td>Less than 0.5</td>
</tr>
<tr>
<td>VoIP Calls</td>
<td>Less than 0.5</td>
</tr>
<tr>
<td>Student</td>
<td>5 - 25</td>
</tr>
</tbody>
</table>

Related Content
- Getting Connected to Broadband
- Getting Broadband Q&A
- Household Broadband Guide
- Map: Search Broadband Availability
# Speed Comparison

<table>
<thead>
<tr>
<th>File Size</th>
<th>1Mbps</th>
<th>5Mbps</th>
<th>10Mbps</th>
<th>20Mbps</th>
<th>100Mbps</th>
<th>1000Mbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Minute Song</td>
<td>4MB</td>
<td>30s</td>
<td>5s</td>
<td>3s</td>
<td>1.5s</td>
<td>.3s</td>
</tr>
<tr>
<td>5 Minute Video</td>
<td>30MB</td>
<td>3m</td>
<td>40s</td>
<td>26s</td>
<td>13s</td>
<td>2.5s</td>
</tr>
<tr>
<td>9 Hour AudioBook</td>
<td>110 MB</td>
<td>10m</td>
<td>2m</td>
<td>1.5m</td>
<td>46s</td>
<td>9.2s</td>
</tr>
<tr>
<td>45 Minute HD show</td>
<td>600 MB</td>
<td>1h</td>
<td>15m</td>
<td>8.5m</td>
<td>4m</td>
<td>50s</td>
</tr>
</tbody>
</table>

***All estimates from fastmetrics.com***
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

<table>
<thead>
<tr>
<th>Usage</th>
<th>1-3</th>
<th>4-8</th>
<th>8-10</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Usage</td>
<td>5-10 Mbps</td>
<td>15 Mbps</td>
<td>25 Mbps</td>
<td>50 Mbps</td>
</tr>
<tr>
<td>Moderate Usage</td>
<td>15 Mbps</td>
<td>25 Mbps</td>
<td>50 Mbps</td>
<td>100 Mbps</td>
</tr>
<tr>
<td>High Usage</td>
<td>25 Mbps</td>
<td>50 Mbps</td>
<td>100 Mbps</td>
<td>150 Mbps</td>
</tr>
<tr>
<td>Very High Usage</td>
<td>50 Mbps</td>
<td>100 Mbps</td>
<td>150 Mbps</td>
<td>200+ Mbps</td>
</tr>
</tbody>
</table>
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

OR

Fiber
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 a very secure way of accessing 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
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: 0f167adb021273e270274b03bb76668df8473734d8bbb33...
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

- 802.11b
- 802.11g
- 802.11n
- 802.11a
- 802.11ac
- 802.11ax
2.4GHz

13 channels available but only 3 are usable because of overlap.
5GHz

802.11ac Channel Allocation (N America)

<table>
<thead>
<tr>
<th>FCC Domain</th>
<th>UNII-1</th>
<th>UNII-2</th>
<th>UNII-2-Extended</th>
<th>UNII-3</th>
<th>ISM</th>
</tr>
</thead>
<tbody>
<tr>
<td>WiFi Channel #</td>
<td>36</td>
<td>40</td>
<td>44</td>
<td>48</td>
<td>52</td>
</tr>
<tr>
<td>Channel Width</td>
<td>20 MHz</td>
<td>40 MHz</td>
<td>80 MHz</td>
<td>160 MHz</td>
<td>DFS Channels</td>
</tr>
<tr>
<td>Frequency</td>
<td>5170 MHz</td>
<td>5250 MHz</td>
<td>5330 MHz</td>
<td>5490 MHz</td>
<td>5710 MHz</td>
</tr>
</tbody>
</table>

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