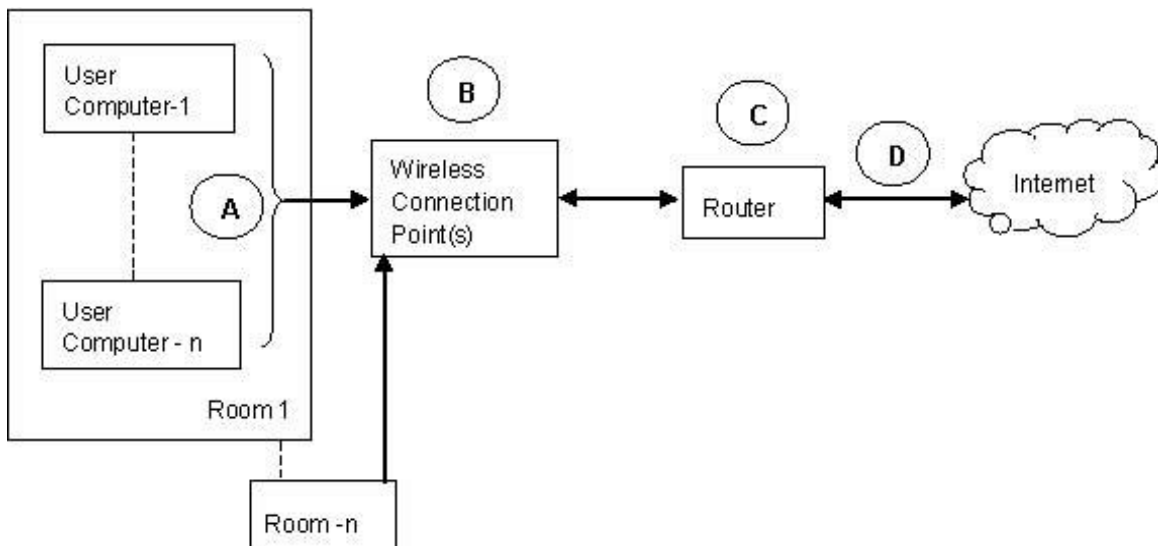


## Introduction

Companies often gather multiple users into a single location and provide each individual with a computer and access to the Internet for online training and testing. If the selected location is a conference or meeting room in a hotel, the computers are usually connected to the Internet via a wireless connection. This document outlines considerations for ensuring a quality experience when using multiple computers on a wireless connection.

## Background Information

The following diagram illustrates a simplified hotel conference room configuration providing wireless connection for the users' computers.



## Considerations and Recommendations

In the above scenario, one of the most common problems experienced is connectivity issues due to the amount of bandwidth not being sufficient for the number of users. Following are a few considerations and recommendations for preventing connectivity issues.

A	<ul style="list-style-type: none"> <li>The absolute minimum requirement <b>for each user computer</b> is 128 Kbps of bandwidth. This means that a room with 10 computers will require a total bandwidth of 1.28 Mbps. <b>IMPORTANT:</b> Be aware that some hotels will have multiple rooms sharing the same access point.</li> </ul>
B	<ul style="list-style-type: none"> <li>Access points must be capable handling the combined bandwidth requirements of all connected components.</li> <li>Wireless connections will have multiple channels; you can overload a channel and may need to manually switch to a lesser used channel.</li> </ul>
C	<ul style="list-style-type: none"> <li>Routers must be capable of handling the combined bandwidth requirements of all connected components.</li> </ul>
D	<ul style="list-style-type: none"> <li>The connections to the internet ("last mile") need to have the capability to handle the combined bandwidth requirements of all component connections within the building.</li> <li>Many hotels may not have a bandwidth connection capable of handling many simultaneous users.</li> </ul>

## Recommendation Summary

1. Plan for at least 128 Kbps for each client computer. Use the following chart for general recommendations for bandwidth requirements by class sizes.

NOTE: The recommendations are for EnergyU usage only, any additional clients, applications and devices using the wireless would require additional bandwidth.

Simultaneous Users	Recommended Bandwidth (at the last mile)
10	1.28 Mbps
15	1.92 Mbps
20	2.56 Mbps
25	3.20 Mbps

2. Do not assume bandwidth is shared equally among client computers. Consider the following:
  - Certain computers may be consuming bandwidth related to other tasks (e.g., researching the web, downloading streamed data such as YouTube and Pandora, etc.).
  - Some computers, such as tablets, typically have less transmit power and take longer to communicate.
  - Location of the computer is important; it may be in a refracted location.
  - Many user computers may be sharing a common wireless channel, while other channels are considerably less used.
  - Wireless channels are subject to interference with adjacent sources such as cell phones, Bluetooth devices, other wireless networks, etc.
  - The antenna(s) on the wireless may need adjustment.
3. To check the connectivity of a client, a good connectivity and speed test tool is located at <http://www.websitepulse.com/help/tools.php>.
  - You will be able to select <https://mea.certpointsystems.com> as a target, and check the performance of the client computer downloading representative data.
4. If possible, the best alternative is to avoid using wireless. Instead, hardwire-connect the computers to a quality Gigabit switch connecting them to the internet router.

**Appendix A Wireless Connectivity Facts** provides a compilation of facts regarding wireless connectivity.

**Appendix B Connectivity Tips** provides some general recommendations for remediating connectivity problems.

## Appendix A: Wireless Connectivity Facts

- The Wi-Fi signal range depends on the frequency band, radio power output, antenna gain and antenna type as well as the modulation technique. Line-of-sight is the thumbnail guide but reflection and refraction can have a significant impact.
- In addition to running on different channels, multiple Wi-Fi networks can share channels.
- Even though employees use tablets like laptops, tablets still have relatively limited battery lives and Wi-Fi adapters. For example, an iPad that uses Wi-Fi at 5 GHz takes just 10 milliwatts to transmit, versus the 30 to 50 milliwatts that a laptop consumes. Lower transmit power results in shorter distances and lower data rates; this means that an iPad takes roughly three times longer to transmit the same amount of data from the same location as a laptop.
- The location where your wireless router and computer are placed affects the performance of your wireless network. To boost the wireless signal, it is ideal to place the wireless router either in the central part of your house or in a location free from any obstructions (major obstructions include walls, floors, and doors) that may block its range.
- The frequency used by your router's wireless network can be set to 2.4 GHz or 5 GHz. Interference happens if there is conflict with some wireless devices that are also using the same frequency within your network. The most common examples of devices that use the same frequency are cordless phones, microwave ovens, and baby monitors. Another factor that could cause interference would be a separate wireless network which operates in the same frequency as your router.
- It would be best if the router is within the line of sight of the computer. This will ensure a stable wireless connection between the devices. The lesser the walls between the computer and the router are, the stronger and more stable the connection would be.
- Sudden power interruptions may result to having intermittent wireless connection or even having none at all as soon as you are able to recover from the outage. If this happens, a recommended workaround would be to powercycle your router.
- For best results, Wireless-N routers should be paired with Wireless-N adapters in the same way that Wireless-G routers should be paired with Wireless-G adapters. Should there be a mix of Wireless-G and Wireless-N adapters connecting to the network, it would be best to set the Wireless Mode to Mixed. This will allow Wireless-G devices to have a stable connection to the network and will allow the Wireless-N device to still connect to the network but will be performing based on the Wireless-G speed
- You should have an updated driver installed for your adapter for better connectivity.
- A Wi-Fi signal occupies five channels in the 2.4 GHz band. Any two channel numbers that differ by five or more, such as 2 and 7, do not overlap.
- 802.11a uses the 5 GHz U-NII band, which, for much of the world, offers at least 23 non-overlapping channels rather than the 2.4 GHz ISM frequency band, where adjacent channels overlap.

## Appendix B: Connectivity Tips

- It isn't uncommon that an 802.11n connection with devices only a few meters apart (and with only wall in between) can fall back to a mere 215 Mbps.
- 0.5-2 Mbps: Is enough for all your basic chatting and mailing services, though it will slow down some content-heavy websites --especially if you've got a 20+ Mbps downpipe.
- 4-5 Mbps: Enough for handling all websites and basic video streaming.
- 20+ Mbps: This is the minimum you need to even consider HD streaming. Even though, the typical bitrate of a 720p iTunes TV show is 26Mbps, your router needs to compensate for dropouts, other connected clients and prebuffering.
- 50+ Mbps: Enough for 1080p movies and over-the-air backups.
- See if your computer is managing your wireless card's power. It may be instructed to shut off your wireless connectivity after a certain amount of idle time goes by. If you have system specific utilities, such as Dell's Quickset, make sure that the wireless power management isn't set to shut off the card if your computer is idle for a certain period of time.
- Another thing to try is to simply shut down all your hardware – ie., your PC, your modem, your router, your laptop, etc. – anything on the network. Then power them back on in the following order: modem -> router -> PC (wired) > laptop (wireless) and see if that fixes the issue.
- Here's a tip that can keep your wireless connection from dropping out repeatedly. If you are using a router (particularly a dual band router), you'll want to go into the wireless settings (usually under "setup"), and specify a channel. Try using a different channel than the default, and make the settings for both of your bands (2.4Ghz and 5Ghz) if you're using a dual band router. Definitely do not use the "auto" setting. It appears that this is the main culprit. Try setting a higher channel, and if that doesn't work, try different channels. It's very possible that there are enough networks in your immediate area on the same channel that they're conflicting with each other.
- Adjust your wireless router settings
  - Lower the MTU (Maximum Transmission Unit) from 1500 to 1492 or less (usually found on your router's main/ basic setup page).
  - Adjust the following advanced wireless settings:
    - Lower the beacon interval from 100 to 50.
    - Lower the fragmentation threshold from 2346 to 2306.
    - Lower the RTS threshold from 2347 to 2304.
- Disable third-party networking utilities. It is possible that third-party software is interfering with your network settings. Try disabling any third-party networking software you may have installed, power cycle through your system, and see if that gets the wireless connection back up and running.