Unlock Communication

The Why and How of Wi-Fi®

Part 2

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IN PART 1 OF THIS ARTICLE, WE LEARNED THE BASICS OF WI-FI, IMPORTANT INDUSTRY DEFINITIONS AND SOME APPLICATION REQUIREMENTS. THAT ARTICLE CAN BE FOUND AT **WWW.RICELAKE.COM/WIFICOMMUNICATION**.

IN PART 2, WE WILL LOOK AT HOW TO DESIGN, INSTALL AND TROUBLESHOOT A WIRELESS ETHERNET SYSTEM.

Design

The five most important factors to consider when designing a WLAN system are data, location, frequency, power and antenna type.

Data

Depending on your frequency, you may get more range but less data speed or less range and more data speed. Transmitting a weight every one-tenth of a second requires a very low rate of data transfer, therefore you can have an increased range. However, if you are transmitting a real-time video requiring more data per second, you will need to decrease your range in order to uphold the quality of the data. Evaluate your project needs before selecting a particular frequency and/or protocol.

Location

Ideally, you want your two antennas to be within line of sight of each other without obstructions. If this is not possible, look for alternatives, like adding wireless access points.

For optimal performance, it is always best to keep radios and their antennas as close to each other as possible. Adding cable between the antennas and the radios can drastically reduce the range if not done exactly right. For outdoor applications, special radios with IP67 rated enclosures are available. Another method is to install the radio in a weatherproof enclosure with an external antenna.

If a line of sight is impossible, look for the minimum amount of metallic and EMI sources between antennas, avoiding liquids at all costs. If these are not possible, then repeaters may be necessary. Also look at the orientation of the antennas; they should be parallel to each other with the lengths facing each other.

If you cannot achieve a clear line of sight between your antennas, the table on this page shows the interference potential of various materials.

Frequency

In order to analyze the frequency of your environment, you will need to analyze the electromagnetic interference and other wireless systems first. Using the 2.4 GHz spectrum, the software on your Wi-Fi enabled laptop can help you with this analysis. If not, free software packages are available on the Internet. Another way to test the frequency of your environment is to use the free software available from radio manufacturers. With the radios, you can test the communications between both or all points. Generally, the two main frequencies that allow unlicensed operation are in the 2.4 GHz and 900 MHz range. However, there are many other devices that use radios in the same frequency range.

Depending on the frequency, there are a number of channels available. Sometimes choosing the correct (least used) channel can make all the difference! The 5 GHz spectrum is divided up into a number of different channels. The 2.4 GHz channels for Wi-Fi are as shown in the figure below.

Notice that channels 1, 6, 11 and 14 are the only groups that do not overlap.

Power

In some cases, the power output of the radios is adjustable. The maximum power is not always the best due to a multi-path type of interference. As we saw in the first part of this article, most antennas have a toroidal (doughnut) shaped transmission pattern. Since the transmission is sent in all directions, there may be reflective paths that the signal takes to get to the receiver.

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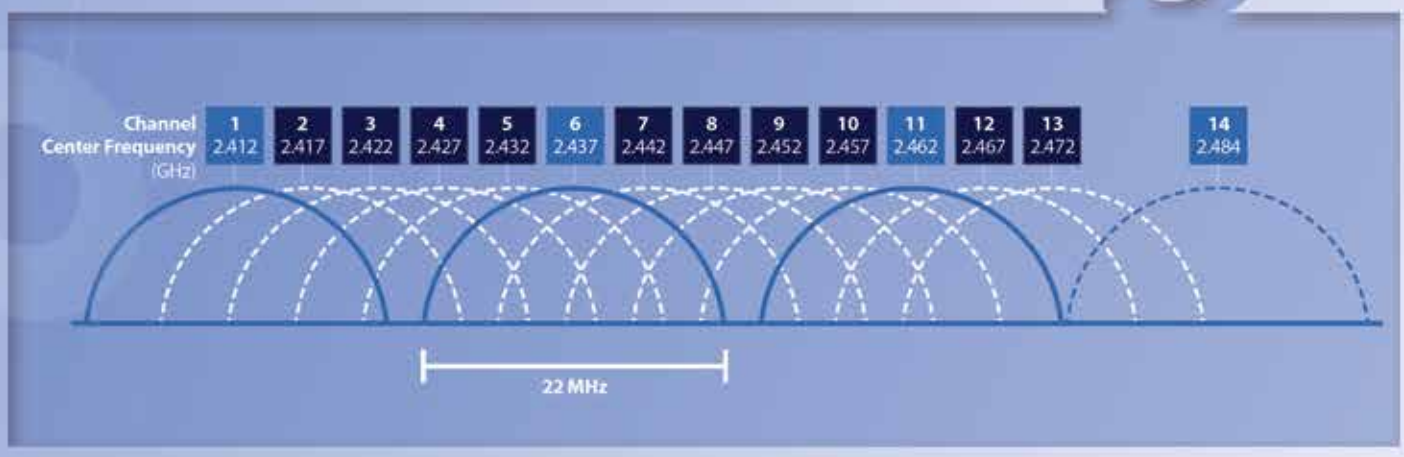
Type of Barrier	Interference Potential
Wood	Low
Synthetic Material	Low
Glass	Low
Water	Medium
Bricks	Medium
Marble	Medium
Plaster	High
Concrete	High
Bulletproof Glass	High
Metal	Very High



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This can cause data corruption; for example, hearing an echo on a cell phone.

Antenna

Many radios are supplied with the standard omni-directional antenna. If a longer range is desired, or if multi-path interference is an issue, a different type of antenna can be used, such as a Yagi antenna. The Yagi antenna is actually designed to concentrate the beam, both sending and receiving, to a more narrow and directional path. This is especially useful if both radios are located in a line of sight path, but at a greater distance.

Installation

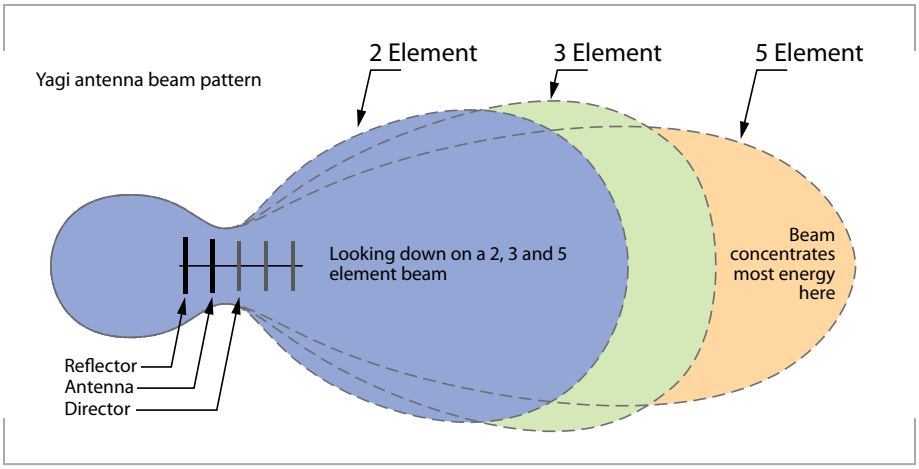
Once you have determined the positioning for each radio, the installation is of vital importance. If the radio is going to be outside, a protective enclosure and even a heater may be needed. Many radios have a temperature limit on both the high and low end.

If the situation calls for the antenna to be located in a different area than the source of the data, always try to extend the input cable rather than the cable from the radio to the antenna.

If the antenna must be located away from the radio, the type of cable, its connectors and its length are critical since the cable now acts as part of the antenna. Using the wrong cable type or cable length can just about eliminate even the strongest signal. Check with your supplier to be sure the items are compatible. This is even more important for "high gain" antennas.

Troubleshooting

Once the system is installed, there may be times when the system does not appear to work, or does not work consistently. The best course of action starts with keen observation. First of all, determine if the problem is in the wireless system at all. Move the devices close enough together to make a wired connection. If that does not solve the problem, there are further questions to ask and steps to take.



First, ask yourself these questions:

- Did it ever work?
- When did you notice that it stopped working?
- Does it work sometimes during the day and not at other times?
- Has any equipment been installed previous to when it stopped working?
- Is there any new construction in the area?

Second, do some investigating.

- Look for installation problems.
- Check for loose antenna connections.
- Is there any weather ingress?
- Confirm antenna and radio placement.
- Is the input signal present and correct?

Third, do some testing.

- Set up a pair of pretested radios.
- Establish a link using line of sight.
- Move outward to final placement on an incremental basis.
- If successful, replace or repair as necessary. Check existing equipment by substitution.
- If unsuccessful, note drop-off point and redesign with different placement, radios, frequency or add repeaters as necessary.

If it works, but not at your desired range, or not consistently:

- Test at closer range and then walk it back.
- Check for spectrum usage. Use a different channel if possible.
- Check connections, especially input and antennas.
- Try a slower data rate or smaller packets.

If it used to work, but not any more:

- Test as before, one step at a time.
  - -First, test a wired solution if possible.
  - -Ask what's different—explore all possibilities.
  - -Run a spectrum test.
  - -Look for EMI sources (any rotating machine).

By following these basic principles, you can design, install and troubleshoot a wireless system that performs just as clear as a wired system. ■