5 Questions You Need to Ask

When Choosing Wireless Ethernet Extenders

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Introduction

Wireless Ethernet extenders provide a very cost-effective method for extending a LAN/WAN beyond the 100-meter Ethernet limit. They eliminate the need to buy new cable or dig expensive trenches for fiber cable, and also the time-consuming waits for rights of way. Wireless Extenders also eliminate the need to buy and install Ethernet repeaters and other expensive network equipment.

Wireless Ethernet extenders are the most seamless way to extend LAN connections across office parks; on business, educational, and medical campuses; in enterprise business complexes; and in industrial settings, such as factories or oil/gas field drilling operations, and even in traffic control.

Wireless Ethernet extension is not just for connecting networks across the street. It is frequently used to connect line-of-sight networks that are miles apart. While wireless extension is often used in enterprise business applications, where it really shines is in industrial applications such as data acquisition, control, and monitoring; HVAC controls; and security and surveillance, to name a few.

This paper will examine five questions you need to consider when choosing wireless Ethernet extenders.

1. What type of topology do you need?

Wireless Ethernet extenders support several network topologies, including point-to-point, point-to-multipoint, and repeater/backhaul.

Point-to-Point Networks

The point-to-point network configuration is the easiest to set up and configure. It provides a single link from point A to point B. It's a simple solution for connecting two buildings' networks wirelessly. It also supports bidirectional traffic flow.

Point-to-Point Application

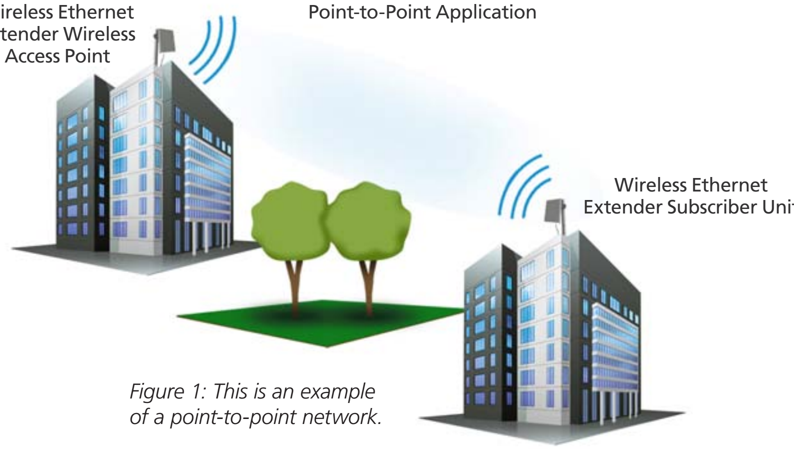
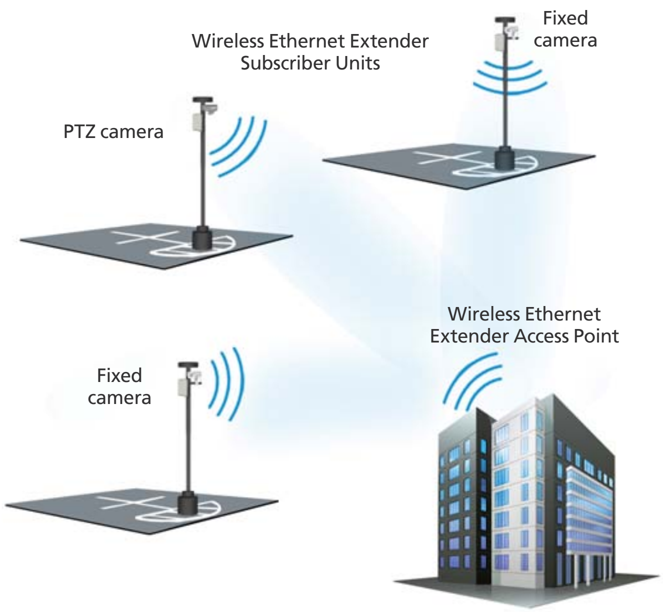


Figure 1: This is an example of a point-to-point network.

Point-to-Multipoint Application



Point-to-Multipoint Networks

A point-to-multipoint wireless configuration is ideal for networks with multiple spokes, like a star topology, requiring a 360-degree coverage area. The center of the star has a single, central wireless access point or hub that connects out to multiple subscriber units. This is an ideal setup for industrial settings where connections need to be made in multiple directions.

Figure 2: In this example, subscriber units have directional Wi-Fi connectivity to the central access point fitted with an omnidirectional antenna.

Repeater/Backhaul Network

The repeater or backhaul solution is designed to achieve maximum distance over a wireless link. In this example, consecutive point-to-point connections are made to extend the distance of a traditional point-to-point network. This is a practical solution when long cable runs are not an option or when all of your network devices follow a linear path.

Repeater/Backhaul Application

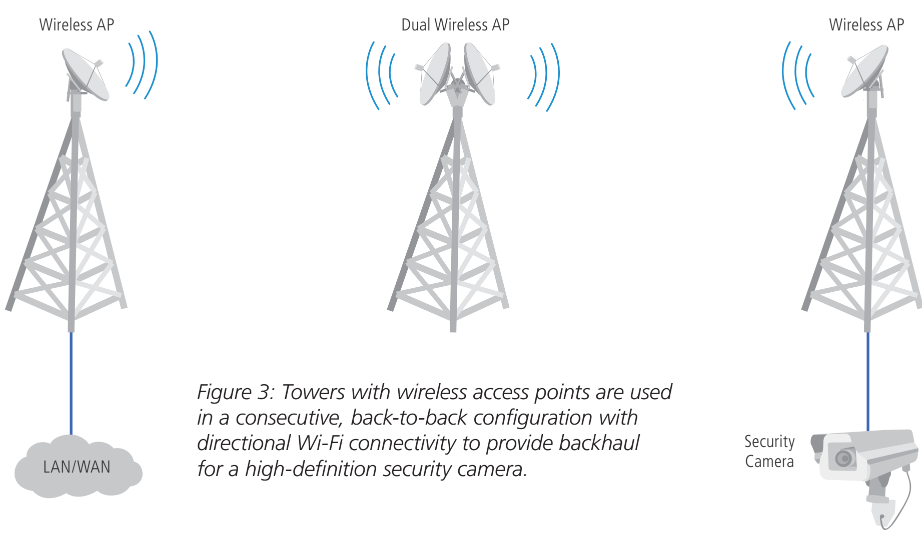


Figure 3: Towers with wireless access points are used in a consecutive, back-to-back configuration with directional Wi-Fi connectivity to provide backhaul for a high-definition security camera.

2. What are your throughput and range requirements?

Bandwidth/Link Speed

Bandwidth, or link speed, is an important factor to consider when purchasing a wireless Ethernet extender. Think of bandwidth as a highway where the more lanes you provide, the more traffic can traverse the highway without collisions or delays. In this visualization, your data (IP cameras, Internet users, etc.) are the cars and trucks on the highway that is your wireless link.

Below is a comparison of speeds in Black Box wireless Ethernet extenders. An important consideration to remember is that these are maximum speeds in perfect conditions. To make sure your wireless applications have enough bandwidth, a general rule of thumb is to only count on 30–40% of the link as stable.

For example, for a device with a maximum speed of 300-Mbps, you should only count on 90–120-Mbps at any given time. This is due to the fact that Ethernet traffic often travels in bursts. Also, counting on a lower bandwidth will help ensure a functioning network in adverse weather or partial line-of-sight blockages. To give an idea of how much bandwidth you may need, here are some typical applications and the bandwidth that is required.

Speed Comparison

Ethernet Extender Selection Guide

Feature	LS900 Series	LWE100 Series	LWE200 Series
Frequency	900 MHz	2.4 GHz (2400 MHz)	5.8 GHz (5800 MHz)
Antenna Type	Omni and Directional	Omni and Directional	Omni and Directional
Antenna Upgrade	Omni and Directional	Omni and Directional	—
Distance (Max.)*	40 Miles	15 Miles	30 Miles
Speed (Max.)	1 Mbps	100 Mbps	300 Mbps
Point-to-Point	✓	✓	✓
Point-to-Multipoint	✓	✓	✓
Subscribers per Access Point (Max.)	16	32	16
Power	AC or Power over Line Injector	Power over Line Injector	Power over Line Injector

* This indicates distance in ideal conditions.

3. What are your path loss considerations?

Line of Sight

Whether you are installing a wireless network indoors or outdoors, you must always consider line of sight (LOS): the path between two antennas. There are three main categories of line of sight. The first is full line of sight, where no obstacles reside between the two antennas. The next is called near line of sight (nLOS), which includes partial obstructions, such as tree tops or buildings between the two antennas. The last is non-line of sight (NLOS), where full obstructions exist between the two antennas.

By determining the specific line of sight conditions in the Wi-Fi network area, you can determine the correct type of wireless system to install. Line of sight is based on the Fresnel zone, or the area around the line of sight where the radio waves spread out after they leave the antenna. This area must be clear or the signal strength will weaken due to reflections (when wireless signals "bounce" off objects) that cause fading (loss of the wireless signal). Trees, buildings, towers, etc., in the Fresnel zone will produce reflections that can result in signal fading.

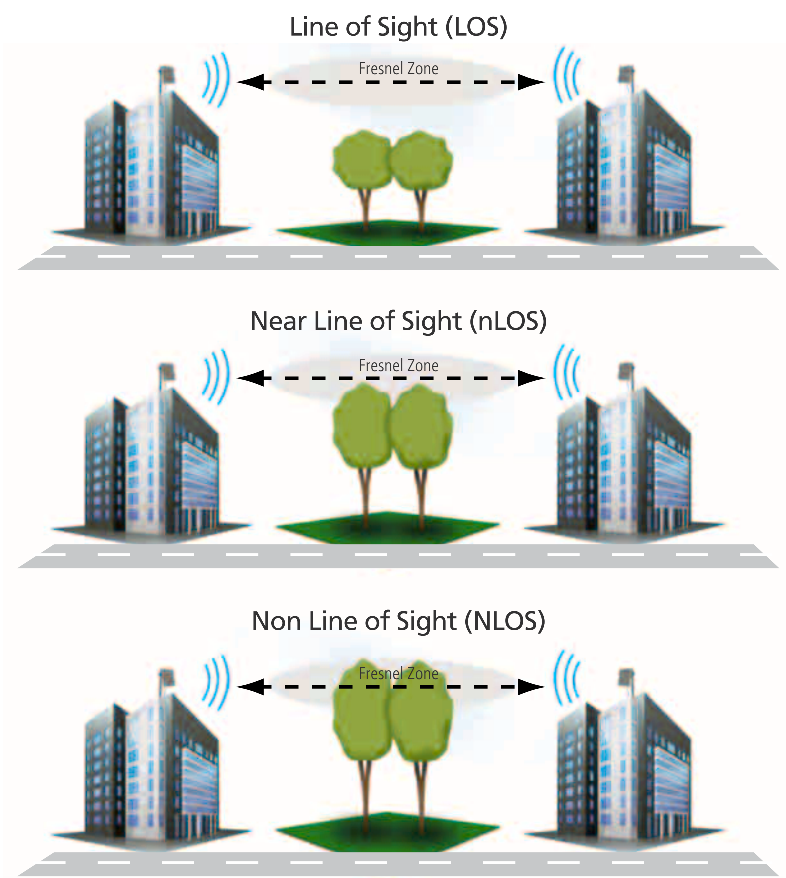


Figure 6: Example of a directional antenna pattern.

Free Space Path Loss

Free space path loss is an area of concern for 2400-MHz (2.4-Ghz) wireless systems. Although 2.4-GHz signals pass rather well through walls, they have a tough time passing through trees. The main difference is the water content in each. Walls are very dry; trees contain high levels of moisture. Radio waves in the 2.4-GHz band are easily absorbed into water. As a comparison, 900-MHz waves do not present as much of an issue when crossing trees. And 5.8-Ghz (5800-Mhz) waves will perform even worse than 2.4-GHz waves in the same situation.

4. What antenna is best for your environment?

The next step in building a wireless network is choosing the correct antenna for your application. Coverage and range will be the driving factors. There are two types of Wi-Fi antennas. Omnidirectional antennas are used for short distances with a large visual scope. Directional antennas are used for long distances with a limited signal scope.

Omnidirectional Antenna: Short range, 360° view.

Omnidirectional antennas provide a 360° signal pattern to provide the widest possible coverage in indoor and outdoor wireless applications. They radiate signals in all directions at once, but at shorter distances. This makes them ideal for deploying as a central access point in a point-to-multipoint network. Other applications for omnidirectional antennas include indoor office spaces, retail stores, warehouses, small office or home networks, outdoor cafés, campgrounds, RV parks, and marinas.

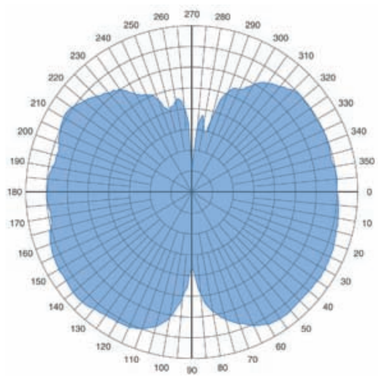


Figure 4: Example of an omnidirectional antenna pattern.

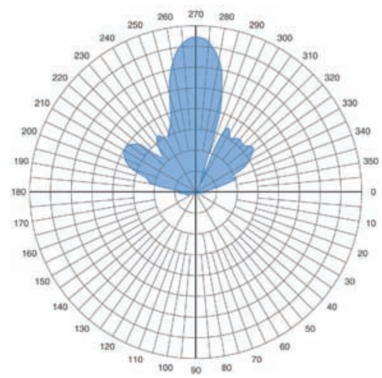


Figure 5: Example of a directional antenna pattern.

Directional Antenna: Long range, limited view.

A directional antenna, as the name implies, focuses the wireless signal in a specific direction, resulting in a limited coverage area. There are multiple types of directional antennas, such as Yagi, parabolic grid, patch, and panel. High- gain directional antennas can transmit and receive wireless signals over a much greater distance than omnidirectional antennas provided there is a clear line of sight and sufficient transmit power. However, directional antennas have a limited scope, as they focus the signal to a smaller viewing radius.

Applications for directional antennas include point-to-point wireless links connecting buildings, a backhaul data link connecting cell towers, and point- to-multipoint wireless subscriber nodes where multiple remote clients with directional antennas communicate with a single, central access point with an omnidirectional antenna.

Rain/Snow Fade and Different Frequencies: Overcoming rain and noise.

Antennas operate at different frequencies to suit different applications. The antenna's frequency must match the frequency of the amplifier, access point, or router it will be attached to in order for the system to work. In the U.S., the 900- , 2400- and 5800-MHz frequency bands are set aside by the FCC for unlicensed Industrial, Scientific and Medical applications. When selecting a frequency range, you want to make sure that other devices in the area are not already using the same range. For instance, many microwave ovens use 2400 Mhz, which can interfere with Wi-Fi antennas. Also take rain/snow fade into consideration particularly for outdoor installations. Speeds tend to be better with higher frequencies. However, the higher the frequency, the more susceptible it is to obstructions such as rain and snow fade. The 900-MHz (LS900PKA) frequency is the best at cutting through rain and snow.

5. Where will you install the antennas?

Antenna Height (Outdoor Installations)

You can use a calculator online like the one at http://netmon.net.bsu.edu/noc/calculators/antennacalc.cgi to calculate the minimum installed antenna height for line of sight. The variables you will need to find the correct installation height for your antenna are listed below:

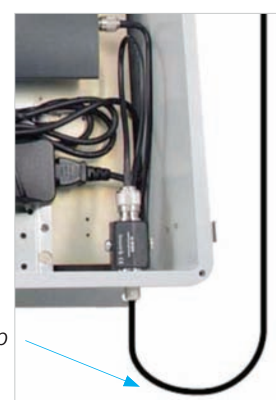
1. Distance from the transmitting antenna to the largest obstruction. This will take into account the curve of the earth as well as the height you will need to clear the Fresnel zone. The longer distance between the two devices, the higher they will have to be placed.
2. Distance from the receiving antenna to the largest obstruction. From this and information in the first variable, we now know how far the signal will need to travel total and where the highest obstruction is in relation to the Fresnel zone.
3. Height of the highest object in the path. At a frequency of 5.8 GHz, you need a clear line of sight. Tree tops will deflect and absorb some of the signal. The theory is that the height of the tallest object in the path of the signal should be added to the Fresnel zone and earth curvature clearance heights. You will need to check the height of the trees, hills, buildings, or any object on the link path and add this to the measurement for the total of the tower height.
4. Frequency of the antenna or wireless signal. This will affect the size of the Fresnel zone. The higher the frequency, the smaller the Fresnel zone will become and the less height you will need to have a clear line of sight. However, as discussed in the Antenna Frequency section of this paper, the higher the frequency, the more susceptible it is to obstructions causing changes in signal strength, including weather and humidity.

Outdoor Antenna Installation Best Practices.

When installing an antenna outdoors, it is important to use the minimum cable length required between the antenna and the access point or enclosure connection point. Make sure the cable enters the enclosure or device from the bottom. And leave enough cable to make a drip loop so rain and moisture will not enter the enclosure or equipment connections. Additionally, we recommend that you wrap all outdoor cable connection points with moldable or self-healing weatherproof tape. Do not wrap the cable around a mast or pole. The cable should run straight down the mast from the antenna to the enclosure.

Wireless Link Distance	Calculation for Minimum Height Above Obstacles to Achieve Line of Sight with a 5.8-Ghz Wireless Bridge
30 Miles	162.1 feet (49.4 m)
25 Miles	123.3 feet (37.6 m)
20 Miles	90.3 feet (27.5 m)
15 Miles	63 feet (19 m)
10 MIles	40 feet (12 m)
5 Miles	23 feet (7 m)
3 Miles	17 feet (5 m)

Drip Loop



Antenna Orientation (Indoor Installations).

When dealing with the installation and expansion of indoor wireless networks several factors must be considered. Most manufacturers of wireless access points and routers indicate a typical range that their equipment can provide. Usually these range estimates require line of sight, which means you will need a clear unobstructed view of the antenna from the remote point in the link. In most cases there will be obstacles present in an indoor installation that could affect performance. Signals will be attenuated when they penetrate walls. Attenuation factors to consider include metal studs, concrete, fiberboard, aluminum siding, foil-backed insulation, pipes and electrical wiring, furniture, and sources of interference. Sources of interference include other wireless equipment, cordless phones, microwave ovens, and radio transmitters. In wireless transmissions, reflections (when wireless signals “bounce” off objects) and multipath (when wireless signals travel multiple paths to arrive at the receiver at different times) are as important as signal strength in determining the success of an installation. A signal will exhibit peaks and nulls in its amplitude and alteration of its polarization when propagating through walls, ceilings and when reflecting off objects.

Powering Your Device.

When installing an antenna, wireless access point, or bridge, it is important to consider how the unit will be powered. You can use AC power, DC power, or send power over the data (Ethernet) line. Both the Black Box LWE100A and LWE200A series units, designed for long distances, are powered by a power injector sending power over the same data line. This is very convenient as you only have to run one line to the antenna.

However, the power injectors included in these kits, while sending power, are not PoE 802.3af or PoE + 802.3at compatible. This is because the antennas have very stringent power requirements and standard PoE and PoE+ injectors would not provide enough power. The injectors included with these kits have different maximum power and distance limitations. (This is true of long-distance wireless radio systems from all manufacturers and not just Black Box.)

You will want to make sure that distance limitations will not be an issue for your deployment. For example, the power injector on the LWE200A series units has a maximum transmit distance over CAT6 cable of 60 meters (196 feet). This would make it very difficult to reach any outdoor height above 12–15 meters (40 to 50 feet) without being on top of a multifloor building. Also remember that while the wireless bridges and access points may be hardened and weatherproof, the power injectors are not and need to be in an indoor location or hardened outdoor enclosure.

About Black Box

Black Box is a leading technology product solutions provider that helps customers build, manage, and secure their networks. The company is a single source for networking products, including switches, Ethernet extenders, media converters, console/terminal servers, industrial hardened, and wireless. Black Box provides its customers with free, 24/7 pre- and post-sales technical support.