
Wireless Networking

Creative Approaches and Possible Pitfalls

High speed wireless networking has become a key tool in industry, government, small business, education and home networking, removing many restrictions previously imposed buy wired networking connections. Additionally, personal communications is being revolutionized by mobile data communications for hand held computing and communications devices. This paper focuses on the use of wireless networks as a replacement for wired networks, rather than the personal communications aspect.

Wireless LAN Basics

Wireless business networking has been in use in industry for a number of years and has seen growth in the last few years due to the rapidly declining costs of equipment and a desire for “any time, anywhere” high speed connectivity. A number of different systems have been developed over the years, but most systems today are based on the 802.11 wireless networking standards (developed by the IEEE - Institute of Electrical and Electronics Engineers), as follows:

- 802.11b - up to 11 Mbps in the 2.4 GHz radio frequency range (also known as “Wi-Fi” - Wireless Fidelity)
- 802.11a - up to 54 Mbps in the 5 GHz radio frequency range (not compatible with the more popular 802.11b systems)
- 802.11g - up to 54 Mbps in the 2.4 GHz range of 802.11b (backward compatible with the older, slower 802.11b)

These systems can provide data, video and voice communications via wireless Ethernet to a variety of users, including:

- Users in office buildings
- Users in areas as large as 6 to 10 miles across
- Point to point connection up to 25 miles, in some conditions

The effective use of these systems is influenced by several factors, including the following:

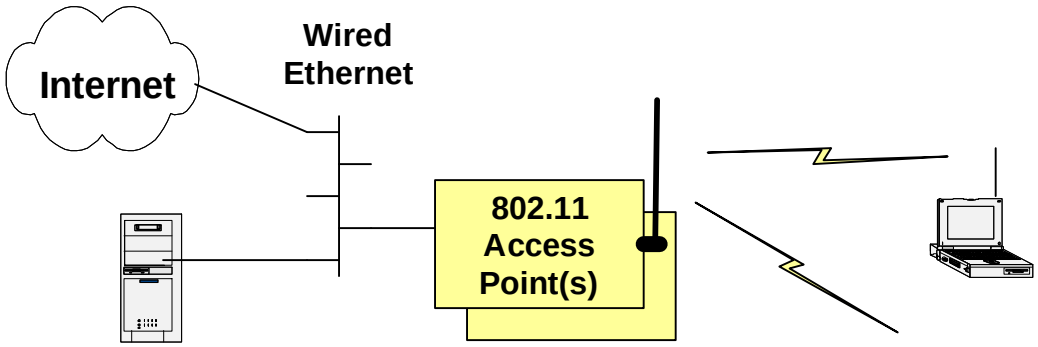
- Network designs
- Wireless coverage
- Data capacity
- Security

These points are discussed in more detail in the remainder of this paper.

Network Designs

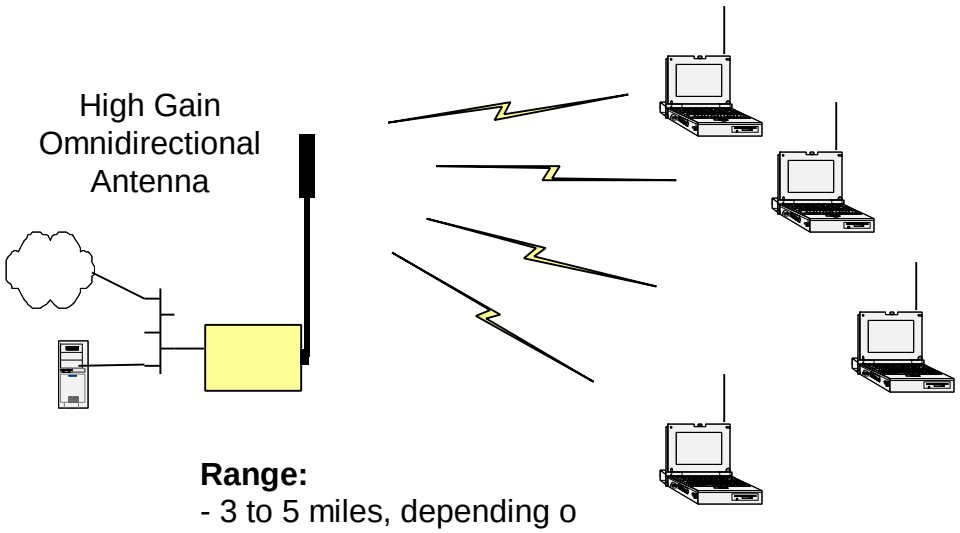
The following diagrams provide three network design diagrams for support of progressively larger geographic areas.

Simple Wireless LAN - suitable for an office or small campus. Depending on the building and campus configuration, more than one access point may be required.



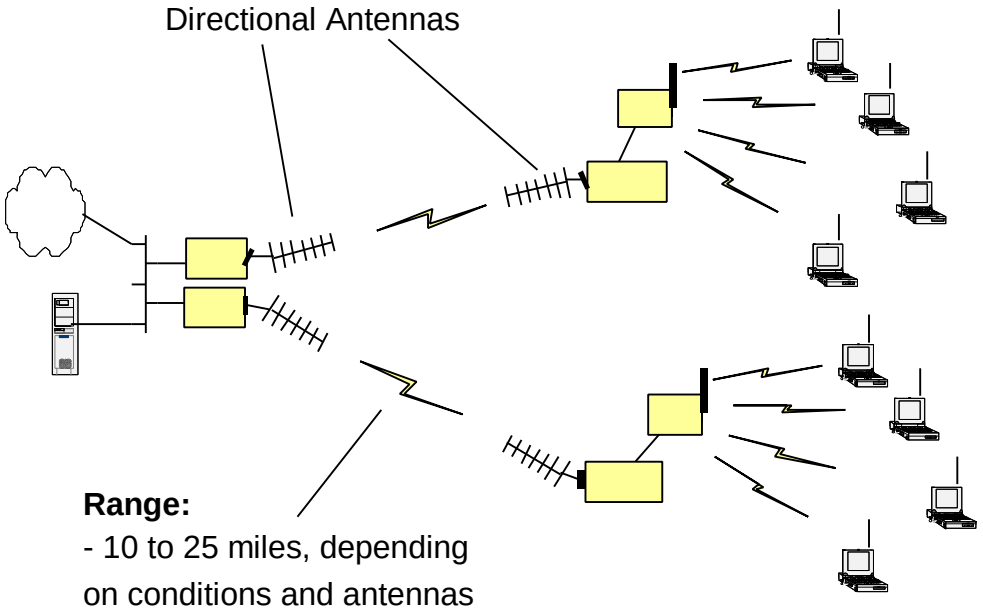
Range:
- Inside - 100 - 300 ft.
- Campus - 300 - 1,000 ft.
(may require multiple access points)

Simple Wireless Community Network - suitable for a 3 to 5 mile radius (6 to 10 mile diameter) service area for end users.



Range:
- 3 to 5 miles, depending o conditions and user

Community or Metropolitan Network with Multiple Access Points - providing coverage over a larger area by implementing multiple networks connected to a central access site by point to point 802.11 links.



Wireless Coverage and Data Capacity

The actual coverage and data capacities provided by an 802.11 network is a function of a number of factors, including the following:

- Type of antennas used at each access point and at the end user PC
- Building construction and obstructions between the access point and the user
- Interference form other sources, including other wireless LANs. The frequency bands allocated to 802.11 services are unlicensed, so anyone can use the frequencies for 802.11. Some electronic equipment produces radio frequency interference.

The effects of these factors are interrelated and can be complex, as summarized below.

- **Distance** - All other factors being constant, the data rate to an 802.11 device will decline as distance increases, with the slowest speed being 1- 2 Mbps before service ceases.
- **Antennas** - The construction of antennas can cause more energy to be radiates in specific direction, called “gain”. Omni-directional antennas can “flatten out” the radiation pattern, allowing longer range in all directions. Uni-directional antennas can significantly increase gain in one direction, allowing distances of 10 to 25 miles between two individual points.

- **Buildings and Terrain** - Building construction with concrete and steel reduces the range of wireless networks. Radio signal are essentially "line of sight", so high terrain between two pints will prevent the transmission of data signals. Heavy foliage in the line of sight will also reduce range, so performance may vary from season to season. Typically, rain or snow will not affect 802.11 signals unless it is extremely heavy.
- **Interference** - 802.11 b and 802.11g operate in the 2.4 GHz frequency range. In interference sources include microwave ovens (within 10 - 20 feet), Bluetooth personal LAN devices and 2.4GHx cordless telephones. Interference will reduce performance and could prevent operation if the interference if strong enough. 802.11a operates in the 5GHz range, with fewer sources of interference, but the maximum range is also less at the higher frequency.
- **Number of Users** - Bandwidth is shared among all users on an access point. In a metropolitan network with 802.11b, all users in an access point "cell" would share 11Mbps of bandwidth. Without a lot of streaming video, this bandwidth can serve a large number of users.

Security

With regard to security, it is best to assume that ***there is no security inherent in any 802.11 system***. Encryption provisions exist in the standard (called WEP or Wired Equivalent Privacy), but it must be configured properly and may be vulnerable to cracking. If security is required, as it is in most commercial settings, it is best to use the organization's VPN access security on any wireless links. This keeps the status of the wireless LAN as an external access system (which it is) and applies appropriate security, consistent with the organization's policies.

Summary

Wireless LAN technology offers significant benefits in terms of flexibility, mobility within a small area and reduced infrastructure maintenance costs. The points in this paper provide the basic knowledge required to evaluate wireless LAN alternatives and see that the systems are implemented in an appropriate manner.

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