WIRELESS LAN TECHNOLOGY

The Current State of Wireless LAN Technology

A Datanamics Labs Research White Paper

WIRELESS LAN TECHNOLOGIES

A look at the current state of the art

By Doug Brandt

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Wireless networking is today's glamour technology. You can hardly pick up a technology publication without encountering articles extolling its virtues or excoriating its faults. The purpose of this white paper is to inform the reader about the current state of wireless technologies, and to raise some of the pertinent issues regarding its possible future directions. It is one of three produced by the Datanamics Labs™ development team dealing in Technology, Deployment, and Security.

The IEEE 802.11 wireless LAN technology has followed the trend of most computing technologies over the past 20 years, and expanded exponentially. This rapid growth has raised some serious issues among both developers and regulators with respect to frequency allocation and congestion. Most of the challenges enumerated here are not yet significant, but their significance will grow as the number of implementations grows. It is important to know them and incorporate them into your decision-making.

I. Technologies and Standards

Nowhere in the modern computing field is the proliferation of acronyms and numerical designators more prevalent than in wireless networking. Here is the short version of what you need to know to bring some order to the chaos.

802. What?

The IEEE (Institute of Electrical and Electronics Engineers) is the body responsible for setting standards for computing devices. They have established a committee to set standards for Local Area and Metropolitan Area Networking named the "802 LMSC" (LAN MAN Standards Committee). Within this committee there are workgroups tasked with specific responsibilities, and given a numeric designation such as "11". In this case the 802.11 workgroup is tasked with developing the standards for wireless networking. Within this 802.11 workgroup, there are task groups with even more specific tasks, and these groups are designated with an alphabetic character such as “a”, or “b”, or “g”. There is no apparent logic to the ordering of these characters and none should be inferred. The specific groups and tasks concerning wireless networking hardware standards are outlined below.

802.11b - This is the standard created by task group “b”, charged with developing the standard for wireless networking in the 2.4GHz Industrial, Scientific and Medical (ISM) frequency band. This standard supports an 11Mbs Ethernet LAN and is currently the most widely implemented.

802.11g - This is a standard currently under development by task group “g”, charged with developing a standard for achieving a higher network speed in the 2.4GHz ISM frequency band. The standard is expected to be issued in late 2002.

802.11a - This is a newer standard created by task group “a”, charged with developing the standard for wireless networking in the Unlicensed National Information Infrastructure (UNII) 5GHz frequency band. This standard supports a higher network speed up to 54Mbs.

Another 802 working group that should be included here is the 802.15 Wireless Personal Area Networking (WPAN) group. This technology is important because it shares the same frequency spectrum as 802.11b. At the same time that the IEEE was forming a study group for WPANs, the Bluetooth Special Interest Group (SIG) was forming with the intent of developing an industry standard for bringing WPAN products to market. The IEEE 802.15.1 standard for 1 Mbs WPAN/Bluetooth is a cooperative effort between the Bluetooth SIG and the IEEE.

Bluetooth

This technology is based on low power signaling in the 2.4GHz frequencies similar to the 802.11b standard, but utilizing a different approach to signal processing. It is intended to provide wireless links between mobile computers, PDA’s, cell phones and the Internet.

“… intended to provide wireless links between mobile computers, PDA’s, cell phones and the Internet.”

Significant operational differences between Bluetooth and 802.11b are the bandwidth, 1Mbs versus 11Mbs, and distance, 10M versus 100M. Bluetooth is capable of greater distances, but the targeted operational area is 10M.

Even though 802.11b and Bluetooth occupy the same frequency, they can coexist. However, they can cause interference and lower throughput, especially when placed in close proximity. FCC rules have been changed recently to allow the Bluetooth frequency hopping spread spectrum to be modified to allow a better interleave factor with the 802.11b direct sequence spread spectrum technology. This should allow greater bandwidth for Bluetooth, and less interference with 802.11b. If Bluetooth and 802.11b were implemented in the same device, an intelligent frequency hopping scheme could be devised that would eliminate interference. Bluetooth was never intended to compete with 802.11b, and in fact it holds a lot of promise as a complementary technology. It is very likely that some future devices will accommodate both 802.11b and Bluetooth in the same unit.

"…the more freedom, the more complexity."

802.11b – The Current Leader

802.11b Wireless Local Area Networks (WLAN) have captured the largest share of the wireless market. A typical 802.11b WLAN (Fig. 1.) would consist of workstations and peripherals equipped with wireless network interface cards, connecting to a wired backbone through Wireless Access Points (WAP). The backbone would contain file servers, Internet gateways, routers and firewalls necessary to support the enterprise.

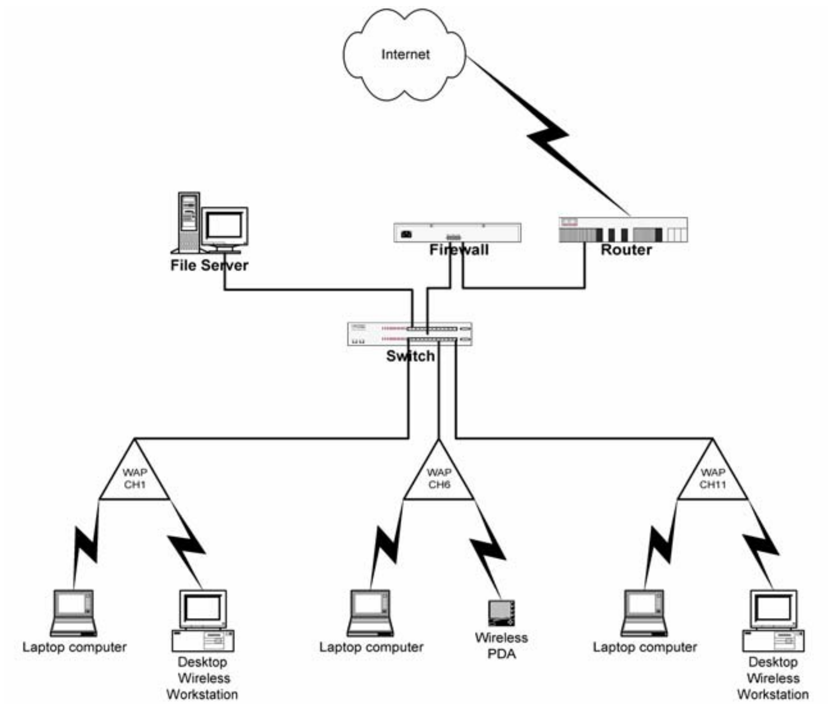

Fig. 1.

The wireless devices enjoy a certain level of freedom of movement because they are not tied to a physical cable. The degree of freedom is directly related to the design of the network. In general terms, the more freedom, the more complexity.

Wi-Fi

"…Wireless Fidelity is the mark of compliance with the standard that assures interoperability."

As manufacturers began designing and producing 802.11b compliant devices, the need for a certification process became apparent as even the strictest standards are often open to interpretation. The Wireless Ethernet Compatibility Alliance (WECA) was formed to act as a certification body for products that interoperate via the 802.11b standard. Wi-Fi, for "Wireless Fidelity" is the mark of compliance with the standard that assures interoperability. There is also a Wi-Fi5 certification that assures interoperability between 802.11a devices. There is no standard for interoperability between 802.11a and b.

II. Technical Details and Design Considerations

Because of its glamour status, there is a bewildering quantity of technical information and media hype about wireless networking. When faced with making the ultimate decision about whether or not wireless networking is appropriate for you, it is essential to know some of the technical details to help filter out the hype., and focus on the reality.

Bandwidth

Before we begin, a word about bandwidth. The 802.11b standard is generally understood as an 11Mbs Ethernet LAN running in the 2.4GHz ISM radio band. Because of the demands of the protocol, and the multiple factors influencing radio signals, it is very unlikely that you will ever achieve 11Mbs as an operational bandwidth on your LAN. Everything is conspiring to steal bandwidth. How much you really end up with is dependent largely on the following.

"Everything is conspiring to steal bandwidth."

Interference

Reduced to its simplest form, wireless networking is a network where the physical wires have been replaced by radio signals. Unlike wires, radio signals are susceptible to a wide variety of physical and radio frequency (RF) interference. This interference will normally manifest itself as a reduction in performance, and occasionally will result in a complete shutdown.

Assuming that you have a signal that reaches from point "A", the wireless access point, to point "B", the wireless network interface card in a workstation, let us examine what can happen to that signal and what the ultimate effects might be.

First, let's examine distance as a physical factor. The closer the wireless device is to the wireless access point, the stronger the signal. A stronger signal requires fewer retransmissions. If we move point "B" further away from the access point the signal will gradually weaken, resulting in more frequent retransmissions, manifested as slower performance. This is usually only a problem at the edges of the range, but is a serious consideration for the designer.

Physical barriers such as walls and widows are obvious sources of interference, but another significant source of interference can result from the placement of furniture and other objects in the space between points "A" and "B" as well as the walls that define the space. This kind of interference is called "multipath propagation". Assuming a line of sight path between points "A" and "B", a portion of the signal will go directly between the two antennae. Another portion of the signal will bounce off adjacent walls and furniture, and will arrive at the receiving antenna some time after the original signal. If the delay is sufficient, the receiving station will not be able to decode the signal and will not acknowledge the packet, requiring a retransmission by the sender. This type of interference is most prevalent in a large space with lots of reflective surfaces such as a warehouse or manufacturing plant, but is certainly not limited to those types of spaces.

"Delays and retransmissions result in poor performance."

Radio frequency (RF) interference can be even more deleterious to the signal, and can come from a variety of sources. The 802.11b sets the standard for wireless networking in the 2.4GHz radio spectrum. This spectrum is known as the ISM (Industrial, Scientific and Medical). This means that there are a host of other devices that can radiate radio signals on the same frequency as your 802.11b networking devices. In addition, other 802.11b networks in close proximity can interfere with your network. The types of devices most likely to cause interference are wireless telephones, commercial microwave ovens and Bluetooth devices. Basically, 802.11 devices use a "Carrier Sense Multiple Access / Collision Avoidance" (CSMA/CA) technique when transmitting a packet. This means that they will only transmit when no other device is transmitting. If a device sees another signal, it will wait for that signal to end before attempting to transmit its packet. If there is another signal of sufficient strength on the 2.4GHz band, an 802.11 device may see it as another 802.11 device and delay transmission waiting for it to go away. Also, since these other radiation sources are not necessarily participating in the protocol, they can start at any time and interfere with a packet being transmitted. This will result in a corrupted packet and a subsequent retransmission. Delays and retransmissions result in poor performance. If the source of the interference is strong enough and continuous, it can completely shut down the network.

Frequency Congestion

802.11b devices share the 2.4GHz frequency spectrum with a bewildering number of other radiation sources. The spectrum was originally designated as experimental and its primary usage was granted

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to amateur radio. ISM and RF devices were allowed to use the band under specific rules governing power output and non-interference. RF devices such as 802.11b must operate at low power levels, must accept interference from other sources, and may not interfere with the primary user. As the number of 802.11b implementations increases, so will the opportunities for interference with other users.

Technology companies are constantly working to develop signaling strategies to minimize interference between 802.11b and other RF devices in the band, but there are theoretical limits to how far they can go. The current 802.11b standard allows for 3 channels to operate simultaneously within the spectrum. In a multi tenant building, this may be inadequate for the demand. 802.11b may well become a victim of its own success.

In a case where multiple 802.11b system cannot coexist comfortably, one system might attempt to overpower another with a stronger and quite possibly illegal signal. In a worst-case scenario, if 802.11b signals become strong enough to interfere with amateur radio signals, the amateur radio enthusiasts could file a complaint with the FCC and shut down the 802.11b source. One such complaint was filed recently against a Wireless Internet Service Provider in Dallas. The company went out of business before any action was initiated, but it sets a precedent for future action.

In addition to the existing RF devices that can cause interference, there is a new technology that could have a serious impact on frequency congestion. This technology is called RF Lighting. In RF Lighting, a bulb containing a mixture of argon and sulphur is exposed to a high frequency RF signal causing it to fluoresce brightly. This technology promises low energy, high output, and long life. It also operates in the 2.4GHz band, and may promise additional challenges for 802.11b users.

III. Summary

When considering wireless networking as a part of your IT infrastructure, keep in mind some of the issues raised in this paper. Even before a detailed site survey, you should evaluate your physical location and structure in terms of "line of sight" radio signaling. Look for the presence of RF interference sources such as 2.4GHz cordless telephones and commercial microwave ovens. If occupying a multi tenant building,

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check with your neighbors to see if they are using wireless technology, and if they are willing to cooperate on channel selection.

Being aware of these factors and their impact on performance should be an important part of the decision as to whether or not wireless is good for you. If you get to the point of performing a survey, do not be hasty in assigning blame to any one factor without research. Resist the urge to economize by stretching the limits of the technology. Be realistic in your bandwidth expectations, and in your minimum bandwidth requirements.

"…wireless technology has a place in the future and with proper planning can be safely and economically implemented."

No one really knows for sure what direction the technology might take, and what forces will eventually shape the outcome. There are those that believe that the market will prevail, and as frequency congestion occurs in the 802.11b band, companies will migrate to the 802.11a band. This will solve the congestion problem, but at a significant cost since it will require replacement of both access points and wireless network interface cards, and may force some redesign because of smaller distance limitations. The FCC could weigh in on the problem, but "the genie is already out of the bottle" and there is little they could do. Whatever the outcome, wireless technology has a place in the future and with proper planning can be safely and economically implemented.

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