



Maximizing Range and Performance with Smart Antennas

White Paper

Introduction

The need for better wireless coverage in home networks continues to grow. Wi-Fi is getting adopted into more devices, including cordless phones, media adapters and gaming devices. Yet while video content offerings through the Internet are becoming more commonplace, current consumer products still do not offer adequate coverage even for data applications. Dead zones and spotty coverage are commonplace and data transfer speeds are generally not sufficient for enjoying Internet delivered audio or video content on home entertainment systems in all parts of the home.

There are basically only two ways to improve the data transfer speed in wireless networks:

- Improve the efficiency of encoding the data on the wireless carrier signal, or
- Reduce the need to re-transmit the same data to make up for poor reception

Improving the encoding efficiency requires a change in the protocol standard, as was the case when the industry transitioned from 802.11b to 802.11g/a. Another effort is on the way in the form of the 802.11n standard, the first draft of which was approved by the IEEE in January 2006.

However, there remains a fundamental relationship between the quality of the wireless signal – the Signal-to-Noise Ratio, or SNR – and the amount of information any signal can carry. More efficient encoding requires better signals. Better signal is also the only avenue to reducing the need for re-transmitting information. Consequently, improving a Wi-Fi systems coverage and speed ultimately comes down to improving signal quality.

Most device manufacturers have been striving for better signal quality by gradually increasing transmit power and receive sensitivity in their products. This can be done by improving chipsets and adding power amplifiers on the transmit side and low-noise amplifiers on the receive side of devices. This not only adds cost, as can be seen in some of the more expensive router and gateway devices, but many are also bumping up against the maximum power regulated by authorities for use in non-licensed bandwidth.

The Smart Way to Wireless

There is another, very effective and inexpensive way of improving the signal quality: It is possible to design antennas that transmit most of the available power in one specific direction. These antennas can also receive the signals from that direction much better than from other directions. Now imagine a device with multiple directional antennas which automatically selects the one direction that is optimized for each data transmission. This is what a Smart Antenna is all about.

Using Smart Antennas to improve signal quality is inexpensive and can be combined with all of the other above mentioned ways of improving data transfer speed. They can be used with any of the IEEE Wi-Fi protocols, including next generation 802.11n platforms which may utilize multiple radio transmitters. Smart Antennas are additive to any improvement provided at the chipset level or through the addition of amplifiers,

and also offer additional benefits such as reducing interference to and from neighboring networks and decreased sensitivity to device location.

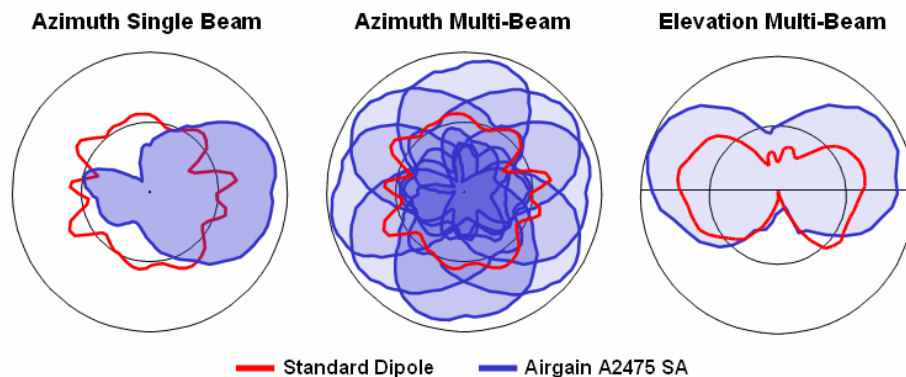
Enter Airgain. Airgain's innovative and patented Smart Antenna solutions deliver superior range and throughput improvements at cost effective price points designed to provide increased wireless performance for the broader residential market.

Coverage. Performance. Smart.

At the heart of Airgain's technology is a very effective and inexpensive way to focus radio wave energy and to point this focused "beam" in a chosen direction. This focused energy is then harnessed to improve data communication in wireless networks through a set of proprietary algorithms implemented in software and firmware that can greatly enhance the range and data throughput performance versus conventional solutions. All of the algorithms operate within the standardized protocols for 802.11 networks and are therefore fully compatible with existing products on the market.

Traditional antenna solutions such as the dipoles used on most wireless router and residential gateway products radiate transmitted energy into a fixed antenna gain pattern that in most cases is omni-directional in shape. Transmitted power in the horizontal plane is more or less equal in all directions, and in the vertical direction is shaped like a doughnut. The unprecedented antenna gain and coverage pattern of Airgain's antennas is based on combining the benefits of directional antennas with self-adaptive automatic antenna switching.

Figure 1: Airgain Smart Antenna versus Standard Dipole



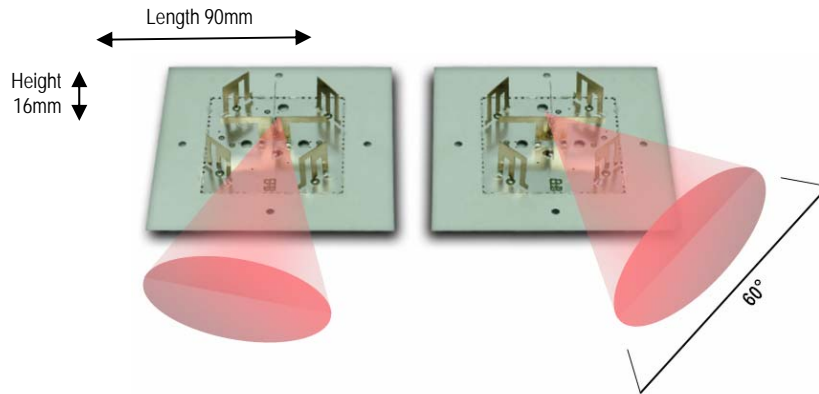
The Airgain smart antenna control function frequently measures the signal quality achieved by using every possible antenna element combination. It then selects the one of several possible antenna configurations that provides the best connection to the selected communication partner at any time. Our patented antenna tuning process is very rapid and is applied automatically both to receiving and transmitting functions. This same control method can be used with many different physical antenna configurations, and allows Airgain to achieve greater performance and cost efficiencies than conventional solutions.

Maximize Range and Throughput

Using smart antennas in WLAN devices improves both the sensitivity of the unit for received signals and increases the effective power of the signals the device transmits. This improved sensitivity and power provide benefits in terms of greater range, increased data transfer speeds, or a combination of the two.

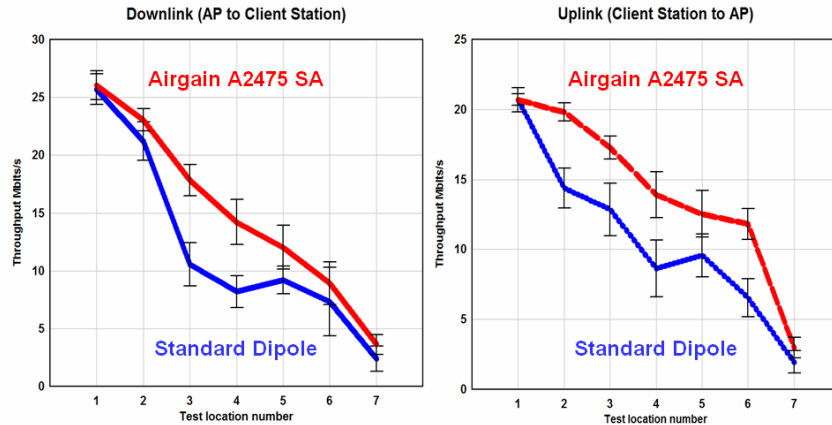
The first implementation of our unique smart antenna solution is the Airgain A2475 Ministar Smart Antenna (See Figure 2). The A2475 smart antenna features 15 individual antenna directions which provide up to 7dBi of peak antenna gain. It utilizes our patented beam forming technology to deliver up to 300 percent greater signal strength than a standard 2.15dBi dipole antenna and has been designed from the ground up to provide superior horizontal and vertical coverage optimized for use in multi-story homes and offices. Its unique design also allows for integration inside most wireless access points, routers and gateways, eliminating the need for external antenna ports.

Figure 2: Airgain A2475 Smart Antenna



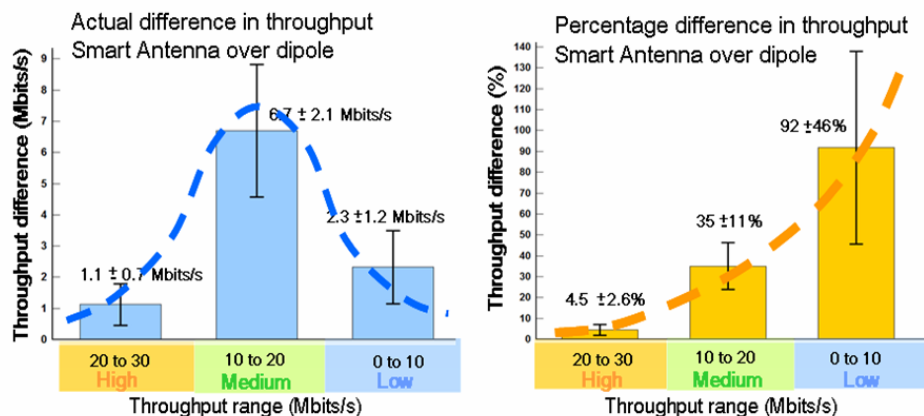
In a residential comparison test between an access point using a standard dipole and the same device using the Airgain A2475 Smart Antenna, the smart antenna increased the signal strength by several decibels (dB) and provided the same signal strength level 40 to 80 percent further from the source than the omnidirectional dipole antenna. Given that better signal strength results in fewer errors in decoding and enables the use of higher performance encoding algorithms, the improvement in signal strength results in higher data throughput. And since the increase in signal occurs during transmit and receive, this translates into higher throughput in both the downlink and uplink and into greater range for connectivity.

Figure 3: Throughput Comparison of Airgain A2475 SA versus Standard Dipole



Another way to define the benefit is to break down the results into three performance categories: High throughput, or speeds of 20-30 mbps, Medium throughput (10-20 mbps) and Low throughput (0-10mbps). Utilizing a statistically significant number of measurements in each category (95% confidence), the Airgain A2475 Smart Antenna generated up to 6.7 mbps greater throughput at mid-range speeds and up to 90% higher throughput in areas with lower signal strength. (For more information on appropriate testing methods for wireless devices and on the tests that produced these results, please visit our support page at www.airgain.com.)

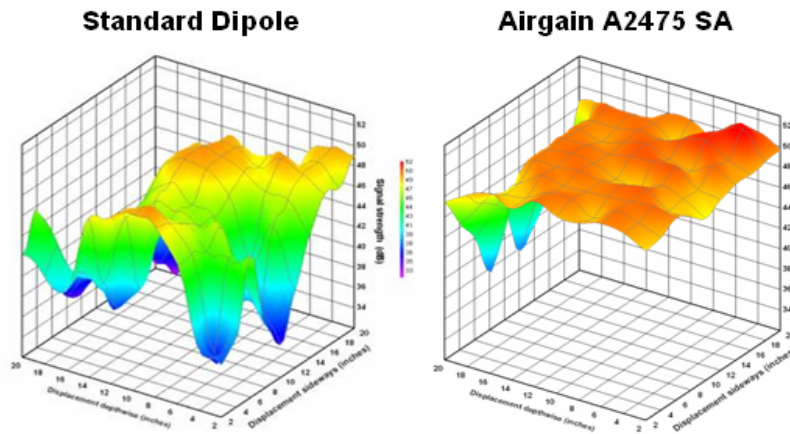
Figure 4: % Throughput Comparison (Airgain A2475 versus Standard Dipole)



Consistent and More Stable Connection

The benefits of our rapidly switched smart antenna extend beyond increased range and throughput. The automatic control of the directional beams reduces variations in the signal strength, resulting in significantly greater availability of consistently high data rate communications between WLAN devices. In comparison tests against a standard dipole antenna, a wireless gateway equipped with the A2475 smart antenna has been show to reduce spatial variations in the signal-to-noise ratio (SNR) by up to 4dB.

Figure 5: SNR Spatial Variation Comparison



The directional nature of the antenna signal also reduces radiation transmitted to unwanted directions and lowers the sensitivity to receiving interference from other directions. As a result, it dramatically reduces cross channel interference in dense deployments of WLAN networks, for example in multi-dwelling buildings with high adoption rates of wireless routers and gateways.

About Airgain

Airgain is a leading provider of cost-effective smart antenna solutions for the WLAN market that deliver dramatic improvements in range and throughput. Our smart antennas can be steered electronically at very high switching speeds, greatly enhancing the performance of home or enterprise WLAN systems and emerging quality of service and VoIP applications. Airgain supplies its smart antenna solutions to original equipment and design manufacturers worldwide. The company's main office is in Carlsbad, California, with a research center located in St. Petersburg, Russia. For more information, visit Airgain on the Web at www.airgain.com.

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