

The Ultimate Solution For Metro and Rural Wi-Fi

Wavion White Paper
April 2008



Executive summary

The current generation of conventional Wi-Fi metro access points use commoditized chipsets originally designed specifically for indoor environments. When brought to an outdoor environment, these access points suffer from limitations in range and capacity.

Wavion's spatially adaptive beamforming technology is designed specifically to address the shortcomings of current outdoor metro Wi-Fi networks. This multiple-antenna technology addresses limitations in coverage, penetration, and capacity of existing Wi-Fi technology.

Wavion provides a highly cost effective Wi-Fi solution for outdoor metropolitan deployments, offering uniform coverage with a third of the number of base stations typically required for such installation. The low number of base stations can be translated to over 50% savings in both the initial infrastructure investment (CAPEX) and ongoing maintenance costs (OPEX).

Outdoor Wi-Fi challenges

Wi-Fi solutions started as an indoor application, where a single or multiple access points were required to provide indoor coverage for a residence or business.

The current generation of conventional Wi-Fi metro access points use commoditized chipsets originally designed specifically for such indoor environments. When brought to an outdoor environment, these access points suffer from limitations in range and capacity. In addition, the indoor chipsets were not designed to handle multipath propagation and high levels of interference that are often found in high density metro settings. The result is a low quality network with spotty coverage and limited capacity. Providing wide-area coverage with these access points is therefore problematic and requires many access points, leading to a very costly infrastructure.

Today's networks are required to handle increasing amounts of traffic and more demanding applications. Like all networks, Wi-Fi networks are required to keep up with the growing demand and rapidly scale in capacity.

In addition, the Wi-Fi 2.4 GHz band is limited in its bandwidth. Hence, intensive use of this band results in a self-interference leading to reduced rates and capacity. Furthermore, low-rate users consume a significant amount of air-time, thereby tying up valuable network capacity.

The success of outdoor Wi-Fi deployments depends on the effective utilization of the available spectrum and the ability to successfully cope with high levels of interference and noise.

Outdoor Wi-Fi requirements

The challenging outdoor metro environment requires a bottom-up design tailored to meeting the specific requirements that this environment poses. Following are the key factors characterizing the outdoor environment and influencing the Wi-Fi performance:

Range: Outdoor environments are characterized by large coverage requirements, in the order of hundreds of meters. Indoor environments are much smaller, with typical coverage requirements of few tens of meters.

Interference & noise: Outdoor environments suffer from a high level of interferences that reach the Wi-Fi base station, and needs to be mitigated. Indoor environments are, by nature, more immune to interferences due to walls separating the access points.

Uniform coverage: Outdoor access points need to provide coverage to a large and diverse area without dead spots. Indoor access points provide the connectivity to a small area in a closed environment

Indoor penetration: While indoor access points provide coverage within a facility or residence, outdoor access points need to provide indoor coverage from the outside of the building.

The solution

In order to create an effective outdoor metro Wi-Fi solution, it is necessary to abandon the current technology base. The single omni-directional antenna transmission and reception is unable to provide an adequate answer. The right solution is based on a multiple- antenna technology that can focus the Wi-Fi signal to the user location, This technology is able to cope better with the multipath and interference challenges of the outdoor environment.

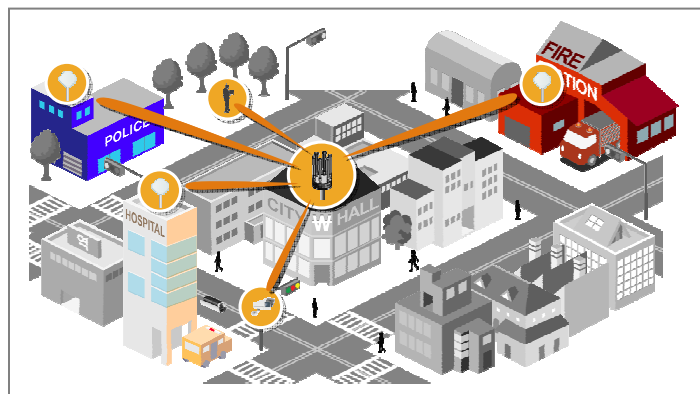


Figure 1 - Directional beamforming

Wavion's spatially adaptive beamforming

Wavion's spatially adaptive beamforming focuses energy to and from the user on a per-packet basis, in both receive and transmit. The technology is able to exploit the different propagation paths – “multipath” – to and from the user, by assuring that the signals in all the different paths combine coherently regardless of electromagnetic environment changes (see Figure 2).

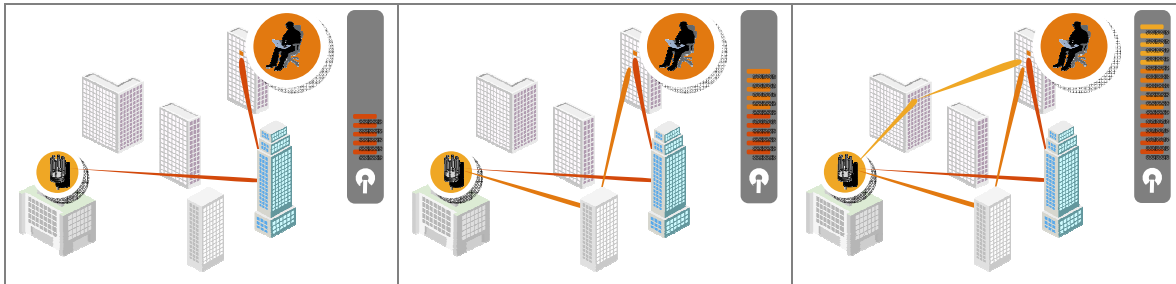


Figure 2 - Beamforming exploiting multipath propagation to increase signal strength

This focusing process increases significantly the link gain and consequently the range of the access point. The ability of beamforming to exploit multipath, rather than suffer from it, significantly enhances the coverage quality in non-line-of-sight conditions.

Dead spots are one of the key problems plaguing current Wi-Fi metro deployments. Since the spatially adaptive beamforming technology excels in non-line-of-site conditions, it provides uniform coverage with very few dead spots. Beamforming also provides significant interference resilience, due to the inherent directivity of the focusing process, and much better mobility support.

Further, the improved link gain enables much better indoor penetration, thus reducing the need for specialized customer premises equipment (CPE), a major cost for service providers which can ruin the cost and support structure of metro Wi-Fi networks deployment.

Beamforming benefits

Coverage

The coverage area provided by Wavion's technology is two to three times that of conventional Wi-Fi Access Points. Superior range and uniform coverage means that the network can be scaled to reach a larger group of users, which can yield higher subscriber revenues at lower costs.

Wavion's technology provides users with a powerful, high quality signal that is not dependent on line-of-sight positioning, and is highly resistant to interference. This results in a much improved uniform coverage with far fewer dead spots that allows users to get stronger connections with fewer re-associations while moving.

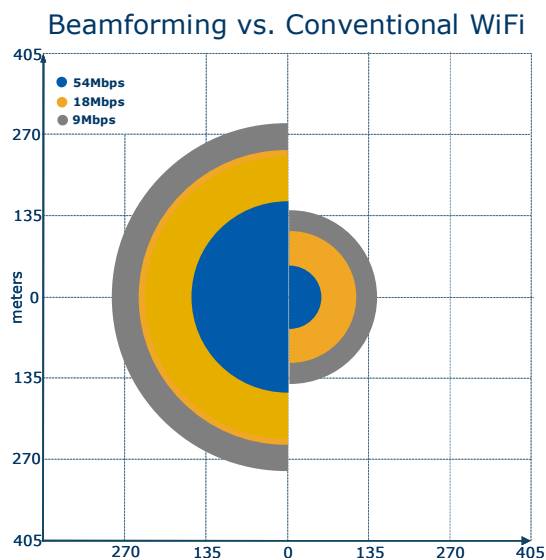


Figure 3 - Range and capacity comparison

Capacity

The spatially adaptive beamforming technology improves the link budget, thus significantly increasing the throughput of the clients and thereby the network capacity. The occasional fades of the links are also reduced, thus providing further improvement to the effective capacity.

This capacity increase allows the operator to offer higher grade of service to clients, as well as increasing the number of clients that can be served per base station.

Figure 3 compares the performance of Wavion's beamforming technology in terms of range and throughput with the performance of a traditional access point.

Indoor penetration

Indoor penetration depends on the link budget and the ability to cope with multipath and signal reflections. Since the spatially adaptive beamforming technology has a significant link budget advantage and exploits multipath to its advantage, it has a superior penetration of buildings and walls compared to any conventional access point. This enables network operators to offer access in residences and in businesses. In addition, deeper indoor penetration makes self-install service a reality by reducing the need for separate outdoor CPEs.

Interference resilience

Wavion's base station has built in advanced mechanisms for interference resilience. The beamforming technology provides resilience by focusing the antenna beam on the client, and thus reducing the level of the interference. Another mechanism is the Dynamic Interference Handling (DIH) which optimizes the air-interface for maximum throughput in severe interference conditions. These two mechanisms minimize the effect that interference may have on the performance in terms of capacity and coverage.

Off-the-shelf clients

Wavion's beamforming technology works with low cost, off-the-shelf 802.11b/g clients. These low-cost clients will dominate the market for many years to come. The high quality Wi-Fi solution provided by Wavion's beamforming technology with these low-cost clients outperforms even the future 802.11n based solutions with their dedicated and more expensive 802.11n clients..

The Wavion solution

Spatially adaptive beamforming technology is the right solution for outdoor metro Wi-Fi infrastructure. Wavion is the first company to successfully utilize beamforming technology for standard off-the-shelf Wi-Fi clients.

It is based on a custom-made application-specific integrated circuit (ASIC) and embedded software designed specifically to address the challenges a Wi-Fi base station faces in the outdoor metro environment. Leveraging six antennas and six radios, it



**Figure 4 - WBS-2400
Wi-Fi base station**

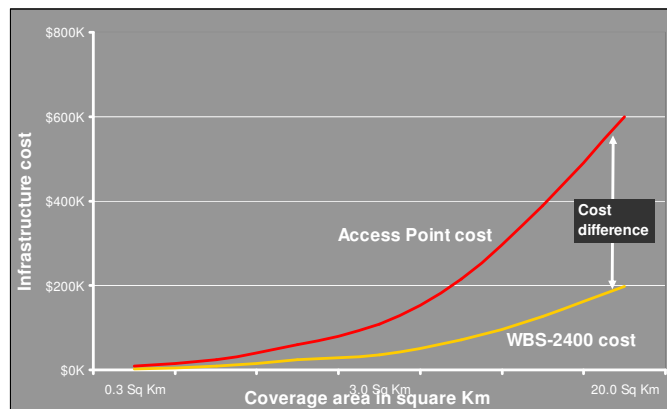
focuses the energy to and from the user on a per-packet basis in both receive and transmit, This extends the range, improves the quality of the link, and provides interference resilience. It is done by exploiting the different propagation paths (multipath) to and from the user and assuring that the signals in all different paths combine coherently regardless of electromagnetic changes, moving objects and other environmental factors.

Wavion's WBS-2400 base stations provide significant performance advantages over current 802.11 Wi-Fi solutions (802.11b, g or even n).

Wavion's outdoor and metro Wi-Fi business case

The technological benefits of Wavion's WBS-2400 base station are easily translated to a profitable business case for outdoor metro Wi-Fi deployments.

The range and capacity gains of beamforming enable the operator to reduce the number of base stations to a third of number typically deployed for metro infrastructure. This reduction does not compromise the quality. On the contrary, with Wavion's WBS-2400 base station and beamforming technology, the quality of the network is significantly improved.



The incentive of using a Wi-Fi infrastructure, as compared to other wireless infrastructure, is very clear. The low-cost off-the-shelf Wi-Fi clients can be found in virtually every computer and laptop. This creates an immediate client base, which does not require any further installation for providing the Wi-Fi service.

Current Wi-Fi infrastructure solutions are costly to install, operate and maintain. As a result they have difficulty in providing investors with a return on their investment. Wavion's solution greatly improves the ROI for metro Wi-Fi deployments. The low number of base stations can be translated to over 50% savings in both the initial infrastructure investment (CAPEX) and ongoing maintenance costs (OPEX).

Wavion Ltd.

6 Ha'yetsira Street PO Box 580
Yoqne'am-Illit 20692 Israel
Phone: +972.4.909.7300 Fax: +972.4.909.7322

www.wavionnetworks.com

© wavion 2008