Maximizing Performance using 3.5 GHz Fixed Wireless Broadband — Three Global Case Studies

How to optimize antenna beamwidth and sidelobe management

ALPHA WIRELESS

Closing the digital divide with 3.5 GHz

The gold standard in wireless communications today is to provide fast, quality broadband service to everyone, especially in preparation for 5G and the continuing explosion of IoT devices. However, interference has emerged as a limiting factor in congested areas that have competing signals from a large number of overlapping sectors and competing operators. Interference can also be an issue in thinly-covered areas within a single carrier's network.

With the availability of 3.5 GHz spectrum worldwide, and more recently CBRS in the U.S., operators have an unprecedented opportunity to deliver broadband to previously underserved areas. New operators are building networks in the 3.5 GHz spectrum, and existing operators are expanding networks in rural locations as well as congested urban areas.

New technology calls for innovative solutions

Wireless operators constantly face the challenge of reducing costs, improving performance and increasing capacity. This is especially true with 5G fixed wireless broadband. It presents unique challenges. You likely deal with multiple carriers, geographic and manmade obstacles, concealment issues, and the interference concerns that greater RF density can cause due to unwanted RF coverage overlap.

There are a number of ways to build an effective 3.5 GHz network business case, from cell splitting and frequency reuse changes, to deploying additional spectrum and creating sector splits. Each solution has benefits and drawbacks. Cost is typically critical in fixed wireless access (FWA) networks, so building smart is important for profitability.

The decisions you're making now have a tremendous effect on your initial costs, but also affect the ongoing operational costs that impact your network's profitability.

Building a new site is more expensive than upgrading an existing site, but not all enhanced technologies are economically viable. Some technology features are better suited for mobile wireless applications, while others work best for FWA. Some costs are up-front and others emerge during operation.

The decisions you're making now have a tremendous effect on your initial costs, but also affect the ongoing operational costs that impact your network's profitability.

Reducing interference is the key to higher performance

A major issue for wireless operators is combatting RF interference to enable faster and better-quality broadband. Fast, reliable service drives customer satisfaction, a larger customer base and higher profitability. Yet modern networks involve increased node density, a greater overlap in signals and unwanted interference that erodes service levels.

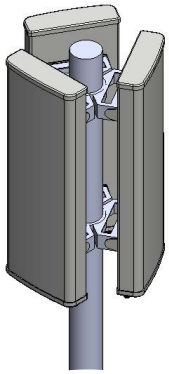
One of the best ways to control interference is using high-performance antennas that minimize side lobe RF energy and reduce beamwidth. Most FWA networks are extremely cost-sensitive, so expert network engineering is critical for selecting optimum configurations, minimizing costs and maximizing profitability.

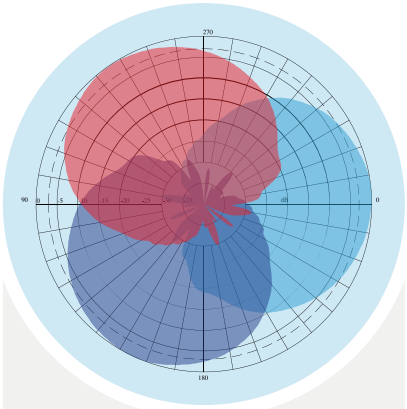
The solution explained

Traditionally, cell sites are constructed using three sectors of antennas that have a horizontal beamwidth of 65 degrees. This provides for broad effective coverage, but because of the large energy overlap from one antenna to others, capacity efficiency drops.

Converting from 65-degree beamwidths to 33-degree beamwidths greatly reduces the energy overlap (Sector Power Ratio). However, this type of implementation requires installation of three additional antennas, adding cost and weight to already heavily loaded towers or rooftops.

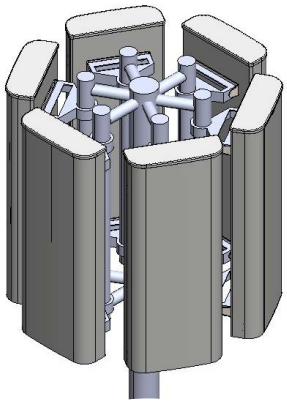
Alpha Wireless' innovative advanced antenna technology provides maximum capacity efficiency and often antenna count reduction. These technologies decrease interference. They also provide options for single-beam 4x4 MIMO per sector face and dual-beam support of 2x2 MIMO per beam. Dual-beam support enables operators to increase capacity while lowering or zeroing leasing costs.

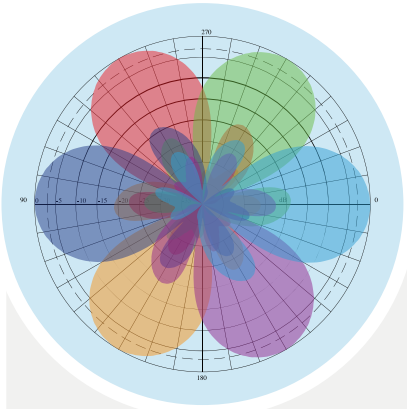




Traditional three-sector

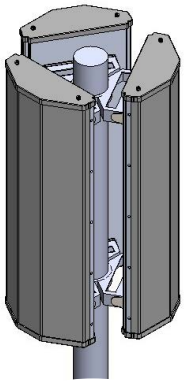
A common deployment is three sectors using 65-degree antennas. In fixed wireless networks, the overlap area can reduce CINR levels and limit download speeds.

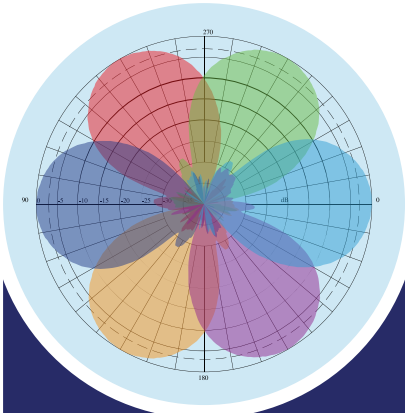




Conversion to a six-sector site

This is a six-sector site where the 65-degree sector is split into two 33-degree sectors. In theory this format doubles users compared to the 65-degree sector. The overlap is much less, which is good for FWA. Typical 33-degree antennas have issues with the azimuth sidelobes. For a house located within an unwanted sidelobe, CINR declines, limiting downloads.





Alpha Wireless' solution

A six-sector site has the advantages of 33-degree beamwidths with the removal of the azimuth side lobes. This enables the operator to offer high download rates no matter where customers are located around the cell tower.

Choosing the right antenna makes all the difference

For operators to cost-effectively provide fast, high-quality broadband service, it is important to design the network for the 3.5 GHz environment. Reducing beamwidth and using the proper antenna configuration will limit sidelobe interference, which may reduce installation costs by decreasing node count. Doing this may avoid early rip and replacement of costly equipment.

In this white paper, we evaluate three recent 3.5 GHz installations. Each faced similar challenges, and each resolved them in collaboration with Alpha Wireless experts using the company's innovative antenna designs. Beyond solving a single issue on a particular network segment, the experience changed the operators' operations going forward.

An Australian operator achieved an 18-20 percent increase in downlink speeds and 2.7 dB to nearly 6 dB gain in carrier-to-noise and interference ratio (CINR) across three different trial markets.

An Irish operator improved network performance more than 15.5 percent across customer premise equipment (CPE) metrics, and overall signal strength increased by 5.1 dB when compared to the soft split design.

A Canadian operator increased average CINR by 3.2 dB, and 42 percent of user equipment (UE) experienced 3 dB to more than 6 dB CINR in performance gains.

An Australian operator seeks better coverage and improved customer experience

The challenge

Tasked with providing broadband internet access across the country, an Australian-government-owned operator wanted to enhance coverage to create better customer experiences. One of the issues was poor sector throughput due to high co-channel interference.

It turned out that azimuth sidelobes from antennas in adjacent sectors were creating interference. A low-side-lobe antenna design was the obvious solution - but a technically difficult one to implement.

The solution

Fixed wireless networks require high-performance antennas with clean radiation patterns to minimize interference. The operator needed a fixed-wireless solution that reduced interference, increased network throughput and delivered added capacity.

Alpha Wireless worked closely with the operator to create a new design concept: the AW3711 low-azimuth-sidelobe antenna. Alpha Wireless optimized the antenna for FWA to reduce co-channel interference from adjacent sectors, creating increased spectral efficiency that resulted in higher site capacity.

Within just six months, the product was ready for trial and came through with flying colors. Throughput increased significantly on the trial site and the operator gave the green light to move forward with the product.

The results

The Australian operator measured average Mbps sector throughput in both downlink and uplink, relative change in CINR, received signal level (RSRP) and call-quality index. Deployment of the AW3711 improved all measured metrics relating to interference.

Metrics such as these are important, interrelated benchmarks, but throughput is the most important result because it defines the customer's experience.

Results vary depending on the operator, but network performance improvement such as this can be measured in tens of thousands of dollars in savings and increased profits to the operator due to improved customer experience and retention.

The result for this Australian operator was a new product that improved its network:

- The antenna improved throughput with an 18-20 percent increase in downlink speeds.
- The new antenna was lighter than traditional 33-degree products and the operator decided to use the AW3711 in place of its existing antennas for all future applications.
- Use of the AW3711 decreased costs by reducing the number of sites needed.

The data

Australia Trial Site		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Sector ID	Frequency	Antenna Type		DL UE Thrput (Mbps)		DL Cap (Mbps)		%CQI >= 12		Avg CINR (dB)	
B42_S1	3410 MHz	AW3497	AW3711	35.1	41.5	75	83.1	87.5	94	23.8	26.4
B42_S2	3410 MHz		AW3711	28.9	34.8	75	74.7	64.5	89.9	19	24.6
B42_S3					18%		11%		7%		11%
B42_S4					20%		0%		39%		29%

Australian operator trial sector performance summary shows gains

The increase in CINR resulted in 18 and 20 percent downlink throughput gains.

Australian operator trial sector map shows substantial improvement

Pre- and post-trial results show a substantial increase in CINR for the two sectors - cell one at 2.6 dB and cell two at 5.6 dB. The total number of UEs that showed improved performance due to reduced interference increased dramatically.

Imagine Communications needed to meet its performance targets

The challenge

Imagine's 3.5 GHz TD-LTE Advanced network is supported by over 264 individual high sites, with a highly optimized FWA network design Imagine is able to provide an up to 150Mbps product to up to 420 customers per site providing them a service with the performance they need to achieve average monthly usage in excess of 450GB, higher than many fibre based FTTH and cable networks, proving that an FWA network is more than capable of providing a viable alternative to FTTH and cable networks.

In order to enhance cell performance and maximize capacity, channel reuse on the site was implemented by deploying a new Soft Split feature on its 8T8R RRU. However, inter-cell or intra-site interference caused by side lobes between the Soft Split defined sectors meant that not all targets set for improved performance were met.

The solution

Alpha Wireless collaborated with Imagine Communications to develop a solution to improve this aspect of the performance and enable it to meet its goal for higher capacity. Given that inter-cell or intra-site interference were the main issues, the newly developed AW3711 was selected in the trial for its azimuth side lobe suppression design.

The results

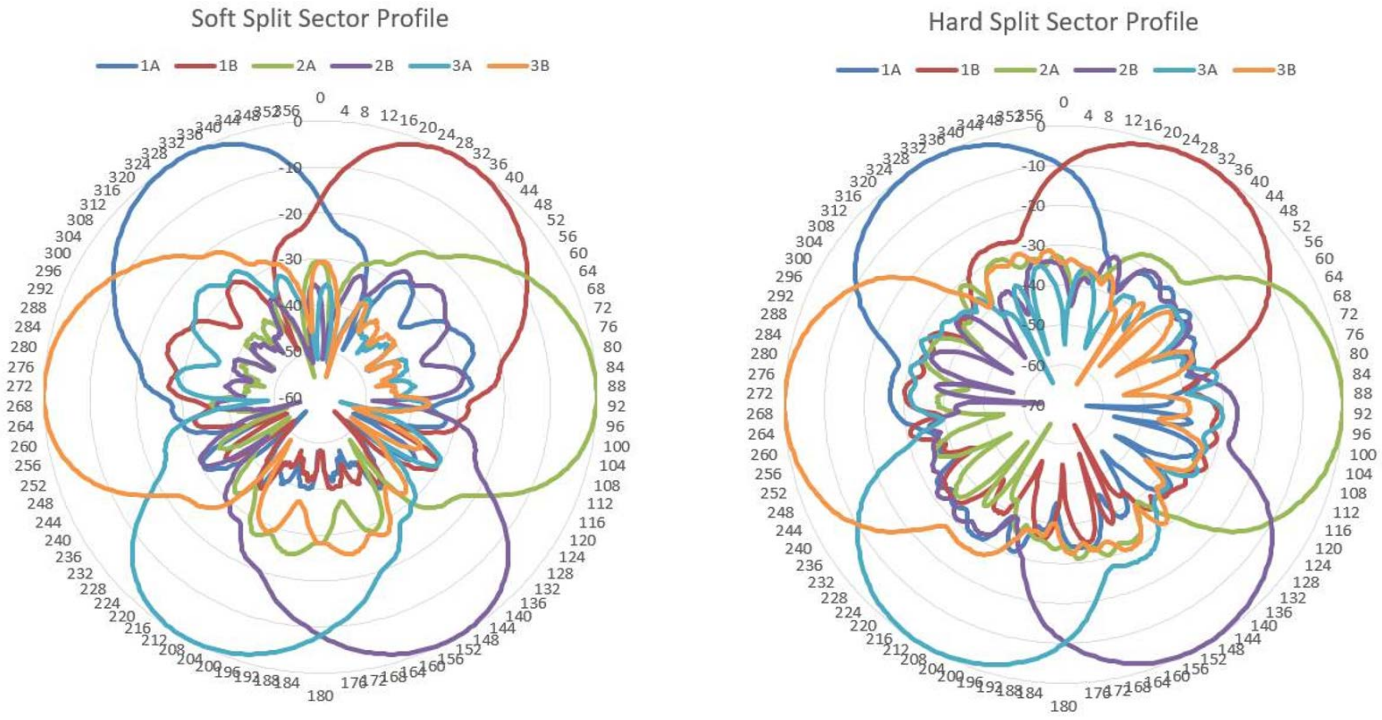
The AW3711 antenna was installed on the existing site with the same center-line in a 6-sector hardware split (6SHDS) design, and the network performance improvement was quickly evident. While a significant number of CPE devices had not previously been meeting the expected performance metrics within the cell coverage area, the introduction of the AW3711 substantially improved that metric.

Using six AW3711 in a 6-sector hardware split (6SHDS) antenna design, network performance improved by more than 15.5% across CPE metrics, and overall signal strength increased by 5.1 dB when compared to the soft split design.

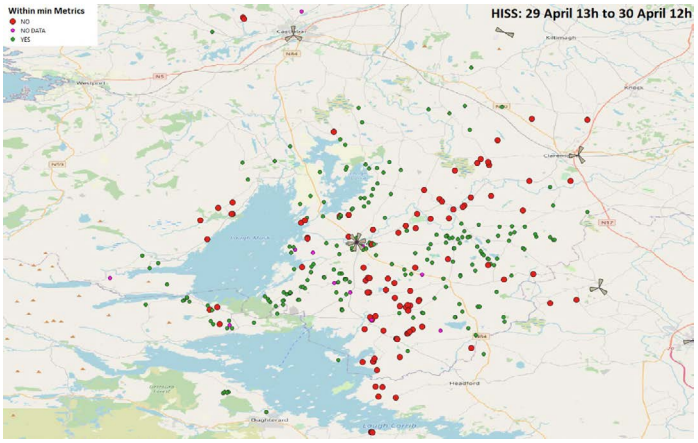
"Alpha Wireless' new narrow beam antennas have enabled us to implement an efficient spectral reuse while also improving network quality. We are still pushing the limits of what we can do with these antennas."

Colin Browne
Head of RF Engineering
Imagine Communications

The data

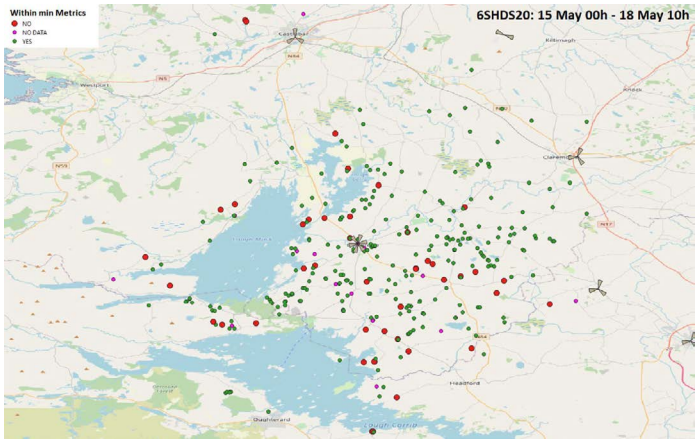


Comparison of antenna profile shows improved sidelobe suppression for each configuration profile



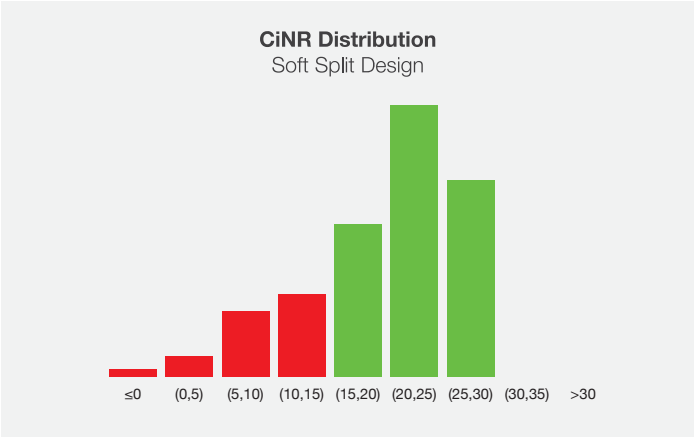
Imagine Communications Trial Sector Geographical Map with SS

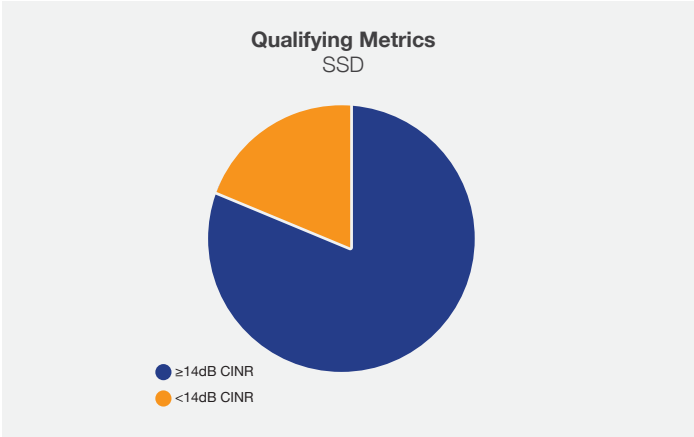
After introduction of the Soft Split feature, the overall CPE devices were not achieving expected performance metrics within the cell coverage area, as shown by the red points.

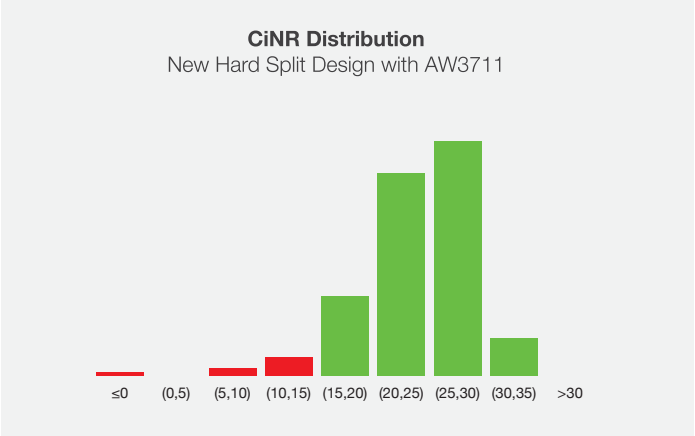


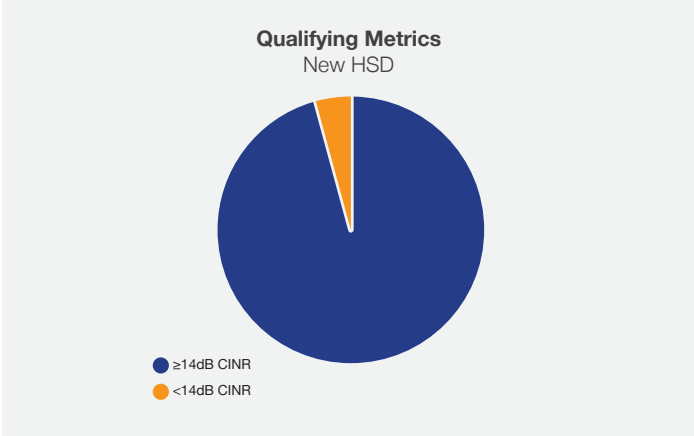
Imagine Communications Trial Sector Geographical Map with 6SHDS

Upon transitioning the trial site to the AW3711 antenna, the overall CPE number of devices meeting expected metrics jumped substantially. Again, as shown by the substantially fewer red points, it is evident how network performance increased.









Imagine Communications Trial Sector CINR Distribution

The pre and post measurements for acceptable CINR Distribution increased substantially as shown in the bar charts below. The target performance CINR Qualifying Metrics pie charts present an improvement in quality which translates to increased down link throughput.

A Canadian operator aims to offer top performance in rural areas

The challenge

As a leading national provider, this Canadian operator was constantly looking to ensure excellent performance throughout its service area. The company offers coverage over a large rural area using satellite and FWA sites.

The operator wanted to increase CINR for individual customers and improve overall cell performance. Its primary metric was its consumer Meaningful Conversation Score (MCS).

The solution

The Canadian operator collaborated with Alpha Wireless to evaluate the performance gains they might achieve with improved side lobe suppression while causing minimal disruption to existing customers.

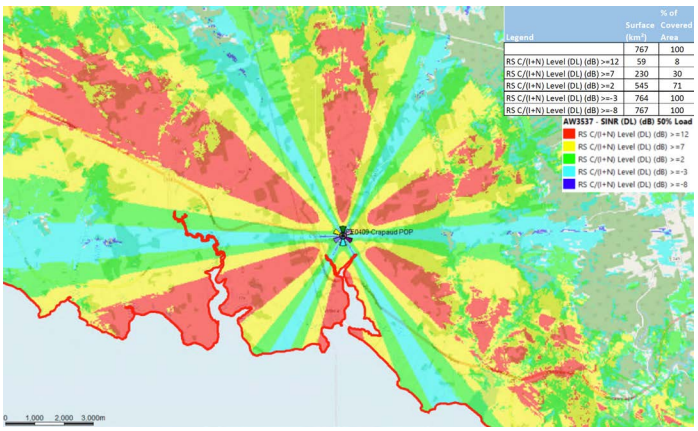
The operator chose a trial site on Prince Edward Island to compare the AW3711 four-port antennas with coverage from an existing dual-beam six-sector configuration.

The results

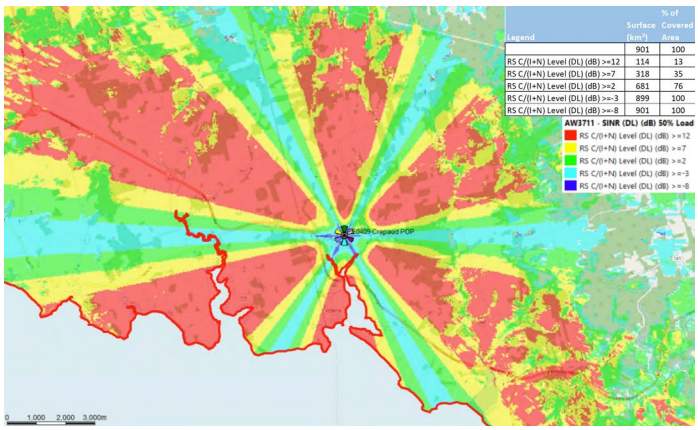
The trial showed the 111 connected CPEs that demonstrated a very notable improvement in CINR, which over time translates to increased MCS ratings. The average delta increased by 3.2 dB in CINR, and 42 percent of UEs experienced 3 dB to more than 6 dB CINR performance gains.

Following the trial, the Canadian operator recommended deployment of the new AW3795 model - an innovative solution based on the AW3711 array, with the difference that it is a dual sector 33-degree model with two ports each, separated at a 60-degree offset.

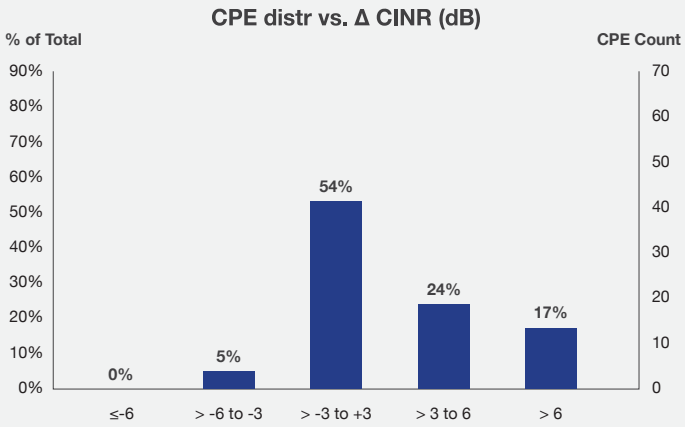
The data



Canadian operator CINR for non-optimized coverage plots



Canadian operator shows marked CINR improvement in optimized coverage plots



Canadian operator trial CINR enhancements show substantial improvement

The bar chart shows substantial increases in post-trial measurements for acceptable CINR distribution. More than 41 percent of users experienced performance increases of more than 3 dB which translates to increased downlink throughput and better service.

In conclusion, RF congestion is not going away

Ongoing management of the RF layer is increasing in importance as broadband demands and thus RF congestion increase. It is critical for operator profitability to make choices when building a network that will stand the test of time. The need for wireless broadband will only increase, so choosing antennas that maintain performance levels and economic viability throughout the life of the network remains an ongoing priority.

As data traffic demands increase and ever-thinning operational margins decrease, it is paramount to preserve wireless network performance through active optimization to yield the best cost per megabit of data served.

Choose an experienced advisor you can trust

Antenna cost is estimated to be only two percent of a cell site construction budget, but that number is deceiving. Choosing the correct antenna array can mean reduced nodes and improved service levels with reduced costs and increased profitability for the operator over the long term.

It is critical to select the right antenna solution for the right application, and that's where expert guidance comes in. Alpha Wireless has more than 15 years experience innovating, building and installing 3.5 GHz networks throughout the world.

Embarking on a new venture with an experienced partner advising you gives you the confidence that you're making the right decisions. We know about concealment, about reducing interference, about the antenna choices that will reduce the number of nodes you need. We also customize when standard solutions won't do. Your network requirements are unique, so we listen and suit our recommendations to your business needs and network topology.

It is undeniable that deployment of well-designed antennas with horizontal and vertical side lobe suppression increase network performance and capacity and improve customer experience. More than ever, the world needs better and faster ways to communicate through improved network coverage and capacity. You can continue to lead the way with Alpha Wireless by your side. We advise, design and deliver.

Glossary

FWA – Fixed wireless access
QAM – Quadrature amplitude modulation
CINR – Carrier to interference and noise ratio
RSRP – Reference signal received power
SISS – Software inter soft split
CPE – Customer premise equipment
MCS – Meaningful conversation score
6SHDS – Six-sector hardware split
V&H Pattern – Vertical (elevation) and horizontal (azimuth) pattern

CONTACT US

Australia
Maser
Unit 9, 15B Rodborough, PO Box 6298,
Frenchs Forest, DC NSW 2086 Australia.
E: info@maser.com.au
P:+61 29452 6062

Europe
Ashgrove Business Centre, Ballybrittas, Portlaoise,
Co. Laois, R32 DTOA, Ireland.
E: sales@alphawireless.com
T: +353 57 8633847

US
7301 W. 129th Street, Suite 150 Overland Park,
KS 66213, USA
E: sales@alphawireless.com
T:+1 913 279 0008

Find out more at www.alphawireless.com

ALPHA
WIRELESS