Antenna quality impacts mobile network performance

Poor quality antennas are now a major limiting factor in the performance of high capacity mobile networks. So why do operators often ignore them?

Customers are demanding more from mobile networks every day, while operators struggle to keep up with this demand. Yet antennas – a low-cost element in the network – can have a significant impact on overall network performance. This White Paper shows that, with correct design and deployment, the right antenna can deliver much improved throughput performance by reducing interference. This can save the operator money, by reducing the number of sites required, and improve customer satisfaction, which directly reduces churn.

In this White Paper

Poor antenna design compromises network performance

For many years, operators and equipment manufacturers have made significant progress in improving the components which make up their wireless networks. However, a major limiting factor of network capacity is the performance of the deployed antennas within the network. This single, vital component can be responsible for significant interference issues in the network, which can in turn limit traffic capacity and maximum throughput.

Deploying poor quality antennas in mobile communications networks can be equated to putting normal road tyres on a Formula 1 car – the vehicle can be driven, but a professional driver will tell you that performance is severely compromised.

This White Paper analyses the costs of deploying a typical site within a network, then shows that antennas account for only a small

Figure 1 – Typical modern roof-top antenna system

compromising on quality is false economy for such a vital network element.

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Antenna cost is a small fraction of lifetime network costs

The cost of deploying a new site into an existing network can be split into two clear elements: firstly, capital expenditure (CapEx) associated with the site build; and secondly, operational expenditure (OpEx) associated with running the site each year. Over a typical 10 year lifetime, the total CapEx and OpEx of a site can be $750,000 – of which less than 1% is associated with the cost of good quality antennas.

Figure 2 shows a typical CapEx breakdown for a new greenfield macro site, designed to provide 2G/3G/LTE wide-area coverage. Note how the antenna purchase cost represents only 3% of the total CapEx budget.

Figure 3 shows a typical OpEx breakdown. While there are no specific OpEx costs associated with antennas, nearly 50% of OpEx is associated with site rental – with many landlords now charging rent per antenna. Any savings that can be made by combining many antennas into one radome (plastic enclosure) will therefore reap significant savings in site rental OpEx, year on year.

Antenna quality is critical in modern networks

Originally, base station sites were designed for a single operating frequency to deliver one service (e.g. GSM). Over the years, operators have been able to add new frequency bands to their base stations, to deliver more capacity for the same service, or to add new services like 3G and LTE. Where the bands are close in the radio spectrum (e.g. 1800 and 2100MHz), a wideband antenna can deliver multiple bands in a single path.

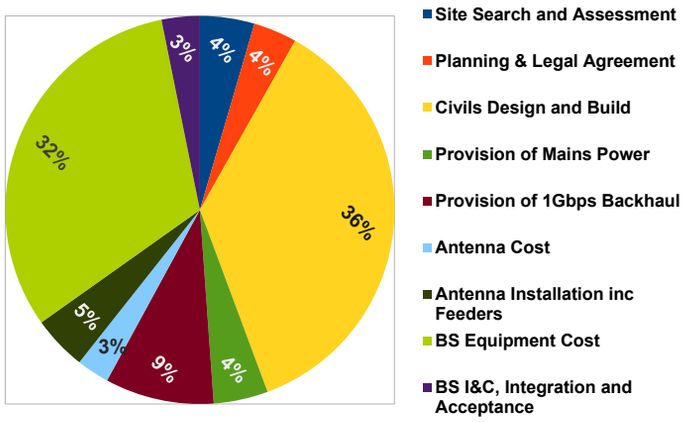

Figure 2 – Breakdown of base station CapEx

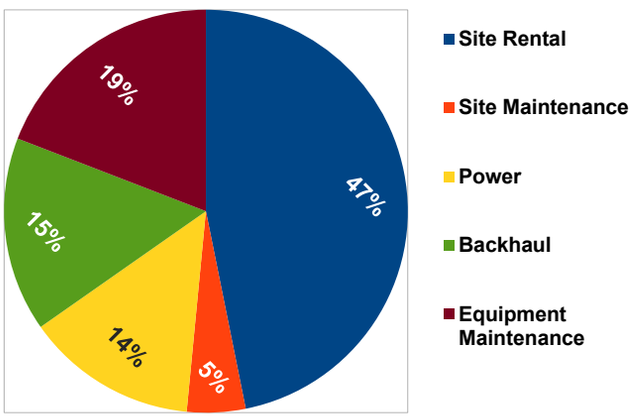

Figure 3 – Breakdown of base station OpEx

For the latest communication standards, such as LTE, antennas need to be able to support multiple input and multiple output (MIMO) capability. This gives rise to what looks like one physical antenna, but is actually a unit packed with technology to deliver a range of services (2G, 3G, LTE) across multiple bands (800, 900, 1800, 2100, 2600MHz).

When considering the deployment of new antennas, an operator needs to ensure that it can maximise capacity throughput per site. It can do this by minimising interference. In tests conducted by one operator [1], it was shown that, by simply changing the antenna to a higher quality unit made by Alpha Wireless, they increased throughput by up to

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30% in areas that had previously suffered high levels of inter-cell interference.

Reducing interference in the network not only improves throughput, it also improves the end customer's satisfaction, and as a result operators can realise a significant reduction in churn.

It is also important to consider the full-life cost of antenna deployment. The cost of installing feeders, mounting brackets, towers, etc., are fixed, irrespective of the quality of the antenna design, so a small variation in antenna costs is negligible when compared to the cost of the site build – as seen in Figure 2. Just as important, any initial cost savings, made by purchasing poor quality antennas, will be wiped out if a site needs to be revisited to change a failed antenna.

Additionally, when considering full-life costs, the energy consumption of the power amplifier is an important element. In modern radio systems the dynamic power control features will automatically turn up the output power in an attempt to overcome interference. This in turn results in higher power draw and increased electricity costs. By reducing interference in the network, an operator can show direct OpEx savings.

How good antenna design reduces interference

As consumers demand more and more from mobile networks – especially in terms of data throughput rates – it is clear that a major limiting factor of network capacity is the performance of the antennas deployed within the network of base stations. It is important to understand why this is, and how the performance of antennas can improve throughput rates.

A major contributor to the performance of mobile networks is the level of interference. Interference comes when signals from different sites get mixed together, making it difficult for the mobile device to work out what is good signal and what is unwanted interference.

In modern networks, operators need to deploy sites close together – sometimes less than 100m apart – in order to deliver sufficient capacity for all users in high-demand areas. But deploying sites closer together means that mobile devices may 'hear' more than one site, and so experience interference.

To minimise interference, operators often down-tilt antennas, to direct the radio signal to a specific local area. This works well to limit interference, but only if the antenna is well designed and has no significant side lobes. Figure 4 illustrates how a poorly designed, 'standard antenna', with significant upper side lobes, increases the level of interference in the next cell, by focusing an unwanted signal into the area, as a direct effect of down-tilting the antenna.

Good design can significantly reduce these side lobes, using a process called 'upper side lobe suppression'. This is reflected in Figure 5, which shows how the 'optimised antenna' has the upper side lobes suppressed. This results in significantly less signal being radiated into the next cell, and hence reduces interference.

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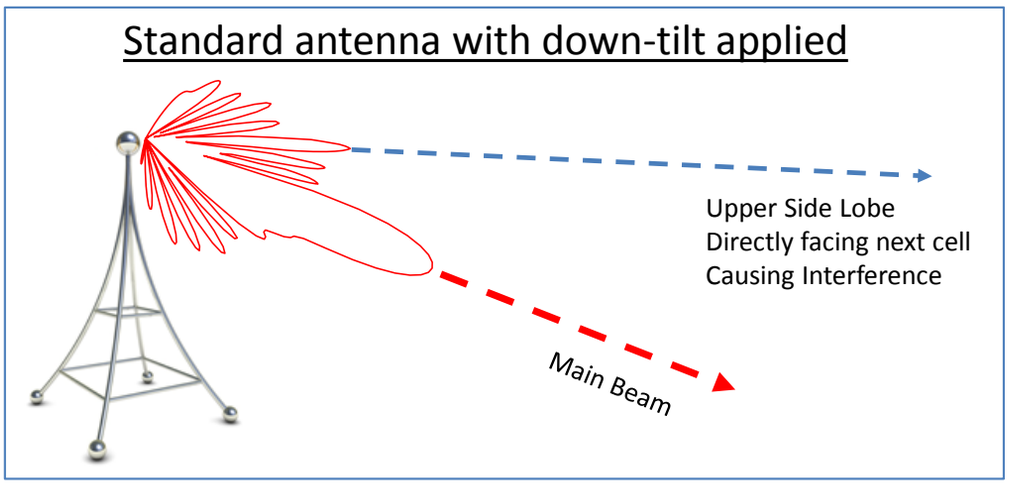

Figure 4 – Effect of upper side lobe causing interference when down-tilt is applied

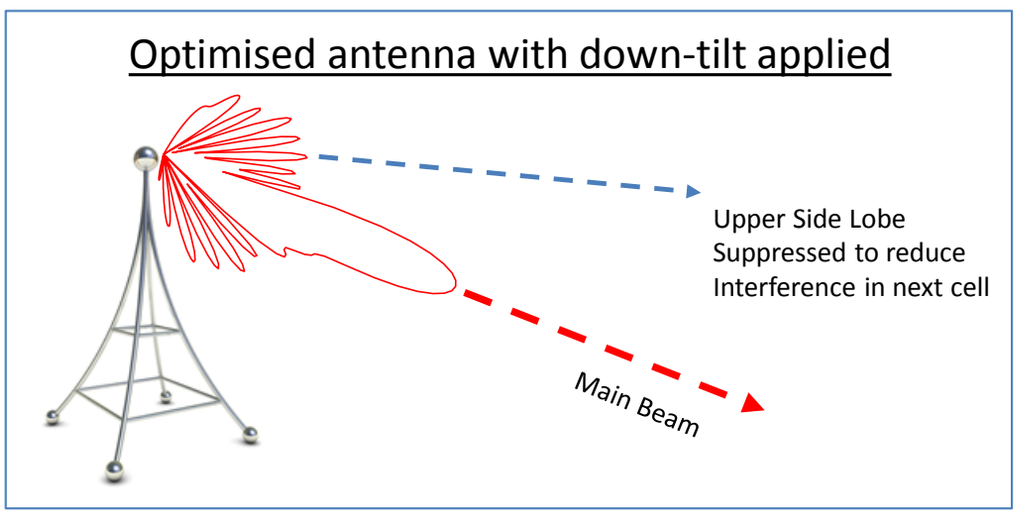

Figure 5 – Effect of upper side lobe suppression which reduces interference

Alpha Wireless delivers superior antenna performance

The ever growing demand for mobile communications, particularly for high speed data services, is driving operators to optimise network performance. Although antennas represent a very low-cost element in a network, they can significantly improve network performance when designed to reduce the effects of interference. Alpha Wireless is proud to develop antenna products which can deliver this superior performance for network operators.

About the author

Paul Jeffery is an independent consultant who has specialised in wireless communications systems for the last 30 years. In that time he has been at the leading edge of deployments in WLL, 2G, 3G, WiMAX and LTE, working for major suppliers like Nortel and Samsung Networks, delivering solutions to global operators such as VF, Telefonica, T-Mobile etc.

[1] *Alpha Wireless Antennas helps Operator increase Sector Capacity (http://alphaantennas.com/resources/)*

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