Choosing the correct base station antenna to minimise interference in a 4G Network

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Network interference is anything which interferes with the integrity of a signal travelling between a transmitter and a receiver. In cellular networks, this can often be caused by frequency reuse, that is the practice of reusing bandwidth across the network. Therefore stray radiation from one cell, can disrupt transmission in other nearby cells using the same frequency. This becomes even more pertinent in LTE networks where a frequency reuse of one is quite common.

Voice is more forgiving than data. But, data corrupted due to interference may have to be re-transmitted, and this puts additional pressure on the network. Studies have predicted a 26X increase in data traffic from 2010-2015. This will put severe strain on networks, so reducing interference so that capacity is not wasted, will become more important.

Badly designed base station antennas are one source of interference.

An antenna radiation pattern describes how an antenna emits radiation. Traditionally, the antenna radiation description is represented by a horizontal and vertical cross-section of this pattern. In addition to the main antenna beam (lobe), the antenna creates some unwanted radiation, in the form of upper sidelobes, lower sidelobes and backlobes. The upper sidelobes are the main source of network interference. One objective of good antenna design is to optimize the radiation pattern and to suppress all upper sidelobes to at least 18dB below peak. Figure 1 shows an example of good and bad upper sidelobe suppression.

How do upper sidelobes contribute to interference? Figure 2 illustrates the problem. The main beam (shown in yellow) defines the cell boundary. Adjusting the downtilt of the antenna increases or decreases the cell boundary. The unwanted upper sidelobes (shown in green) are a known source of interference in cellular networks. When the antenna has no downtilt (main beam pointing at boresight), the upper sidelobes travel upwards and there is little chance of interference. However, when downtilt is applied to the antenna these unwanted upper sidelobes can now be directed towards neighbouring cells which causes interference if the same frequency is being used.
Mentum PLANET is a popular planning and optimization software tool for wireless access networks.

Alpha Wireless used Mentium PLANET to analyze the effects on a network of using antennas with optimized upper sidelobe suppression versus using antennas with typical upper sidelobe suppression. The city of Paris was used as an example of a high density network. Both the downtown and suburban areas were analyzed, and included 809 three-sector sites.

The performance of both antenna types was evaluated by using Mentum PLANET to generate coverage maps of the following performance indicators in both downtown and suburban Paris.

- Receive Signal Receive Power (RSRP)
- Receive Signal Receive Quality (RSRQ) and or Downlink C/(N+I)
- Downlink Average Data Rate

Table 1 summarises the improvement in coverage gain for data rates of <5Mbps and >42Mbps when the antennas with optimized upper sidelobe suppression were used. Improvements of 40-200% were achieved. Significant improvements, which can only lead to greater user satisfaction.

<table>
<thead>
<tr>
<th></th>
<th>Optimized Antenna (non-covered area)</th>
<th>Non-optimized Antenna (non-covered area)</th>
<th>Coverage Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5Mbps Downtown</td>
<td>13.9%</td>
<td>23%</td>
<td>40%</td>
</tr>
<tr>
<td>&gt;42Mbps Downtown</td>
<td>3.8%</td>
<td>2.1%</td>
<td>70%</td>
</tr>
<tr>
<td>&lt;5Mbps Suburban</td>
<td>1.3%</td>
<td>4.5%</td>
<td>70%</td>
</tr>
<tr>
<td>&gt;42Mbps Suburban</td>
<td>6.5%</td>
<td>2.3%</td>
<td>200%</td>
</tr>
</tbody>
</table>


Your base station antenna choice can impact on the efficiency of your network. Inadequate upper sidelobe suppression in an antenna design can lead to increased interference, which can only result in less and more dissatisfied network users. In this study, a large city network was analysed using both optimised and non-optimised antenna parts, and gains in coverage area from 40-200% were achieved using antennas with optimised radiation patterns.