A Guide to Planning Small Cells for Network Densification

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As 5G adoption continues to proliferate, mobile network operators (MNOs) worldwide are focused on providing ubiquitous coverage to ensure the best possible quality of experience (QoE). Yet, in order to meet growing demand for high data throughput and reliable connectivity in densely populated areas, the deployment of multiple cell sites is needed to provide the necessary capacity for high density areas with requirements for high performance peak throughput. This task can be quite challenging and costly when pursuing a traditional macrocell deployment strategy.

To address this challenge, more MNOs are deploying small cell networks to serve dense urban and suburban areas, as well as providing service for large events. Small cells play a critical role in high-traffic areas, helping to fill coverage gaps and boost capacity. This is particularly true in urban settings, where traditional macrocells fall short due to difficulties in site acquisition, space constraints and regulatory hurdles.

These small cells commonly use low-powered 4G and 5G base stations designed to increase localized network capacity and improve coverage. However, with base stations deployed in small cell configurations, there is a risk of overlapping signal interference, which can reduce network capacity and degrade service quality.

Therefore, when planning deployment of small cells for network densification it's important to ensure the highest possible performance and efficient coverage strategy. Broadly speaking, there are three main techniques for maximizing small cell coverage, while minimizing interference and ensuring coexistence with macrocells:

- Optimal site design and radio coverage planning
- Coordination including centralization of baseband processing
- Interference mitigation techniques.

Optimal Site Design and Radio Coverage Planning

When planning site deployments, radio frequency (RF) planning is vital to ensure maximum network performance. Those networks with poorly designed or improperly deployed antennas will experience interference from multiple small cells and mobile devices, degrading network performance, reducing data throughput and resulting in a poor user experience, especially with regard to uplink performance.

In fact, if site planning of small cells is incorrect, it will be impossible for the MNO to deliver the needed high capacity to meet network densification demands from Day One. The repercussions of this issue can lead to excessive radio planning and optimization efforts.

Best practice entails building a network site plan that maximizes small cell radio coverage, minimizes cell interference and enables small cells to co-exist in the macro environment. Choosing the right high-performance antenna design with the appropriate targeted directivity, along with complementing planning and optimization tools and capabilities such as Remote Electrical Tilt, MNOs can reduce interference, optimize signal strength and improve network throughput, ensuring optimum performance.

Coordination and Centralization of Baseband Processing

MNOs may encounter scenarios where there is a significant amount of signal spillover and interference when building out small cells. All too often, the result will be a poor customer experience, with connectivity services becoming spotty or even inaccessible. This can be particularly problematic in high-traffic areas when trying to enhance the upload experience, such as deployments for events, leaving subscribers unable to quickly upload content to social media such as pictures, selfies, videos and other content from their smartphones.

Coordination is a set of radio base station features that group macro and small cell base stations into clusters, turning the interference into useful traffic. The base stations work directly together over fiber optic connections, without the need for additional network elements. One such feature is Uplink Coordinated Multi Point (CoMP), which enables capacity and cell edge gains by mitigating signals and leveraging signal spillover, making sure that valuable baseband resources are not wasted.

This feature is particularly beneficial when combined with Multiple Antenna Aperture Selection (MAAS), also known as four-way RX diversity with Maximum Ratio Combining (MRC), where the base station algorithms support maximizing the output signal-to-noise-ratio (SNR) of the receiver.

Likewise, Centralized RAN offers an approach to optimally coordinate and schedule resources in the baseband processing, thereby improving uplink capacity and performance. When deployed correctly in conjunction with CoMP and MAAS, this approach can double the uplink capacity in existing LTE networks, achieving up to ten times faster uploads at the edge of the cell.

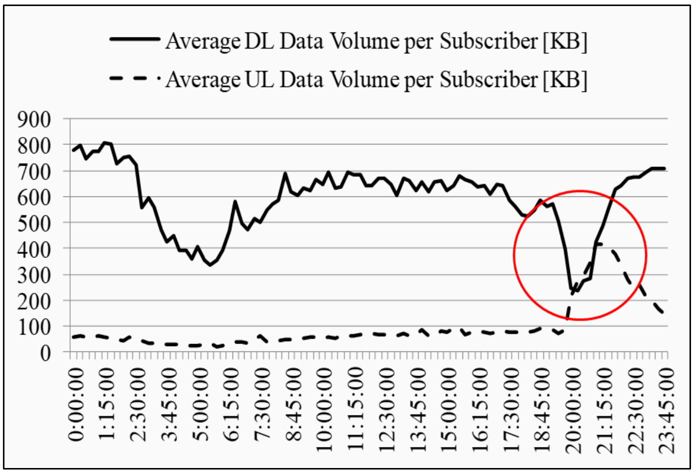

Figure 1: *Traffic profiles can switch dramatically during mass events*

Interference Mitigation in Densified Networks

In addition to the optimal radio planning and site design approach mentioned above, there are many ways to manage interference in converged macro and small cell environments, including mitigation features and techniques.

Features such as Further Enhanced Inter-Cell Interference Coordination (FeICIC) are specifically designed to mitigate interference on the cell edge, which is accomplished by controlling which cells can use the same time slot and frequency simultaneously. This is arguably a coordination feature and provides the most benefit when the traffic load is light. This technique is ideal for small cell sites located within a few hundred meters of each other.

Another feature known as Interference Rejection Combining (IRC) is an efficient alternative to increase uplink bit rates in areas where small cells overlap. Moreover, IRC performs quite well in the presence of radio fading, helping to ensure consistent QoE.

Go Big with Small Cells

With existing mobile network cell sites already saturated in many cities worldwide, the process of 5G network densification is increasingly challenging. In today's competitive landscape, it's critical for MNOs to focus on strategic network design and deployment. This includes careful radio planning together with coordination and interference mitigation to improve uplink performance and ensure that small cells are optimized for peak performance.

With the ability to leverage the latest in high-performance base station antennas together with new advanced features and capabilities, MNOs can vastly improve data throughput and user experience. Careful consideration of these technologies allows full use of spectrum assets to maximize spectral efficiency and deliver the best possible overall service experience, particularly in high-demand environments like urban centers and major events. To learn more, contact our experienced small cell network planning experts.

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