

Antenna digitization: Industry evolution to better CSPs' service monetization in the AI era

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Summary

For communications service providers (CSPs) to deliver their mobile network services to customers in an optimal manner, they must ensure the antennas are adjusted to face the exact coverage area intended. Given that mobile users do not stay in one place, their needs vary with time. However, current wireless networks still rely on fixed cell coverage and cannot dynamically adjust the signal beams, which is a key limiting factor in improving the user experience. This issue is also dynamic and varies with time and geographical location. Furthermore, CSPs should also have access to the antenna orientation and other engineering data in real time.

This article will discuss some of the challenges CSPs face and why the industry should work to standardize and ensure the right ecosystem is in place to enable operators to deploy the next-generation passive antennas known as digital antennas.

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Poor antenna beam orientation will lead to customer dissatisfaction and higher costs

CSPs have benefited from growing mobile data capacities for over a decade, competing by investing in and deploying the next evolution of mobile technologies to deliver more data capacity at stable or reduced prices. This strategy may have now reached its limit; CSPs should no longer expect to be able to prevent churn by offering just larger monthly data bundles, nor will customers feel the benefits of ever-increasing allowances as their data utilization plateaus. Consequently, CSPs will need to develop alternative service-based and experience-based tariffs based on their available network quality of excellence to remain competitive.

Coverage is a key strategic asset for CSPs, and antennas are crucial to deliver this seamlessly—anytime, anywhere. CSPs have relied on passive antennas for decades, and despite the significant prominence of massive MIMO (mMIMO) antennas in the 5G era, their cost, power consumption, limited practicality in low bands, and lack of need in non-dense areas make them unsuitable for all deployment scenarios. Consequently, passive antennas will remain essential for CSP coverage strategies.

Optimized passive antenna orientation delivers twofold advantages: enhanced customer satisfaction through consistent signal strength across the operator's committed coverage areas and reduced capital expenditure by eliminating the need for additional site investments when properly configured existing sites can achieve the required signal quality and coverage.

Furthermore, CSPs have faced prolonged financial pressure due to stagnant or declining average revenue per user (ARPU) while simultaneously requiring substantial capital investments for 5G and 5G-Advanced (5G-A) network deployments. To meet their financial objectives, CSPs must leverage cost optimization as a critical strategic tool.

For years, CSPs in many markets have invested in more efficient multi-port passive antennas as well as green antennas to cut energy consumption to deliver on their sustainability goals. Yet, in the age of artificial intelligence (AI) and automation, the industry has overlooked one critical aspect of the RAN—antenna digitization.

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Digital antennas will improve network quality and monetization

However, CSPs will not be successful in delivering the optimal network coverage necessary for tailoring and monetizing experience-based services without addressing antenna-related challenges.

The main challenge confronting most global CSPs is the lack of accurate antenna orientation information during the entire life cycle, from installation to end-of-life replacement. The issues stem from a lack of precise alignment tools for installers and ongoing monitoring possibilities.

Today, it is possible to remotely adjust antenna beams in one dimension only, the down tilt. However, the same is not true for the horizontal configuration. Additionally, user requirements can vary as mobile users change locations. However, current wireless networks still rely on fixed cell coverage, where signal beams are not dynamically adjusted according to user requirements. This is a key factor limiting user experience improvements. This issue is dynamic and varies with time and geographical location.

Furthermore, installation engineers often rely on basic tools (such as compasses), which can introduce errors of several degrees and result in suboptimal antenna orientation from the initial deployment. This imprecision compromises overall network performance from the outset.

Inadequate antenna orientation causes cell beams to either overlap excessively (generating high-interference zones) or fail to overlap sufficiently (creating coverage gaps). Both scenarios result in performance degradation that prevents customers from receiving high-quality services.

The second challenge for CSPs is their inability to remotely modify existing antenna horizontal orientation. Most antennas have a 7- to 10-year lifespan, and CSPs typically avoid site revisits during this period due to the elevated revisit costs. In some markets, these costs can equal the antenna's purchase price. Consequently, CSPs require remote antenna adjustment capabilities.

Antenna digitalization solves these challenges by providing enhancements to the adjustment dimensions as well as high-precision digital data for both site installers and support teams for remote operations.

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The capability to collect data in real time from tens of thousands of antennas (depending on market size) will substantially enhance network optimization efforts. Automation tools will further expand CSP capabilities, enabling multiple daily antenna adjustments across the entire network to accommodate varying traffic demands during peak and off-peak periods.

Industry collaboration and standardization will improve the ecosystem and deliver CSP benefits

To minimize coverage gaps, network managers and RAN automation tools benefit from additional valuable data points, including precise antenna positioning and elevation at each site through global navigation satellite system (GNSS) receivers mounted on antennas. For instance, cell antennas on rooftops may be positioned at different physical locations across the roof structure compared with the ideal locations found in network planning tools. The elevations may also be different.

Industry standards must facilitate a uniform approach for collecting, storing, and transmitting these data points to CSPs' operations centers across all vendors.

To help the digital antenna ecosystem evolve, CSPs, vendors, and industry bodies (such as NGMN) must collaborate to address 3GPP specification gaps and deliver open, non-proprietary interfaces. This collaboration will facilitate improved integration between RAN vendor solutions and digital antenna vendor solutions, creating a pathway for passive antenna evolution.

Appendix



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