Antenna Monitoring for Programmable Performance

Active monitoring of antenna equipment enables 5G service innovation and digital site operations.

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Digitizing passive antenna infrastructure

Antenna infrastructure deployed on towers and rooftops must survive harsh conditions and operate reliably over a multi-year lifespan. Once installed, the operator will return to the site as infrequently as possible.

In advanced networks, however, where performance depends on precisely located and orientated equipment, there is an increasing need to monitor and control antennas remotely. Antenna monitoring units (AMUs) enable operators to integrate antenna equipment into a programmable operations model.

Importance of actively monitoring antenna hardware

- **Digitize installation and automate inventory.** Typically, the sign-off for an antenna installation relies on manual processes (photos, etc.). With an AMU, key parameters can be remotely checked and approved while the installation team is still onsite.
- **Ensure security and resilience.** Active monitoring allows operators to continuously update inventory systems and network configuration models. More acutely, the increasing focus on security and resiliency creates a need for timely alerts if an antenna has been tampered with or otherwise interfered with.
- **Improve performance through optimal orientation and tilt.** AMUs provide data to the network management systems that drive remote electronic tilt (RET) processes, which ensure antennas remain accurately aligned over time. This helps, for example, to identify and rectify when site maintenance, upgrades, weather, etc., result in misaligned equipment.
- **Enable accurate outdoor positioning and programmable services.** In the programmable network paradigm, rApp control of RET can be used to adjust the antenna direction according to demand density or environmental changes. In the services domain, extremely accurate timing (derived from GPS in the AMU) helps deliver more accurate 5G Advanced outdoor positioning services.

Antenna monitoring functions

The AMU should be aesthetic, easily integrated on top of the antenna, and cost-effective. Ideally deployed at the same time as the antenna system itself, it is an effective way to add digital capability to passive infrastructure. The key functions of an AMU are as follows:

- **Integrated gyroscope.** This enables the AMU to detect changes to mechanical tilt (to ±0.5 degrees) and azimuth (to ±2 degrees). Real-time monitoring can be used to inform RET adjustments to optimize beam direction within the sector.

- **Integrated GNSS (Global Navigation Satellite System) module.** A GPS (typically) module can provide latitude, longitude, and altitude to ±3-meter accuracy. The AMU can be used as a GPS antenna and provides time sync to the site. For security and resiliency, it can alert operators if GPS spoofing or jamming is active in the area.

- **Real-time data feed.** AMUs are a form of "network sensor" that provides traceable data that can be used to maintain and update network configurations. In this way, a passive antenna can be modeled in a RAN digital twin and more deeply integrated into the network management system and operations support systems.

Programmability and advanced network services

Bringing antenna equipment into the programmable network domain creates opportunities for enhanced network services. Two illustrative examples are outdoor positioning and dynamic capacity/coverage optimization.

5G Advanced outdoor positioning

5G Advanced uses a range of techniques to achieve higher accuracy outdoor positioning than is currently achievable (target is consistent 10cm to 1m accuracy vs. 1–10 meters in earlier 5G releases). GPS modules in the AMUs provide highly accurate synchronization across multiple base stations to enable more accurate time difference of arrival (TDoA), observed time difference of arrival (OTDoA), and real-time kinematic (RTK) calculations.

Outdoor network-derived positioning to 5G devices will be useful for numerous industry sectors, including automotive, transportation, logistics, public safety, and utilities. It may be used in hybrid mode to ensure robust positioning even in areas where GPS signals are weak or obstructed, such as urban canyons or dense forests.

Accurate outdoor positioning is a new 5G Advanced capability that can be sold as "location as a service." It will give operators a competitive advantage in high end, large enterprise accounts.

Programmable RET for capacity and coverage optimization

The combination of RET technology with centralized control in the service management and orchestration domain allows operators to use antennas to support dynamic capacity and coverage, offering opportunities for service enhancement.

Antenna alignment can be adjusted according to changes in the environment (e.g., new buildings), to meet time-bound usage requirements (e.g., around a stadium during a game or concert), or to shift capacity according to time-of-day usage patterns. rApps focused on RET use cases are emerging that will make this possible.

While not a directly monetizable service itself, this form of dynamic network control can improve user experience and has value as part of a network quality proposition.

Conclusions

Historically, antennas have been “install and forget” equipment. The costs and timelines associated with tower and rooftop visits resulted in reliable but static deployments.

New antenna designs with active monitoring help operators to digitalize passive equipment and meet network performance, security, and resiliency targets.

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