This IDC Technology Spotlight is a guide as to why RF propagation modeling takes on elevated importance in the budding 5G era, particularly as communications SPs look to deploy 5G networks across a range of spectrum, including mmWave bands.

The Elevated Importance of 5G RF Propagation Modeling

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Introduction

With an initial focus on consumers, and later on business customers, communications service providers (SPs) are now investing to launch 5G-based services. While the promise of new revenue streams from these services is appealing, the reality is that network planning will be significantly more challenging in the 5G era than in an LTE world as communications SPs race to achieve positive return on investment (ROI). The emerging playbook is to reuse existing spectrum (e.g., low band) and to deploy 5G in new, midband and millimeter wave (mmWave) spectrum to deliver ultra-high-level data capacity and downlink speeds surpassing gigabytes per second (GBps). In particular, at the higher frequency bands, factors such as proximity to natural or man-made obstacles, strength of an RF signal at a particular distance (path loss), heightened interference between radio sites, and RF signal penetration of hard surfaces must be more carefully considered in the RF propagation modeling process.

AT A GLANCE

KEY TAKEAWAYS

- With 5G communications SPs expected to deploy 5G across a wide array of spectrum, the network planning function takes on heightened importance.
- mmWave spectrum promises some of the highest advancements in mobile communications; however, planning for these networks becomes more challenging than planning for other spectrum bands.
- RF propagation modeling can potentially provide a significant benefit to the communications SP's network and business performance.

Background

5G is, in many ways, an extension of LTE; however, 5G is expected to leverage several resources that firmly differentiate it not only as a technology but also in planning for the implementation of 5G network capacity. For example, in many regions, 5G service providers will exploit three main spectrum bands simultaneously:

- Low band (sub-1GHz)
- Midband (1–6GHz)
- High band (24GHz and above)

While new spectrum generally translates to greater service potential, the vastly different performance characteristics of these three bands will increasingly challenge communications SPs to decide how and where they deploy 5G sites. The intersection of these new spectrum bands and the desired introduction of new 5G services further complicate the RF planning process. For reference, the industry-defined triumvirate of 5G services is as follows:

» Enhanced mobile broadband (eMBB)

» Massive machine-type communication (mMTC)

» Ultrareliable low-latency communication (URLLC)

Given the vast array of potential deployment scenarios, it is unrealistic to expect that simply overlaying 5G onto existing LTE sites will result in improved performance or the ability to fulfill service-level agreements (SLAs). As such, RF propagation modeling takes on even greater importance as a key pillar of network planning and optimization (NPO) services to ensure that 5G investment delivers positive business outcomes and improved customer experiences. Communications SPs that take the time to optimally plan and deploy 5G networks are more likely to gain distinct business and network performance advantages over operators that follow more traditional planning pathways.

Definitions

RF propagation modeling is a key step in the planning phase prior to executing network rollout. Without this step, communications SPs are ill-equipped to deploy mobile networks with demonstrable ROI, fall short in designing adequate RF coverage, and lack a solid ability to avoid unnecessary site deployments. RF propagation modeling is typically packaged as a subsegment of NPO services. This technique leverages advanced modeling to accurately predict path loss from a transmitter to any given location. The overarching purpose of the RF modeling step is to demonstrate a real-world deployment scenario, ahead of committing capex to a project, thus helping achieve an optimized level of network coverage for every dollar spent on delivering the RF network.

Given the higher order of complexity 5G will produce, RF propagation modeling will become even more important to avoiding scenarios such as overdesigning the network (unnecessary spend) or underdesigning a planned coverage (poor customer experience and increased churn). Indeed, RF propagation modeling provides value in deploying mobile networks.

mmWave Spectrum for 5G: Pushing RF Propagation Modeling to the Forefront of Planning

While path loss in the LTE world was more or less understood, the inclusion of new spectrum for 5G will press operators to lean more heavily on models to properly plan. In particular, a new challenge in the 5G world will be how communications SPs plan for mmWave (high-band) deployments. There have been several limited mmWave rollouts in certain sites and dense urban areas, but these deployments are expected to scale slowly over time.

While mmWave-based services promise to deliver significantly improved network performance in areas such as capacity, latency, and downlink, the inherent characteristics of this band include reduced coverage, higher susceptibility to path loss, and less ability to penetrate hard surfaces. As such, network planning takes on even greater importance to minimize the impact from these natural and man-made barriers to RF signal reduction.

Past LTE deployments were often located high on cell towers, power lines, or rooftops. These deployments took advantage of low-band spectrum to beam LTE signal for miles, with minimal impact from obstacles due to favorable diffraction properties at low band and midband. While both low-band and midband 5G will replicate this approach for coverage, mmWave 5G is targeted for deployment in dense, urban areas, or even indoors, and will need to be in places closer to end devices, such as a user moving through a city on a smartphone. Placing these 5G sites near natural and man-made obstacles will further exacerbate the challenge in deploying 5G on mmWave spectrum by introducing the variables previously noted, which are not present in other RF technology scenarios. The difference between signal levels at line of sight and non–line of sight will pose a challenge in maximizing signal-to-noise ratio, which aims to increase coverage while containing interference.

Benefits

As discussed, RF propagation modeling, particularly in the emerging 5G landscape, provides a vital service to help communications SPs plan network rollouts accordingly. The reality is 5G will unlock hundreds of new use cases across both the consumer space and the enterprise space. However, without proper planning, many of these rollouts are likely to fall short across several business and performance metrics. Leveraging calibrated, or "tuned" models, which draw from real-world data, can help communications SPs achieve benefits such as the following:

- **Accurate network visibility in a predictive manner.** Accurately representing the propagation environment is the first step to model validation. Not all models contain the latest or most accurate real-world data. However, models that incorporate these data sets can accurately replicate network potential in a real-world setting, helping communications SPs make informed decisions about where they deploy 5G sites.
- **Accurately predicted models that will drive optimally designed networks.** Service differentiation in the mobile landscape often hinges on the ability to outperform competitors, and as communications SPs press for greater exposure to industry verticals, emphasis on the ability to meet stringent SLAs will also rise. This is one of the many reasons RF propagation modeling will be as important as, if not more important than, it was during the LTE era. Enterprises will demand a wide range of network performance characteristics, particularly as mMTC and URLLC services enter the mainstream. Network design will need to be closely aligned with strategic goals; otherwise, communications SPs will be throwing dollars away or, worse, significantly underperforming compared with peers.
- **Network planning that can lead to optimized network capital outlays (budget planning).** With communications SP bottom lines more challenged than ever, the days of spending billions on network rollouts with little recourse are over. IDC has observed wireless capex as a percentage of total capex in communications SPs expand only slightly, even as 5G arrives. Said differently, getting 5G network rollouts right is of upmost importance — the exact role that RF propagation modeling was designed to fill. Without precise modeling, communications SPs could potentially overdesign the network, leading to excessive capital spend. Conversely, underdesigning the network could lead to degraded performance or coverage holes.

- **Support for regulatory coverage compliance.** Recent events, particularly in the United States, including the decision by the FCC to revise its broadband mapping to a "more accurate and granular" scale, will put more pressure on communications SPs to report their coverage data in greater detail. As the data that feeds RF propagation models helps solve network planning, it can also be leveraged to create broadband maps. This will help communications SPs meet regulatory demands.
- **Ability to help enable greenfield design and new site build decisions.** As noted, delivering 5G on multiple spectrum bands is likely to lead to a mix of site redundancy and greenfield builds. Some midband and mmWave rollouts will likely prompt communications SPs to construct greenfield sites. Modeling these sites ahead of time will be required, considering existing user conditions, zoning and siting requirements, and seasonal patterns.

Trends

- **5G service evolution means that going forward, the network will do much more than it traditionally did but also challenge communications SPs to deploy optimally.** While Release 15 ushered in the 5G NR era, Release 16 and beyond will push 5G beyond simple broadband connectivity. mMTC and URLLC will support the launch of services ranging from LPWAN for 5G (Internet of Things [IoT]) whereby millions of sensors are connected to the 5G WAN. URLLC services could include automated factories or new drone systems for first responders. 5G service creation will be vast and
far reaching over the next decade, signaling mobile network planning today will need to be strategic.
- **mmWave slowly becomes a mainstream technology.** While mmWave 5G sites will likely concentrate in select, urban areas for some time, recent auctions, particularly in the United States, indicate mmWave will move to mainstream over the next five years. Moderate investment in both 24GHz and 28GHz, combined with existing assets, signal these bands will be a critical part of the mmWave story. Further, Auction 103 (37GHz, 39GHz, and 47GHz) recently wrapped up with leading United States–based tier 1 carriers committing considerable bids to receive licenses.
- **3.5GHz–4.2GHz is the de facto 5G band; U.S. auctions to occur later this year.** With communications SPs realizing that to differentiate LTE from 5G, they will need to lean heavily on midband and high-band services, the 3.5GHz–4.2GHz band has emerged as the de facto starting point globally. First-mover regions such as China, Japan, South Korea, and Europe have seen communications SPs launch networks on this band. The United States will likely join in later this year, with auctions scheduled for June (CBRS PALs) and December (C-Band).
- **Small cells are at the forefront of 5G and LTE.** In tandem, communications SPs are moving more to densification for LTE, leveraging small cells, while they construct plans to build out macro coverage for 5G. In some instances, 5G small cells will be the best option for services, particularly in dense, urban areas. In almost all cases.
RF propagation modeling can help ascertain optimal locations for small cells whether on a street pole or tucked into a busy street on a rooftop.

Considering NETSCOUT's 5G RF Propagation Modeling

NETSCOUT is a leading provider of application and network performance management products designed to support optimal performance across datacenters, the cloud, DevOps, applications, network performance, cybersecurity, and unified communication systems. From a communications service provider standpoint, NETSCOUT's portfolio delivers analytics across both end devices and the network itself. Both views are critical to ensuring network investments are meeting their intent. In this section, we look closer at NETSCOUT's RF propagation modeling approach.

NETSCOUT's RF propagation modeling solution is designed to be a comprehensive approach for equipping communications SPs with the tools needed for mobile network planning, particularly in a 5G world. It draws from a range of techniques, which aim to deliver an industry-leading approach to RF model calibration. NETSCOUT's portfolio includes:

» Path Loss Database is fed by NETSCOUT's Continuous Wave Data collection, ensuring communications SPs have access to the most relevant drive test data. Outsourcing this function can help communications SPs save on opex and capex and can also significantly reduce propagation modeling project timelines for time-critical network design.

» NETSCOUT's proprietary software, TruePath, is designed to automatically calibrate RF models on behalf of customers. As noted, calibrated models offer the best course of action to ensure accurate testing results.

» Dynamic Range Compensation (DRC) is designed exclusively to mitigate traditional models, which may overpredict cell edge. Traditional models often do not consider overmeasurement at lower signal levels, which is addressed by DRC. Said differently, DRC accounts for this bias and ensures accurate propagation estimation.

» NETSCOUT put an early emphasis on building expertise in mmWave. To date, NETSCOUT has performed thousands of mmWave measurements across dozens of states, including 55 metro areas producing hundreds of models for mmWave 5G. As noted, mmWave 5G is likely to be both a major challenge and a major opportunity for 5G communications SPs.

As the 5G race picks up, communications SPs are pushing to deliver high-quality network services. RF propagation models from NETSCOUT help address this demand by putting knowledge into the hands of RF engineers who can then work internally to align network performance with service strategy. In some cases, service strategy may differ greatly based on spectrum, site location, and SLA goals. Taken as a whole, NETSCOUT's RF propagation solutioning becomes a critical asset for any communications SP looking to proactively optimize both business and network performance.

Challenges

Solutions such as NETSCOUT's approach to RF propagation modeling face adoption challenges as communications SPs weigh how to allocate capex for 5G, particularly mmWave and other initiatives. However, NETSCOUT's approach can be part of the solution by enabling communications SPs to save money through proactive planning. Additional challenges are as follows:

» **Capex challenges with 5G.** While most tier 1 communications SPs have introduced 5G commercially, scaling 5G networks will take time. Most communications SPs currently experience flat to single-digit growth in traditional businesses and will wait to scale 5G until demand picks up. In tandem, wireless capex is managed in line with revenue. This could dampen the potential market for RF propagation, driving a "slow burn" 5G market instead of faster uptake as was experienced during the LTE era.

» **Unlocking 5G spectrum.** The United States is a leading example of how delays in 5G auctions can slow service creation. While most communications SPs globally have access to low-band spectrum, and auctions are completed or underway for mmWave, midband spectrum in the United States is unlikely to be available until late 2020.

» **Communications SPs choosing instead to conduct their own drive tests.** Many communications SPs choose to do their own drive tests, which may be easier to enact in some situations, but extensively engaging in this type of testing strategy likely means that opex costs will go up. Still, it is reasonable to expect that self-reliance could be a hindrance to outsourcing RF propagation modeling, which could limit NETSCOUT's business opportunities.

» **Government regulations that mandate certain "do" and "don't do" requirements.** Regulations might state that combined RF and Wi-Fi 6 models be followed or that 5G at any location cannot go above certain power levels due to health concerns or potential interference with yet undetermined bandwidths. Other regulations could include using certain safeguards for situations that will become significant with time. If regulation forces nontechnical constraints on 5G deployments, then planning becomes very important in avoiding violations and/or adding extra resources in certain areas that would otherwise not need them.

Conclusion

While the market for 5G is still in its infancy, the reality of the 5G era is that it will last more than a decade as communications SPs move past the first phase of 5G, which is coverage, and look to expand their service offerings going forward. 5G's success will be measured not only by how fast or how wide coverage is but also by how well communications SPs plan their rollouts. The stakes have never been higher as the current mobile services landscape grapples with compressed margins with 5G set to usher in a very different way for communications SPs to do business.

Successfully implementing 5G networks and leveraging network planning tools such as RF propagation modeling will be table stakes as connectivity needs are measured and then measured again before 5G deployment. Communications SPs would do well to consider best-of-breed solutions in this functional domain to ensure networks align with their strategic service goals, which could range from a simple broadband upgrade to a raft of IoT or low-latency services. Critical to this will be how communications SPs create differentiation in the 5G era, both now and in the future.

About the Analyst

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