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The Tools to Track a Predictable and Secure 5G Network

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If we could create a future designed specifically to enable our progression to an ever more digital world, certain tools would be essential to businesses in navigating the way forward. These include better simulation and modelling programs. But first, let's rewind the clock to consider how we got here.

In 1979 the first 1G network was launched in Tokyo, and by the mid-1980s it spread to the United States with the first US-based commercially automated cellular network located in Chicago. Later, signals were digitized with the 2G networks of the early 1990s. Modern networks in use today are on the fourth major iteration of mobile network standards, known as 4G.

These 4G networks combine several different components to cultivate high-quality voice and advanced data services to all kinds of subscribers all over the globe. 4G networks birthed the smartphone revolution and empowered a new kind of high-speed networking that transformed how people, enterprises, and governments think about communication on the move.

Looking back, it's hard to conceive how groundbreaking the technological developments of 1G seemed at the time. Here in 2020, commercial mobile networks have become so exceedingly complex that the achievements of 1G seem like a tin-can telephone and string by comparison. On the verge of the 5G revolution, it is important to consider how businesses and governments can best equip themselves for the breathtaking advancements just over the horizon.

The 5G jump

The humble 1G network was designed and deployed for a single telephone system in a single city. The move to 5G network frequencies involves intricate architecture across continents and is intended to enable and proliferate an entire new sphere of Internet-connected devices that will transform our day-to-day life. These include smart buildings and sensor networks to telematics and mobile-to-mobile convergence.

Furthermore, communication systems have moved from networks to *ecosystems*. 4G, for instance, is currently deployed on over 600 individual commercial networks that may span across multiple countries. And 5G will prove to be even more expansive.

All commercial networks operating today—even the single 1G network still in existence—must adhere to a defined set of interfaces and protocols to meet the standards set by the Third Generation Partnership Project. The 3GPP is a standardization group that provides the basis for interoperability between hardware and software vendors. Transitioning from 4G to 5G, however, requires particularly robust work to ensure interoperability and seamless communications between connected systems across the world.

As the necessity for standardization increases, the difficulty of such standardization increases at an even greater rate. As 3GPP determined the specifications for the transition to 5G, the assumption was that the transition would be similar to the move from 3G to 4G. However, there are technical barriers that stand in the way of a traditional network implementation, not to mention the implications of the existing infrastructure. The progression from 2G to 3G to 4G represents technological shifts aimed at improving speed. As in the past, the move to 5G is spurred by an increased demand for bandwidth and low latency. However, the move to 5G differs in that it involves improvements in regard to channel optimization and high frequency usage that indirectly increases network output.

Overall, 5G networks aim for ubiquitous connectivity; this is the first network designed to support the massive Internet of Things and advanced analytics, enabling communicating on a machine-to-machine basis. Unlike the move to 4G, the move to multi-function 5G networks isn't just about connecting humans to data—and is significantly more complex. The introduction of millimeter wave high-frequency bands supported by massive multiple-input multiple-output methods means that 5G base stations might support 100 antennas where 4G base stations have 12. On top of that, there will need to be far more base stations, all of them employing beamforming all the time.

Bumps on the road to advanced analytics

These new 5G system environments create challenges for wired and wireless network planning, network analysis, and cyber threat analysis. Take, for example, optimizing cell tower placement for cost and operational effectiveness, as analyzing networks and creating layouts becomes increasingly knotty. Or consider the more elaborate scenario of military operations. In past 4G environments, military personnel looking to disrupt communications in a contested region could simply target cell towers in the area to cut off service. Base stations in 4G environments are powerful cells that cover a large range with little overlap. However, with a 5G network, eliminating a cell tower will likely not affect communications for users in that area. 5G networks are virtualized and distributed, featuring multiple overlaid access points, so that a device that loses a signal from one access point automatically transfers to another without loss of service.

Beyond increased complexity, there are other, compounding considerations when operating in 5G environments. This is to say that because of its complexity, deployment of 5G is likely to be evolutionary, not revolutionary. The implementation of 5G will be a slower, protracted progression, not a generational transition like the 3G-to-4G transition.

What sort of implications does this progression have? One important ramification is that, in the early stages of 5G deployment, it will coexist with outgoing 4G networks. So, the difficult network planning and analysis examples given above may actually involve not only the novel and multifaceted 5G network but also the new network interwoven with the previous-but-still-functioning 4G one.

Understanding how 4G and 5G networks work simultaneously in the same environment is critical for organizations. Adopting a broader scope, the need to develop an efficient, high-fidelity approach for understanding, evaluating, and protecting critical infrastructure has never been greater. In the move to advanced analytics, an important part of the solution lies in innovative new techniques for modeling and simulating 5G mobile networks.

Modeling the future

Let's revisit our first example: optimal cell tower placement. Being able to first model these 4G/5G systems in a completely simulated domain to understand radio frequency performance in relation to terrain and environmental conditions presents a massive safeguard. Hardware-in-the-loop capabilities only increase the fidelity of these platforms, allowing the user to understand with pinpoint accuracy how a system will react and perform under specified conditions. With this type of modeling, the user can toggle between a live, virtual, and constructive view of the mobile network big data in any given locale with confidence.

This type of simulation applied to our second, military-based example presents even stronger advantages. First, network modelling allows instructors to train personnel with hands-on scenarios for cyber network attacks on devices like handsets, IoT devices, telematics systems, and industrial control sensors. Military personnel no longer need to wonder how network functions work within the larger system of handsets, signaling, and data messages. Cyber-attacks within a big data cellular network can now be simulated with precision, allowing for modelling a 4G/5G jam right down to the wavelength. The models can be applied to test one's own resiliency, or to plan an offensive on a combatant's systems.

These simulations are a cutting-edge approach to mission rehearsal, where trainees can now walk through various cyber situational awareness and network analysis scenarios, testing and evaluating each potential course of action in a closed and repeatable environment. Not only can a participant analyze his or her results with ease, but he or she can now tweak the exercise to account for different NE configurations, switch to a different AOR, alter network architecture, and ultimately replay the exercise to observe and understand potential impacts. These technologies offer unparalleled performance improvements for point-to-point communications, radar, imaging, and communications across geographical areas, for applications as diverse as fire control systems and point-to-multipoint networking.

Cyber security in the 5G age

Threats to cyber security are not solely a military matter. Essential infrastructure like communications systems or power grids are now more important than ever and, unfortunately, 5G could make these systems more vulnerable to cyber-attack. Because of the dramatic expansion of bandwidth, the vastly increased number of antennas in a 5G network means vastly increased targets of attack for malicious hackers as the IoT will generate mass amounts of new data. Not only will the number of targets increase as more bases create more big data, but the types of targets will diversify. Different types of devices will now be online, as 5G creates opportunities for smart cities, automated factories, self-driving cars, remote surgeries, and more. This means that not only will devices like your phone be at risk, but perhaps even things like your car, your home appliances, or even your pacemaker. As advanced analytics progress, modelling for potential threats is vital on a national level, a personal level, and everywhere in between.

From smart cities to military bases, critical infrastructure is about to get more complex with 5G and (perhaps especially) 4G/5G networks. The cyber-situational awareness, proficiency training, and network analysis toothpaste will not go back into the tube. Modelling and simulation software represents not just an impressive solution, but an imperative technology to lead the 21st century.