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5G ARTICLE
SOLUTION INTEGRATORS

The Future is 5G: Why 5G Continues to Transform Everything

Put simply, 5G is the fifth generation of cellular wireless/mobile technology.

As we step into 2024, the crucial question is the progression from 4G to our present state and the forthcoming transition to 5G. The unequivocal answer remains evolution.

Every mobile technology generation encompasses a core network, a radio access network (RAN), and end-user devices. Reflecting on the past, only the inaugural generation (1G) was created from scratch—a blank canvas. Subsequent generations (2G, 3G, and 4G) have incrementally built upon their predecessors, following the logical path of evolution. This practical approach mitigates the financial burden associated with deploying an entirely new network before generating substantial cash flow. No generational shift results in an immediate hard cutover. Instead, a segment of the existing generation's RAN is retired to make room for the initial deployment of the new RAN—operating initially with the existing core network. After a sufficient number of end-users transition to the new generation, the core network undergoes an upgrade, and the remaining RAN follows suit. Once this transition concludes, that generation becomes homogenous and ubiquitous.

The Three Promises of 5G

Each successive generation of cellular technology amplifies service provider capacity and end-user speed. 5G continues this evolution, promising significant enhancements. Specifically, 5G commits to 1) delivering speeds surpassing 1 Gbps, 2) achieving ultra-low latency of <1 mSec, and 3) enabling effective IoT connectivity for a massive number of devices. While these three promises are interconnected, they traverse independent evolutionary paths.

For instance, achieving speeds beyond 1 Gbps demands more spectrum than any single service provider can access at conventional sub-3 GHz frequencies. The solution lies in utilizing millimeter-wave (mmWave) frequencies (28 GHz, 39 GHz) with extensive bandwidth. Ultra-low latency necessitates relocating core application "compute and storage" resources closer to end-users, transforming them into virtual functions. Enabling Massive IoT demands that 5G concurrently supports both narrowband, low-power devices and advanced broadband user devices.

mmWave Mobility Rollouts

Major US carriers, including AT&T and Verizon, have initiated mmWave mobility rollouts in major urban city centers, utilizing their 4G core networks. While these frequencies have been used before, such as in the late 1990s with FCC-authorized fixed point-to-multipoint (Local Multipoint Distribution System [LMDS]) usage of 28 GHz and 39 GHz frequencies, challenges persist. The industry quickly realized that mmWave had poor penetration through weather (rain), windows, walls, and vegetation.

The same physical limitations hinder current attempts to use mmWave for mobility. Initial adopters report high speeds in urban centers while walking but experience reduced speeds inside vehicles or buildings. While mmWave mobility can offer very high speeds in small, targeted areas with dense deployments, its application is limited to point-to-multipoint deployments in suburbs, potentially never reaching low-density rural areas.

In a fully connected world, IoT encompasses traditional low-data-rate machine-to-machine remote monitoring and expands to include high-data-rate, low-latency, real-time control applications. The broadband focus of 3G and 4G briefly left traditional IoT with legacy narrowband 2G—until service providers deactivated it. Recent narrowband LTE addressed this gap but introduced RF channel planning inefficiencies. The 5G New Radio (NR) standards, with virtual channel slicing and virtual network slicing, facilitate the coexistence of narrowband and broadband within a single RF channel.

The 5G Evolutionary Timeline

Each of the three major components of 5G will inevitably progress along its evolutionary timeline. While service providers initially embraced mmWave, expect them to reassess their deployment strategies in the near future. Nevertheless, anticipate 5G NR technology infiltrating existing frequency bands. Immediate replacements of core networks to achieve <1 mSec latency are unlikely. Instead, ongoing upgrades, built on virtual network functions, will progressively move towards ultra-low latency. The full functionality of Massive IoT may only materialize when a fully native 5G network operates in parallel with the legacy 4G network.

Considering that after about ten years of deployment, 4G LTE has recently reached maturity and is far from obsolete, we can expect 5G to follow a similar timeline. We stand at the onset of a ten-plus-year evolution into the transformative era of 5G.

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