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Solving the Challenges of 5G Indoor Connectivity

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It’s hard to escape talk about 5G these days, even as 4G becomes more robust. Thanks to carrier aggregation, mobile network operators can leverage a number of separate LTE carriers in order to increase the peak user data rates and overall capacity of their networks, as well as exploit fragmented spectrum allocations. This will help the industry squeeze more capabilities out of 4G over the next few years.

This current state of boosted 4G LTE as LTE-Advanced+ is a prelude to what will eventually become 5G, at least from the network speed perspective. While true 5G will be based on currently developing standards, final versions of which are still some time away, we have a basic idea of what we can expect from it.

5G’s primary promise is that it will grant access to vast amounts of new spectrum and allow wireless networks to support use cases never supported by 4G. This millimeter wave spectrum provides — at least by order of magnitude — wider bandwidths for mobile applications. But, it presents enormous challenges from an indoor propagation perspective.

Next, small but powerful base station antenna arrays using massive multiple-input multiple-output (MIMO) will combine beamforming with a massive network to extend the range of the signals and increase network efficiency.

5G networks will provide much less latency, which is one of the main requirements for critical use cases such as self-driving vehicles. These three qualities of 5G have the potential to almost triple the annual gain in wireless network capacity over the next decade versus the annual gain over the past 20 years, but these gains will not come without challenges.

Challenges of Indoor Coverage in 5G

Most outdoor 5G tests today use millimeter wave frequencies — 28 GHz and higher. Compare this with today’s mobile networks which use various frequency bands below 3 GHz to provide coverage over large areas.

There are significant challenges associated with using such high frequency bands, especially indoors. In a nutshell, higher-frequency radio signals are less capable of penetrating obstructions, which presents an immense problem in indoor networks.

The key to effective indoor mobile cellular coverage and capacity is a far-traveling, uninterrupted radio signal. Modern buildings are unfortunately the perfect countermeasure against radio signals because of the materials with which they are built, such as treated glass, steel frames, and metalized insulation. It’s hard enough for some of today’s licensed spectrum to get through building walls, and 5G’s high-frequency transmission will further complicate this.

The higher the frequency, the shorter the range. At even the low end of the projected 5G frequencies, the signal range will be very short. Even standard plaster walls will block the signal, let alone the high-tech building materials now used for modern construction.

And that’s a problem, because reliable indoor coverage is already an issue — one that will only get worse as true 5G comes into play.

Current Indoor Connectivity Challenges

The problem of poor indoor cellular coverage already is widespread, with 74 percent of U.S. workers in industries from hospitality to healthcare, warehouses to enterprises, saying they “frequently” or “sometimes” have problems with connectivity. Mobile coverage is essentially another utility these days – tenants and employees expect it the way they expect the lights to always turn on and the water to always run, and when it doesn’t work well, people notice immediately.

Connectivity is only going to become more critical in the future to enable employees to complete their tasks using the technologies that help them work most productively, and to ensuring those technologies are usable in the workplace. 5G will intensify in-building connectivity issues, impacting not just businesses within the buildings, but also commercial real estate (CRE) building and facilities managers who want to get top companies into their office space.

To meet current challenges of indoor connectivity, and to be ready for true 5G, some businesses are considering investing in a full-spectrum distributed antenna system (DAS) network, which best supports carrier aggregation features of today’s 4G and will be in the best position to support indoor 5G in the future.

Full-Spectrum DAS: Meeting the Challenges

DAS comprises cabling, small remote units and antennas that are distributed throughout a building and linked to a central distribution hub. This hub in turn connects to the RF source used by the mobile operators. Through a DAS, the operators’ wireless signal is distributed to all parts of the building.

Because the signal used to support a DAS is separate from outdoor cellular towers, capacity is dedicated to the building, unlike for users of repeaters, which take the capacity away from the outdoor towers. And because it’s actually an operator-provided and -supported cellular signal that is being brought into the building, users receive a guaranteed level of service, as opposed to unguaranteed performance of a voice-over-Wi-Fi, for example. Plus, calls can seamlessly hand off from the inside network to the outside network as users move from inside to outside the building.

Some DAS are capable of supporting all of the most common cellular and public safety frequencies at the first installation, with no additional hardware needed to add new frequencies or wireless operators. New technologies that take advantage of radio frequencies, like location-based services and Internet of Things (IoT) devices, need no additional infrastructure either, greatly saving costs over the lifetime of a system.

To choose this type of 5G-ready DAS, ensure the system has the following attributes:

- It facilitates the ways tenants and residents prefer to communicate now.
- It is multi-carrier, giving access to everyone in the entire building, no matter what carrier they use.
- It is full spectrum, so it can access all of the most utilized cellular and public safety signals as well as all of the frequencies available between 150 MHz and 2700 MHz on a single hardware layer.
- It supports simple, inexpensive upgrades to meet tenants’ and residents’ future connectivity and communication requirements.
- It uses a “one-and-done” approach to hardware installation, with the single original hardware layer able to support all carriers and frequency bands, as well as new connectivity requirements in the future, without additional hardware.
- It is fully fiber based, instead of coaxial cable based or a hybrid of cable and fiber, to ensure optimal performance now and in the future, as well as to keep costs lower and minimize installation time.
- It supports emerging technologies like 5G as well as IoT and machine-to-machine (M2M) communications – all of which need stable and reliable cellular connectivity

Moving Toward the Future: 5G Standards and Forward Compatibility

3GPP is the international standards body that covers cellular communications network technologies. This includes the radio access, core network and service capabilities. 3GPP has been working on 5G standards for years, but is not quite at the point where it can issue the final release.

In June 2016, the 3GPP Technical Specifications Groups (TSG#72) agreed on a detailed work plan for Release 15, which includes a set of intermediate tasks and checkpoints to guide the ongoing studies in the Working Groups. These discussions stressed the importance of forward compatibility in radio and protocol design, according to 3GPP, “as this will be key for phasing in the necessary features, enabling all identified use cases, in subsequent releases of the 5G specification.”

If the work plan goes according to schedule, the final release of 5G specifications will hit sometime in mid-2018, but it’s also possible this may get pushed back.

3GPP’s emphasis on forward compatibility further cements the need to choose a wireless network now that can still function well into the future, including when 5G becomes standardized and more widespread.

The demand for strong indoor wireless connectivity is high now and will only increase in the coming years as 4G becomes more powerful. In the next few years, the existing frequency bands that carriers use will continue to be aggregated, meaning DAS systems that offer access to all frequency bands will be prepared for this scenario as well as true 5G.

As true 5G comes into being, outdoor frequencies will have to be moved onto other frequencies inside a building – potentially multiple frequency bands, all better equipped for indoor propagation. In a solution with simplified architecture, users can access all of the frequency bands at the lower end of the licensed and unlicensed spectrums, all the way up to 6 GHz, which will eventually be used for indoor 5G in some form. It’s not certain at this point where exactly indoor 5G would fall from a frequency point of view, so having an all-fiber-based solution that can support all frequencies with no additional infrastructure in the future is ideal from a future-readiness standpoint.