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In-Building Wireless: The Road to 5G

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The wireless industry is seeing a convergence of licensed cellular frequencies and unlicensed protocols such as LTE Unlicensed (LTE-U), License Assisted Access (LAA), and MulteFire and this convergence should play a major role on the road to 5G. While mobile operators are testing millimeter wave frequencies in the 28-30GHz bands for fixed wireless access in the macro network, 5G propagation indoors will most likely happen within existing licensed spectrum bands and future unlicensed spectrum in the 3GHz-6GHz bands. In this article, we'll look at the convergence of licensed and unlicensed frequencies as a stepping stone to 5G services inside buildings, and outline possible frequency and infrastructure requirements for transitioning to 5G.

The role of unlicensed LTE frequencies

There's continuous work being done to get more out of the currently used frequency spectrum. Mobile operators are always looking for more spectrum in order to expand bandwidth and provide their users with faster LTE service. Once they have extracted all they can out of new cell sites, splitting sectors, and carrier aggregation, the next step is to look at the unlicensed spectrum. LTE-U, LAA, and MulteFire are all terms that describe approaches to unlicensed spectrum that will deliver more from current technology.

- **LTE Unlicensed** (LTE-U) is a protocol that enables mobile operators to increase bandwidth in their LTE networks by using the unlicensed frequency bands, which are also used by Wi-Fi devices.
- **License Assisted Access** (LAA) is the name given to the Third-Generation Partnership (3GPP) effort to standardize the use of LTE in Wi-Fi frequency bands. LTE-U is an implementation of LAA.
- **MulteFire** is another license-free implementation of LTE.

LTE Technology Guide		
LAA	License Assisted Access	3GPPP standardization of LTE use in Wi-Fi bands
LTE-M	LTE for Machines	Short-range LTE designed for M2M applications
LTE-U	LTE Unlicensed	LTE using unlicensed frequency bands
MulteFire	N/A	LTE using unlicensed frequency bands

Table 1: LTE Technology Guide

While 5G standards are not fully developed, 5G is being tested outdoors with 28-30GHz frequencies. Those frequencies do not propagate well in indoor environments. Thus mobile operators will need lower frequencies for indoor 5G use, where, after all, 80 percent of mobile traffic originates and where 5G will see a wide range of use cases.

Converging licensed and unlicensed frequencies

So how will these unlicensed frequencies converge onto 4G and 5G? While it's too early to tell when and how 5G will be used in buildings (2020 is a possible target date for widespread implementation), the path to adding unlicensed frequencies for LTE use is fairly clear. Chip makers like Qualcomm (which favors MulteFire) must produce cellular transceivers that can operate in the 3-6 GHz bands, and these chips must be implemented in phones, tablets, and other devices. Networks at these frequency bands must be built.

At some point, users' devices will implement both licensed and unlicensed frequencies for LTE use and mobile operator networks will decide, for any given environment, what works best for the user to get to the highest throughput.

LTE-M and the IoT

From what we can see today, LTE protocol deployed for IoT applications is LTE-M, which is a licensed, short-range LTE designed for machine-to-machine applications. Some mobile operators are already deploying LTE-M in their networks. At the same time, LTE-M will be one of several wireless standards used for IoT implementations. Wi-Fi, ZigBee, Bluetooth, and others will also provide support for the coming Internet of Things.

Mobile operators also like LTE-M because it opens up another revenue stream for them. As end users deploy radio-equipped sensors, cameras, security systems and other devices, operators want those devices to use their LTE networks to communicate. One big advantage of LTE-M over ZigBee or Bluetooth is that it shouldn't require any upgrades to a building's distributed antenna system (DAS) as long as the DAS supports LTE.

The role of Wi-Fi

So you may be wondering, "What happens to Wi-Fi during this transition?" The short answer is "nothing." Wi-Fi will continue to be a separate option for data and, to a lesser extent, voice services. It's a good-enough solution for voice and data in smaller enterprises, but once you start comparing what you can deliver to the user, LTE is inherently superior to it in terms of both capacity and throughput.

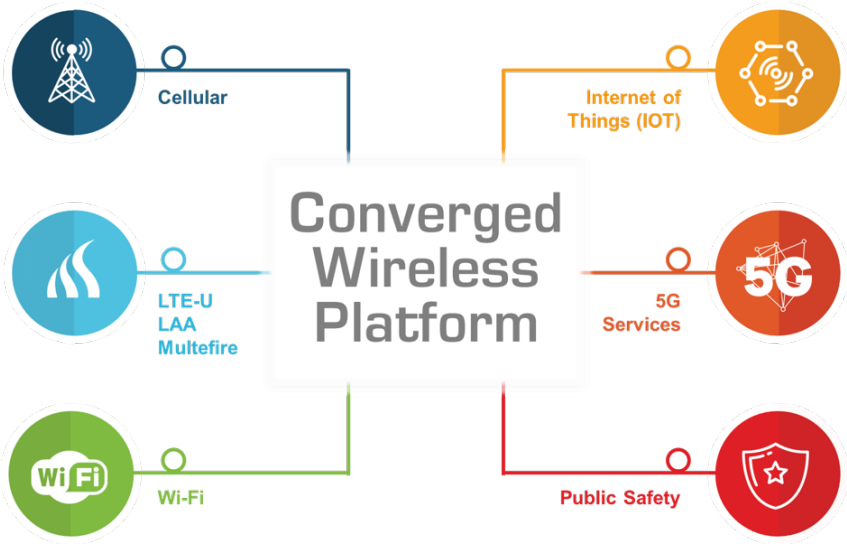

Figure 1: Converged wireless infrastructure

Requirements for in-building infrastructure

Unlicensed LTE protocols will play a significant role in boosting LTE bandwidth between now and the advent of in-building 5G. So what does that mean for those considering buying or upgrading an in-building DAS? There are three basic requirements:

1. **Support 3-6 GHz frequencies while still supporting existing licensed spectrum.** Since all the unlicensed LTE protocols run on 3-6 GHz frequencies, the DAS must support those frequencies. Currently, most DAS products only support today's frequencies, which include 700 and 800/850 MHz, 1.9 and 2.1 GHz, 2.3 GHz and will soon include 600 MHz. Non-broadband systems using coaxial cable will have to be significantly upgraded to support unlicensed LTE.
2. **Use fiber infrastructure.** Many current DAS solutions use coaxial cabling or a hybrid architecture that combines fiber and coax cabling. It is much more difficult for coaxial cable to efficiently deliver signals in the 3-6 GHz range because of its relatively poor propagation characteristics when compared with fiber. Instead, building owners and managers should look for all-fiber infrastructure in a prospective DAS.
3. **Support converged IT and cellular deployments.** The move to license-exempt LTE is an opportunity to converge what have always been separate Wi-Fi and cellular infrastructure within buildings, and to also accommodate coming IoT devices. Efficiently deployed in-building architecture will thus support the converged cellular and IP (devices such as Wi-Fi access points, surveillance cameras, and sensors) platforms.

Within the next couple of years, unlicensed LTE frequencies will become part of the in-building wireless delivery architecture, and IoT devices will proliferate. Astute in-building wireless planners will prepare for this evolution by choosing wireless infrastructure today that supports these coming changes.