TANTRA ANALYST

Building 5G IoT on the Solid Foundation of LTE IoT

Why it makes sense to invest in LTE IoT today to secure leadership in 5G IoT tomorrow

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Executive Summary

With the first 5G commercial mobile broadband networks getting off the ground, and the first devices coming to market, the focus of industry leaders is shifting toward exploring what's next. 5G IoT is naturally the next major opportunity for the cellular industry. A leading industry analyst firm, Machina Research, forecasts a staggering 6 billion Low Power Wide Area Network (LPWAN) IoT connections by 2026. While the 5G-NR (New Radio) IoT standard is still in development, LTE IoT has already started building a strong foundation and will support the bulk of those connections. Capitalizing on this foundation, 5G IoT, which is comprised of Massive IoT and Mission Critical Services, will take the performance to a new level, allowing a very high density of devices, as well as ultra-low latency and extreme reliability.

LTE IoT, comprised of eMTC (enhanced Machine Type Communication, aka LTE-M) and NB-IoT (Narrow Band IoT), offers the best suite of technologies for LPWAN IoT applications and services. They support the full range of IoT use cases, ranging from low-data-rate, latency tolerant sensors to data-intensive, low latency, mobile, voice supported, wearables, healthcare devices, video monitors, and others. These technologies are evolving and continuously improving performance, and will ultimately become 5G Massive IoT. 5G-NR, the new radio interface for 5G will have in-band support for LTE, and be fully backward compatible. This means today's LTE IoT devices will seamlessly work when the networks are upgraded to 5G-NR.

LTE IoT has established a solid base, and the ecosystem is growing rapidly. According to the industry group GSA (Global Suppliers Association) as of March 2019, there were 149 operators in 69 countries investing in either eMTC, NB-IoT or both.

From a standards perspective, most of today's networks are based on 3GPP. Rel. 13 specifications. Rel. 14 and 15 specifications have enhancements to LTE IoT, and Rel. 16 will define 5G IoT, both Massive IoT and Mission Critical Services. Rel. 17 will further improve performance.

As evident, LTE IoT will be the key to success in 5G IoT. For industry participants who envision to be leaders in IoT, it is imperative that they continue to invest in LTE IoT, or else they risk losing their market leadership to competition.

Contents

The Three Tracks of 5G

5G has been the most visible and marketed cellular technology ever. The popularity of 5G can easily be illustrated by how quickly it has achieved strong global traction, from regulators, operators, infrastructure vendors, device OEM, and almost everybody in the cellular industry. According to GSA, there were 224 operators in 88 countries investing in 5G, as of April 2019. There were more than 30 devices from more than 20 OEMs expected in 2019 or early 2020.

5G promises to be the most dominant wireless technology ever and will touch almost everybody's lives and transform almost every industry. The dominant 5G player, Qualcomm, estimates the total impact of 5G to be more than $ 12 Trillion. Obviously, such a large undertaking can't be accomplished in a short period of time and in a single step. The industry is meticulously planning 5G commercialization primarily on three tracks: 1) Enhanced Mobile Broadband; 2) Massive IoT; and 3) Mission Critical Services, as shown in Fig. 1. The last two tracks, Massive IoT and Mission Critical Services can be combined together as 5G IoT

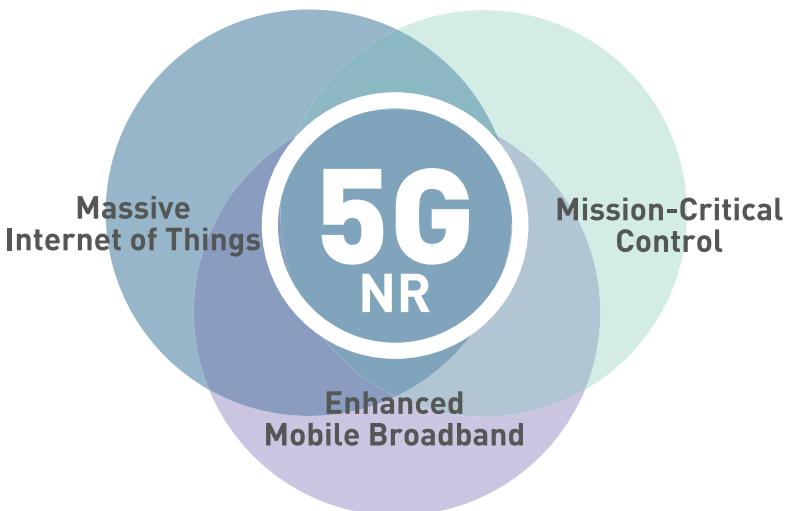

Figure 1 - These tracks of 5G

Enhanced Mobile Broadband (eMBB)

5G is designed to offer gigabit user data speeds and huge amounts of capacity. That means immersive always-on connectivity wherever you go, and consistent fiber-like speeds no matter how crowded the networks are. The networks will use a combination of Sub-6GHz bands for expansive coverage, and bandwidth-rich millimeter Wave (mmW) bands for ultra-high speeds. All deployments of 5G that are underway now are primarily to offer eMBB supporting smartphone and other consumer and enterprise data devices. The initial set of services include ultra-high speed mobile broadband, new existing services such as VR and AR, fixed broadband services for residential and enterprises, and more. The incredible speeds and capacity of 5G eMBB will surely empower, inspire, and challenge the large app developer community to develop innovative and exciting applications and services.

While the new 5G networks are gradually being built, and services rolled out, the underlying Gigabit LTE network will continue to be the fallback option when users move out of 5G coverage areas. So it is important to evolve your enterprise networks and devices to newer versions of LTE.

Massive IoT

5G will propel IoT to the next level. One of the specific aspects of 5G IoT is the ability to support an extremely high density of IoT devices in a small area, the target being up to a million devices in one square kilometer area. The idea here is efficiently connecting any device that can benefit from being connected to the internet, without overwhelming the network. LTE IoT did the pioneering work of optimizing the cellular technology that was primarily built for high-speed connectivity for sophisticated smartphones to a large number of low speed, low complexity, low-cost, low-power (long battery-life) devices. These technologies will evolve into 5G Massive IoT. As mentioned before, Massive IoT is one part of the larger 5G IoT construct.

Mission Critical Services

The hallmark of 5G is its ability to provide ultra-low latency and extremely high reliability. This will enable applications, services and use cases that were not possible with 4G. For example, replacing the ethernet and wireline connection in industrial automation, that will make the factories of the future more flexible and agile to adapt to changing market conditions. Othe use cases include remote access to health care, remote command, and control of hazardous operations and many more. Major industrial houses such as Bosch and others are now realizing the promise that 5G holds and are actively engaging with cellular industry leaders to explore this new frontier.

Mission Critical Services is the other part of 5G IoT, and together with Massive IoT, expected to herald the next industrial revolution, often referred to as industry 4.0, a smart, connected, and efficient massive industrial infrastructure setup.

LTE is Connecting IoT Today

Unlike smartphones for which the cellular systems were initially created, IoT devices have vastly different and diverse needs. For example, applications such as video monitoring, connected cameras, etc., require very high speeds and capacity, whereas applications such as utility meters, tracker, etc., require very low speeds, but extremely long battery life. Some other applications that need voice/ VoLTE support require lower latency. The evolution of LTE IoT has successfully addressed these challenges and continues to evolve, bringing even more flexibility and performance.

LTE IoT is comprised of two technologies, eMTC, and NB-IoT. There are specific device categories defined for these as well— Cat-M1 and M2 for eMTC and Cat-NB1 and NB2 for NB-IoT. Collectively, these, along with some other proprietary technologies, are often referred to as LPWAN. Fig. 2, lists high-level specifications of both of these technologies.

	eMTC/Cat-M1 For the broadest range of low-complexity IoT use cases	NB-IoT/Cat-NB1 For the delay-tolerant, ultra-low complexity IoT use cases
Peak data rate	Up to 1 Mbps	<100 kbps
Bandwidth	1.4 MHz	200 kHz
Rx antenna	Single Rx	Single Rx
Duplex mode	Full or half duplex FDD/TDD	Half duplex FDD
Mobility	Limited-to-full mobility	Cell reselection only
Voice	VoLTE	No voice support
Transmit power	23, 20 dBm	23, 20 dBm
Deployment	In-band	Standalone, in-band, guard band

Figure 2 - Specifications of eMTC and NB-IoT

eMTC is primarily designed for high data rate, low-latency, mobile, and voice-supporting applications. These include industrial handhelds, health monitors, wearables, high-precision mobile trackers, etc. NB-IoT is designed for low-data, low-complexity, delay-tolerant and non-critical applications that need more expansive coverage, such as utility meters, industrial and environmental sensors, agricultural monitors, low-precision mobile trackers, etc. Both technologies support years of battery-life and much larger coverage than regular LTE devices.

NB-IoT, because of its similar channel bandwidth as legacy 2G/GSM system, is a great option for operators looking to retire their GSM networks and redistribute the spectrum for LTE. NB-IoT is far superior to GSM in terms of efficiency as well as capacity and leverages the large LTE ecosystem. On the other hand, eMTC is a must for any application that needs voice or VoLTE support.

The larger point is, eMTC and NB-IoT are complementary, and together efficiently address the full spectrum of diverse IoT applications, services, and use cases today.

LTE IoT Leverages Existing LTE Networks and Ecosystem

The biggest advantage of LTE IoT technologies over other proprietary LPWAN technologies is that they fully leverage existing LTE network and ecosystem. Both eMTC and NB-IoT can be deployed in-band within existing LTE or dedicated spectrum, as shown in Fig. 3. NB-IoT can even be deployed within the guard bands. Of course, there are new devices needed for both eMTC and NB-IoT, but on the network side, there is a minimal change needed, in most cases, only a software upgrade.

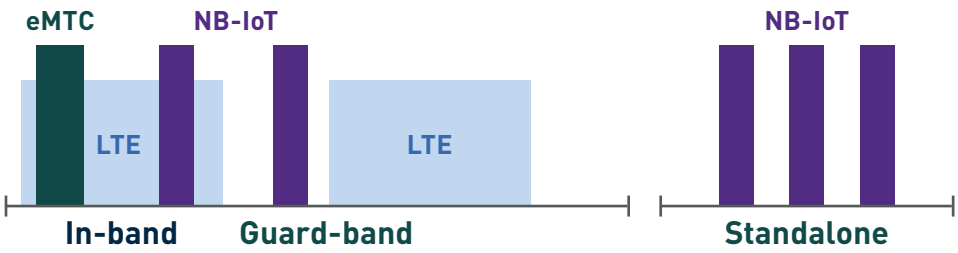

Figure 3 - Deployment Flexibility of eMTC and NB-IoT

The Expanding LTE IoT Ecosystem

LTE IoT is rapidly gaining momentum, according to GSA, as of March 2019, there were 149 operators in 69 countries investing in either eMTC, NB-IoT or both. Fig. 4 shows the global traction of LTE IoT.

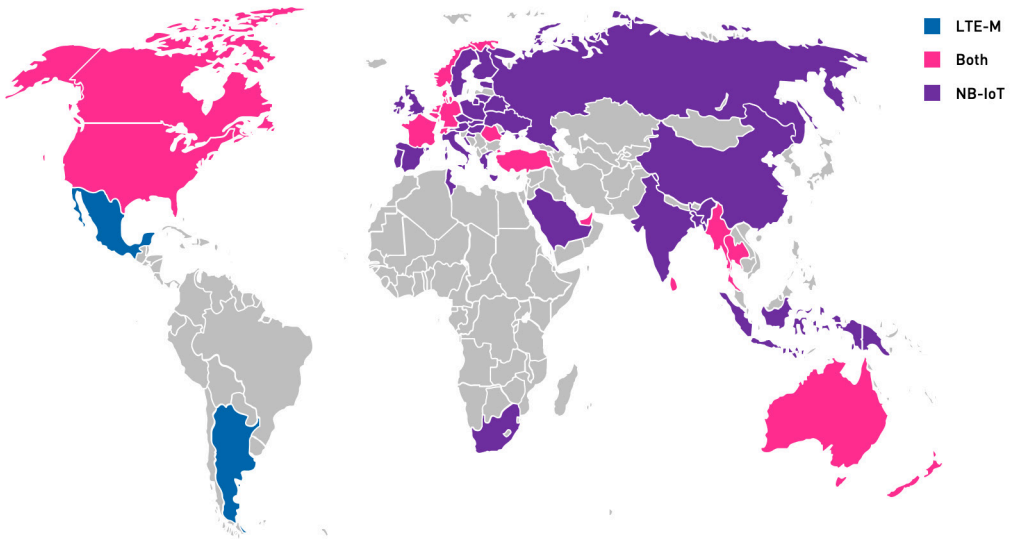

Figure 4 - Global Ecosystem of LTE IoT | Source: GSA

There is a large and vibrant LTE IoT devices ecosystem as well. The devices cover the full range from expensive wearables and high-precision industrial trackers to inexpensive environmental sensors. These devices are a mix of single-mode eMTC or NB-IoT only, or multi-mode supporting both technologies, including 2G fallback, providing complete flexibility to end users.

LTE IoT is the foundation of 5G IoT

As 5G starts its pervasive rollout, is it still worthwhile to continue investing in LTE IoT, or wait for 5G IoT? For companies that have not yet adopted LTE IoT, should they consider leapfrogging directly to 5G IoT? LTE IoT will evolve into 5G Massive IoT, as shown in Fig 5. So, investing in LTE IoT indeed is investing 5G IoT.

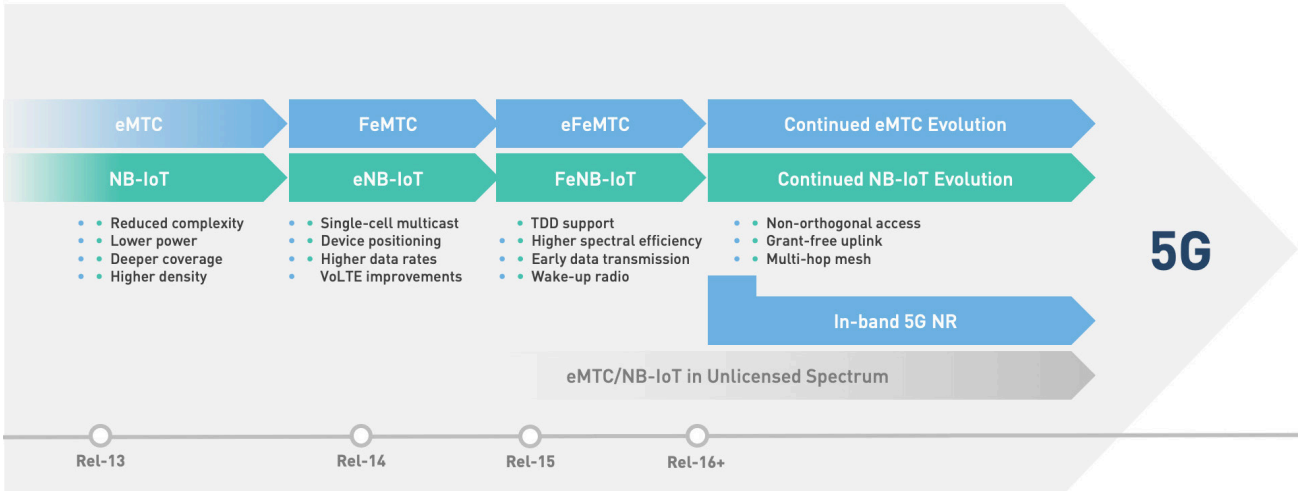

Figure 5 - The evolution of LTE IoT and transition to 5G IoT | Source: Qualcomm Technologies Inc.

LTE IoT Will Evolve Into 5G Massive IoT

LTE IoT was introduced in 3GPP Rel. 13. Most, if not all the LTE IoT networks today are Rel. 13. As can be seen from Fig. 5, both eMTC and NB-IoT have a strong roadmap. Rel. 14 and Rel. 15 bring many new and significant enhancements to both technologies. They are also being refreshed to reflect the profound changes going forward. eMTC is called Further enhanced MTC (FeMTC) in Rel. 14, and even Further enhanced MTC (eFeMTC) in Rel 15. NB-IoT, similarily, will be called eNB-IoT in Rel. 14, and FeNB-IoT in Rel. 15.

The objective of the improvements is to offer:

- Less complexity means lower costs
- Lower power consumption means longer battery life
- Better granularity in speeds means more flexibility for applications to select the most appropriate speed
- Deeper coverage means fewer dead spots
- Higher capacity, higher efficiency, better VoLTE support

Enhancements in Rel. 16 for LTE IoT aim to achieve the critical requirement of 5G IoT, which is to support a density of one million devices per square kilometer. That's how LTE IoT will evolve into 5G Massive IoT.

5G-NR is Fully Backward Compatible with LTE IoT

Most activities surrounding 5G, including operator traction, device announcements, etc. are solely focused on eMBB, specifically Rel. 15 version of the 3GPP standard. Rel. 15 introduces a new radio interface called 5G-NR (New Radio). 5G-NR is specifically designed to support in-band LTE IoT. Both the 5G-NR deployment models—NSA (Non-Stand Alone) with 4G/EPC Core, and SA (Stand Alone) with new 5G core—natively support LTE IoT. That means today's LTE IoT devices will be able to seamlessly work when the infrastructure is upgraded to 5G-NR, with minimal changes. Investments that are being put into LTE IoT are investments in 5G IoT and are well protected for the foreseeable future.

5G-NR Mission Critical Services take IoT to the Next Level

Beyond traditional IoT services that LTE IoT or Massive IoT can support, 5G-NR will enable many new use cases that can't be supported by 4G. The 5G Mission Critical Services brings features such as eURLLC (enhanced Ultra Low Latency Communication) which offers sub-millisecond latency and CoMP (Coordinated Multi-Point) which offers ultra-high reliability. These services, for example, will enable Industry 4.0 and the factories of the future.

Invest in LTE IoT Today for Leadership in 5G IoT Tomorrow

When you look at the evolution of LTE IoT, it is very apparent that early investment in it is crucial.

It not only allows the industry participants to meet today's market needs but also puts a solid foundation in place to address the opportunities of the future effectively. Indeed "LTE IoT vs. 5G IoT" is a false choice, and investment in LTE IoT is not an option but a necessity.

Without the solid foundation of LTE IoT, it is almost impossible for companies to be a force to reckon with in 5G IoT. Unless they invest now, it would be impossible for them to get a strong foothold in the 5G IoT market. So, the decision for all the industry participants is to get in now or heed the market to competition.