FUTURE OF IOT

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1- IoT Background

From the perspective of technical standardization, the Internet of Things (IoT) has been defined in Recommendation ITU-T Y.2060 (06/2012) as a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies (ICT).

The Internet of Things (IoT) is a network of physical objects, machines, people and other devices that enable connectivity and communications to exchange data for intelligent applications and services to be developed.

These devices consist of smartphones, tablets, consumer electronics, wearable gadgets, vehicles, motors and all type of sensors that are all capable of IoT communications.

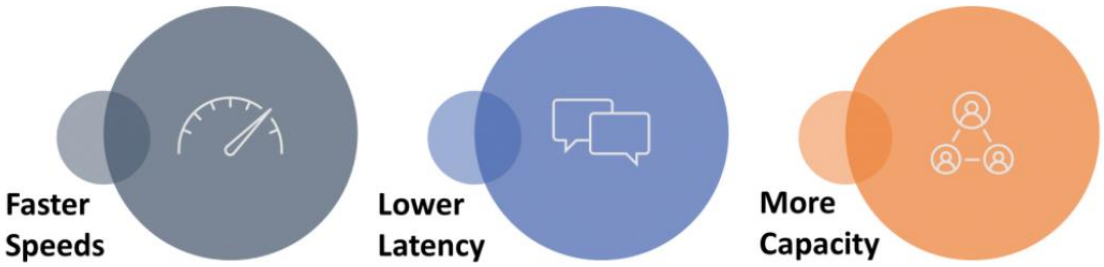
The Internet of Things allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for direct integration between the physical and digital worlds resulting in improved efficiency, accuracy and economic benefits.

As a natural evolution of Machine-to-Machine (M2M) technology, the Internet of Things (IoT) is the interconnection of intelligent devices and management platforms that collectively enable the “smart world” around us. From wellness and health monitoring to smart utility meters, integrated logistics, and self-driving cars and drones, our world is fast becoming a hyper-automated one.

In the future, all devices that will benefit from an internet connection will be connected. In this Networked Society, every person and every industry will be empowered to reach their full potential.

Internet of Things (IoT) technology is a key enabler of this vision by delivering machine-to machine (M2M) and machine-to-person communications on a massive scale.

2- Why IOT?



3- Technology

From Technology perspective, in order to satisfy the IoT Requirements, the connectivity is the foundation for IoT, and the type of access required will depend on the nature of the application and the service. That is why the Mobile Operators should build the maximum of connectivity capabilities in order to enable all these new service areas.

In fact, several wireless technologies have emerged to enable the IoT applications that are set to explode. And while there are many differences between them, they can roughly be separated into two discrete groups:

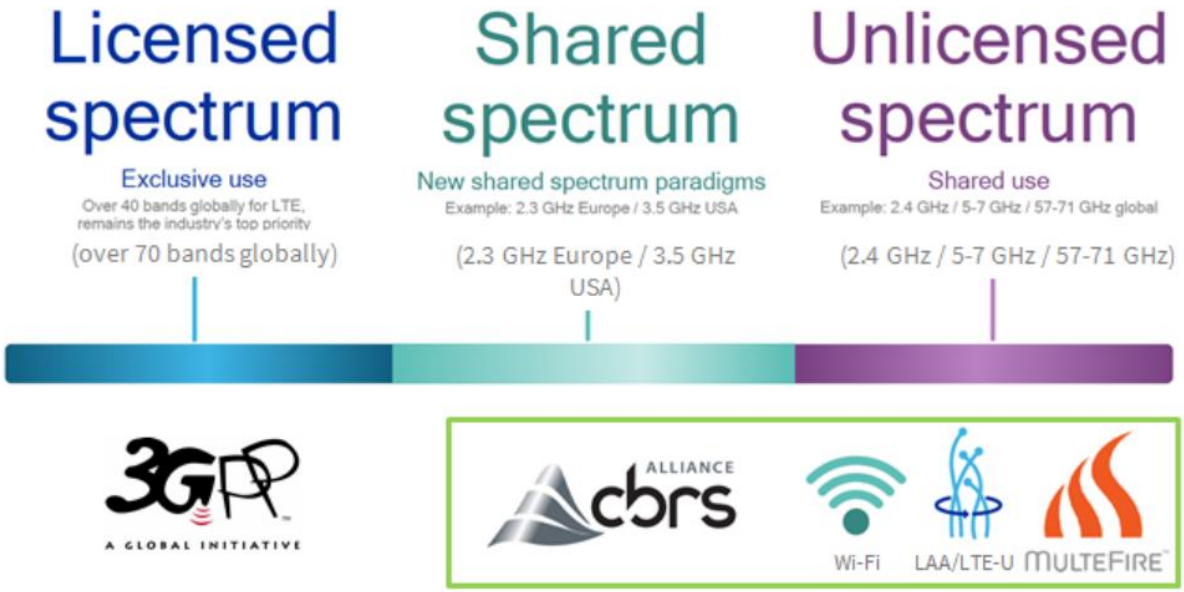
1- Non 3GPP solutions operating in an unlicensed spectrum
2- 3GPP solutions operating in a licensed spectrum

- Non 3GPP Unlicensed Spectrum IoT Technologies

Many IoT devices will be served by radio technologies that operate on unlicensed spectrum and that are designed for different connectivity ranges with limited QoS and security requirements.

- 3GPP Licensed Spectrum IoT Technologies

Currently, all the Licensed Spectrum IoT applications are mainly operating in wide-area coverage environments which rely on Cellular Technologies such as 2G, 3G or 4G connectivity (and future 5G).



4- GPP Licensed Spectrum IoT Technologies

Cellular networks, especially GSM/GPRS (2G) is by far the most used WAN IoT network. These wide area networks (WANs) operate on licensed spectrum and historically have primarily targeted high-quality mobile voice and data services.

However, the actual mobile network connectivity can be used only for a limited set of IoT application due to cost and power consumption. Then, in order to support the further growth and development of the Internet of Things (IoT) the mobile industry is developing and standardizing a new class of Cellular Technologies for Low Power Wide Area (LPWA) IoT applications with low mobility, low power consumption, long range, low cost and security.

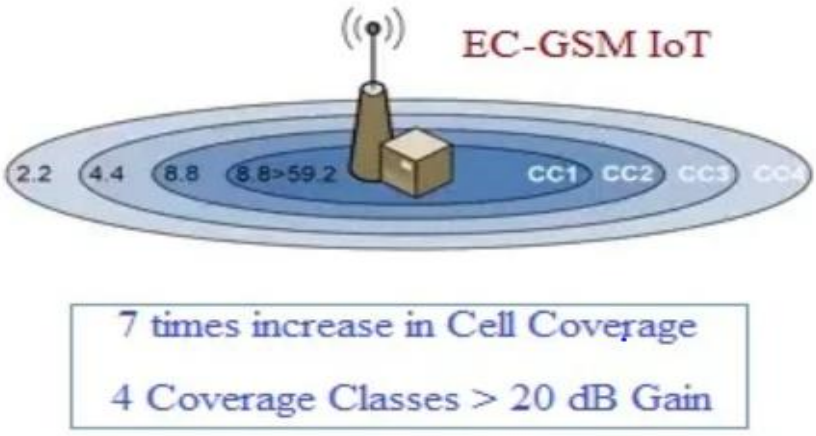
These Low Power Wide Area (LPWA) networks will play an important role in connecting up the billions of new devices making up the IoT. LPWA technologies are expected to serve a diverse range of vertical industries and support a range of applications and deployment scenarios, which existing mobile technologies may not currently be best placed to connect.

Due to the diversity of IoT application requirements, a single technology is not capable of addressing all of the LPWA use cases and so the mobile industry has focused on three proposed complementary licensed 3GPP standards.

- Extended Coverage GSM for the Internet of Things (EC-GSM-IoT),
- LTE-Machine Type Communication (LTE-MTC) standard,
- Narrow Band – Internet of Things (NB-IoT).

- **EC-GSM-IoT**

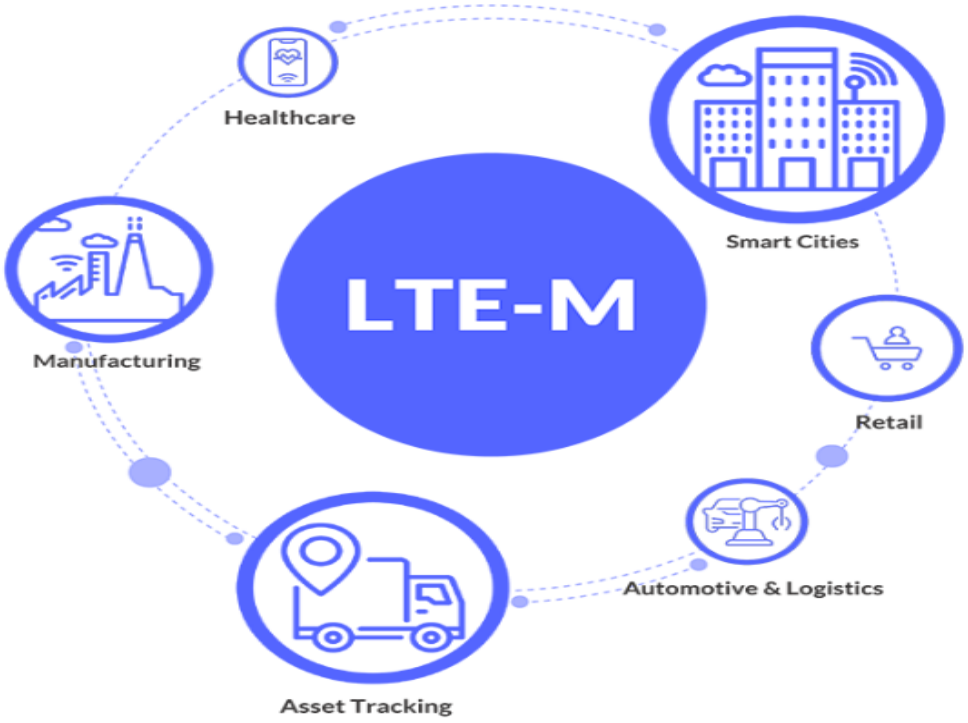
GSM is still the dominant mobile technology in many markets from
population coverage perspective, and the vast majority of cellular M2M applications today use GPRS/EDGE for connectivity. GSM is likely to continue playing a key role in the IoT well into the future, due to its global coverage footprint, time to market and cost advantages



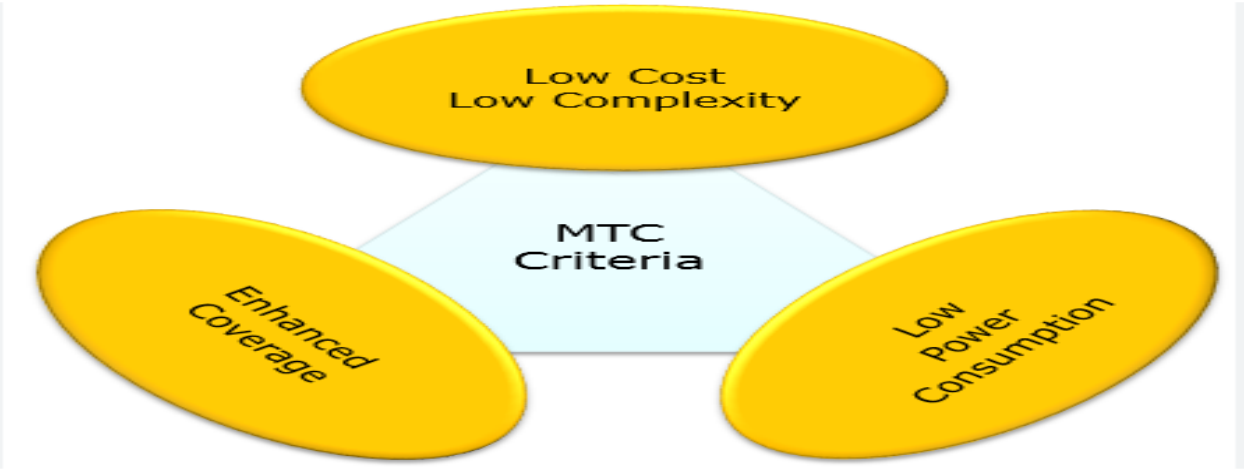
- **LTE-MTC/LTE-M**

LTE is the leading mobile broadband technology and its coverage is expanding rapidly. So far, the focus has been on meeting the huge demand for mobile data with highly capable devices that utilize new spectrum. With features like Carrier Aggregation, MIMO and Lean Carrier, the gigabit per second performance for LTE cell throughput is now reaching levels that result in an excellent mobile broadband user experience.
LTE supports also both frequency division duplex (FDD) and time division duplex (TDD) modes using a common subframe structure of 1ms. Having such a short subframe length allows for latency to be minimized, thus ensuring a good user experience.
The advent of LTE-Machine Type Communication (LTE-MTC) signifies an important step in addressing MTC capabilities over LTE. LTE-MTC brings new power-saving functionality suitable for

serving a variety of IoT applications; Power saving features extend battery life for LTE-MTC to 10 years or more.



The main technical objectives of LTE-MTC Standard are as follows:



- Long battery life: ~10 years of operation with 5 Watt Hour battery (depending on traffic and coverage needs).

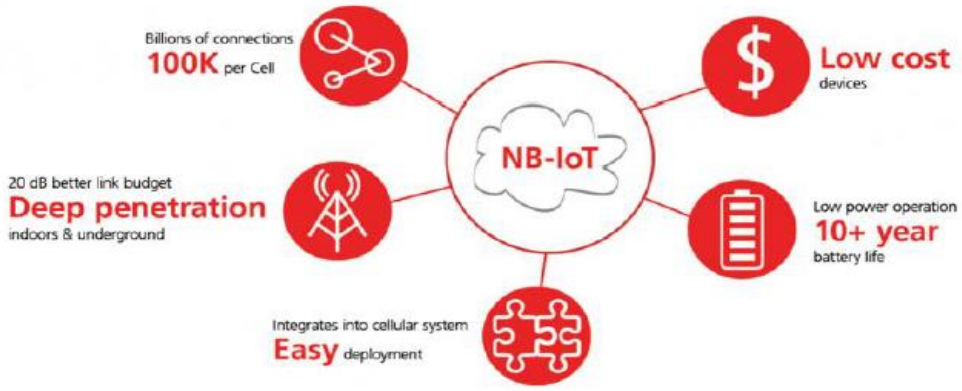
- Low device cost: comparable to that of GPRS/GSM devices.
- Extended coverage: >155.7 dB maximum coupling loss (MCL).
- Variable rates: ~10 kbps to 1 Mbps depending on coverage extension.
- Can be deployed in any LTE spectrum.
- Coexist with other LTE services within the same bandwidth.
- Support FDD, TDD and half duplex (HD) modes.
- Reuse existing LTE base stations with software update.
- Spectrum Resources: LTE-MTC needs a minimum of spectrum bandwidth of 1.4MHz
- (Release 13).
- - Deeper Coverage: We have only 15dB coverage extension (<20dB as target).
- Battery Usage: For high traffic and coverage needs, we can have less than 10 years of
- operation.

- **NB-IoT.**

In June 2016, 3GPP completed the standardization of NB-IoT as another 3GPP Rel 13 proposal which is not based on LTE, and demonstrated the ability to quickly respond to the emerging market needs. With the completion of the new narrowband radio technology developed for the Internet-of-Things (IoT), 3GPP has concluded a major effort in Release 13 to address the IoT market.

As shown in Figure below, the 3GPP NB-IoT evolution was also the result of a joint effort of Industry players to customize a new Narrow Band IoT standard satisfying all the LPWAN application requirements. It began with 2 standards: NB-CIoT and NB-LTE and ends with a consolidated standard NB-IoT.
The Narrowband IoT (NB-IoT) proposal is set for approval in 3GPP Rel. 13 with the following improvements over LTE-M:

- Reduced device bandwidth of 200 kHz in downlink and uplink.
- Reduced throughput based on single PRB operation.
- Provide LTE coverage improvement corresponding to 20 dB (5 dB better than LTE-M).



5- Conclusion:

As they are largely responsible for wireless connectivity on a global scale, operators are in an excellent position to capture a share of the added value generated by the emerging IoT market. The size of this share will depend on the role that operators adopt in the value chain. This could range from being a straightforward connectivity provider (monetizing connectivity in new ways), all the way to being an end-to-end solution provider of turnkey solutions to vertical markets. The market is now expanding toward both Massive IoT deployment as well as more advanced solutions that may be categorized as Critical IoT.

Massive IoT changes the requirements for connectivity significantly, mainly with regards to long battery life, low device costs, low deployment costs, full coverage and support for a massive number of devices. Based on these requirements, several different non-cellular LPWA connectivity solutions are emerging and are competing for IoT business and the overall connectivity market.
While operators and vendors are reviewing their connectivity roadmaps against the IoT requirements and the potential threats from new entrants and start-ups, Ooredoo's view is that the 3GPP standardized IoT solutions (LTE-M, NB-IoT and EC-GSM) are the superior ones to satisfy the connectivity profiles and requirements for IoT since cellular IoT provides an easy software upgrade of existing networks while providing optimized device KPIs, battery life, coverage and cost.
Based on the actual IoT ecosystem evolution, we can note that the main vendor and global operators' view of IoT is supporting the Narrow Band Internet of Things (NB-IoT) for LPWA/Massive IoT implementation.
For the Critical IoT implementation, all the Operators do not see any other competitor to LTE-M and LTE Solutions at the moment (waiting for 5G standardization).
The LTE evolution for LTE-M and the NB-IoT will enable Cellular IoT for low cost, low power and wide area (LPWA) deployments that provide:

- Long battery life through power saving mode and eDRX.
- Low device cost via low complexity devices category.
- Low network deployment cost.
- Full coverage via new coding, repetition and power spectral density boosting.
- Optimized core network for IoT.

A growing Internet of Things provides a huge range of socio-economic benefits. IoT solutions deliver benefits to society, governments, citizens, end-users and businesses. Governments and regulators can unlock these socio-economic benefits by implementing policies that promote innovation and investment, as well as introducing regulatory frameworks that build trust and that are technology neutral. This will give confidence to consumers and the industry that will help to drive adoption of the IoT.

6- References

- 3GPP recent release
- Actual trial in the telecom markets (OG Telecom Company)
- Huawei engineering references.