TATA COMMUNICATIONS

PORTFOLIO : SERVICE

CELLULAR LPWA TECHNOLOGIES

CONSIDERATIONS AND COMPARISONS

MAY 2021| TATA COMMUNICATIONS

OVERVIEW

There is increasing interest in deployment of communications protocols for low power wide area (LPWA)

connectivity. While LPWA technology is applicable for a wide range of use cases, it is not suitable for all uses cases. The type of application, the amount of data to be generated on a regular basis, the type of environment within which a connected asset is deployed and the nature of the connected asset itself are all determinants of what is and what is not appropriate. LPWA technologies are suitable in some cases, while full 4G/LTE or 5G cellular technologies can be more appropriate for other use cases.

LTE-M (LTE-MTC) and NB-IoT (Narrow Band IoT) are example of cellular based, Low Power Wide Area (LPWA) network access technologies specified by 3GPP in Releases 13 to 15 to address the fast-expanding market for LPWA connectivity. This technology is focused around serving M2M/IoT use cases.

INTRODUCTION

The expanding market for Low Power Wide Area (LPWA) connectivity includes many competing access technology types for enterprises to consider. The market has developed in this way because as yet, there is no one size fits all solution that can accommodate and help solve the specific business problems of individual enterprises. This paper aims to shed some light on the different access technology types, their advantages and disadvantages and generally what the enterprise should be considering in their evaluations.

The document contains:

- An overview of LPWA access technology stack,
- Status of LPWA deployments worldwide (as of May 2021)
- Availability of LPWA through Tata Communications MOVE™ platform

The paper concludes with a look at how Tata Communications can support an enterprise LPWA IoT strategy.

LOW POWER WIDE AREA (LPWA) NETWORKS

LPWA technologies can be divided into technology that uses licensed spectrum and technology that uses unlicensed spectrum. The focus of this paper is on LPWA technologies using licensed spectrum.

LPWA technology has the following characteristics:

• Low power consumption, enables devices to operate for several years on a single charge or battery

• Low device unit cost

• Improved outdoor and indoor coverage compared with existing wide area technologies

• Secure connectivity and strong authentication

• Optimized data transfer for small, intermittent blocks of data

• Simplified network topology and deployment

• Network scalability for capacity upgrade

LPWA technologies that use licensed spectrum include:

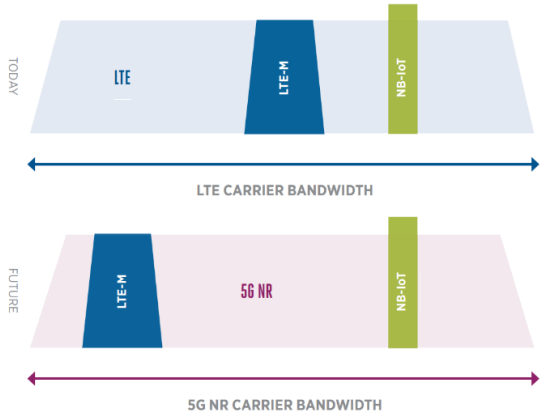
LTE-Cat M

The industry term for the Long-Term Evolution (LTE) machine-type communications (MTC) LPWA technology standard introduced by 3GPP in Release 13. LTE-M supports lower device complexity, massive connection density, low device power consumption, low latency and provides extended coverage, while allowing the re-use of the LTE installed base. The deployment of LTE-M can be done “in-band” within a normal LTE carrier, or “standalone” in a dedicated spectrum. Today, all MNOs have deployed LTE-M in ‘in-band’ mode.

Narrowband IoT (NB-IoT)

Is a 3GPP radio technology standard introduced in Release 13 that addresses the LPWA requirements of certain IoT applications and use cases. NB-IoT is characterized by improved indoor coverage, support for a massive number of low throughput devices, low delay sensitivity, ultra-low device cost, low device power consumption and optimized network architecture. Like LTE-M, NB-IoT can be deployed “in-band” within a normal LTE carrier, or “standalone” for deployments in dedicated spectrum. Additionally, NB-IoT can also be deployed in an LTE carrier’s guard-band.

LPWA in the 5G Era: Both LTE-M and NB-IoT are designed to co-exist with 5G network functions. Both LTE-M and NB-IoT are being considered to support 5G mMTC use cases.



(image source: GSMA)

3GPP standards are evolving to ensure 5G supports in-band LTE-M and NB-IoT access technologies.

The in-band operation for NB-IoT and LTE-M within 5G carrier bandwidths is achieved by including:

- A 5G modulation numerology and frame structure compatible with LTE
- A 5G duplex frequency configuration allowing 5G Nr, NB-IoT and LTE-M subcarrier grids to be aligned, and
- Support for "forward compatibility" configuration making it possible for 5G user equipment (UE) / devices to rate match around radio resources that are being used by non-dynamically scheduled NB-IoT and LTE-M signals.

These features help achieve the desired 5G NR, NB-IoT and LTE-M coexistence performance.

LTE-M

LTE-M is the simplified industry term for the LTE-MTC low power wide area (LPWA) technology standard published by 3GPP in the Release 13, 14 &15 specification. It specifically refers to LTE Cat M1, suitable for the IoT. LTE-M is a low power wide area technology which supports IoT through lower device complexity and provides extended coverage, while allowing the re-use of the LTE installed base.

As per GSMA, LTE-M can operate in bands: 1, 2, 3, 4, 5, 12, 13, 20, 25, 26 and 28 worldwide. However, every MNO in individual countries has deployed LTE-M in either one or more of the above-mentioned bands depending on its availability.

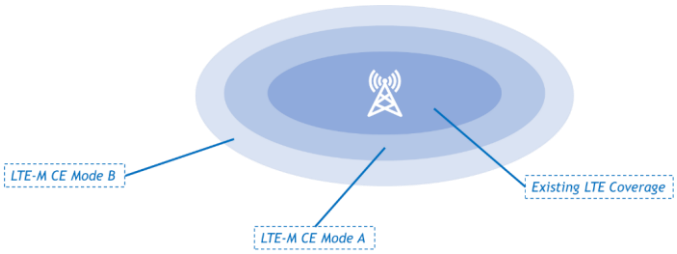
The LTE-M technology stack supports the following features:

1. Reduced energy consumption per device -
   - Power Saving Mode (PSM): In PSM, the device can effectively "power OFF" for long periods of time (~413 days – in theory) and yet remain attached to the LTE-M network.
   - Extended Discontinuous Reception (eDRX): With eDRX, the device will be able stay asleep for a longer DRX cycle (~ 3 hours).
   - Both PSM and eDRX allow devices to power down for extended or relatively longer periods of time than traditional LTE devices. This helps in conserving battery power

2. Reduced device complexity -
   - Regular LTE devices use full duplex operation, which means device supports simultaneous transmission and reception.
   - LTE-M devices, on the other hand, use half duplex operation, which means devices alternate between transmission and reception.
   - Half duplex implementation in turn reduces complexity which in turn helps in reducing the overall cost of devices

3. Re-use existing infrastructure – LTE-M can be deployed and re-used in existing LTE bands and can co-exist with regular LTE infrastructure. Usually, MNOs work with their network equipment partners to upgrade the software and configuration to support LTE-M on existing LTE infrastructure.

4. Coverage enhancement (CE) modes –
   - LTE-M supports coverage enhancement modes viz. CE Mode A and CE Mode B.
   - CE Mode A is default mode of operation wherein LTE – M offers moderate coverage enhancements compared to regular LTE.
   - CE Mode B is an optional coverage extension that offers even greater coverage at an expense of throughput and latency. CE Mode B is intended mainly for deeper coverage within buildings and for use cases that require fixed coverage for stationary devices.



(image source: GSMA)

5. LTE – M supports Voice (via VoLTE) and SMS capability natively as part of the technology stack. Voice and SMS services, if delivered simultaneously are done so at the expense of throughput and latency.

6. LTE – M also supports mobility as part of CE Mode A.

7. Maximum theoretical throughput supported by LTE – M is 1 Mbps / 1Mbps (in DL/UL).

NB-IOT

NB-IoT is a new cellular radio access technology specified by 3GPP in Release 13, Release 14 and Release 15 to address the fast-expanding market for low power wide area connectivity.

As per GSMA, NB-IoT can operate in bands: 1, 2, 3, 4, 5, 8, 12, 20, 26 and 28 worldwide. However, every MNO in each country has deployed NB-IoT in either one or more of the above-mentioned bands depending on its availability.

NB - IoT technology stack supports the following features:

1. Reduced energy consumption per device -
   - PSM and eDRX modes are also available as part of NB-IoT standards-based technology stacks.
   - Features are similar to those available with LTE-M.
2. Coverage extension (CE) modes -
   - NB-IoT supports 3 CE modes viz. CE0, CE1 and CE2.
   - CE0 corresponds to regular NB - IoT coverage whereas CE2 deals with worst case scenario where coverage is extremely poor.
   - CE level support decision within an NB - IoT network depends on the network design decision of individual MNO/s.
3. As NB – IoT is a new cellular radio access technology additional Radio infrastructure deployment within the LTE network is necessary to support it.

4. NB-IoT offers Data ONLY services and SMS services within an NB-IoT network is limited.

5. Maximum theoretical throughput supported by NB-IoT is 250 Kbps / 230 Kbps (in DL / UL).

Comparison of NB-IoT and LTE-M

The following table summarises the difference between both cellular LPWA access technologies.

Feature	LTE - M	NB-IoT
Mobility	Full mobility is supported with seamless handover under CE mode A.	No mobility support due to absence of soft – handovers. Cell reselection occurs when NB-IoT device move between cell sites.
Data Rates	1 Mbps (Downlink) 1 Mbps (Uplink)	250 Kbps (Downlink) 230 Kbps (Uplink)
Latency	Low (< 1s)	High (< 10s)
Coverage	Good indoor coverage can be achieved using CE mode B at an expense of mobility, throughput, and latency.	Maximum indoor coverage can be achieved using CE mode 2 at expense of reduced throughput and larger retransmissions (may indirectly affect battery life).
Voice / SMS	Voice support is available through VoLTE. SMS support is available through standard LTE SGs interface.	Voice support is not available. SMS support is not available however limited implementations support SMS in MT direction. Most MNO implementations today DO NOT support SMS over NB-IoT
Expected max. battery life	Very long battery life	Maximum battery life possible (up to 10 years)
Radio module costs (expected ballpark)	€ 5 - € 10	< € 5

STATUS OF GLOBAL IOT LPWA DEPLOYMENTS

With regards to global LPWA deployment, NB – IoT deployments started earlier vs LTE – M.

Most MNOs in North Asia as well as MNO groups like Vodafone and Deutsche Telekom initially preferred deploying NB-IoT in their respective countries.

LTE-M is slowly gaining momentum since the beginning of 2019 with North American MNOs and European MNO groups like Orange and Telefonica opting to follow LTE-M as a preferred LPWA access route.

For both these cellular LPWA access technologies, coverage will be initially restricted to individual home markets of respective MNOs. Roaming access on LPWA access technologies is still very restrictive (as on March 2021) with limited roaming agreements between MNOs due to evolving roaming methods under the purview of GSMA.

Up to date status about LPWA access in individual countries for respective MNOs is available in the public domain on GSMA | Mobile IoT LPWA - LTE-M & NB-IoT Commercial Launches | GSMA.

As of March 2021, LPWA access is available in 156 networks worldwide within their respective countries. 52 networks support LTE – M whereas 104 networks support NB – IoT as LPWA access technology.

GSMA defines standard practices to be followed to enable roaming access amongst MNO partners.

LPWA roaming methods and practices were introduced by GSMA members at the beginning of 2020.

As per GSMA, an explicit agreement must be executed, to allow roaming access to LPWA access technologies in MNO's network.

Inter LPWA access technology roaming is not standardised and allowed to date, due to inherent differences between LTE-M and NB-IoT..

TATA COMMUNICATIONS MOVE AND LPWA

Tata Communications MOVE has been designed to support all types of cellular based connectivity, and the nature of the service is such that access to specific connectivity technology is dependent on the technology deployments across the hundreds of individual mobile networks we work with.

The most important consideration when thinking about different types of IoT connectivity technology is the use case.

- How much and what type of data will be generated? Will data be generated in small bursts or on a continuous basis? What is the detination of the data, such as an application in the cloud or a specific location?
- Is latency an issue? Is there a requirement for near real-time data streaming or is latency not important?
- Will your connected devices operate with an independent power supply, or is there access to mains electricity? What type and how much data will be transmitted on a regular basis?
- Is the expectation to support an asset in motion, requiring seamless handover between cell sites/locations?
- Will there be a requirement for multi-country connected device deployment, or is there only a requirement for deployment in a single country?

Depending on the answers to these questions, along with other considerations such as form factor, the environment in which the deployment will take place, and device access, the type of connectivity that is needed can be decided.

With a still relatively fragmented country by country deployment for NB-IoT and LTE-M, then a multi-country deployment would need to take into consideration whether the technology is even available to support the connected devices.

Standard cellular technology (3G, 4G and growing 5G) remains the only ubiquitous, high capacity terrestrial connectivity technology.

CONCLUSION

In general, Tata Communications aggregates access into the Tata Communications MOVE™ platform through the following routes:

IMSI Sponsorship:

- Tata Communications onboards IMSIs from multiple IMSI sponsors on the MOVE platform.
- This allows Tata Communications to access the roaming footprint of IMSI sponsors.
- KPN is currently the largest IMSI sponsor for Tata Communications. KPN has adopted LTE – M as its chosen LPWA access technology on its own network in Nederland.
- KPN has been actively participating in GSMA forums to define LTE-M roaming standards with other GSMA member MNOs.
- KPN currently offers explicit LTE-M roaming based access into 11 MNOs globally.
- Other European IMSI sponsors viz. Orange and Telefonica have a strong preference for LTE-M based LPWA access within their individual group MNO affiliates.
- Orange and Telefonica have recently initiated discussions to offer LTE-M based roaming access with their MNO partners. Availability of group-wide LTE M access on Orange and Telefonica IMSIs is scheduled for H1 2022.

Direct Roaming Access:

- Tata Communications executes direct roaming agreements, as per GSMA standards, on its own IMSIs.
- As per standard GSMA practices, 901 IMSIs are optimised for enabling M2M/IoT usage.
- With certain enhancements in standard roaming documents, Tata Communication can execute explicit direct LPWA roaming agreements on its own 90154 IMSI range.
- We are working with KPN to execute explicit LTE-M roaming access agreement in KPN's own network in Nederland.
- Direct LTE-M roaming access on Tata Communications' 90154 IMSI range will be available for usage in H2 2021. Learnings from this first direct LTE-M roaming agreement will be documented and reused for other direct LTE-M roaming agreements in future

Local eSIM Profile Access:

- Tata Communications is onboarding local eSIM profiles on its own eSIM subscription management platform through a light touch API based integration.
- So far, the ambit of eSIM based access is restricted to regular cellular (2G/3G/4G) based access technologies in respective MNO's domestic network.
- LPWA support is on roadmap with eSIM partners like Bell Canada, China Mobile and Deutsche Telekom.
- LPWA support on eSIM profiles will be subject to MNO partner's conditions like –
    - Device certification,
    - Non-availability of eSIM profiles for NB-IoT access,
    - Driven by opportunity size, nature and use cases,
    - Restricted to customer opportunities wherein there is no direct, competition between Tata Communications and MNO partner, etc.

Local MVNO Access (UK, NL only):

- Tata Communications offers local MVNO services in Netherlands and the UK.
- Usually, local MVNO access is suited for human usage hence local host MNO partners KPN in Nederland and EE/BT in the UK will offer LPWA access in their respective networks on Tata Communications' 90154 IMSI range (through standard GSMA based agreement).
- KPN is working on opening its LTE-M network to Tata Communications' 90154 IMSI range.
- EE's network in the UK supports NB-IoT as the sole LPWA access technology. Access to EE's NB-IoT network will be enabled once Tata Communications' MOVE platform supports NB-IoT capability.

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About Tata Communications

Tata Communications is a leading global digital infrastructure provider that powers today's fast growing digital economy.

The company's customers represent 300 of the Fortune 500 whose digital transformation journeys are enabled by its portfolio of integrated, globally managed services that deliver local customer experiences. Through its network, cloud, mobility, Internet of Things (IoT), collaboration and security services, Tata Communications carries around 30% of the world's internet routes and connects businesses to 60% of the world's cloud giants and 4 out of 5 mobile subscribers.

The company's capabilities are underpinned by its global network. It is the world's largest wholly owned subsea fibre backbone and a Tier-1 IP network with connectivity to more than 240 countries and territories.

Tata Communications Limited is listed on the Bombay Stock Exchange and the National Stock Exchange of India and is present in over 200 countries and territories around the world.

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