DEVELOPMENT GUIDE FOR

LTE-M CONSUMER DEVICES

ABOUT THE GSMA

The GSMA represents the interests of mobile operators worldwide, uniting more than 750 operators with over 350 companies in the broader mobile ecosystem, including handset and device makers, software companies, equipment providers and internet companies, as well as organisations in adjacent industry sectors. The GSMA also produces industry-leading events such as Mobile World Congress, Mobile World Congress Shanghai, Mobile World Congress Americas and the Mobile 360 Series of conferences.

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The GSMA's Internet of Things Programme is an industry initiative focused on:

COVERAGE of machine friendly, cost effective networks to deliver global and universal benefits.

CAPABILITY to capture higher value services beyond connectivity, at scale.

CYBERSECURITY to enable a trusted IoT where security is embedded from the beginning, at every stage of the IoT value chain. By developing key enablers, facilitating industry collaboration and supporting network optimisation, the Internet of Things Programme is enabling consumers and businesses to harness a host of rich new services, connected by intelligent and secure mobile networks.

Visit gsma.com/iot or follow gsma.at/iot to find out more about the GSMA IoT Programme.

CONTENT

1. Introduction

The GSMA Internet of Things (IoT) programme helps mobile operators add value and accelerate the delivery of new connected devices and services in the IoT. The programme supports industry collaboration, appropriate regulation, and the optimisation of networks as well as developing key enablers to support the growth of the IoT in the longer term. The vision is to enable the IoT to deliver a world in which consumers and businesses enjoy rich new services, connected by an intelligent and secure mobile network.

This document provides an overview of the deployment plans for key features of LTE-M, and related set up and configuration guidelines for manufacturers of consumer devices, such as wearables (including fashionable low-end leisure devices and smart watches for VIP/pet tracking) and white goods/appliances.

This guide includes the features standardised in 3GPP Releases 10-13, focusing on the key features that will be deployed over the next 12 months. The features specified in 3GPP Release 14, published in the summer of 2017, are not included in this document.

Non-3GPP LPWA technologies, such as SigFox or LoRa, as well as NB-IoT (Narrowband IoT) are out of the scope of this document.

2. Example of Consumer Applications

This document illustrates how consumer applications can utilise LTE-M by describing two examples: a doorbell and a consumer tracker. These two examples employ a good range of the capabilities provided by LTE-M in different conditions.

2.1. Doorbell System

A connected doorbell can place a call to a preselected number (typically the occupier or family members) when nobody answers the door. The device could also have a camera to view the person at the door and the occupier could set up a call to the doorbell directly. This document assumes that the door bell:

- Is normally attached to mains power, but in case of power loss it would utilise auxiliary batteries;
- Requires two-way communication, both to receive a voice call, and to upgrade firmware and software.

2.2. Consumer tracker

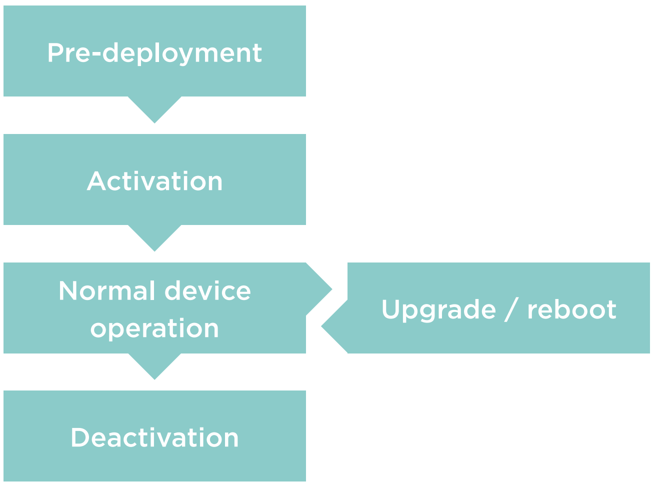
A consumer tracker is a small device that can be used by the owner to locate objects (such as keys or pets). The tracker will regularly provide updates about its location to its owner. The application also regularly collects information about the device that is relevant for the provided service, such as the battery level. This document assumes that:

- The device is battery powered;
- The location information can be sent periodically at a user-defined interval or under different options/scenarios:
  - Geo-fencing: when the device leaves a predefined area (geo-fencing) and/or upon request by the user;
  - Chrono fencing: the device is configured to send a status update after staying at a location for a certain pre-defined time.
  - On demand location request: when the user (or an authorised third party) sends a request to the tracker to update its status and position.
- The service provides the device location, which could be obtained using different technologies, such as the mobile network or a satellite-based system.

3. LTE-M in the Consumer Device Lifecycle

This section considers the phases of the consumer device lifecycle and describes how the features of LTE-M can be used and what the benefits are. For further information on the features of LTE-M see the LTE-M Deployment Guide.

Generally, there are several phases of the lifecycle of the application and device that need to be considered, as illustrated in the graphic below.



Pre-deployment
The main purpose of this phase is to be able to select the right module and components of the device in order to fulfil the planned service.

Before deploying the service, there are a few considerations that need to be taken in account. Understanding these aspects helps to select the right communications module for the application.

- Area of deployment: country of operation, urban or rural, indoors or outdoors;
- Power supply: mains power, battery powered;
- Type of communication required: packet data, voice or SMS;
- Amount of traffic needed;
- Operational lifetime of the device;
- Need to support upgrades over time;
- Security.

There are many different LTE-M modules available commercially; some examples are listed on the GSMA website. Each module supports a set of frequency bands that are appropriate for a particular region or mobile operator. The LTE-M Deployment Guide provides information about the frequency bands that are required to guarantee global coverage. In addition, the solution provider needs to consider whether the device will be deployed mainly outdoors or indoors, or in an urban or rural area, as this will help determine whether extended coverage is required and also to select the right antenna.

For battery-powered devices, it is important to select a battery suitable for the specific application. Furthermore, to optimise the battery lifetime of the device, the solution provider needs to consider the impact of the estimated data traffic on power consumption. It is also important to consider potential device upgrades: how they will be performed and how often.

In all phases of the device life cycle, the solution provider should consider the security aspects and features required to provide a secure end-to-end solution: for more information, see the GSMA IoT Security Guidelines.

Activation
The purpose of the activation phase is to be able to configure the LTE-M features appropriately. The activation phase is when the device and service is deployed and switched on for the first time, and the SIM is activated so that the device can send and receive data.

The timing of the activation of the SIM depends on the format of the SIM. For a traditional SIM, the activation is already complete at the time of purchase and the services included in the subscription will be active from the start. The SIM can be inserted into the device, which can then start to send and receive data. In the case of some bulk orders, the activation will take time, so the device will check at regular intervals if the SIM is activated.

In the case of an embedded SIM, the activation might be performed remotely and the process will differ depending on the type of remote provisioning procedure required: remote provisioning for M2M or remote provisioning for consumer. In the case of remote provisioning for M2M, the SIM will have a bootstrap profile that allows the device to obtain the connectivity needed to retrieve the operation profile from the mobile operator. As in the traditional case, the mobile operator needs to provide a profile. All procedures will be initiated by means of a SMS that will open a data channel (by using the bootstrap profile) to download the operational profile. In the case of the remote provisioning for consumer procedure, the mobile operator also needs to provide a profile. However, as soon as the device turns on, the module will try to contact the GSMA Root Discovery Service to see if there are any profiles waiting for it, coming from any mobile operator in the world. The device will either use a Wi-Fi connection or a connection through the mobile operator's bootstrap profile for this initial data transmission.

During the consultation with the selected mobile operator, the solution provider should describe the service and how the various features of LTE-M will be employed. This will ensure the mobile operator can provide the best advice for a dedicated service. During this phase, the APNs (access point names) that can be used for the specific profile will also be decided. APN auto configuration is sufficient in most cases

Normal device operation
This phase represents the normal operation of the application, where the relevant information is exchanged between the device in line with the intended functionality of the application. The device may also send diagnostic information about itself at regular intervals, as well as the information related to its specific purpose, such as its location.

Over the Air Software Upgrade
Depending on the expected lifetime of the device and whether a security vulnerability is found, there might be a need to perform an 'over-the-air' upgrade of the device's firmware or software. A device might require different type of updates, such as firmware for the module, firmware for the device itself, configuration setting, and application software. Depending on the type, the upgrade might be conducted by a module manufacturer or operator, a device manufacturer or third party, or a service provider. All upgrades need to be carefully considered and governed by a schedule based on when they normally happen and how they will be performed.

LTE-M can support software upgrades, but the number of upgrades required during the lifetime of the device will have an impact on devices that are battery powered, since such upgrade procedures could be power hungry. As throughput degrades at the edge of network coverage, an upgrade at the edge of the coverage may have a major impact on battery consumption. Before performing the upgrade, the battery level of the device should be checked.

It is also a good practice not to try and upgrade all devices at the same time, especially when dealing with a large number of devices. It is best to apply a throttle software update campaign that spreads the updates over as wider a period of time as possible, as the upgrades could affect the network capacity and therefore impact the success of the upgrade. A re-try mechanism must also be factored in to the software update campaign.

Another best practice is to design the device software architecture in a modular way so that the software upgrade does not need to be monolithic, allowing small, targeted, software upgrades for the parts that require changes. Other points to consider are: the ability to recover, or fall back, to the previous software version in case of a failed upgrade, and to make sure the software update mechanism is secure (see GSMA CLP.13 IoT Security Guidelines Endpoint Ecosystem Section 7.5) to prevent a hacker injecting malware into the devices, for example.

Connection Efficiency and the Prevention of Mass Synchronised Events (e.g. Reboots)
In some circumstances, there might be a need to reboot a device. Normally, this happens after a software update, when some error or unexpected circumstances occurs, such as a wide area power cut, followed by a sudden re-connection of power.

In such scenarios the application must be designed in a robust way to avoid loop situations or other mass synchronised events that can cause a signalling storm, in which huge numbers of devices try to attach to the network simultaneously and, upon failure, due to network congestions, retry immediately.

Devices should not try to constantly reconnect to the network, but should follow the recommendations provided in the GSMA TS.34 IoT Device Connection Efficiency Guidelines. Adherence to these guidelines is essential for large deployments of devices.

Deactivation
This paper does not describe this phase in detail, but at the end-of-life of a device, the SIM needs to be deactivated to inform the mobile operator that no more traffic is expected for that SIM, which will help prevent any tampering.

3.1. Doorbell System

The following are the stages of the doorbell system life cycle:

Pre-deployment
As indicated in section 2.1, this paper assumes:

- The device is attached to mains power, but batteries are used as a backup in case of power cuts, therefore, there is no particular need to optimise power usage by activating PSM (power saving mode) or eDRX (extended discontinuous reception) when the device is connected to the mains power, but it is recommended to use both PSM and eDRX when the device is running on batteries.
- The device will have the ability to initiate and receive voice calls, which requires the support of VoLTE (voice over LTE).
- There is a requirement for device firmware and software upgrades and otherdevice management functionality, possibly by leveraging existing protocols, such as OMA LwM2M, OneM2M or MQTT-sn.

This paper also assumes

- The solution could be deployed worldwide, meaning it will need to use a LTE-M module that supports a number of frequency bands for different regions.
- The device could operate either indoor and outdoor, meaning it may be necessary to use extended coverage mode (Mode B), depending on where the antenna and the receiver is positioned in the building and the network signal strength. (To maximise the performance of LTE-M, a solution provider would typically use Mode A with normal coverage, and design the system accordingly).
- VoLTE is used to initiate a voice call from the doorbell and also to be able to call back;
  - Packet data is used to perform upgrades;
  - SMS is used, in cases where it is supported by the mobile operator and by its roaming partners.
- The traffic patterns will not be regular, as voice calls and/or camera images will only be needed in some scenarios depending on the customer's preferences. But firmware and software updates should utilise a scheduled connection.

Activation
At this stage, the solution provider needs to select the appropriate subscription for the service and activate the SIM as indicated in the previous section.

Normal device operation
Now the device is active, it can start to use the LTE-M features as intended. For example, the user could configure the system to set up a call from the door bell when somebody rings the bell, at the second ring or after a few seconds. Alternatively, the system could be configured to notify the owner by an SMS or another form of notification when the door bell rings.

Over the Air Software Upgrade, Connection Efficiency and the Prevention of Mass Synchronised Events
These phases are sufficiently described in the introduction to section 3.

3.2. Consumer tracker

A consumer tracker is a small device that can be use by the owner to locate objects, such as keys, or pets.

Pre-deployment
As indicated in section 2.2, this paper assumes:

- The device is battery powered, meaning it is essential to use both PSM and eDRX to reduce the battery consumption as much as possible.
- Tracking location will require the device to regularly connect to the network. Ad hoc update requests from the end user could be carried using the different transport mechanisms provided by LTE-M.
- There is a requirement for device firmware, software upgrades and other device management functionality, possibly by leveraging existing protocols like OMA LwM2M, OneM2M or MQTT-sn.

The paper also assumes
- The solution could be deployed worldwide, meaning it will need to use a LTE-M module that supports a number of frequency bands for different regions.

- The device could operate either indoor and outdoor, meaning it may be necessary to use extended coverage mode (Mode B), depending on the network signal strength. (To maximise the performance of LTE-M, a solution provider would typically use Mode A with normal coverage, and design the system accordingly).
- Packet data transmissions are used to send application-specific information and for performing upgrades.
- SMS is used, in cases where it is supported by the mobile operator and by it roaming partners.
- The device will connect to the network with a predictable traffic pattern, while firmware and software updates should utilise the scheduled connection. However, in some cases, the request to provide a location update will be prompted outside of the regular updates.

Activation

At this stage, the solution provider needs to select the appropriate subscription for the service and activate the SIM as indicated in the previous section.

Normal device operation

Now the device is active, it can start to use the LTE-M features as intended to send location information. In this specific case, the device will already have selected the timers for PSM and eDRX. It will start the cycles as defined in the settings.

Over the Air Software Upgrade, Connection Efficiency and the Prevention of Mass Synchronised Events

These phases are sufficiently described in the introduction to section 3.

4. LTE-M Feature for ‘Consumer Devices’

The following section provides an overview of the various features that are available in the LTE-M networks that are live today.

4.1. Coverage and Connectivity

As LTE-M networks were first deployed in March 2017, coverage varies from country to country and from mobile operator to mobile operator. Therefore, it is important to check the coverage in the areas of interest. However, as LTE-M is designed as a software upgrade to existing LTE infrastructure, customers might find coverage expands almost overnight. The current coverage of LTE provided by the mobile operator could be a good indicator of the potential LTE-M coverage a customer could utilise.

Note, that the 3GPP standard encompasses both the uplink (data sent from the device to the network) and downlink (data sent from the network to the device). With conventional LTE, there might be different performances for uplink and downlink depending on the chosen configuration and condition.

LTE-M offers various ways to set up a connection to and from the device:

- For a voice call, it supports VoLTE;
- For packet data communication, it sets up a user plane channel.
- Alternatively, for transmitting small amounts of data, SMS can be used.

All three types described above can be used to enable communication either from or to the device. Conventional LTE also supports VoLTE, SMS and user plane transmissions. Although the way to set up and use these features is the same, some small aspects are particular to LTE-M.

As indicated in the LTE-M Deployment Guide, VoLTE is an optional feature so a user should verify with the mobile operator that VoLTE is supported and in which configuration.

To set up a data connection through the user plane it is necessary to set up the appropriate APN (Access Point Name), which enables a connection to the right IP address. Mobile operators might have a generic APN for LTE-M or they might provide a dedicated APN upon request to enable a secure end-to-end channel for their customer though a virtual private network VPN. The mobile operator will provide the right settings for the APN.

Like LTE, LTE-M supports both TCP (transmission control protocol) and UDP (user datagram protocol) connections, where UDP is considered more efficient from a power efficiency point of view.

Generally, traditional M2M applications, which run on GPRS, only use SMS for collecting data from the devices. However, SMS has some constraints: higher power consumption and limits of 140 bytes for the payload. The selection of the best connection type to minimise the signalling overhead will be governed by the application’s payload raw data size and upload frequency. For data below 100 bytes, SMS might be more efficient, but not for a higher amount of data.

4.1.1. Support for extended coverage mode A and B

The LTE-M standard supports two Coverage Enhancement (CE) Modes: CE Mode A and CE Mode B. Both CE Modes enable coverage enhancement using repetition techniques for both data channels and control channels. The main difference is that CE Mode A supports only moderate coverage enhancements whereas Mode B supports very deep coverage. CE Mode A is a mandatory feature for LTE-M whereas CE Mode B is an optional feature.

Therefore, solution providers planning on roaming on another LTE-M network should expect Mode A to be supported, but will need to verify whether the roaming partner of the mobile operator supports Mode B. Although CE Mode B provides better coverage, outdoor and indoor, it is unable to support other features, such as Connected Mode Mobility (see section 4.1.5). Moreover, using the CE Mode B will increase latency and decrease throughput, so it should be used sparingly and for transmitting smaller amounts of data. For further understanding on how much extra coverage can be achieved with CE Mode B, please see: Coverage Analysis of LTE-M Category-M1 by Sierra Wireless, Ericsson, Altair, Sony, Virtuosys, AT&T, Verizon, Sequans, Orange, KDDI, Nokia, NTT Docomo, KT, Softbank, Telkomsel, SK Telecom.

4.1.2. Power classes and duplex mode

For LTE-M, there are two power classes available for a LTE-M module: class 3 (23 dBm) and class 5 (20 dBm). Class 3 is slightly more demanding in terms of power consumption, but it provides better performance and, since it is the same power class as conventional LTE, it is widely supported by LTE-M modules.

LTE-M support operations in full-duplex mode (FDD) or half-duplex mode (HDD). In FDD operation, the device supports simultaneous transmission and reception, while in HDD operation, the device alternates between transmission and reception. Devices that only support HDD operation have a lower peak transmission rate compared to devices that support FDD operation: rather than reaching the peak performance of 1Mbps in uplink and downlink, transmission by HDD devices is more in the order of about 400 Kbps. But devices that only support HDD operation are less complex and less costly since they may be implemented with fewer and/or less expensive components.

4.1.3. Managing software updates

There are two main way to perform an upgrade of firmware/software or a reboot of the device: Utilise a connection that is already established by the device or set up an ad-hoc connection by sending an SMS with the request to start an IP connection. In the first case, the network can indicate to the device to keep the connection open since there is some data to be sent to the device. The second case is only possible if the mobile operator supports SMS and the SMS will be only sent when the device reconnects to the network, in any case. Mobile operators may store the requested SMS for some time, but if the PSM cycle is very long, there is no guarantee that the SMS will be sent.

As the device management features offered by each individual mobile operator may vary, the solution provider should check with the selected mobile operator on what is available.

4.1.4. Security

Developing new and innovative services for particular market segments may open up new security threats. If adversaries understand the technology and security weaknesses, they can quickly take advantage if vulnerabilities are exposed. There have been many security attacks that have resulted in compromised devices, which may then infiltrate data, attack other devices, or cause disruption for related or unrelated services. To help ensure that the new IoT services coming to market are secure, mobile operators, together with their network, service and device equipment partners, are seeking to share their security expertise with service providers who are looking to develop IoT services.

The GSMA has, therefore, created a set of security guidelines for the benefit of service providers who are looking to develop new IoT services. The complete GSMA IoT Security Guidelines are available here.

4.1.5. Connected Mode Mobility

LTE-M supports two main mobility modes: Idle Mode Mobility and Connected Mode Mobility. In Idle Mode, the user equipment (UE) is responsible for reselecting a cell if it loses a connection. However, in the Connected Mode, the network controls UE mobility: the network decides when the UE should connect to a new cell and triggers the handover procedure. Note, Connected Mode Mobility is supported only in Coverage Extended Mode A. When using Idle Mode Mobility, the device might lose a message as it drops the connection to a specific cell. The device will try to reselect another cell and the message needs to be resent.

4.1.6 Deployment Bands

The solution provider needs to ensure that their modules support the frequency bands used for LTE-M in the area where the device will be deployed, taking into account dual-mode modules.

4.2. Power Consumption (PSM (Power Save Mode) and eDRX (Extended Discontinuous Reception)

Power saving mode (PSM) is a feature designed for IoT devices to help them reduce power consumption and potentially achieve a 10 year battery life. This capability, which is defined for both LTE and GSM technologies, enables devices to enter a new deep sleep mode. PSM is intended for devices designed for infrequent data transmission and that can accept a corresponding latency in the mobile terminating communication. The device decides how often and for how long it needs to be active in order to transmit and receive data. As the timers also need to be agreed by the network, in most cases the timers are negotiated between the device and the network. In general, as recommended in the LTE-M Deployment Guide, mobile operators will accept the timer requested by the device. PSM mode is similar to power-off, but the device remains registered with the network. When the device becomes active again there is no need to re-attach or re-establish PDN (packet data network) connections. The device requests the PSM simply by including a timer with the desired value in the attach, tracking area update (TAU) or routing area update. The maximum value for the timer is ~413 days.

Extended discontinuous reception (eDRX) is an extension of an existing LTE feature, which can be used by IoT devices to reduce power consumption. eDRX can be used without PSM or in conjunction with PSM to obtain additional power savings. It allows the device to turn part of its circuitry off during the eDRX period to save power. During the eDRX, the device is not listening for paging or downlink control channels, so the network should not try to contact the device. For eDRX, the networks and devices negotiate the timer for when devices can sleep. eDRX can be applied in idle and connected modes. When the device wakes up the receiver will listen for the physical control channel. For eDRX there are a pre-defined set of timers that can be used for LTE-M (in seconds)

eDRX cycle length for LTE-M (in seconds)
5.12
10.24
20.48
40.96
81.92 (~1 min)
163.84 (~ 3 min)
327.68 (~ 5 min)
655.36 (~ 11 min)
1310.72 (~22 min)
2621.44 (~44 min)

4.3. Location

There are two main mechanisms to obtain device location information:

- Provided by the device itself;
- Provided by the mobile network.

For consumer devices where accurate positioning information is required (in the range of a few metres), it is recommended to utilise mechanisms directly in the device. The most common way to obtain accurate information is to use the global navigation satellite system (GNSS). Most of the major manufacturers provide LTE-M modules with embedded GNSS modules for positioning provided by satellite system such as GPS, GLONASS and Galileo. As GNSS modules consume more power than mobile transmission over LTE-M, it is important to understand the impact of using GNSS on devices that are battery powered. However, new GNSS modules are much more power efficient than their predecessors. GNSS only works for outdoor scenarios, while for indoor scenarios, other methods, such as the use of beacons, are required.

Alternatively, for consumer devices that do not require high position accuracy, using mobile network location services could be a better option from a power consumption point of view. The level of accuracy available from mobile operators may differ, based on their network ability. The basic and default feature supported by LTE-M is Cell-ID, which indicates the cell where the device is attached. This feature is only available for devices in the network of the mobile operator and not when the device is roaming in another operator's network.

More advanced features can be provided if the LTE Location Protocol (LPP) is used, including Enhanced Cell ID (E-CID), Observed Time Difference of Arrival (OTDOA), Assisted GNSS (A-GNSS), Terrestrial Beacon System (TBS), Sensor Based Positioning, W-LAN based positioning and Bluetooth-Based Positioning, as described in the 3GPP TS 36.355 LTE Positioning Protocol. Note, support for these systems is optional, so not all modules and operators will support them. In cases that the feature is supported by a mobile operator, it may not also be supported by its roaming partners. Each of the mechanisms provided by LPP offer a more accurate positioning than Cell-ID, but still with less accuracy than the device-provided location enabled by the GNSS. Still, there are two main advantages to using the network for providing the position information: As well as reducing power consumption, using the mobile network to provide position information helps to reduce the risk of tampering.

5. Definitions

Term	Description
IoT	The Internet of Things is a generic term for the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment. The IoT offers functions and services that go beyond the scope of pure M2M.
M2M	Machine-to-Machine is a general term referring to any network technology allowing devices, other than phones and laptops, to communicate with each other. For example two industrial robots connected to each other via Ethernet in a factory is a part of M2M, but not MIoT.
Mobile IoT	Mobile Internet of Things is a GSMA term for 3GPP-standardised low power wide area technologies using licensed spectrum (aka LTE-M and NB-IoT). From 3GPP Release 13 and the following releases, the category of user equipment that supports power consumption optimisations, extended coverage and lower complexity are part of Mobile IoT (CAT M1, CAT NB1 from Release 13 and CAT M2, CAT NB2 from Release 14). As this particular term, is widely used throughout the GSMA, it is also used in this document. Not to be confused with the term “mIoT” which means 5G massive IoT in 3GPP terminology.
NB-IoT	Narrowband IoT (NB-IoT) is a new 3GPP radio technology standard that addresses the requirements of the IoT. The technology provides improved indoor coverage, supports a massive number of low throughput devices, low delay sensitivity, ultra-low device cost, low device power consumption and an optimised network architecture. The technology can be deployed “in-band”, utilising resource blocks within a normal LTE carrier, or in the unused resource blocks within a LTE carrier’s guard-band, or “standalone” for deployments in dedicated spectrum

6. Abbreviations

Term	Description
A-GNSS	Assisted GNSS
E-CID	Enhanced Cell ID
DL	Downlink
eDRX	Extended Discontinuous Reception
eNB	Evolved Node B
EPS	Evolved Packet System
GNSS	Global Navigation Satellite System
GSM	Global System for Mobile Communications
GSMA	GSM Association
GTP	GPRS Tunnelling Protocol
HLCom	High Latency Communication
HPLMN	Home Public Land Mobile Network
HSS	Home Subscriber Server
IoT	Internet of Things
IP	Internet Protocol
IP-SM-GW	Internet Protocol Short Message Gateway
IPX	Internetwork Packet Exchange
IWF	Interworking Function
IWK-SCEF	Interworking Service Capabilities Exposure Function
LPWA	Low Power Wide Area
LTE	Long-Term Evolution
LTE-M	Long-Term Evolution Machine Type Communications
LTE MTC	Long-Term Evolution Machine Type Communications

Term	Description
M2M	Machine-to-Machine.
MIoT	Mobile Internet of Things
MME	Mobile Management Entity
MOBILE OPERATOR	Mobile Network Operator
MSC	Mobile Switching Centre
MTC	Machine Type Communications
NB-IoT	Narrowband IoT
OTDOA	Observed Time Difference Of Arrival
PGW	Packet Gateway
PRB	Physical Resource Block
PSM	Power Saving Mode
RAN	Radio Access Network
SCEF	Service Capabilities Exposure Function
SCS	Services Capabilities Server
SGSN	Serving GPRS Support Node
SGW	Serving Gateway
SIM	Subscriber Identity Module
SMS	Short Message Service
SMS SC	Short Message Service Centre
TAU	Tracking Area Updating
UDP	User Datagram Protocol
UE	User Equipment (User Device)
UICC	Universal Integrated Circuit Card (sometimes known as the SIM card)
UL	Uplink
VPLMN	Visited Public Land Mobile Network