WHITE PAPER

A GUIDE TO MOBILE IOT:
HOW TO CHOOSE BETWEEN LTE-M AND NB-IOT FOR GLOBAL DEPLOYMENTS

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Connecting things. It's all about people.

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Two new network technologies, both based on mobile (cellular) technology, are entering the market in the form of LTE-M and NB-IoT - both created to be particularly suitable for enabling global IoT connectivity.

LTE-M and NB-IoT are both good connectivity options for industries looking to take advantage of LPWAN (Low Power Wide Area Networks) technology, that enhances the battery life of devices and connects devices that have previously been hard to reach. They are both available today, standardised and built on the 4G network which means they are future-proof, have global network coverage and are backed up by GSMA and telecom standards.

But which is the best choice for your low-power IoT application? This guide describes the relative merits and limitations of each technology to help you make the right selection for long term success

INTRODUCTION

Connectivity is a crucial part of product design and performance and the choice of connectivity technology must be considered early in the process. This is a challenging choice given the quick technology and market development. 5G technologies are around the corner, 2G and 3G networks are starting to be phased out and new network technologies that support LPWAN are starting to become globally available in the form of LTE-M and NB-IoT- also referred to as Mobile IoT.

For the first time networks have been developed to answer to the specific needs of connecting things. Previously, connected units have been communicating on infrastructure developed for consumer needs.

LTE-M and NB-IoT are standardized, secure, and operator-managed in licensed spectrum. They are designed for IoT applications that are low cost, use low data rates, require long battery lives and often operate in locations that are hard to reach.

LTE-M and NB-IoT will be the obvious choices for industries looking for 2G and 3G replacements for devices with long lifecycles, requiring extended device battery life and coverage.

Both technologies are good choices for deployments with expected lifespans of a decade or more, however there are differences between them which make each of them more suitable for some IoT applications rather than others.

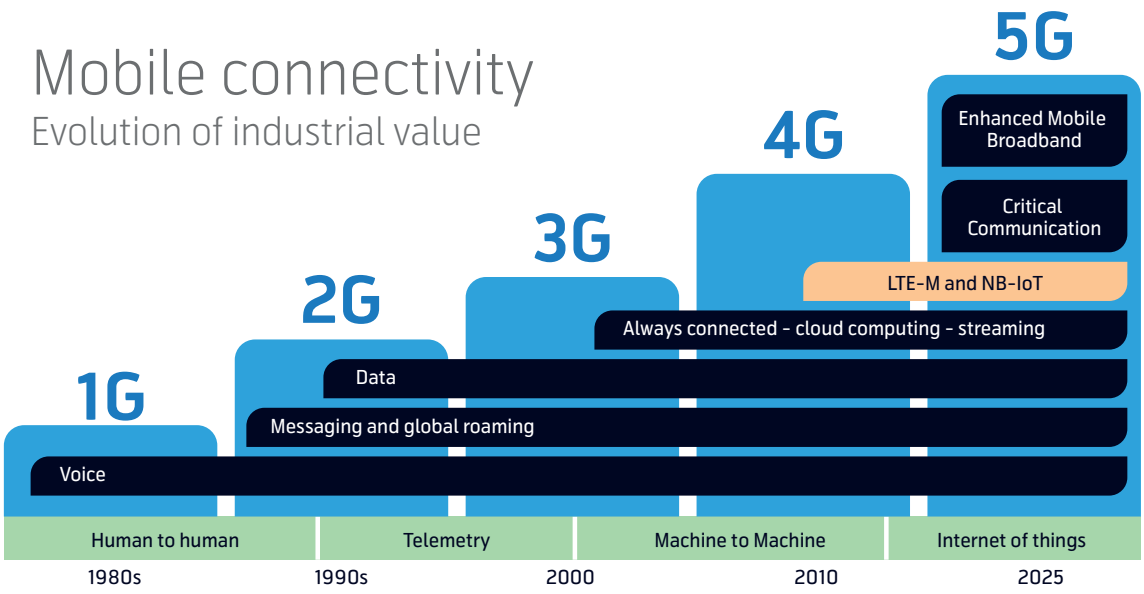
So which one is the best choice for your application?

This guide describes the relative benefits and limitations of each technology to help enterprises to make the right selection for long-term success.

Definitions of industry terms and abbreviations can be found at the end of this white paper.

MOBILE CONNECTIVITY - AN EVOLUTION OF INDUSTRIAL VALUE

But first a short overview of the development of mobile connectivity technologies. Mobile connectivity has evolved from being the infrastructure for human communication to telemetry, machine-to-machine and the internet of things applications.



- The first version of mobile connectivity – 1G – introduced wireless voice.
- In 2G, roaming and SMS messaging were introduced and were later enhanced with GPRS for data communication. SMS messaging and GPRS became widely used for basic telemetry. Roaming made mobile technology suitable for deployments in multiple countries. Telenor was one of the first operators to offer M2M communications with things connected over the 2G network as early as the 1990s.
- 3G became a truly global standard and combined the best of competing technologies in a single standard. 3G evolutions were mainly centered around high speed data applications.
- 4G introduced LTE technology used for devices constantly connected to the internet. 4G answered the consumer need for bandwidth and speed and introduced a new way to handle voice, replacing 2G voice.
- LTE-M and NB-IoT (Mobile IoT) are especially designed for the Internet of Things. LTE-M and NB-IoT support devices that need a long battery life and devices that need good network access in areas that are difficult to reach.
- 5G networks use a combination of existing 4G LTE and new 5G New Radio (5G NR) technology. 4G and 5G have been designed to co-exist and applications designed for 4G, including LTE-M and NB-IoT, can be expected to have a very long life. Today most networks that claim to be 5G networks are in fact using 4G LTE.
- 5G enhances 4G in three main use case areas; enhanced mobile broadband, critical communications and mobile IoT.
  - Enhanced mobile broadband is currently targeted towards consumers that need ever-increasing bandwidth. It also enables new IoT use cases that require high data volumes, for example streaming video.
  - Critical communications demands a much faster response and increased quality of service and security. 5G introduces 5G New Radio Technology which uses a higher radio frequency.
  - Mobile IoT - LTE-M and NB-IoT - are forward compatible with the 5G NR technology, which means that LTE-M and NB-IoT technology can be used throughout the complete 5G life cycle.

LTE-M AND NB-IOT TECHNOLOGIES - INCREASED BATTERY LIFE, ENHANCED COVERAGE AND SIMPLIFIED HARDWARE

LTE-M and NB-IoT are designed to support IoT devices that need a long battery life or are used at locations that are difficult to reach with normal 4G technology, such as deep indoor locations.

So how are they different and how will they affect the market?

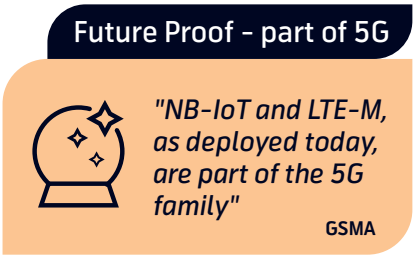
BATTERY LIFE AND INCREASED COVERAGE

Battery life is increased by reducing the radio communication between device and network, and devices can go into sleep mode or listen less often to the network. LTE-M and NB-IoT both offer better coverage than 4G in, for example, deep indoor or remote areas. There is however a trade-off between battery life, coverage and responsiveness. To leverage this requires access to new types of functionality in the network- for example PSM and EDRX use cases that need a fast response are less suitable for battery saving and enhanced coverage.

Likewise, devices that need a life cycle of 10 years need to be deployed in areas with good coverage. To support a balanced approach, battery saving and enhanced coverage are applied in step with each other. Significant improvement in battery life and coverage can be achieved by sleep mode and applying the right level of repetitions.

NEW PRICING MODELS LIKELY TO EMERGE

Pricing models for LTE-M and NB-IoT will likely be different to traditional telecom pricing because of the different traffic profile involved with IoT connectivity. There will be a vast number of connected LTE-M and NB-IoT devices but they will send low amounts of data. Rather than the data consumption per device price model, network providers will most likely consider charging access fees for devices on a per device basis for LTE-M and NB-IoT, or a combination of both, to better match the network resources consumed by these devices.



HARDWARE SIMPLIFICATION

LTE-M and NB-IoT both use simplified versions of regular 4G which reduces hardware complexity and cost once the technology is operating at scale.

GSMA maintains a list of modules that are commercially available at: https://www.gsma.com/iot/mobile-iot-modules/ showing that the market for modules is fragmented into three main categories: modules supporting either LTE-M or NB-IoT and modules that support both LTE-M and NB-IoT.

LTE-M AND NB-IOT - GLOBAL AVAILABILITY AND OUTLOOK

Moving towards local availability in all countries

For global deployments of devices, enterprises need to take the life cycle of technology in consideration.

Global deployments need global availability, but new technologies are first locally available, typically in urban areas or with nationwide deployments. So when can we expect global availability for LTE-M and NB-IOT?

Today, the status for LTE-M and NB-IoT is that they are both locally available and on their way to becoming globally available.

We see that sometimes one operator in a region starts focusing on either LTE-M or NB-IoT, after which their competitors in the same region often offers the alternative.

We expect that in a few years both LTE-M and NB-IoT will be locally available in all countries.

REGION	FIRST FOCUS	SECONDARY FOCUS
Asia	NB-IoT	LTE-M
Europe	NB-IoT	LTE-M
North America	LTE-M	NB-IoT

Nationwide deployments are a good start but for global availability, commercial global roaming agreements between operators must be in place, so enterprises can deploy their devices using only one contract and one point of contact.

With 4G widely available and 5G around the corner, 2G and 3G are slowly being phased out. 2G technology is today still widely used in IoT solutions. 2G voice technology is used for voice calling, including emergency calls such as eCall - a European initiative for rapid assistance to motorists involved in a collision anywhere in the European Union. eCall was made mandatory in all new type-approved cars sold in the European Union from April 2018. As eCall mandates 2G voice, operators in the European Union cannot simply phase out 2G.

We expect that most European operators will support 2G until 2025. In North America, 2G is less widely available and certain countries in Asia and the Pacific have already phased out 2G.

LTE-M and NB-IoT are starting to become globally available, starting with LTE-M. We expect LTE-M and NB-IoT to be available during the complete lifecycle of 5G.

CHOOSING BETWEEN LTE-M AND NB-IOT

So which are the most important factors a company should consider when selecting between LTE-M and NB-IoT, or both? Below we detail the most relevant considerations and how they differ from each other, as a guide to make the optimal choice.

ADAPTABILITY TO NEW USE CASES

When choosing a connectivity technology, the complete lifecycle of the connected product must be taken into consideration. Enterprises need to choose a technology that can grow with new use cases.

Imagine a product called “The connected door”. Initially it should just be possible to open and close the door and the door should send usage statistics every night to the cloud. The typical door has a lifecycle of 10 years. After just looking at the initial use case, the data amount is very low, so the focus is on technology with the lowest bandwidth and the door is mass produced and successfully launched. After three years the enterprise wants to monitise this success and add new value - the door should not just connect, but also interact with a parcel delivery service. For use cases where the application can be expected to evolve over time it is thus important that the whole solution has potential to develop. LTE-M provides greater potential to grow over time.

Due to its wider bandwidth LTE-M provides more adaptability to new use cases where the use cases of the IoT solution will develop over time. NB-IoT is an alternative when the requirements are more static and known from start.

SUITABILITY FOR 2G/3G REPLACEMENT

Due to the shutdown of 2G and 3G networks in many parts of the world many legacy use cases need to be transferred to new connectivity technology.

We believe that 2G technologies will continue to be available in many parts of the world and outlive 3G. In Europe we anticipate 2G will be available until 2025, due to the legally required emergency services in the EU which depend on 2G technology.

As the coverage of LTE-M and NB-IoT deployments may not, as of today, be good enough everywhere, we recommend enterprises verify coverage in more detail and/or ensure devices are compatible with existing technologies as a backup.

IoT use cases will eventually move from old to new technology. As LTE-M meets or exceeds the technical characteristics of 2G/3G services, it appears to be a natural, evolutionary step. NB-IoT has lower responsiveness and limitations in mobility and may be relevant for use cases with lower requirements.

GLOBAL AVAILABILITY

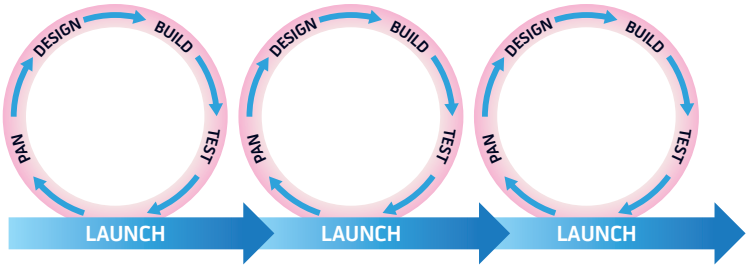
We believe that LTE-M will be the first to become a globally available technology as it has technically been designed for roaming from the start, like all other 2G, 3G, 4G and 5G technologies. NB-IoT was initially designed for static devices only, and roaming has been added later as afterthought.

Operators will be more reluctant to support incoming roaming NB-IoT devices that use network resources, but hardly generate revenue. Roaming on NB-IoT will most likely be limited to the business units within an operator group. We expect that LTE-M roaming will be available globally in the coming years, similarly to normal 4G roaming, and it is indeed already available today as a best effort offering on existing 4G roaming contracts.

LTE-M has been designed for roaming from the start and can leverage existing roaming and wholesale business models between operators. NB-IoT will require new business models to be a good alternative for global connectivity. Therefore we expect that LTE-M will be relevant for international IoT solutions earlier than NB-IoT.

SOFTWARE UPDATES AND SECURITY

IoT devices can have a typical life span of 10 to 15 years. For many use cases it is desirable to update the software in the device several times over its lifecycle. Therefore, enterprises must choose a technology that can handle updates to work with modern software development practices - and to keep devices secure.



Enterprises typically use agile software development (small and frequent increments) to decrease time to market. This makes the waterfall approach to software development – where large software are deployed that are never touched again - a practice of the past.

The characteristics of NB-IoT mean it is not suitable for upgrading large fleets of IoT devices. This is expected to be addressed in a future version of NB-IoT, called NB2. In this variety software upgrades can be managed using multi-cast.

This means that there will be two varieties of NB-IoT available - NB1 and NB2 (also sometimes called LTE-cat NB1 and LTE Cat NB2). The current status is however that today most networks only support NB1, and it may take years before NB2 is widely available.

Increased security improvements and the agile software development methods used today, will continue to drive software updates. This has a large impact on the bandwidth consumption during the lifecycle of devices which is often underestimated. LTE-M is considerably better at handling device updates as its higher bandwidth can handle more data.

MOVING DEVICES

Previous mobile technologies all support devices that can move around without connectivity being interrupted. Devices constantly measure radio signals of nearby radio towers (cells) in the network and dynamically and seamlessly adjust their signaling to different towers (cells). Here we see significant differences between NB-IoT and LTE-M.

NB-IoT is designed for static devices. It is designed to increase battery life by reducing measurement of signals to nearby radio towers (cells). When NB-IoT devices are moved, sessions may get dropped, or devices may need to reconnect. This can lead to interruptions and reduces battery life. This makes NB-IoT less suitable for moving devices.

LTE-M on the other hand is designed for moving devices, just like 2G, 3G, 4G and 5G. LTE-M can support moving devices without losing data sessions, at speeds of up to 200km/hr.

LTE-M is the better choice for moving devices as it has been designed for this from the start. As NB-IoT is designed for static devices it can lead to interruptions if devices are moved.

REMOTE CONTROL DEVICES

If devices need to be remotely controlled, responsiveness is important.

Devices controlled by people need a fast and consistent response. LTE-M provides the same consistent response time as regular 4G, so it can be used by people to remotely control devices. NB-IoT is designed to send small amounts of data and is not designed for a fast response. With NB-IoT it may sometimes take up to 10 seconds to receive a response from a device.

Not all use cases need a fast response and it may for example be perfectly acceptable to wait 10 seconds for sensor readings.

When there is human interaction a slow response risk being perceived as poor usability, which could harm the brand perception of enterprises.

LTE-M is needed for a fast and consistent response, while NB-IoT can handle use cases where a delay of minutes is acceptable.

VOICE READINESS

LTE-M is designed for voice and the specification includes Voice over LTE (VoLTE) - which is deployed by 194 operators in 91 countries.

Today however, VoLTE is not globally available in LTE-M networks and there are not many hardware modules that can support VoLTE over LTE-M. We expect that VoLTE will grow in importance in the coming years in LTE-M, just as it did in the consumer market for LTE.

The bandwidth and especially the responsiveness of LTE-M can also be used as an alternative to Voice over IP solutions. Devices need to respond quickly to calls and must be able to send and receive data at the same time (full duplex). Only LTE-M can support full duplex communication.

NB2 adds push to talk technology to NB-IoT, only one party can talk at any one time because the technology is half duplex, like walkie-talkies used to be.

LTE-M is designed for voice with Voice over LTE and can also be used for Voice over IP with full duplex. NB2 adds push to talk technology to NB-IoT but only at half duplex.

SIM LOCALISATION- EUICC

Physically swapping the SIM card of deployed devices can be a costly and complicated process, especially in an IoT environment. SIM cards with eUICC technology allows switching of identity over the air, without the need for physical replacement of SIM cards.

When the life cycle of connected devices is longer than the commercial agreement with an operator, the eUICC technology makes a change of operator possible. eUICC can also be used for devices deployed in locations where roaming is not possible. While eUICC is still in an early stage today it will become a vital technology for large and international deployments of IoT devices.

Not all operators support the combination of NB-IoT and SMS which means that eUICC cannot be initiated in many networks. The bandwidth of LTE-M is also more suitable for transmission of SIM profiles, just like software updates. Enterprises considering eUICC should therefore also consider LTE-M.

TIME TO MARKET - INTERNET COMPETENCE

Time to market is essential when launching new products. Connectivity technology is only one aspect of the product. Access to people with the right competence is vital to ensure time to market which is why many enterprises choose common technologies over specialized technologies. Common technologies make product development faster, and product maintenance more cost efficient, because it is easier to get access to developers and other specialists.

The internet is built on technologies like IP, TCP, UDP and TLS. These protocols are familiar and easy to use for developers, as they hide much network complexity and are easy to scale without central control.

NB-IoT is designed to perform in local deployments, for example connecting streetlights in a city. Here it is not necessary to use standard internet technologies, such as IP.

Enterprises can access their devices through the Service Capability Exposure Function (SCEF) provided by the network operator. SCEF simplifies the access to devices by hiding the complexity of the operator's network making device access familiar to application developers.

Today SCEF is available in some networks for local deployments. Enterprises that would like to use NB-IoT without IP would need to connect to all individual NB-IoT operators that support SCEF.

The roaming and interworking of SCEF is standardized, but it will take several years before SCEF are widely deployed and roaming is available.

LTE-M is using standard IP protocols which makes it straightforward to develop applications. NB-IoT is using tailormade protocols requiring specific application development and competence.

CONCLUSION & RECOMMENDATIONS

Deciding between the new mobile connectivity technologies, LTE-M and NB-IoT, requires an understanding of the key differences between them.

LTE-M and NB-IoT are both globally available, vendor independent technologies, based on open standards. With the introduction of eUICC enterprises can take a commercial decision based on the most suitable technology and irrespective of operator.

Both LTE-M and NB-IoT enable relevant use cases and are telecom grade, which means they operate on dedicated radio frequencies in telecom networks with a proven capability to scale, and with committed support through the whole life cycle from the operator.

Both technologies also support improved battery life and substantial coverage enhancements, when compared to older mobile technologies.

FOR MOST INTERNATIONAL USE CASES LTE-M IS THE PREFERRED ALTERNATIVE

	Firmware updates	Global roaming	Indoor coverage	Remote control devices	Suitability for moving devices	Voice readiness	Possiblity to grow with new use cases
LTE-M	●●●	●● (today)	●●●	●●●	●●●	●●●	●●●
NB-IoT	●	● (today)	●●●	●●	●	●	●

- LTE-M is the better alternative with respect to handling firmware and software updates that are expected during the lifecycle of the devices. LTE-M is built for roaming and has the best support for international deployments using a single point of contact and subscription for enterprises.
- Both LTE-M and NB-IoT have significantly improved indoor coverage compared with LTE.
- LTE-M is a better alternative for moving devices as it will not lose ongoing data transfers.
- LTE-M is prepared for voice technology and Voice over LTE.
- With LTE-M, devices can react in milliseconds if required, enabling use cases where a fast response is needed which is relevant for the usability of human-machine interactions.

RECOMMENDATIONS

Choosing the right connectivity technology is one of the critical decisions when implementing an IoT solution. The right choice is essential for deploying a well working solution in a cost efficient way and that can develop over time. New mobile IoT connectivity standards, LTE-M and NB-IoT, opens up for new and evolved use case by offering better coverage, longer lasting batteries and/or lower device cost. In addition they offer a future-proof path as 2G and 3G networks are gradually sunset across the world.

For most international IoT solutions LTE-M will be the preferred connectivity standard as it is expected to become globally available faster and to be more straightforward when developing and maintaining applications. NB-IoT may still be the better choice for some applications, -for example for very large scale sensor networks where the requirements are known at deployment and the best possible indoor coverage is absolutely essential.

As of today neither LTE-M nor NB-IoT are deployed widely enough to be solely relied on for international fleets of devices. For now it is recommended to use hardware that is able to use LTE-M or NB-IoT as well as networks with mature footprints, for example, 2G and/or 4G. The deployment status of mobile IoT network is developing rapidly and therefore the right setup will vary over time.

Independent on the choice of technology standard, Telenor Connexion can help you with all your connectivity needs. Get in touch to find out more about the first steps to take for your low-power, wide-area IoT application.

GLOSSARY

MOBILE IOT refers to low power wide area (LPWA) 3GPP standardised secure operator managed IoT networks in licensed spectrum. In particular, LPWA are networks designed for IoT applications that are low cost, use low data rates, require long battery lives and often operate in remote and hard to reach locations.

IOT MODULE A small electronic device embedded in objects, machines and things that connect to wireless networks which sends and receives data.

eDRX (Extended Discontinuous Reception) is an extension of an existing LTE feature that 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.

eSIM (also embedded SIM or eUICC) secure element designed to remotely manage multiple mobile network operator subscriptions and be compliant with GSMA specifications.

LPWAN (Low-Power Wide Area Network) A network based on mobile communications technology which uses a low bit rate typically catering to smart devices.

LTE-M (also LTE-MTC and LTE Cat M) an LPWAN technology which allows the reuse of an LTE installed base with extended coverage. LTE-M, which stands for LTE-Machine Type Communication (MTC), is also a LPWAN technology developed by 3GPP to enable devices and services specifically for IoT applications. LTE-M offers a data rate of 1Mbps for 3GPP Release 13, rising to 4Mbps for Release 14, greater mobility and voice capability over the network.

NB-IOT (Narrowband IoT) A radio technology deployed over mobile networks which is especially suited for indoor coverage, low cost, long battery life, and large number of devices. NB-IoT limits bandwidth to a single narrow band of 200kHz, offering peak downlink speeds of 26kbs in Release 13 of the 3GPP standard. Release 14 will see this increase to 127kbps.

SIM (Subscriber Identity Module) A smart card that stores including identity, location, phone number, network authorization data and security keys that is installed into a wireless device.

SCEF (Service Capability Exposure Function) Network operators can expose the SCEF service to find devices that do not use the IP protocol.

NR (New Radio) is a new radio access technology developed by 3GPP for 5G, designed to be the global standard for the air interface of 5G networks.

MQTT (Message Queue Telemetry Transport) is a lightweight, publish-subscribe network protocol that transports messages between devices. The protocol usually runs over TCP/IP.

MULTICAST describes the updating of many devices at once. It works similarly to public broadcasting of TV and requires devices to be ready to receive updates at the same time. TCP/IP. The Internet Protocol suite is the computer networking model and set of communications protocols used on the Internet and similar computer networks.

PSM (Power Save Mode) is a functionality to reduce power consumption by allowing IoT devices to go into sleep mode when not active. The PSM feature was introduced in 3GPP Release 12 and is available for all LTE device categories.

TELEMETRY is the process of recording and transmitting the readings of an instrument.

TLS Transport Layer Security (TLS), and its now-deprecated predecessor, Secure Sockets Layer (SSL), are cryptographic protocols designed to provide communications security over a computer network.

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ABOUT TELENOR CONNEXION

Telenor Connexion is the specialized IoT company within the Telenor Group, one of the world's major mobile operators. Building on more than 20 years of experience, Telenor Connexion provides global IoT connectivity and cloud services to enterprises with large fleets of connected devices as well as third-party service providers.

Telenor Connexion manages more than 10 million connected things in more than 180 countries for global customers including Volvo, Scania, Hitachi, Verisure Securitas Direct and Husqvarna. With headquarters and tech centre located in Sweden, the company has regional sales representation in the UK, US, Germany, Italy, South Africa, Singapore, South Korea, China, Malaysia and Japan.

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