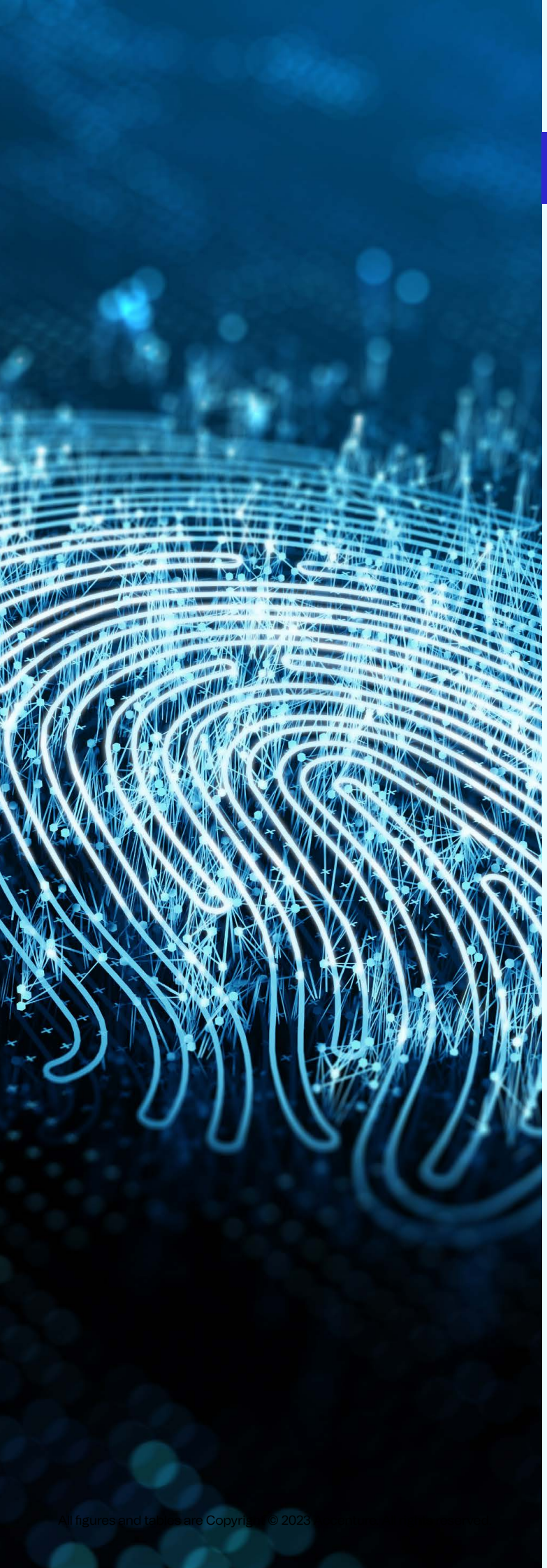
Sunset Strategy Guide:

Adapting Connected Products for the Post-2G/3G Era

2024 Edition

telenor IoT



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Executive Summary

In an era marked by both the dawn of 5G and the shutting down of 2G and 3G networks, enterprises face critical decisions in choosing the right connectivity technology for their IoT deployments.

This strategic guide serves as a deep-dive into the three technologies that we feel are currently particularly well-positioned for enterprises impacted by the network sunsets: LTE-M, NB-IoT, and LTE Cat-1. We also examine the risk of hardware becoming outdated or obsolescent, and explore why IoT Complete is a viable solution.

As global networks continue to evolve, our guide empowers decision-makers to navigate the complexities of IoT connectivity, helping you make more informed choices for resilient, scalable, and future-ready deployments.

Introduction: IoT's Connectivity Crossroads

Over the coming pages, we explore the evolving terrain of connectivity technologies and examine viable solutions tailored to enterprises impacted by the sunsetting of 2G and 3G networks.

From hardware updates resulting from the network transitions to the adoption of advanced connectivity technologies such as LTE-M, NB-IoT, and LTE Cat-1, we provide insights to help decision-makers navigate these complexities effectively.

For a comprehensive examination of a broader range of technologies, please read out 2023 edition of our

Connectivity Technologies for IoT guide.

Table 1

Low Medium High

Technical considerations	Traditional cellular				Other cellular	LPWA Cellular		Proprietary LPWA	Short range		
	2G	3G	4G	5G	LTE-Cat-1	LTE-M	NB-IoT	LoRaWan	Wi-Fi	Zigbee	Bluetooth LE
Outdoor range											
Indoor coverage											
Energy efficiency											
Typical uplink data rate											
Typical downlink data rate											
Mobility											
Positioning											
Latency											
Device density											
Commercial considerations	**Traditional cellular**				**Other cellular**	**Cellular LPWA**		**Proprietary LPWA**	**Short range**		
	2G	3G	4G	5G	LTE Cat-1	LTE-M	NB-IoT	LoRaWan	Wi-Fi	Zigbee	Bluetooth LE
Module cost											
Subscription cost	yes	yes	yes	yes	yes	yes	yes	yes/no	no	no	no
Deployment & maintenance cost											
Reliability											
Security											
Scalability											
Ecosystem considerations	**Traditional cellular**				**Other cellular**	**LPWA Cellular**		**Proprietary LPWA**	**Short range**		
	2G	3G	4G	5G	LTE Cat-1	LTE-M	NB-IoT	LoRaWan	Wi-Fi	Zigbee	Bluetooth LE
Future proofness											
Global reach & operability											

Table 1: Main technologies for IoT with strengths and weaknesses

Empowering Enterprises in the Era of Evolving Connectivity Technologies

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.*

IoT Solution stack

IT SERVICES
Services that help bring together the various components of the IoT stack into one tailor-made solution.
→ System integration, technology advisory, application development services.

SOFTWARE & APPLICATIONS
Horizontal and vertical IoT applications for specific use cases or industry verticals.
→ Predictive maintenance, fleet management, smart parking, smart city applications.

PLATFORMS
Platforms allowing developers to build applications, manage devices, process and store data.
→ Application enablement, connectivity mng, device mng, analytics platforms.

CONNECTIVITY
Network connectivity via which the device connects to the internet and can send data to the cloud.
→ Traditional cellular (2G-5G), LPWA, Wi-Fi, Bluetooth.

FIRMWARE
Embedded device software to control device components, manage connect-ivity and handle necessary logic on the device.
→ Modem integration, software update manage-ment, security mechanisms, protocol conversion etc.

DEVICE COMPONENTS
Hardware embedded into connected "Things" to enable collection of data.
→ Connectivity module, sensors, battery, processor, gateways.

Smart devices ("Things")

Figure 1: Main components of an end-to-end IoT solution

LTE-M, NB-IoT, and the Resurgence of LTE Cat-1

LTE-M and NB-IoT are standardized, secure, and operator-managed in licensed spec-trum. They are designed for IoT appli-cations 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 are obvious choices for industries looking for 2G and 3G replace-ments 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.

A more recent addition to the mix is the longer-established LTE Cat-1 which, although less-widely considered as a replacement technology for 2G and 3G, has gained traction since the sunsets of 2G and 3G were announced by operators. Two significant developments have happened which have transformed the prospects for Cat-1. First, the cost of

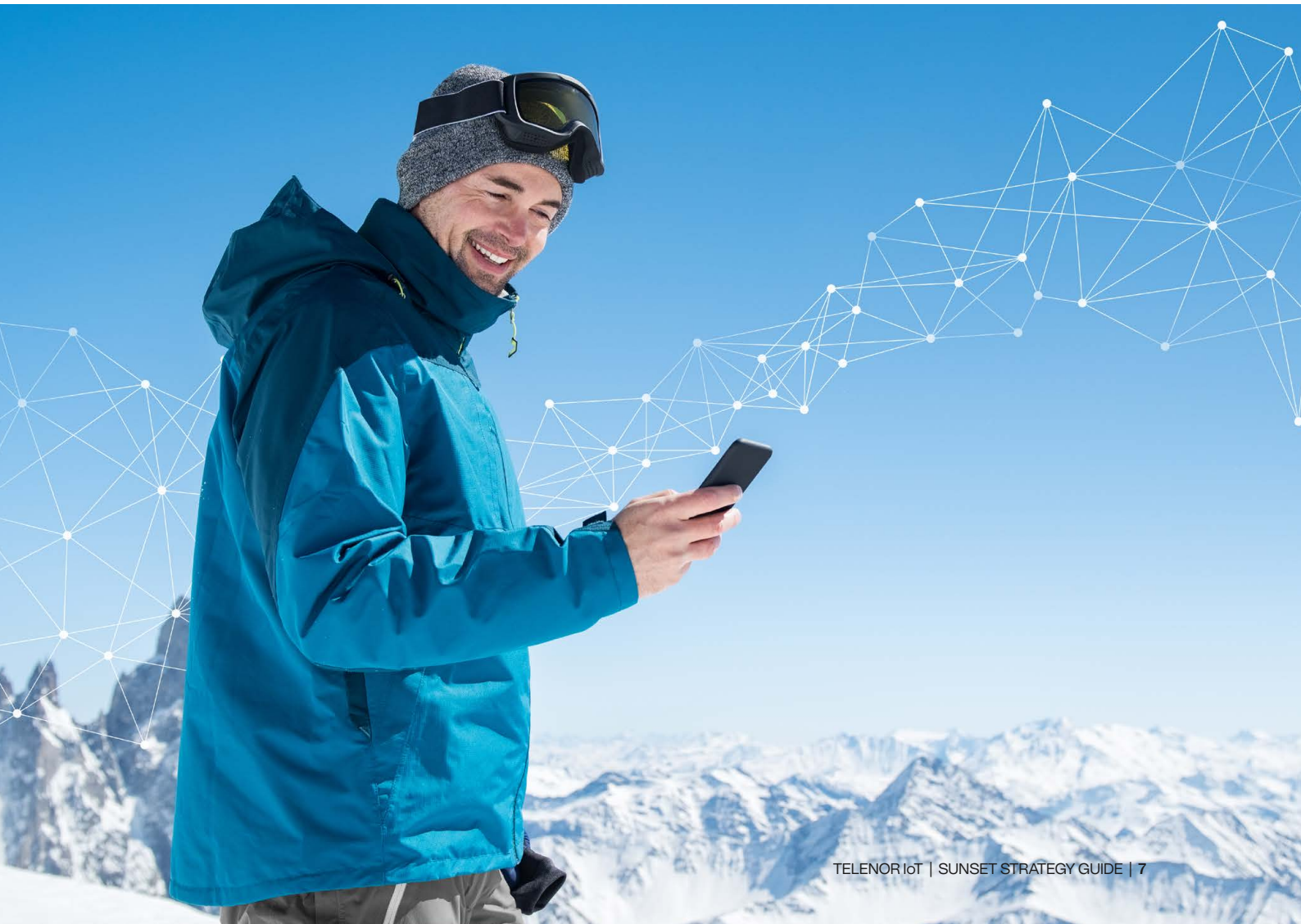
Cat-1 modules, especially for the single antenna version Cat-1 bis, have come down to a level that is only slightly more expensive than NB-IoT or Cat-M, removing a significant barrier to adoption. Next, the roll-out of both Cat-M and NB-IoT at various operators around the world has been slower than anticipated and full global coverage has not been achieved, leading to greater adoption of Cat-1 among organizations that truly need global coverage.

Berg Insight[1] reports that, in China, Cat-1 bis modules are now approximately half the price at US$10 of standard Cat-1 modules and, in large tenders, prices for LTE Cat-1 bis modules have dropped below US$5 per unit. This has resulted in Cat-1 modules accounting for the major share of volume across all regions as customers embrace the ubiquitous coverage the technology offers. LTE Cat-1 bis is therefore provides an attractive performance sweet spot for IoT applications that need greater performance than LTE-M while achieving form factor and cost advantages over LTE Cat-1. However, Cat 1 bis hardware can be more expensive than LTE-M and NB-IoT devices so it is most practical for use cases that need the higher data rate it offers to outweigh the lower costs of LTE-M and NB-IoT.

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.

[1] https://www.berginsight.com/cellular-iot-module-revenues-increased-12-percent-to-reach-us-59-billion-in-2022



Mobile Connectivity - an Evolution of Industrial Value

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 centred around high-speed data applications.
- **4G** introduced LTE technology, including LTE Cat-1, 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 NSA** is the first step most operators implement to enable 5G. 5G NSA enables 5G New Radio (5G NR) but still requires 4G in parallel. With 5G NSA the devices can access higher data throughput.
- **5G SA** (Stand Alone) networks do not depend on 4G. 5G SA enables functions like Network slicing and ultra-low latency. LTE-M and NB IoT will be supported by 5G SA core. LTE Cat1 need 4G but most operators will likely continue to have a 4G LTE core in parallel with 5G Core for a long time.

TECHNICAL	COMMERCIAL	ECOSYSTEM
COVERAGE Determines where the devices can be deployed and connected indoor and outdoor	**TOTAL COST OF OWNERSHIP (TCO)** Decides the business viability of implementing and operating the IoT service	**FUTURE-PROOFNESS** Ensures that the strategic investment in IoT is economically and technologically sustainable in the long run
ENERGY EFFICIENCY Affects battery life and maintenance cycle	**RELIABILITY** Ensures that a continuous connection can be provided to the device with a certain level of guarantee	**GLOBAL REACH AND INTEROPERABILITY** Brings simplicity and efficiency to international IoT deployments
DATA RATE (ON UP- AND DOWNLINK) Limits the types of services that can be provided	**SECURITY** Protects the privacy and integrity of IoT users	
MOBILITY Addresses the extent to which movements across larger areas can be accommodated	**SCALABILITY** Determines the flexibility for managing growth	
POSITIONING Is the ability of a technology to accurately determine the position of a connected device		
LATENCY Determines to what extent time-sensitive services can be provided		
DEVICE DENSITY Denotes the number of devices that the network can handle within a given area		

Figure 2: Connectivity technology requirements

Today, most networks that claim to be 5G are in fact 5G non-standalone (NSA) networks that use a combination of a 5G radio access network with an existing LTE core. 5G standalone (SA) networks which exclusively utilize 5G are being rolled out but at a slower pace to 5G NSA.

- **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 while it can utilize higher frequencies can also use lower frequencies, such as those previously used for 2G, which can be re-assigned for 5G.
  - Mobile IoT - LTE-M and NB-IoT - are forward compatible with 5G Core. technology, which means that LTE-M and NB-IoT technology can be used throughout the complete 5G life cycle.

LTE-M, NB-IOT and LTE CAT-1 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. While LTE Cat-1 could utilize power saving mode (PSM), few operators support that. In general, LTE Cat-1 is not seen to be as power-efficient as LTE-M and NB-IoT.

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 have specific coverage enhancement functions that Cat-1 does not have. These functions enable repetition to ensure a message can be sent even when radio conditions are poor. This capability means that LTE-M and MB-IoT can be used in basements and other challenging situations where Cat-1 cannot perform.

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 using sleep mode, for example.

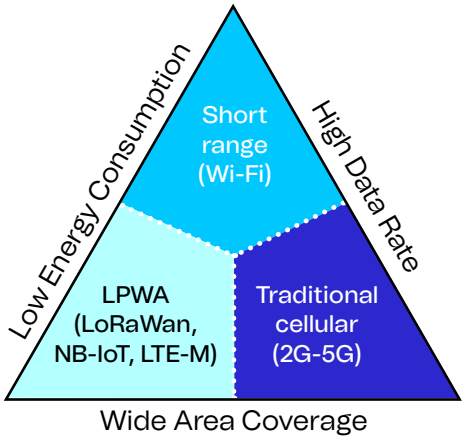


Figure 3: Trade-offs on the technical level

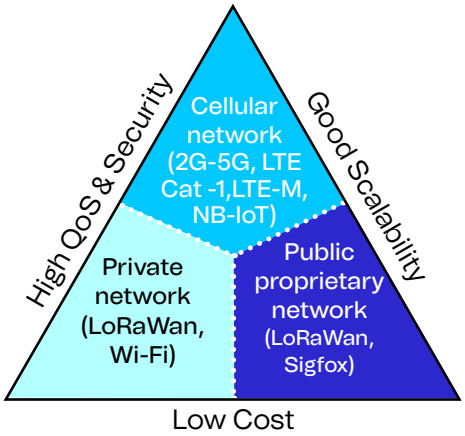


Figure 5: Trade-offs on the commercial level

New Pricing Models

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 offer reduced hardware complexity than regular 4G and have the potential to deliver reduced cost once the technology is operating at scale.

GSMA maintains a list of modules that are commercially available here, showing that the market for modules is fragmented into two main categories: modules supporting either LTE-M or NB-IoT and modules that support both LTE-M and NB-IoT.

In the LTE Cat-1 arena, LTE Cat-1 bis, which has been developed to support IoT applications, uses a single antenna in contrast to LTE Cat-1 which requires IoT devices to have two antennas. The hardware is therefore simplified for LTE Cat-1 bis, enabling devices to be compact and cheaper than LTE Cat-1 devices. An important benefit is that LTE Cat-1 bis can offer the same data rate, latency, roaming capabilities and robustness as LTE Cat-1, even though it has a single antenna. In addition, LTE Cat-1 bis uses the same infrastructure, including existing LTE networks, and standards as LTE Cat-1 so there is no need to rethink development approaches or introduce completely new technology.

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.

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, NB-IOT and LTE CAT- 1

So which are the most important factors a company should consider when selecting between LTE-M, NB-IoT LTE Cat-1 or a blend of all three? 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 monetise 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. LTE Cat-1 offers significant flexibility gains because of its greater capacity and the possibility it provides of adopting a single, unified connectivity technology for global deployments.

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.

LTE Cat-1 has re-invented its appeal as a replacement for 2G and 3G because its hardware and network costs have come down to levels that enable it to be considered as an alternative to the Mobile IoT technologies. With LTE Cat-1 bis in particular, the throughput on offer exceeds both LTE-M and NB-IoT and offers a greater performance band, making it applicable to greater numbers of IoT use cases.

	LTE-M	NB-IoT	LTE Cat-1
Energy consumption	●●●	●●●	●●
Deep coverage	●●●	●●●	●●
Speed	●●	●	●●●
Latency	●●●	●	●●●
Firmware updates	●●	●	●●●
Voice or SMS support	●●	●	●●●
Moving devices	●●●	●	●●●
Roaming	●●	●	●●●

Global Availability

Aside from the already globally available LTE Cat-1, which has full roaming support we believe that LTE-M will beat NB-IoT 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.

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 life-cycle of devices which is often under-estimated. LTE-M is considerably better at handling device updates as its higher bandwidth can handle more data.

LTE Cat-1 has further advantages here because of the greater throughput it can offer. It is possible for firmware over the air (FOTA) upgrades to be performed for security and other functions with greater ease than for LTE-M.

Moving Devices

Previous mobile technologies all support devices that can move around without connectivity being interrupted. As an established technology, LTE Cat-1 offers this benefit. 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, including LTE Cat-1, 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

Devices controlled by people need a fast and consistent response. LTE-M and LTE Cat-1 provide the same consistent response time as regular 4G, so they 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 or LTE Cat-1 are needed for a fast and consistent response, while NB-IoT can handle use cases where a delay of minutes is acceptable.

Voice Readiness

LTE Cat-1 and LTE-M were designed for voice and the specification includes Voice over LTE (VoLTE).

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 but availability depends on whether an operator supports this.

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 duplex. Again, availability of full duplex and voice over LTE is dependent on operator support. NB2 adds push to talk technology to NB-IoT but only at half duplex. For LTE Cat-1 both voice and SMS are offered by many operators so if voice is required LTE Cat-1 offers a solution that is available for all.

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. For LTE Cat-1 the bandwidth required for eUICC is not an issue. Enterprises considering eUICC should therefore also consider LTE-M and LTE Cat-1.

Time to Market – Internet Competence

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.

Since its introduction in 3GPP Release 8 in 2008 a large ecosystem of experts and developers has grown up in support of LTE in general and Cat-1 specifically. Even LTE Cat-1 bis is well-established having been introduced in 3GPP Release 13 in 2016. This makes Cat-1 the most mature technology considered here.

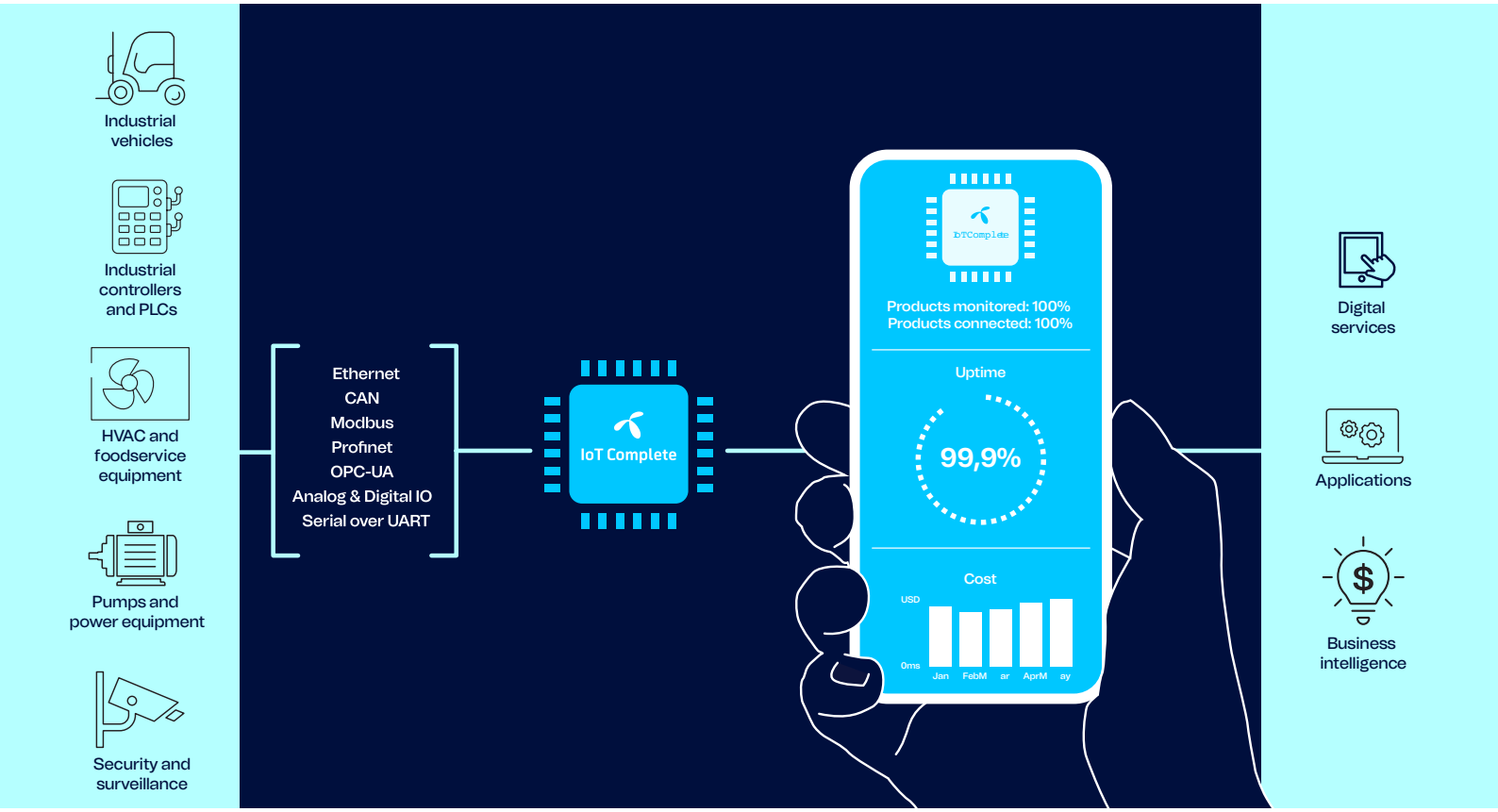
IoT Complete: End-to-End Infrastructure for Connected Products - As a Service

As we've explained, enterprises across industries are grappling with the impending shutdown of 2G and 3G networks, which directly impacts their hardware infrastructure. For companies heavily invested in developing connected products and digital services, this transition poses a significant risk of obsolescence without a suitable connectivity solution.

Specifically, product manufacturers reliant on legacy networks to connect their hardware face numerous challenges. These include disrupted operations, decreased efficiency, and potential revenue loss due to the inability to deliver essential digital services, remote monitoring, and enhanced customer experiences.

IoT Complete is a well-equipped solution to address the needs of customers facing the 2G and 3G sunsetting, particularly those with impacted hardware. By offering an end-to-end IoT infrastructure as a service, IoT Complete provides a comprehensive package encompassing certified connectivity devices, configurable firmware, global connectivity and optional end-user interfaces.

All managed and monitored through a single pane of glass, streamlining deployment and management processes.



With IoT Complete, enterprises can accelerate product deployment with ready-to-configure infrastructure, eliminating the complexities associated with traditional multi-supplier IoT solutions. By consolidating the connectivity chain under a single partner, IoT Complete enhances operational efficiency, cost predictability, and accountability.

In addition, IoT Complete ensures higher uptime by enabling access to 500+ mobile networks worldwide. Through unique network optimization and health monitoring, Telenor IoT optimizes product connectivity and promptly addresses any disruptions, empowering enterprises to maintain control and take immediate corrective action.

IoT Complete is well-suited for enterprises in various industries thanks to its different form factors and the native capabilities for simple configurations of industry protocols like e.g., Modbus, OCP-UA, Siemens S7 or CAN, to mention a few.

Some examples of industries where IoT Complete is deployed includes industrial controllers/PLC, HVAC, foodservice, EV charging, battery management solutions, industrial vehicles, and security/access solutions.

IoT Complete is a perfect match for companies looking for a quick and cost-effective way to manage the risks associated with ongoing network changes. Get in touch to learn more and understand the possibilities to replace existing solutions quickly without extensive development effort.

Conclusion

Deciding between the new mobile connectivity technologies, LTE-M and NB-IoT and the far more established LTE Cat-1 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. 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.

On the other hand, LTE Cat-1 offers greater throughput, low latency, voice and SMS capabilities, global coverage, the ability to support FOTA and eUICC and a mature development and support sector. Its weaknesses lie in less widely available power consumption control and lack of coverage extension capabilities that mean it does not enable the same level of coverage in bad radio conditions as alternatives. The cost of LTE Cat-1 has been higher than LTE-M or NB-IoT in the past but, prices have decreased. This especially the case for Cat-1 bis where pricing is now either the same or lower than for LTE-M devices.

- **2G & 3G** will be closed down and NB-IoT, LTE-M and LTE Cat1 could be good replacements.
- **NB-IoT** could be a good and cost efficient match if you have a very defined and limited scope and the technology matches your requirements.
- **LTE-M** will support almost all use cases that NB IoT plus many more and gives you the flexibility to grow over time if you want to expand the functionality.
- If you have a global deploy-ment and the use case do not have a need for extreme power saving or extended coverage LTE Cat1 or LTE Cat 1bis could probably be the best match.

		Automotive	Building automation	Government	Healthcare	Manufacturing	Security & surveillance	Transportation	Utilities
Technical requirements	Outdoor range								
	Indoor coverage								
	Energy efficiency								
	Uplink data rate								
	Downlink data rate								
	Mobility								
	Positioning								
	Latency								
	Device density								
Commercial requirements	Low module cost								
	Low subscription cost								
	Deployment & maintenance cost								
	Reliability								
	Security								
	Scalability								
Ecosystem requirements	Future proofness								
	Global reach & interoperability								
Common connectivity technologies		Cellular LTE Cat-1, LTE-M	BLE, Wi-Fi	LoRaWan, Cellular	BLE, NB-IoT, LTE-M	Cellular, LoRaWan, Wi-Fi,	Wi-Fi, Cellular	Cellular, LTE Cat-1, LTE-M	LoRaWan, NB-IoT

Table 2: Application areas, typical requirements and most common connectivity technologies

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 solution that works well and is cost effective and that can develop over time.

New mobile IoT connectivity standards, LTE-M and NB-IoT, open up new and evolved use cases by offering better coverage, longer lasting batteries and/or lower device cost than 2G or 3G. LTE Cat-1 has a significant role to play here because of its greater maturity and wider capabilities but for some low margin use cases, or those that simply don't need the additional features, there is no justification for the small additional cost. All three technologies offer a future-proof path as 2G and 3G networks are gradually shutdown across the world.

For most international IoT solutions LTE Cat-1 or LTE-M will be the preferred connectivity standard. LTE-M is expected to become globally available faster than NB-IoT 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 and this explains the increased adoption of LTE Cat-1. For now, it is recommended to use hardware that is able to use LTE-M and/or NB-IoT as well as networks with mature footprints, for example, 2G and/or 4G. The deployment status of mobile IoT networks is developing rapidly and therefore the right setup will vary over time as LTE-M and NB-IoT become more widely available.

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
A 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)
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
Stands for Embedded Subscriber Identity Module. The eSIM – embedded SIM – is a SIM where the subscriber profile can be changed over the air without changing the actual SIM.

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 Cat-1 bis
A variant of LTE that has been designed to support IoT applications. Introduced within 3GPP Release 13, LTE Cat-1 bis uses existing LTE networks but, critically, has been designed to operate with a single antenna, in contrast to LTE Cat-1 which requires that IoT devices have two antennas. Typical LTE Cat-1 bis applications include massive IoT deployments such as asset tracking, wearable cameras, logistics, transport, telematics, point of sale terminals, health monitors, smart watches, sensor networks, smart cities, smart meters and micromobility applications. Many of these have a need for greater speed than lower performance network technologies can provide but the cost savings and potentially lower power consumption of Cat-1 bis can be a compelling advantage.

LTE-M
A 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.

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

PSM (Power Save Mode)
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
The process of recording and transmitting the readings of an instrument.

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.

telenor IoT

Telenor Connexion

Telenor IoT is the portfolio of IoT solutions from Telenor Group, one of the world's major mobile operators. With more than 20 years' experience of providing global IoT connectivity, cloud services and expert support to companies of all sizes, Telenor is one of the world's most advanced IoT solution providers. Telenor IoT manages international IoT deployments for global customers in some 200 countries and today operates more than 20 million connected devices to enterprises such as Volvo, Scania, Hitachi, Verisure Securitas Direct and Husqvarna. The IoT solutions are offered to national customers in the Nordics through the local Telenor operations in each country, and on a global level through Telenor Connexion, Telenor's specialized unit that provides IoT solutions for large, international enterprises who need a customized offer with advanced support.

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