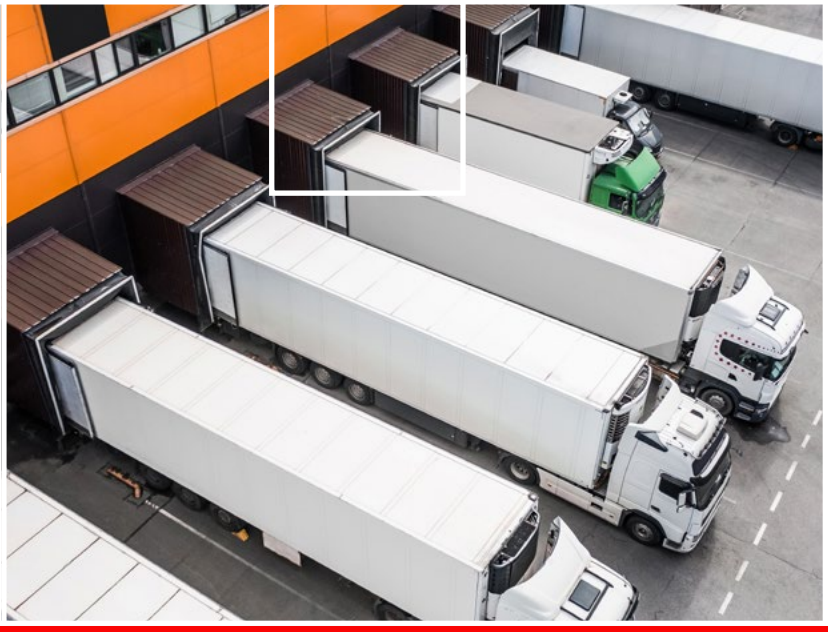
Build a smarter world

Cat 1 bis white paper

Why LTE Cat 1 and Cat 1 bis continue to drive cellular IoT connection growth



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Introduction

LTE or 4G are now well-established as a go-to cellular technology for IoT. LTE Cat 1 is particularly attractive for use cases that benefit from its blend of competitive cost, ubiquitous coverage and adequate performance. Within the LTE family, variants exist that encompass lower end offerings such as LTE-M and niche technology, such as LTE-Advanced. With LTE-M and NB-IoT handling the low power wide area (LPWA) end of the market, there's an enormous middle ground for LTE Cat 1 to serve, along with Cat 4 and other variants.

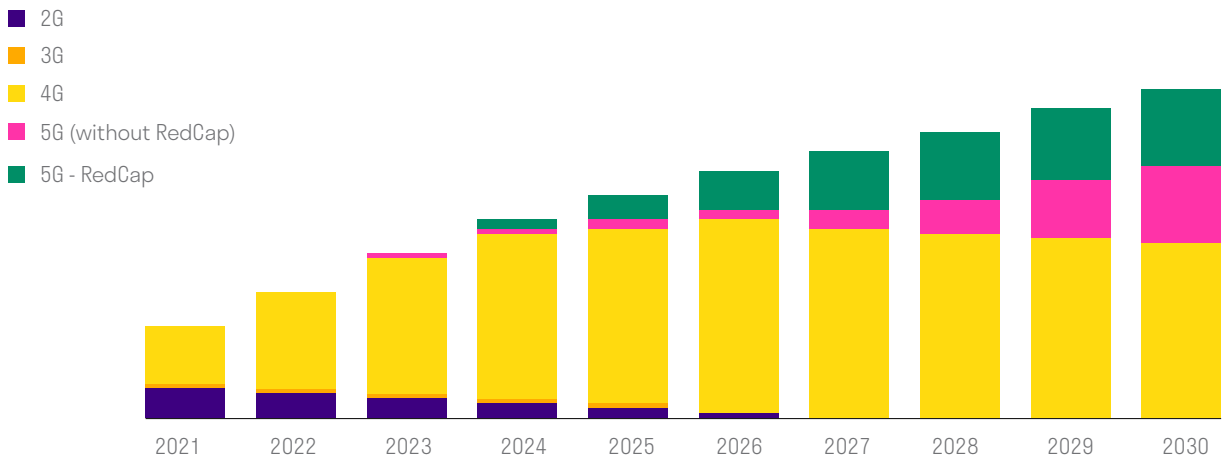
In addition to this, Cat 1 bis, a single antenna variant of Cat 1, provides compelling performance, efficiency and cost benefits which are detailed in this paper. Analyst firm Omdia reports that cellular IoT connections will hit 5.4 billion in 2030[1] with significant growth driven by the introduction of 5G RedCap, Massive IoT (NB-IoT) and LTE Cat 1 bis modules.

The 5G variants are at the very beginning of deployment with low shipment volumes today. These technologies will need time to mature and for adoption to become mainstream.

The current market and the market of 2030 are dominated by LTE connections. The composition of this is likely to shift towards variants, such as Cat 1 bis, but the bulk of the installed base today remains Cat 1.

Cat 1 has become so pervasive in cellular IoT (see **Figure 1**) because of the blend of functionality it offers. Introduced as part of 3GPP Release 8 in 2008, the technology was the first LTE variant to be developed for IoT applications. Cat 1 offers typical speeds of 10Mbps downlink and 5Mbps uplink, which is sufficient to support video streaming. In addition, it supports voice, in common with all LTE variants, via voice over LTE.

FIGURE 1: CELLULAR IoT CONNECTIONS BY AIR INTERFACE, 2021-30



Source: Omdia 2024

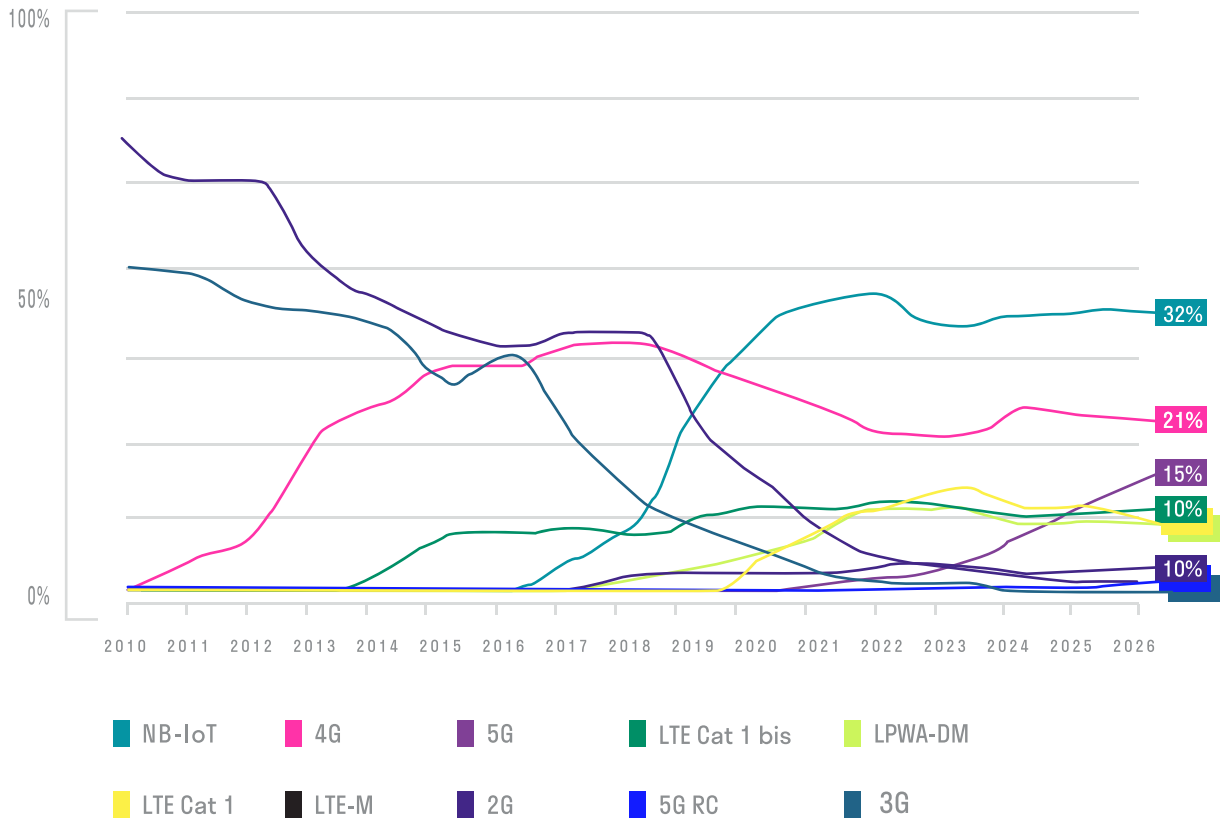
1 https://omdia.tech.informa.com/pr/2024/jan/new-omdia-research-shows-cellular-iot-connections-will-reach-5-4bn-in-2030

For latency-sensitive applications, Cat 1 offers latency of 50-100 milliseconds, placing it above Cat M and NB-IoT but beneath higher LTE categories. Cat 1 is sufficient to support popular IoT activities such as firmware upgrade over-the-air (FOTA) with better capability than LTE-M. Power saving techniques such as power saving mode (PSM) and extended discontinuous reception (eDRX) are also supported.

Still expected to account for around 10% of cellular IoT modules in 2028, according to data from IoT Analytics in **Figure 2**, Cat 1 will continue to be a significant IoT connectivity technology well into the next decade. Figure 2 also contrasts Cat 1with NB-IoT and 5G uptake, notably illustrating that Cat 1 and Cat 1 bis combined will outstrip 5G connections in 2026 as slow introduction of 5G RedCap continues to progress.

It is worth noting that in comparison to LPWA and NB-IoT, LTE is by far the most ubiquitous technology across the globe. This is largely because of the massive infrastructure base that has been deployed to support consumer mobile users but this provides substantial advantages for device rather than human connectivity. This global coverage makes LTE so much more suitable for international and worldwide deployments that LPWA or NB-IoT. Africa, for example, does not have Cat-M or NB-IoT available.

FIGURE 2: CELLULAR IoT MODULES: TECHNOLOGY SHARE 2010-2026



Source: https://iot-analytics.com/iot-modules/

How Cat 1 bis has matured to meet the needs of massive IoT applications

LTE Cat 1 bis was defined later than Cat 1 so carriers could distinguish between Cat 1 devices with two antennas and single antenna devices.

Originally part of GSMA Release 13 in 2016, the technology didn't really gain much attention until 2023 when a growing number of IoT applications started to recognize that LTE Cat 1 bis offers a significant upgrade to standard Cat 1 with a long lifespan and an appealing cost base. At launch, Cat 1 bis was needed to provide differentiation between single and multi-antenna Cat 1 devices but now the technology occupies far more than a classification role in the LTE family.

Recent cellular module forecasts from ABI Research show that Cat 1 bis will replace nearly 70% of the LTE Cat 1 market by 2029.[2] Popular use cases include industrial routers, home security and automation, smart electricity meters, fleet management and point of sale (POS) devices.

Cat 1 bis is in a cellular sweet spot, offering more than adequate performance for video applications, attractive cost and the assurance that LTE networks will be in operation until at least the end of this decade.

Cat 1 bis offers data rates of up to 10Mbps downlink and 5Mbps uplink, latency of less than 100ms. Operating in all LTE frequencies, the technology supports power saving capabilities such as extended discontinuous reception (eDRX) and power saving mode (PSM) which achieves similar power consumption in sleep mode and standby to Cat M and NB-IoT. In addition, the higher data rate gives Cat 1 bis a clear advantage in power consumption over Cat M and NB-IoT when transmitting because Cat 1 bis transmits more data with less power. This is because it enables a shorter time in transmit mode, during which the module consumes maximum power.

[2] https://www.abiresearch.com/press/despite-2023-decline-cat-1bis-and-redcap-are-bright-spots-for-iot-cellular-module-market/

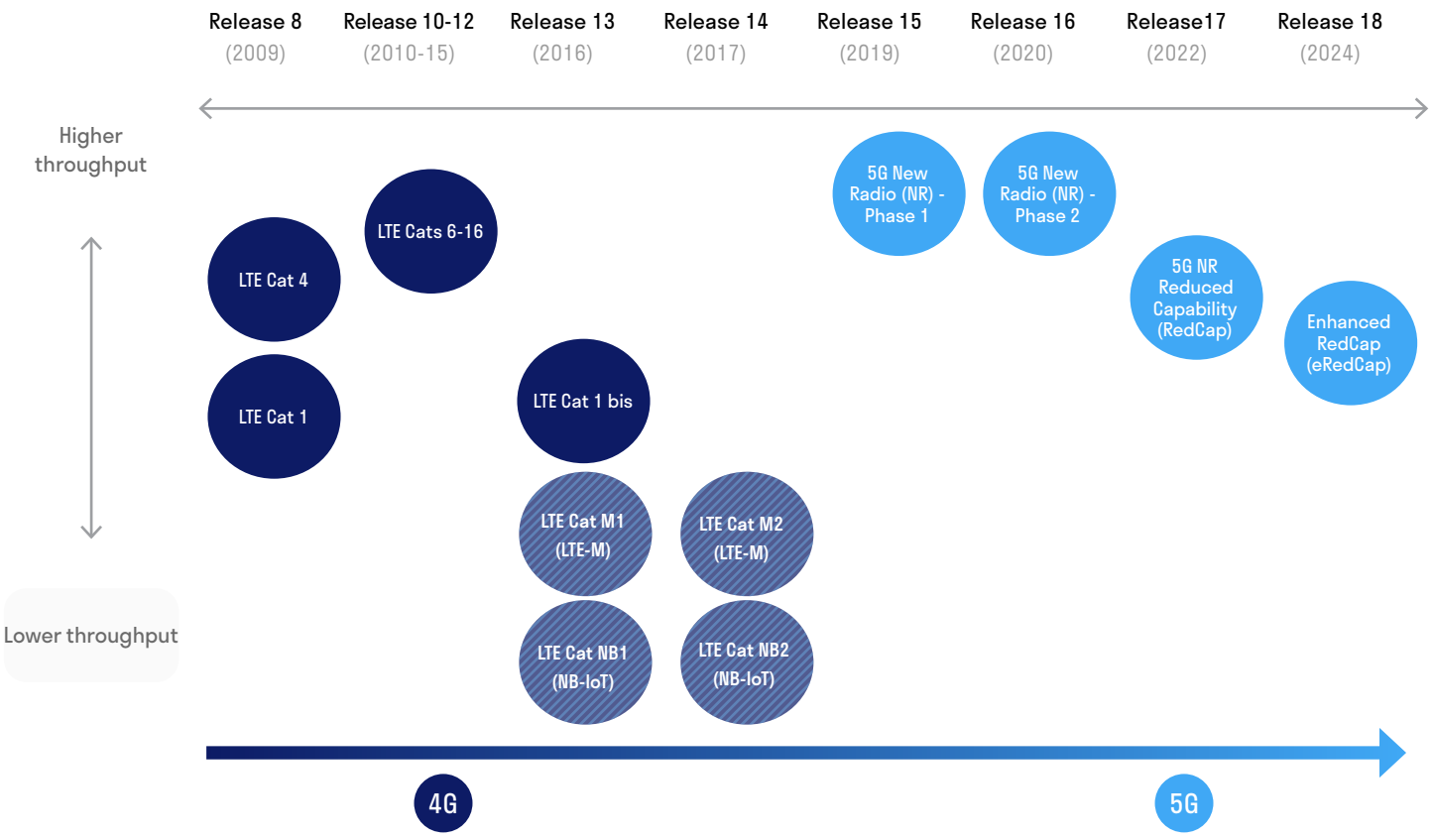
Why is Cat 1 bis needed?

LTE Cat 1 is a popular, resilient technology that provides good coverage at a reasonable cost but device OEMs and chipset vendors have realized that Cat 1 module costs could come down further if a dedicated Cat 1 bis chipset with send and receive functions delivered over a single antenna were developed. There are cost optimization benefits of using a single antenna in comparison to two antennas. The Cat 1 bis standard in 3GPP Release 13 is significant because it formalizes the common but informal use of single antenna Cat 1 devices. The original Cat 1 specification in 3GPP Release 8 required two antennas.

Put simply, Cat 1 bis is gaining mass-market traction now because it offers:

- Ubiquitous service that is comparable to, if not better than, 2G
- Worldwide roaming agreements
- High data rates compared to 2G/3G
- Low power consumption
- Low cost

FIGURE 3: CAT 1 BIS INTRODUCED IN GSMA RELEASE 13



Source: Transforma Insights, 3GPP (https://portal.3gpp.org/#/55934-releases)

Bis benefits drive adoption

The lower cost of Cat 1 bis is a compelling advantage, reports ABI Research. Outside of China, Cat 1 bis modules are at least 30% cheaper than Cat 1, with even greater reductions seen in China. Network roaming is also a benefit as 4G roaming agreements are well established, unlike the challenges seen today with NB-IoT and Cat-M in international markets.

Counterpoint Research has also noted the cost-effectiveness of Cat 1 bis. It says the average selling price of Cat 1 bis almost halved over the year to Q2 2024, making the technology more attractive for smart meter and soundbox applications. The firm reports that LTE Cat 1 bis is the fastest growing segment in the global cellular IoT module market in Q2 2024, capturing 42% of the market, driven by growth in China and India.

That performance is borne out by IoT Analytics which expects to see double digit growth for Cat 1 bis. Although the firm reports that only 6% of the cellular IoT module market in Q1 2024 was Cat 1 bis based, it is the best-selling cellular IoT module type in China.[3] In addition, LTE Cat 1 bis has experienced the steepest climb in year-on-year shipments and the market forecasts are for a continued upward trend in this regard, resulting in 14% revenue growth in 2024.

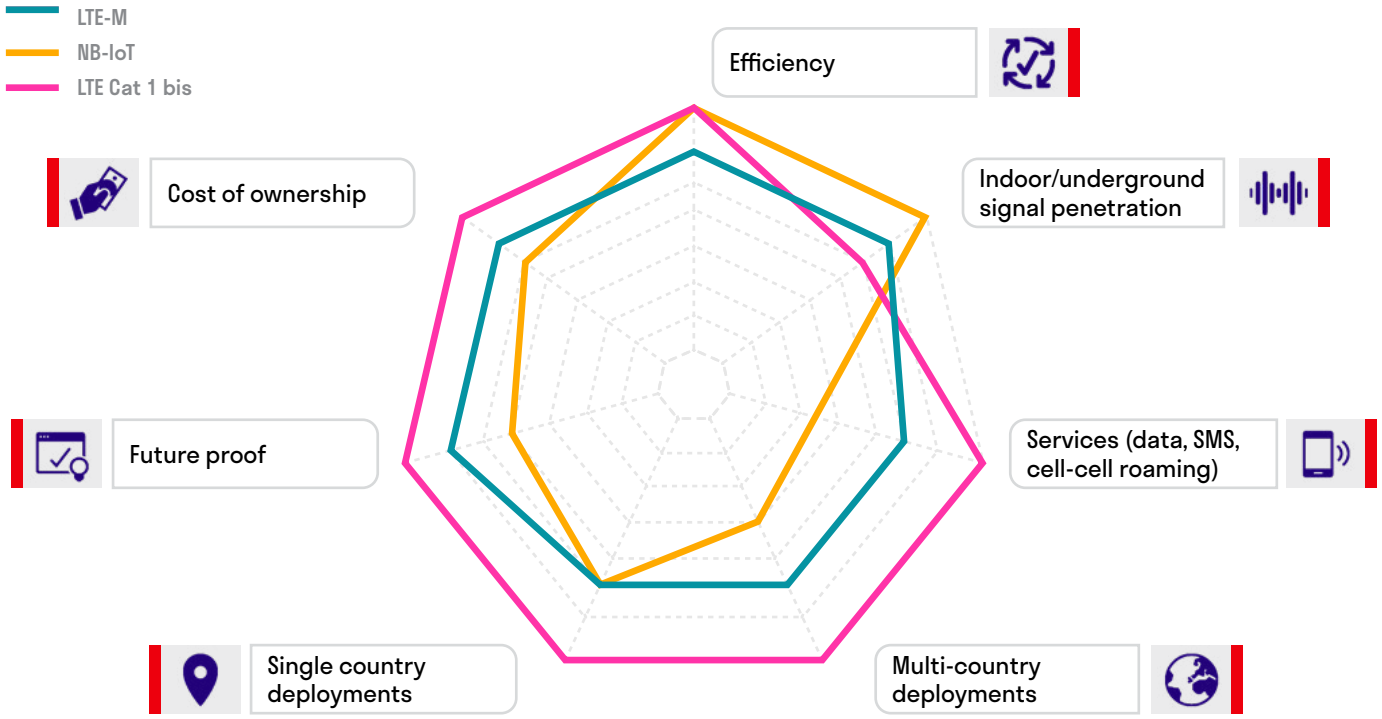
The firm adds that demand for this technology is particularly notable in applications where ultra-high-speed connectivity is not essential, like POS terminals, smart meters, vehicle telematics units and asset-tracking devices. Cat 1 bis offers a balanced, efficient and sufficient performance for many IoT and mobile applications, the firm says.

3 https://iot-analytics.com/global-cellular-iot-module-market/

The rapid growth of LTE Cat 1 bis module shipments has also been noticed by Berg Insight. LTE Cat 1 bis modules account for more than 100 million units of the annual volume of cellular IoT modules and are expected to remain the largest category during the firm's forecast period which extends to 2028.[4]

LTE Cat 1 bis is also becoming a popular option across other regions, especially where 4G LTE networks are expected to remain in operation for the foreseeable future. Former cost and power consumption challenges have been addressed with the power consumption of Cat 1 bis modules equivalent to Cat M or NB-IoT if eDRX or PSM are used. In addition, there are now Cat 1 bis modules on the market which are significantly cheaper than Cat M or NB-IoT modules.

FIGURE 4: LTE CAT 1 BIS BENEFITS



4 https://www.berginsight.com/cellular-iot-module-revenues-declined-9-percent-to-us-54-billion-in-2023

Cat 1 bis is proving so appealing because of the attributes it combines, as set out in Figure 3. For existing Cat 1 users, it offers lower end device cost and complexity, thanks to the single RX antenna that Cat 1 bis needs. In addition, module cost is lower. For those assessing 5G, the technology is still too expensive for many cellular IoT business cases and that expense isn't justified because 5G offers features that are not needed in the majority of LTE applications.

More recent variants, such as 5G Reduced Capacity (RedCap) may bring some 5G features to deployments at lower cost but this uplift in performance isn't needed by the mass market yet.

LPWA networks also face challenges from Cat 1 bis because of their weaker data throughput, lesser service availability and roaming constraints. LPWA technologies also offer less mobility and have not been able to follow the price reduction curve that Cat 1 bis has been able to offer to the market.

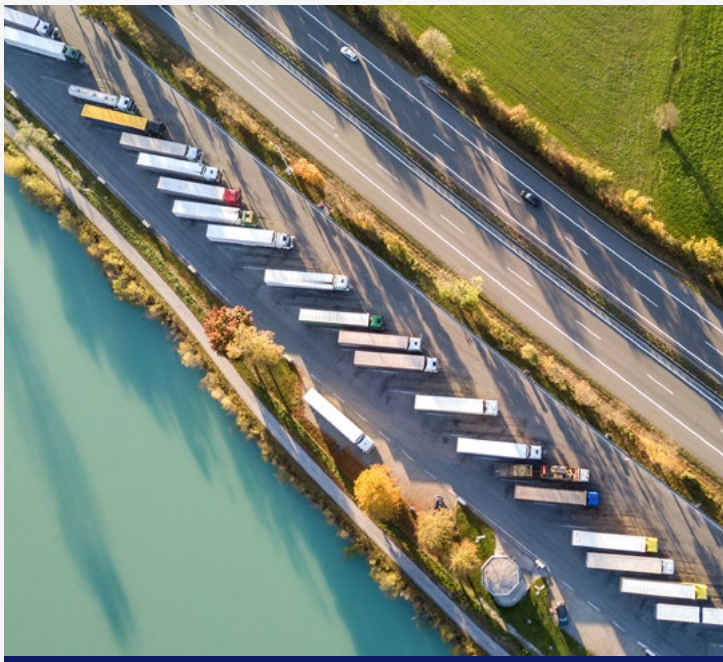
FIGURE 5: COMPARISON BETWEEN LTE CAT 1, CAT M AND NB-IoT

Items	LTE Cat 1 / Cat 1 bis	Cat M	NB-IoT
Service availability	●●●●● Global	●●○○○ NA, LATAM, Western & Northern Europe, ANZ, JP&KR etc.	●●●○○ NA, LATAM, Europe, ANZ, JP&KR, China, India
Future network developments	Existing LTE networks	Network operators may decide not to invest in the technology	Network operators may decide not to invest in the technology
Voice capability	●●●●○ Yes	●●○○○ Yes (*)	●○○○○ No
Data throughput	●●●●○ 10Mbps DL/5Mbps UL	●●○○○ 588Kbps DL/1Mbps UL	●○○○○ 127Kbps DL/158.5Kbps UL
Mobility	●●●●●	●●●●○	●●○○○
Roaming	●●●●●	●●○○○	●●○○○
Link budget	●●●○○	●●●●●	●●●●●
Power consumption	●●●●○ Idle mode: 13mA Sleep mode: 1.2mA(DRX=1.28s) PSM: 5.7uA (**)	●●●●● Idle mode: 16.5 mA Sleep mode: 1.1 mA(DRX 1.28 s) PSM: 1.5 uA	●●●●● Idle mode: 16.8 mA Sleep mode: 2.2(DRX 1.28s) PSM: 1.4 μA
Cost	●●●○○	●●●○○	●●●○○

Cat 1 bis use cases

Cat 1 bis is seeing significant uptake in a wide range of IoT use cases and applications. Some select examples are listed below:

- **Point of sale terminals** Cat 1 bis has been adopted to allow both mobile merchants and retailers in large stores to take advantage of ubiquitous cellular coverage to process transactions. Cat 1 bis throughput is comfortably able to support POS communication and offers a secure, low-cost solution for retailers.
- **Smart meters** The low power consumption of Cat 1 bis, which supports eDRX and PSM, makes it ideal for long-life meter deployments. Smart meters can be simply installed and utility providers can be assured that the cellular connection will be available for the life of the meter. The low cost is essential for meter deployments which can number in the tens of millions of units.
- **Vehicle telematics units** Vehicles by definition are mobile so Cat 1 bis makes an ideal connectivity solution because coverage is near-total, devices can roam from country-to-country and throughput is adequate for in-vehicle applications, including video. This market is also cost-sensitive so being able to access globally-adopted LTE networks with good performance is compelling for this sector.
- **Asset-tracking devices** Tracking assets accurately relies on uninterrupted access to connectivity so positions can be reported and status and usage monitored. Cat 1 bis is easily able to handle these types of data payload and, importantly, in this sector, can offer near-complete global coverage thereby assuring asset owners that their devices can be tracked. For tracking higher value assets, cost is less of a priority but no one wants to pay more for features they don't need and Cat 1 bis is perfectly dimensioned for asset tracking criteria.



Conclusion

As a single RX antenna variant of Cat 1, Cat 1 bis is a well-understood and now increasingly popular technology. The volumes of modules and devices being shipped today that contain Cat 1 bis assure the technology's market status for the coming decade. Quectel believes that Cat 1 bis will remain a popular cellular connectivity option for at least the next ten years and emphasises that mobile operators are not yet even thinking of deactivating their LTE networks.

Ultimately, LTE Cat 1 bis may be replaced by enhanced RedCap (eRedCap) but that technology is yet to mature and is some years away from mainstream adoption. The balanced blend of performance, cost and coverage that Cat 1 bis offers today means developers can confidently select the technology for their devices.

APPENDIX 1

CAT 1 BIS MODULES – OPTIMIZED FOR M2M AND IoT APPLICATIONS

The Quectel **EG916Q-GL** and **EG915Q** are LTE Cat 1 bis modules that adopt 3GPP Rel-14 LTE technology and deliver maximum data rates up to 10Mbps downlink and 5Mbps uplink. The **EG916Q-GL** and **EG915Q** are compatible with Quectel's LPWA BG95 series and BG96 modules and LTE Standard EG91 series, EG95 series and EG915Q-NA modules. With the EG915Q measuring 23.6mm x 19.9mm x 2.4mm and the EG916Q measuring 26.5mm × 22.5mm × 2.4mm, both modules operate in an extended temperature range of -40°C to +85°C.

The Quectel **EG800Q** series of LTE Cat 1 bis modules is designed in a compact and unified form factor, based on 3GPP Rel-14 LTE technology and supports Cat 1 bis, delivering maximum data rates of up to 10Mbps downlink and 5Mbps uplink. The series consists of two variants for different geographies – EG800Q-EU (Europe) and EG800Q-NA (North America). Measuring 15.8mm × 17.7mm × 2.4mm, the modules are suitable for a wide range of M2M and IoT applications such as asset management, commercial telematics, smart payments, RMAC, security and automation, smart metering and smart grid. The modules operate in an extended temperature range of -40°C to +85°C.

EG800Q series
LTE Cat 1 bis

EG916Q-GL
LTE Cat 1 bis

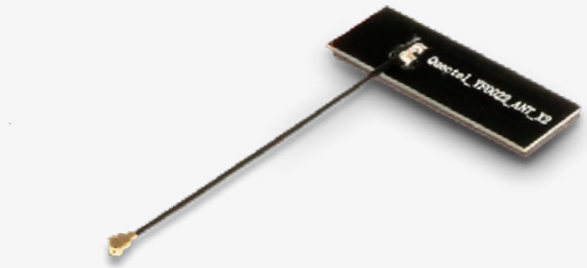
EG915Q series
LTE Cat 1 bis

THE ANTENNAS

The Quectel **YECT005W1A** is an external 5G terminal-mount rubber dipole external antenna. This ultra-wide band 5G antenna provides broad coverage from 600–6000MHz whilst offering backward-compatibility to support 4G/3G and 2G networks as well as LTE Cat M and narrowband IoT (NB-IoT). The antenna is terminated with SMA male connector. Ideal for applications where the antenna is required to be discreet, this low-profile, terminal mount omni-directional antenna is easy to install with maximum durability assured thanks to its PC + ABS enclosure. The antenna has dimensions of 135mm x 15.6mm x 13mm and is RoHS compliant.

YECT005W1A 5G terminal mount rubber dipole external antenna

The Quectel **YF0022DA** is an embedded 4G adhesive mount PCB and cable monopole antenna. This antenna is designed to be added to the walls of a device. Ground plane independent, it's designed for ease of integration with a cable and connector. Ideal for all 4G/LTE applications, including LTE Cat 1 bis, it also supports worldwide Cat M and NB-IoT frequency bands too. Supporting the 600-960MHz and 1710-2690MHz frequency bands and offering dimensions of 40mm x 15mm x 0.8mm, the antenna is RoHS and REACH compliant.



YF0022DA 4G adhesive mount PCB + cable monopole embedded antenna

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