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A Comprehensive Guide to Manage the 2G/3G Shutdowns

—How to Pick the Right 4G LTE Technology for Your IoT Applications?



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1. Executive Summary

According to Machina Research, the number of global IoT conections will reach 27 billion by 2025. Among them, the total size of cellular IoT connections is expected to exceed 5 billion. Technologically, as the world is moving towards the 5G era, and 4G has become the mainstream mobile communication system, shortcomings of 2G/3G become increasingly obvious either regarding spectrum allocation efficiency, wireless performance, or operation and maintenance costs. The worldwide 2G/3G sunset is in progress with many countries giving their own timelines based on their needs for telecommunications networks (see Figure 1).

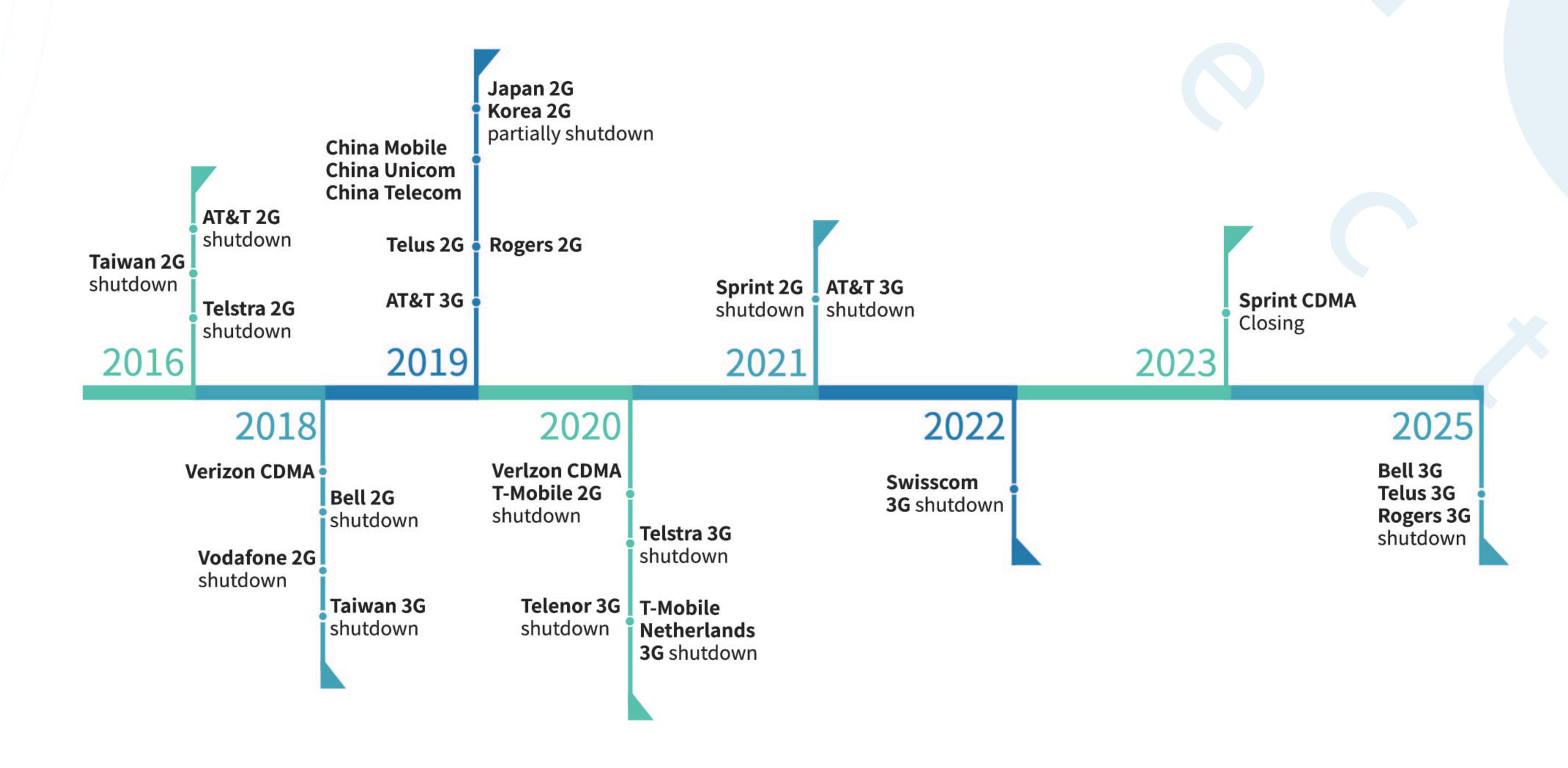


Figure 1:Global cellular carrier 2G/3G sunset dates (Source: Digi International Inc.)



The retirement of 2G/3G requires mature alternative technologies to meet the development needs of low and mid-speed IoT applications (within 10Mbps on the downlink and 5Mbps uplink) that account for 90% of the overall cellular IoT connections (see Figure 2).

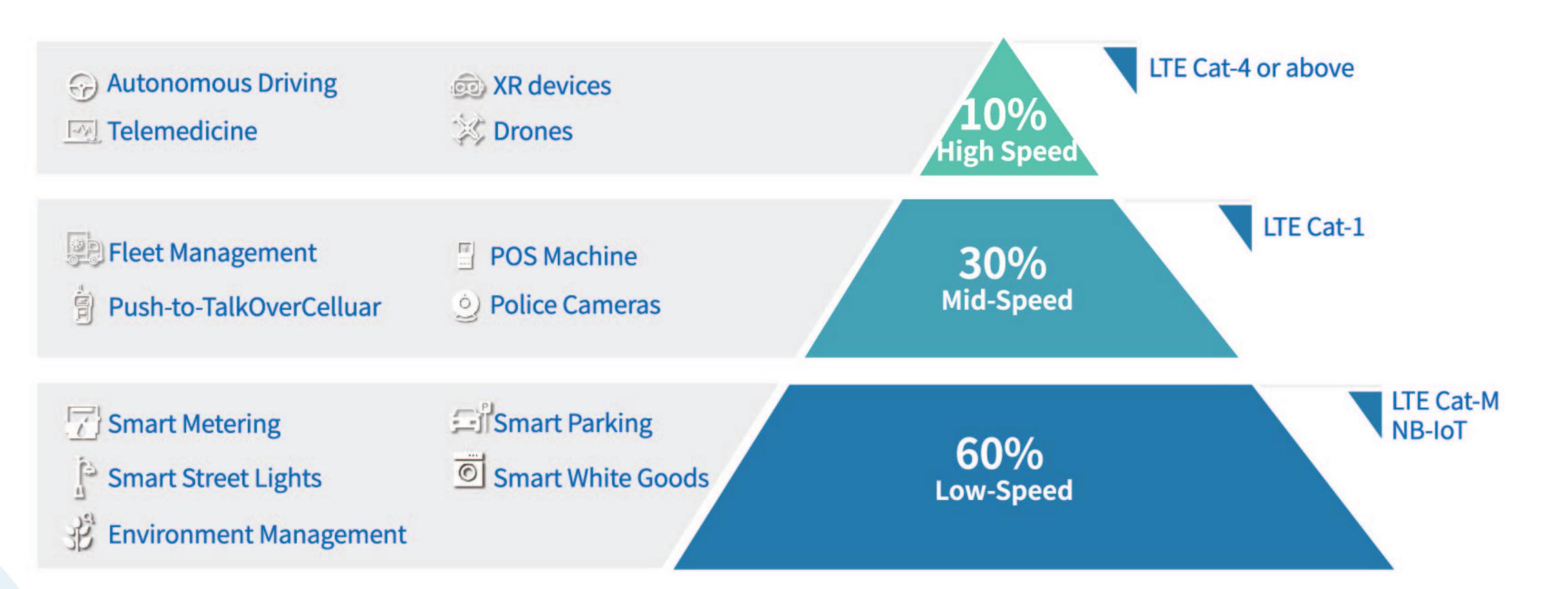


Figure 2: IoT business distribution per data speed

This white paper is to help you through the 2G/3G sunset to find the right, replacing cellular technologies for your IoT applications. We will compare the characteristics of the alternative technologies and their applicable IoT scenarios respectively, analyze the factors in decision-making, and list the successful IoT cases using the substitute technologies.

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2.Technologies Replacing 2G/3G for Next-Gen IoT Connectivity

LPWA (Low Power Wide Area), including NB-IoT and LTE Cat M, as well as LTE Cat1, have become the main choices for wireless connectivity for low and mid-speed IoT applications after 2G/3G has started to withdraw from the stage (see Figure 3).

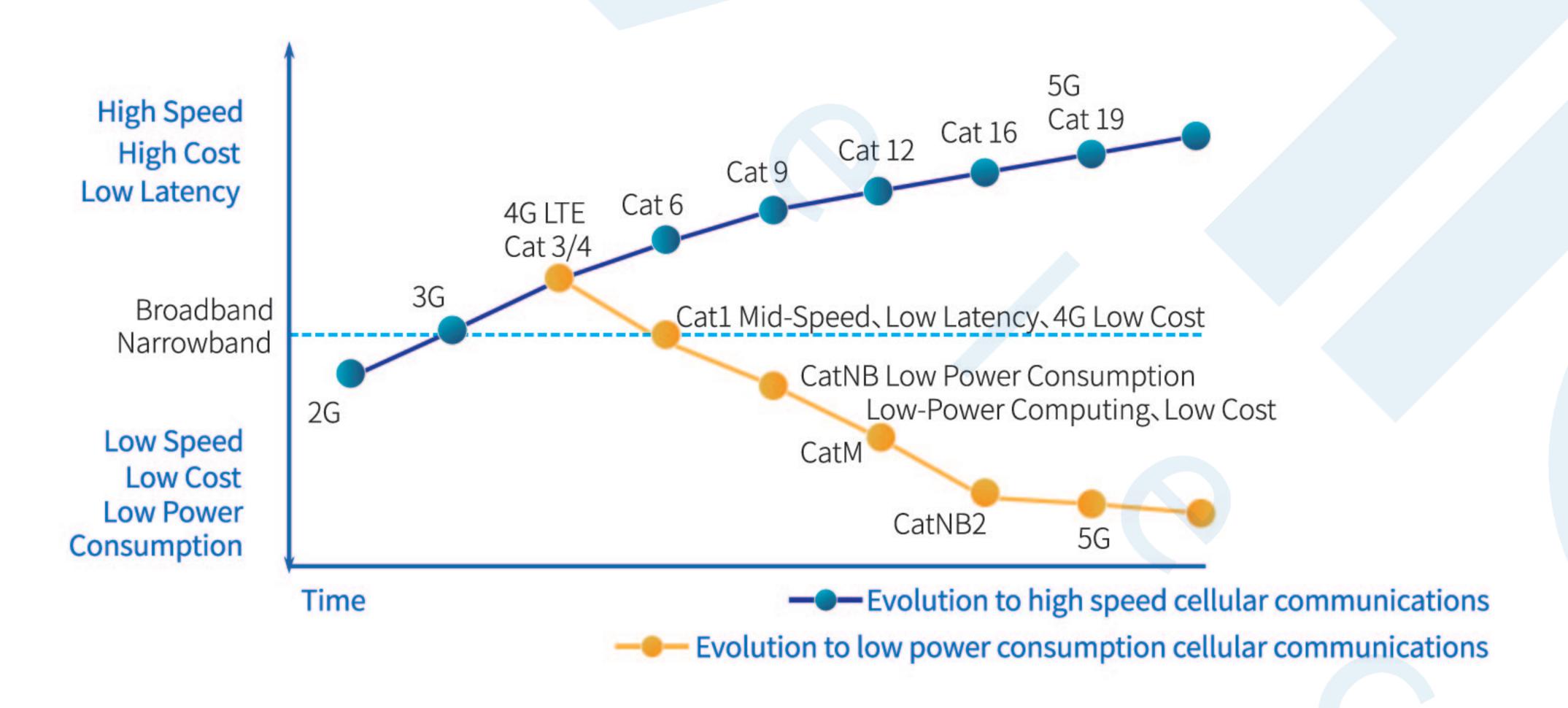


Figure 3: Cellular Technologies Evolution

According to GSMA, as of September 2020, the total number of deployed NB-IoT and Cat M-based low and medium-speed IoT networks worldwide reached 112, of which 96 support NB-IoT, 46 support Cat M and 30 support both NB-IoT and Cat M. In China, the three major operators are deploying LTE Cat 1 technology for the mid-speed IoT businesses. Up to now, the scale of domestic LTE Cat 1 commercial chips in China has reached 10 million.



NB-IoT, featuring wide network coverage and ultra-low power consumption, is suitable for low-speed IoT applications that needs long-distance, small amount of communication data transmission with mere latency demand. LTE Cat 1 and Cat M technologies are more suitable for IoT applications that require relatively high mobility, high data rate and volume, as well as voice capabilities (see Figure 4, Figure 5).

		3G	CAT1	CATM	NB-IoT	GSM
N	Released	Rel.99	Rel.13	Rel.11	Rel.14	Rel.4
	Bandwidth	5MHz	20MHz	1.4MHz	200KHz	200KHz
(1)	Speed (UL/ DL)	384kbps(DL) 384kbps(UL)	10Mbps(DL) 5Mbps(UL)	375Kbps(DL) 1119Kbps(UL)	126.8Kbps(DL) 158.5Kbps(UL)	85.6Kbps (DL) 85.6Kbps (UL)
(A)	Number of antennas	1	1	1	1	1
U	Duplex mode/ Latency	Half duplex/<10s	Full duplex/<10ms	Half duplex/<1s	Half duplex/<10s	Full duplex/>100ms
-	Receive bandwidth	5MHz	20MHz	1.4MHz	200KHz	200KHz
•	Transmit power	22.5dBm	23dBm	23dBm	23dBm	23dBm
5	Mobility	YES	YES	YES	YES	YES
	IP-based	YES	YES	YES	YES/NO	YES
	Power Consumption	sleep:5mA	sleep:2.2mA	sleep:1.4mA	sleep:1.4mA	sleep:1.4mA

Figure 4: 4G LTE IoT communications technologies comparison (Source:Internal Research)



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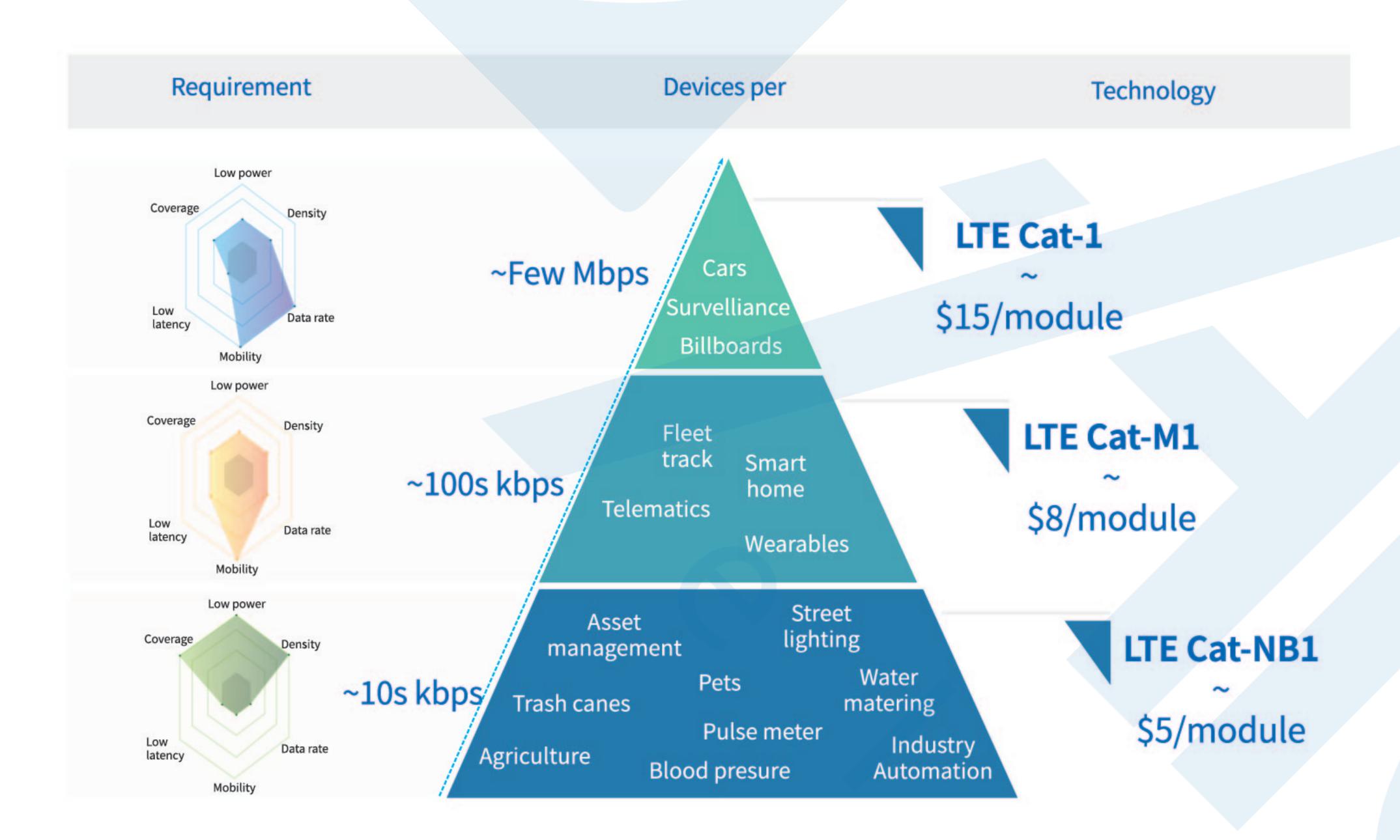


Figure 5: Cat 1&Cat M & NB-IoT Comparison (Source: Keysight)

2.1 LTE Cat 1 offering all-round advantages

— a preferred alternative to 3G

LTE Cat 1 is the preferred alternative option for IoT scenarios that applied 3G, balancing between the consideration of both wireless performance and migration cost. With similar or higher uplink and downlink data rates than 3G, Cat 1 is carried on the existing LTE network, which has good coverage worldwide.

Therefore, operators do not need to upgrade the hardware configuration of their base stations, but only need to modify the parameters to enable the access of Cat 1 terminals to the LTE network. It is worth mentioning that LTE Cat 1 bis is proposed in the Technical Review of 3GPP Release 13, so as to strengthen 1Rx antenna that will further drive down the Cat 1 terminal deployment cost.

With low latency, good mobility and VoLTE, Cat 1 fits for a wide spectrum of IoT applications such as industrial controller, electric meter, smart grid, video surveillance, kiosk, digital signage, sharing economy devices, mobile POS, vehicular entertainment, push-to-talk, and police enforcement recorder, etc. (see Figure 6)

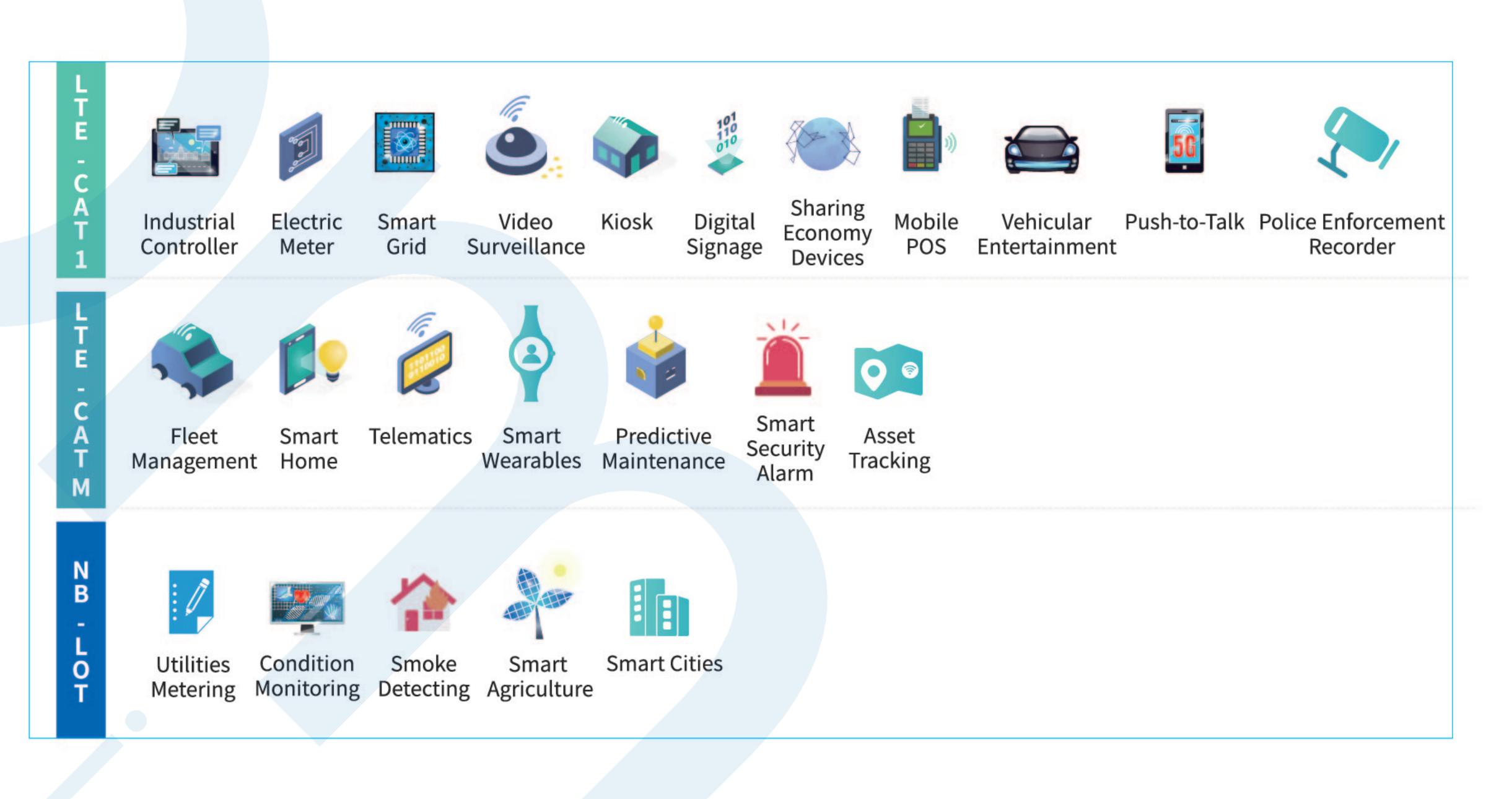


Figure 6: Low-Medium-Speed IoT Applications Powered by 4G LTE Technologies





Cat 1 vs. NB-loT

NB-IoT requires new base stations and additional hardware resources, and the existing NB-IoT network coverage is much lower than that of the LTE network where Cat 1 is operated on.

Cat 1 vs. Cat M

Operators with existing LTE base stations that want to support Cat M will need to pay additional fees to upgrade their networks, which is also not a cost concern for Cat 1 on the existing LTE network.

Cat 1 vs. Cat 4

Cat 1 is compatible with Cat 4 on the existing LTE network, and has the same advantages of Cat 4 in terms of latency, bandwidth, and mobility. Furthermore, Cat 1 bis offers a single-antenna, low-storage solution design, along with simpler hardware architecture, higher integration capability as well as lower power consumption and cost.



2.2 NB-IoT — a preferred solution to replace 2G

NB-IoT is now a significant alternative to 2G in a number of ways, especially after Release 14. Release 14 delivers substantial improvements over the previous R13 in many aspects, including uplink and downlink rates, carrier capacity, mobile performance, network coverage, concurrent access, positioning, etc. NB-IoT uplink and downlink rates reach 150/100kbps, which is higher than the peak rate of 2G; the capacity of R13 itself is higher than 2G, while R14 expands its capacity by 2-8 times compared to R13; R14 does not need GPS to realize positioning services for many scenarios, which is not possible with 2G.

In 2020, ITU officially approves NB-IoT as 5G mMTC technology as proposed by 3GPP R16, and thus, NB-IoT will co-exist with 5G in the long term. At the same time, 3GPP launched the evolution of Release 17 to further enhance the uplink and downlink rates, from 128Kbps to 280Kbps for downlink and from 158kbps to 210kbps for uplink respectively.

NB-IoT is best fit for battery-powered IoT scenarios that do not require mobility, such as utilities metering, condition monitoring, smoke detecting, smart agriculture, smart cities, etc. (see Figure 6).

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NB-IoT has become the prevailing choice of global operators for low-speed IoT business. 56 mainstream operators, including Vodafone, Deutsche Telekom and Softbank, have deployed NB-IoT commercial networks to drive the global NB-IoT industry across the rift valley, accelerating development across the world.

2.3 LTE Cat M — the ideal alternative of both 2G and 3G

LTE Cat M is the ideal alternative for both 2G and 3G in the network deployed regions. Use cases of LTE M include fleet management, smart home, telematics, smart wearables (fitness wristbands, smart watches), predictive maintenance, smart security alarm, asset tracking and so on (see Figure 6).

LTE Cat M is predominant in North and Latin American as well as Asian markets with early LTE adoption.

NB-IoT vs. Cat M

Similarities:

Both NB-IoT and LTE Cat M are to connect a large amount of devices per base station, which can support massive amounts of sensors and tracking devices with guaranteed connectivity. The two technologies feature very low power consumption as well as wider coverage than normal 4G / 5G networks.

Differences:

Firstly, LTE-M employs the full TCP/IP stack, whereas NB-IoT currently only supports the UDP protocol. Secondly, based on existing LTE specifications, LTE-M is easier to be deployed, whereas NB-IoT is easier for operators with GSM networks to incorporate. Lastly, NB-IoT generally is better for devices where lower-data, higher-battery life is required.

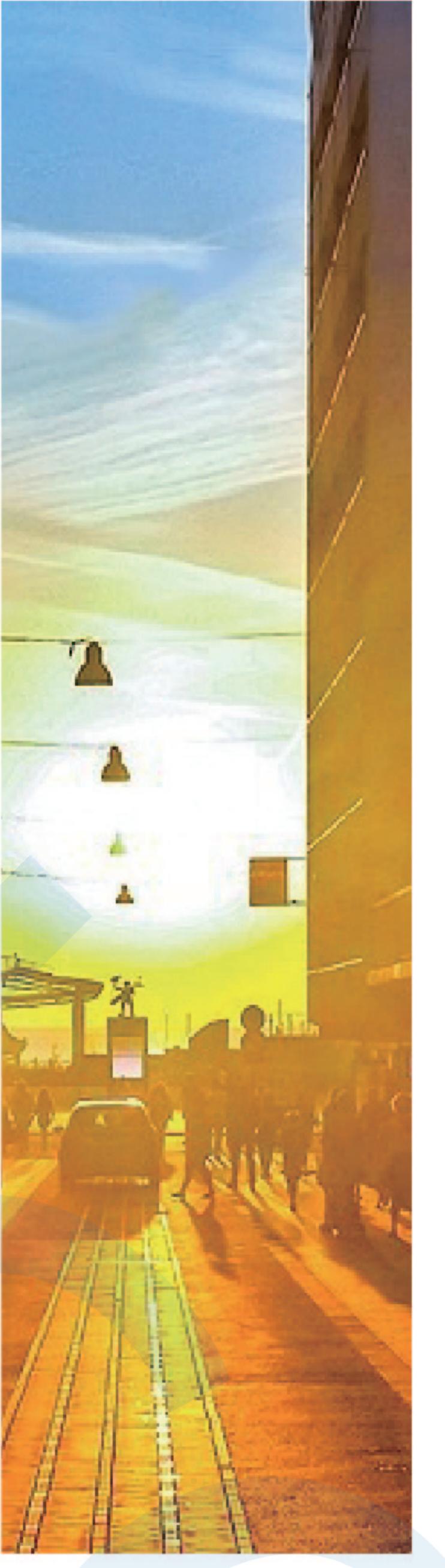




3. Future-Proof Technology for Your IoT Project

With the retirement of 2G and 3G networks approaching, many IoT companies who deployed 2G and 3G connectivity as their solutions may find the transition very challenging. The critical issues for them to consider are what applications they apply and what will be the right solutions with the network capabilities of new LTE technologies.

- Specify whether you require data to be delivered in bursts or in a constant stream over time, and whether you need to transfer a few bytes or several GB per day.
- Determine whether data is required in real time or if a delay of a few seconds, minutes, or hours is acceptable, and then select the most cost-effective option.
- •Evaluate whether your company's communication needs are localized within a building, facility, city, or even across a country or globally. Determine whether you need to be online all the times, and whether downtime could result in lost income, regulatory penalties, or safety breaches.
- Consider if your equipment will be used in environmental-stable locations or in severe, perhaps hazardous conditions. Determine whether there will be access to AC (alternating current) power or if battery or solar power will be the only choice.



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4.IoT Applications Nurtured by 4G LTE Technologies

Hello Shared E-bike

As a local shared mobility and life service platform in China, Hello leverages digital technology to provide people with more convenient mobility and inclusive local services of higher quality. The Hello e-bikes powered by the 4G network have better coverage and less latency than typical two-wheelers that use the 2G network. By utilizing the Fibocom 4G Cat 1 module L610, locking and unlocking times may be reduced by over 30% on average. Furthermore, the faster network will enable Hello e-bikes to deliver more diversified services to customers, such as providing LBS-based dynamic weather prompts and pushing commercial advertising.

Vodofo 4G C-V2X Smart Terminal

Shenzhen Vodofo Science and Technology Co., Ltd. is a national high-tech enterprise specializing in R&D, production, sales, and operation of Internet of Things (IoT) location services.

Embedded with Fibocom's LTE Cat 1 module MC615, Vodofo's smart terminal is able to provide location services for vehicles, objects (such containers), smart warehouses, big data platforms, etc. The product leverages the extensive network coverage of MC615, with high integration level, robust extensibility, numerous interfaces and cost efficiency, empowering logistics, fleet management, remote e-bike monitoring, BMS (Battery Management System) and so on.

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Northmeter Smart Energy Devices

Shenzhen Northmeter Co., Ltd. is a company focused on smart energy, who provides a full range of technical services from cloud, pipe and end devices suitable for smart communities, smart campuses and smart cities. Fibocom's L610 modules are embedded in the Northmeter smart gateway, split AC (Air Conditioner) controller and smart charging pile, which make full use of the scale, stability and low power consumption of LTE Cat 1 connectivity in static scenarios.

• Secure net In-vehicle Smart Surveillance Terminal
Shenzhen Secure net Technology Co., Ltd. is a high-tech
company develop IoT products, business covering intelligent
transportation, smart cities, shared mobility, unmanned
service, artificial intelligence and other sectors. Embedded with
Fibocom's LTE Cat 1 module L610, the in-vehicle smart
surveillance terminal enables smooth communication and
stable positioning signals, real-time online support and
minimal network blind spots, high-precision BeiDou/GPS
dual-mode positioning and compatibility with LBS/AGPS
assisted positioning, as well as custom shell antenna design.
The terminal consumes very little power, accurately detects all
failures and quickly sends out warning when detecting problem.

Changde WaterMeter NB-IoT Water Meter

Hunan Changde Water Meter Manufacture Co., Ltd. is one of the most powerful manufacturers in the water meter industry in Southern and Central China. The NB-IoT water meter is a wireless remote water meter integrated with Fibocom's NB-IoT module N700, which can transmit data including flow rate, temperature and signal strength to the meter reading platform through the carrier's base stations to support data collection, remote control and fault alarm.

Goldcard NB-IoT Smart Water Meter

Goldcard Smart Group Co., Ltd. is a leading metrology digitization solution provider. Embedded with Fibocom's NB-IoT module N700, the information of the smart water meter such as consumption data, remaining power and signal strength can be transmitted through the NB-IoT network to the management platform, realizing remote meter reading, maintaining and billing. The backend platform can also remotely monitor the fault and alarm status of the smart water meter and send feedback to the users, allowing users to take actions in time.





5.Fibocom High-Performance 4G LTE Modules for Low & Mid-Speed IoT Applications

Module	Features
MC116	LTE Cat 1/ WCDMA/ GSM; LCC+LGA; GNSS; DFOTA/ SMS; Linux/ Windows/ Android; Rich Interfaces; Pin-to-Pin Compatible with Fibocom LTE Cat 4 module NL668
MA510	LTE Cat M1/ NB2/ EGPRS/ LTE 450 MHz; LCC+LGA; GNSS; eDRX/ PSM/MUX/ LBS/ DFOTA/ Audio/ SMS; Android/ Linux/ Windows; Rich Interfaces; Pin- Compatible with Fibocom G510 & MC610 Module
N510	LTE Cat NB2; LCC+LGA; eDRX/ PSM/ MUX/ DFOTA/ SMS; Open CPU; Linux/ Windows; Rich Interfaces; Pin-Compatible with Fibocom G510 & MC610 Module

Figure7: Fibocom Advanced Modules

6.Experience Perfect Wireless Connectivity with Fibocom

Future IoT network mainly consists of LTE Cat 1, NB-IoT and LTE Cat M, which will account for 90% of the overall IoT connections. Broadband IoT technology such as LTE Cat 1 is versatile in all aspects and will continue to develop fast in industries like video surveillance, smart grid, asset tracking and shared economy, to name it. It is applicable in all mid-speed IoT applications. R14 based NB-IoT network capability is greatly improved and exceeds 2G in all aspects, especially in spectrum efficiency, latency and air interface security. It is ideal for fixed battery-powered IoT devices such as smart water and gas meter. LTE Cat M sharing the low-power advantage of NB-IoT and good mobility feature of Cat 1, is a good choice for IoT uses in regions with Cat M networks coverage.

Fibocom offers a variety of LTE Cat 1, Cat M and NB-IoT wireless modules to support the global needs of large, low and mid-speed IoT applications, with excellent network performance, great reliability and mobility, as well as amazing cost performance, providing the perfect solution to a variety of verticals. With what Fibocom can offer, we look to lead the way in this constantly updating world.

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Reference

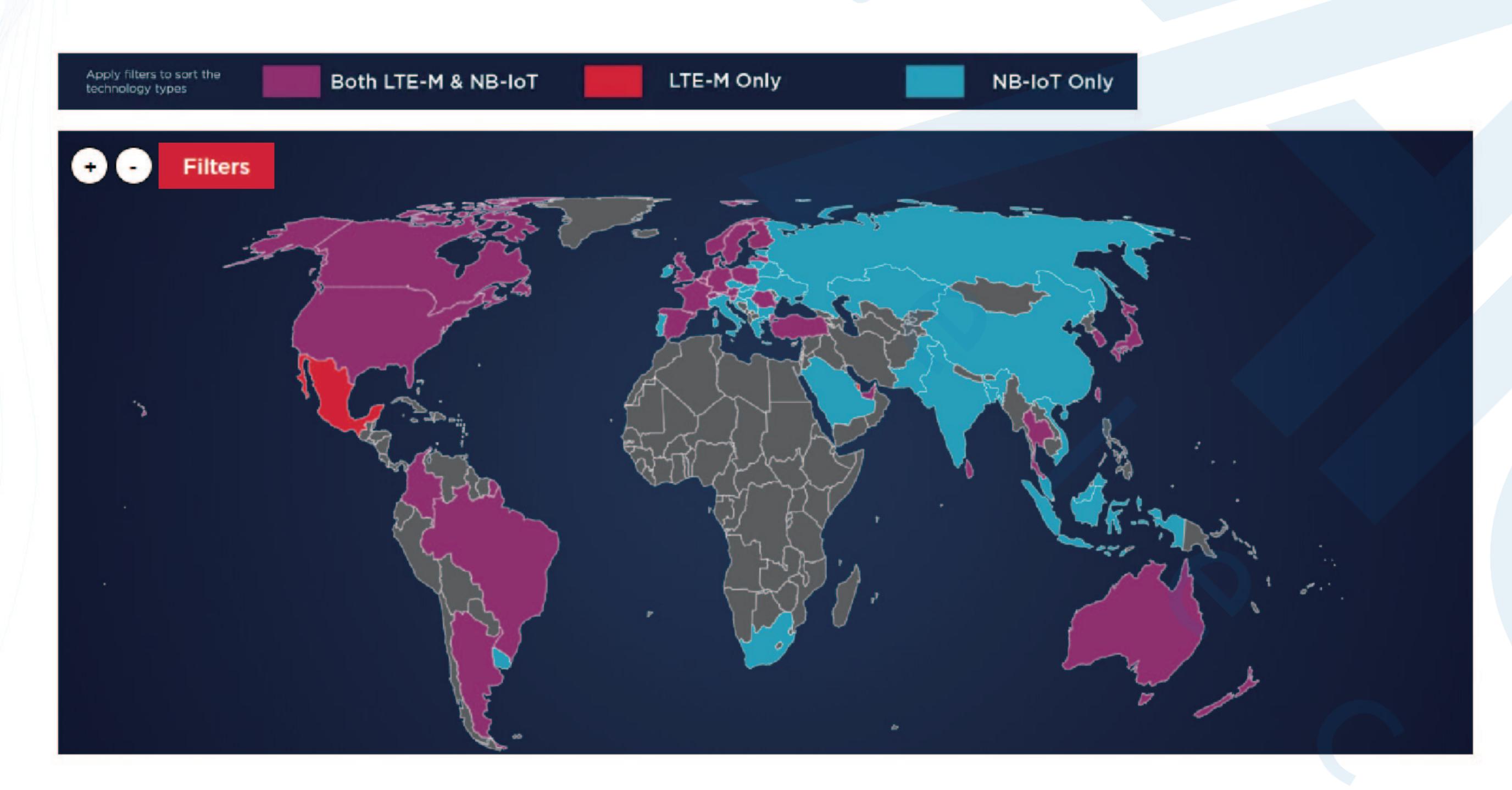


Figure8: LTE Cat M and NB-IoT Networks Global Deployment (Source: GSMA)

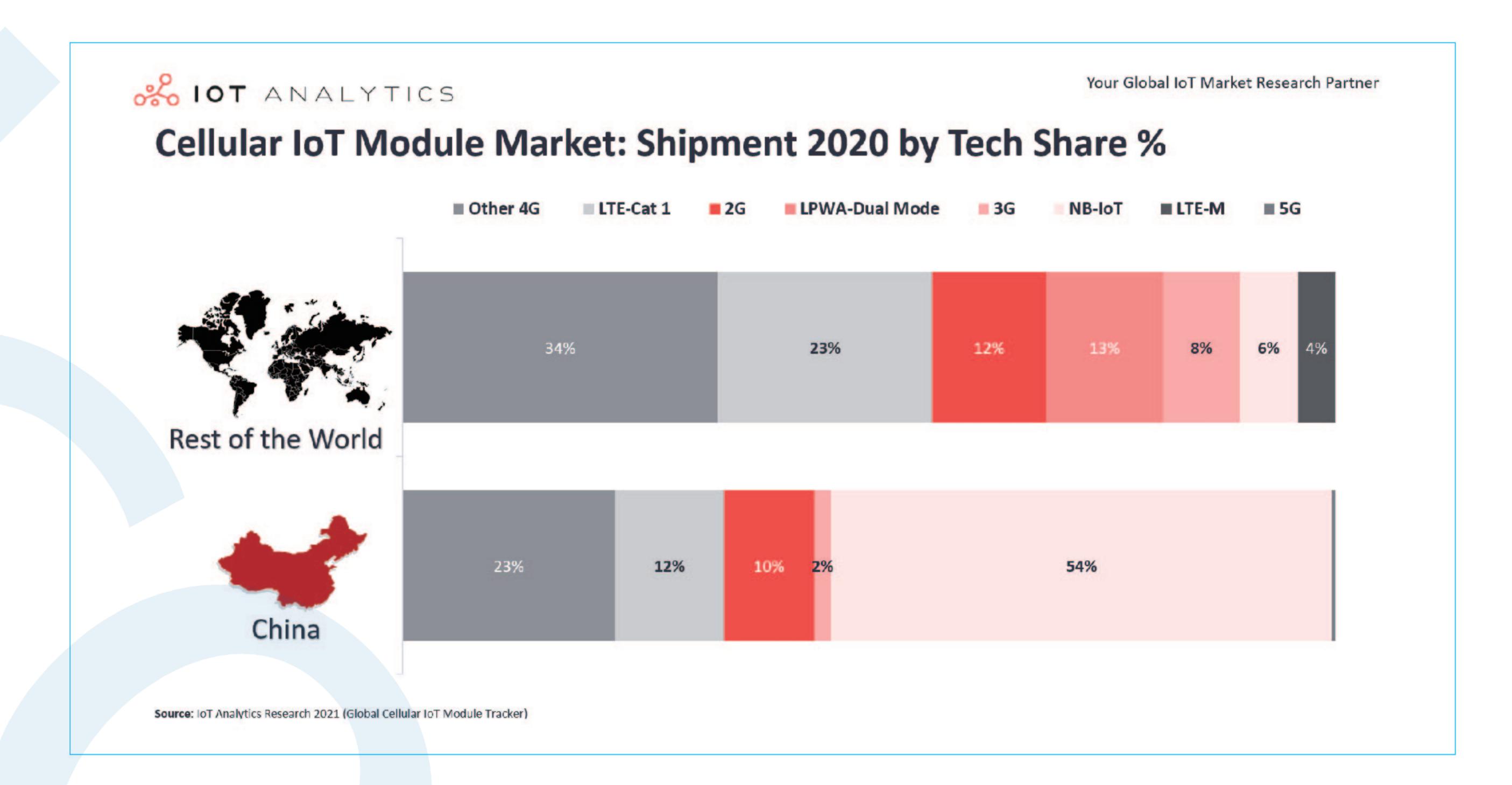


Figure 9: Cellular IoT Module Market: Shipment 2020 by Tech Share % (Source: IoT Analytics Research 2021(Global Cellular IoT Module Tracker)

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