

Embrace a Beautiful Tomorrow with Cellular IoT Technology

A futuristic, blue-toned digital landscape. Two sleek, glowing cars are driving on a road that recedes into the distance. The scene is overlaid with a complex network of glowing lines and data points, suggesting a highly connected environment. Two Wi-Fi symbols are visible, one above each car, indicating connectivity. The overall aesthetic is clean, modern, and high-tech.

Jakub Borkowski

We are entering a smart, interconnected society



Everything
Perception

Device



Internet of
Everything

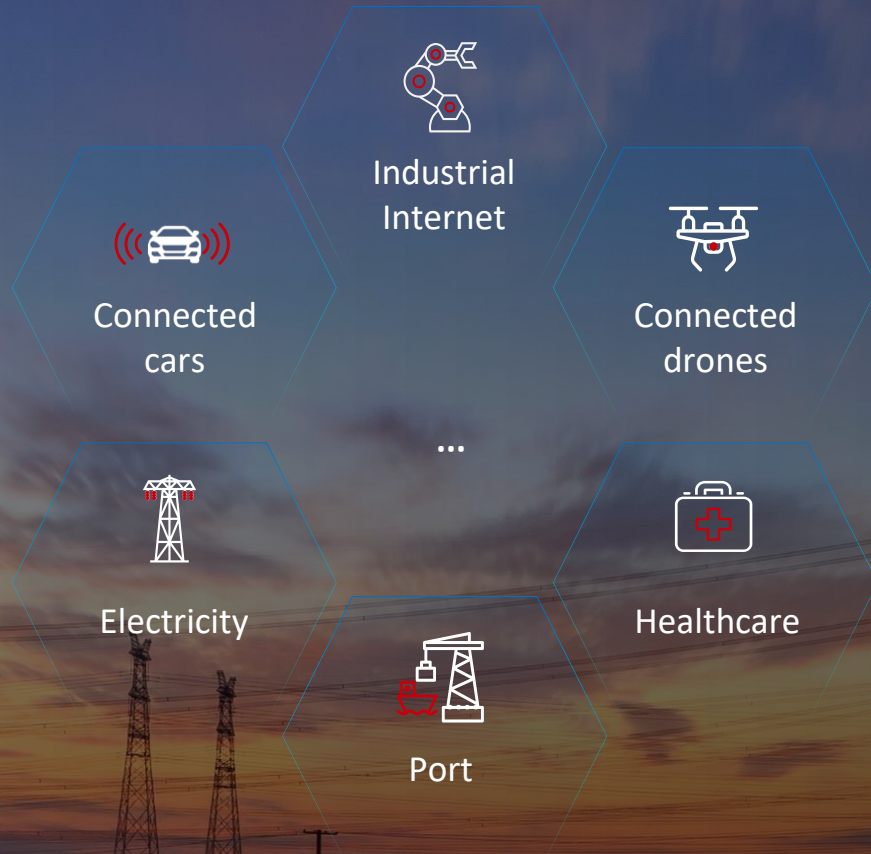
Pipe



Intelligence of
all Things

Cloud

IoT drives industrial digitalization



75%

of enterprise production processes using AI by 2025

\$40.2B

5G IoT market by 2026 (CAGR: 73%)

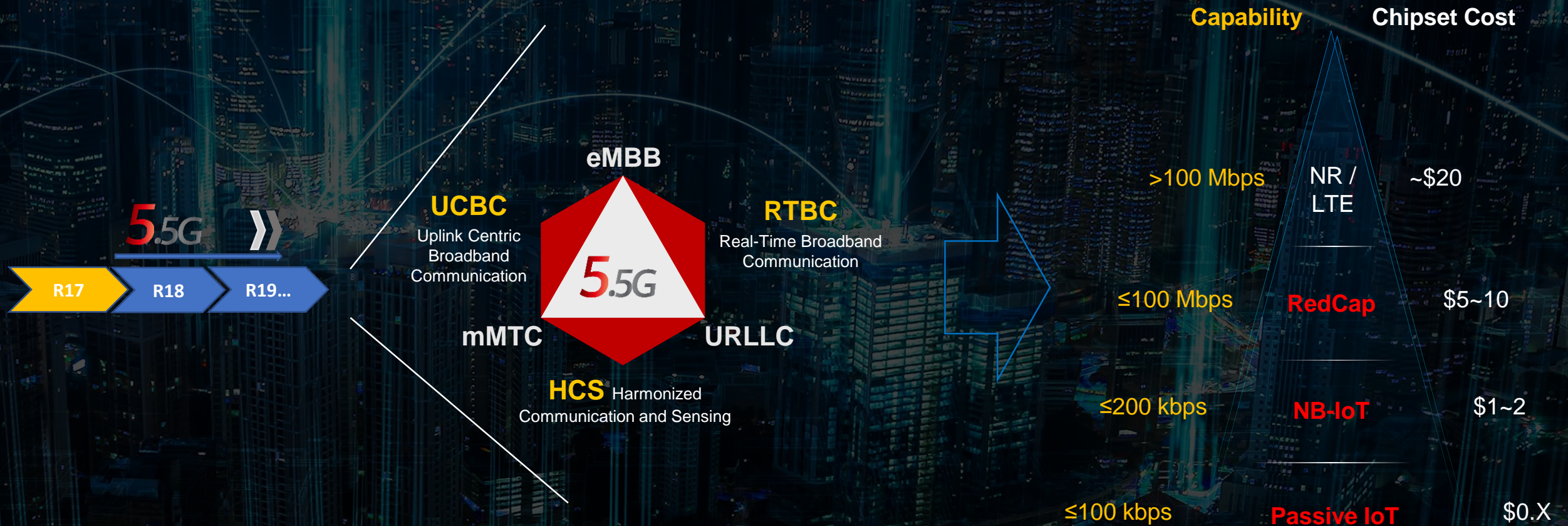
390

robots for every 10,000 workers by 2030

Source: IDC, MarketsandMarkets, Huawei *Intelligent World 2030*

5G keeps evolving

5.5G brings new technologies, new capabilities and new business



IoT 5.5G technologies aim to address every market scenario

100+Bn potential of IoT connections



1 billion level
RedCap
Mid-speed

10 billion level
NB-IoT
LPWA

100 billion level
Passive IoT
Passive

Scenarios



Smart wearable



Smart vehicle



Smart parking



Water meter



Asset lable
(Factory)



Inventory
(Supermarket)

Capability

≤100 Mbps

≤200 kbps

≤100 kbps

Chipset Cost

\$5~10

\$1~2

\$0.X

Coverage range

Kilometer level

Penetrate to basement

~ 200 meters

NB-IoT Start from smart metering to diverse applications

4 Ten-Million-Level Applications



Water Meter



Gas Meter



Electric Meter



Smoke Detector

7 Million-Level Applications



Appliance



Street Light



Parking



Agriculture



Door Lock



Tracking



Electric Bike

Smart Metering Projects



➤ **Telefonica**: 130,000 NB-IoT smart meters, expanding to 650,000 in 3 years, to monitor water usage, wastage, and leakage for water utility Canal de Isabel II, which manages the water supplies for Madrid, in Spain.



➤ **Vodafone** partnered with **SES Water** to develop and implement NB-IoT to create an intelligent water distribution network



➤ "...we are going to install roughly 1 million more smart meters with NB-IoT"

-- Manuela Pagella
Head of Gas Metering, **Italgas Reti**



Diverse Applications



DT Smart City in Patras, Greece
(Smart Parking, Smart Lighting)



Vodafone Hungary Smart Parking in Budapest

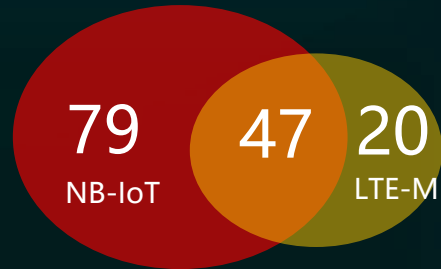


Vodafone Spain Help to Flash, V16 Connected beacon

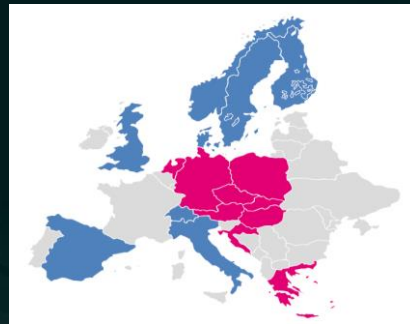
Europe: NB-IoT network is the most popular LPWA technology

126 NB-IoT networks and quick growing Modules

European Commercial Networks
126 NB-IoT **67 LTE-M**

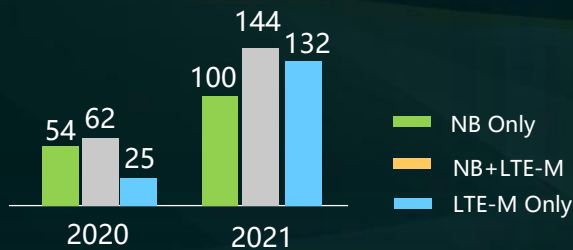


Roaming
 20 Countries



IoT modules shipment

NB-IoT & LTE-M are the main stream

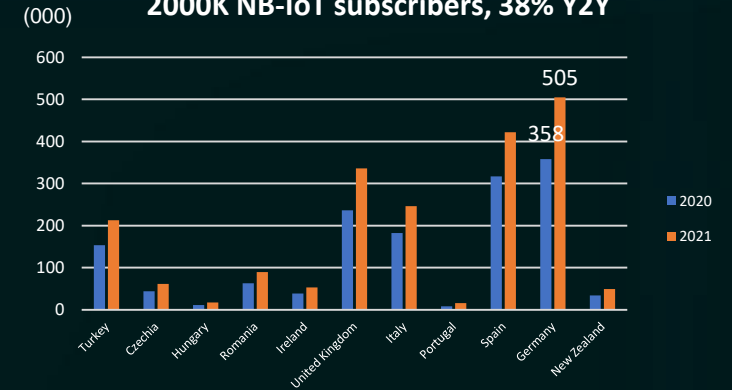


Solid Growth of NB-IoT user development

Vodafone

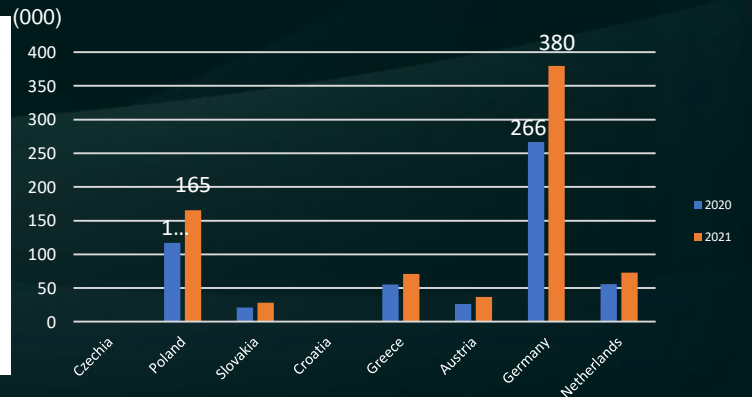
- Vodafone doubles its NB-IoT network sites to cover 98% of the UK. ([link](#))

Major OpCos have accumulated 2000K NB-IoT subscribers, 38% Y2Y



Deutch Telecom has 750K NB-IoT subscriber, 39% Y2Y

- Reasons for DT to invest in NB-IoT
- Support Massive IoT use cases
 - Re-use existing network infrastructure
 - Be future-proof (as part of 5G)
- ▼
- NB-IoT first (close the biggest gap)
 - LTE-M in second step

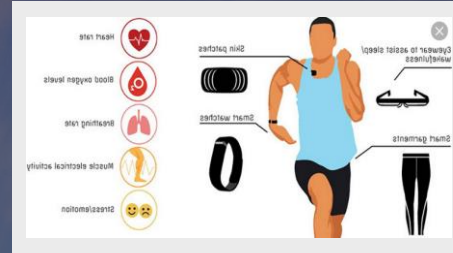


RedCap Key Scenarios: video surveillance: smart Wearable, industrial sensor



Video surveillance

- ✓ Intelligent vehicle-mounted monitoring
- ✓ Pan security monitoring



Smart Wearable

- ✓ Smartwatch
- ✓ Various intelligent wearables



Industrial sensor

- ✓ Predictive production and maintenance in campuses, driving real-time, low-cost, and low-latency exploration

4 Key Technology Definition Directions for Standards Discussion

Low-cost UE

- ✓ Reduce bandwidth/cost
- ✓ Reduce complexity
- ✓ Reduced size

UL Rate

- ✓ High-end 7.5-25 Mbps
- ✓ Economical 2-4 Mbps

Low power consumption

- ✓ The battery of the device should be used for multiple days, up to 1-2 weeks

Low latency

- ✓ < 100ms@99.99%
- ✓ Explore High Safety 5-10 ms

RedCap addresses High-Value services by differentiated value

REDCAP Bring Stronger Capabilities than LTE

Capability	LTE CAT1	LTE CAT4	REDCAP
Module Cost	~\$4.5	~\$9	R17~\$9 R18 ~\$4.5
Peak Throughput (single user)	UL:5Mbps DL:10Mbps	UL:50Mbps DL:150Mbps	UL: 120Mbps DL: 240Mbps
Peak Capacity (single cell)	UL:50Mbps/ DL:150Mbps @1.8G	UL:50Mbps/ DL:150Mbps @1.8G	UL:400Mbps/ DL:1.5Gbps @2.6G
Slicing	Not Support	Not Support	Support
Power Consumption	~	Working: 120-160mA Standby: 12-22 mA	Benchmark CAT4 Module Power Consumption 20% Reduction
Latency /Reliability	>100ms	>100ms	~20ms@99.99% (Support URLLC)
Coverage Radius	A	A	A+ (2-4dB)
Positioning Accuracy	>100m@90%	>100m@90%	<10m@90%

Equal
2X
8X
New
0.8X
New
1.2X
10X

Differentiated Value

Lower Cost & Better Coverage

4-5X Lower cost comparing to 5G Module
30-50% Less Power
20% extra coverage

Improved Capacity

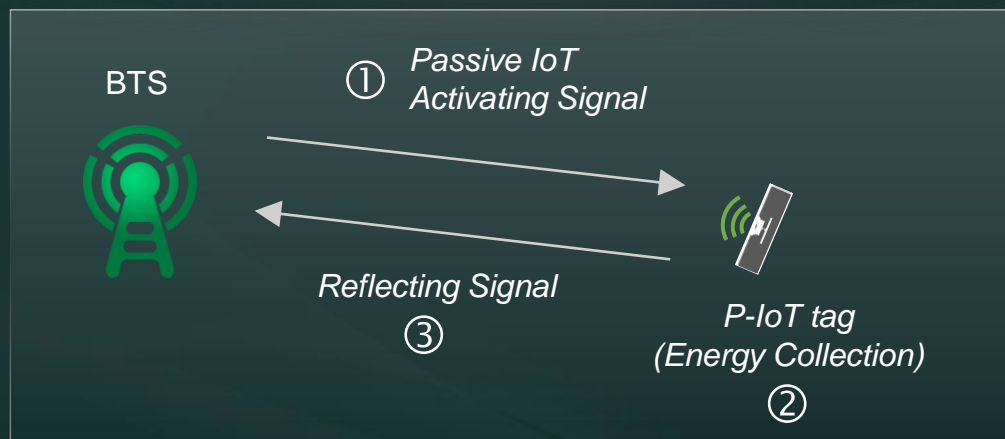
Mitigating negative impact on the network due to bandwidth incompatibility

Extra Capabilities

Slicing, Positioning, Low Latency

Passive IoT helps MNOs to enter 10xBillion IoT connections market

5.5G Extends C-IoT to Passive Connections



Ultra-low Cost UE

- <\$0.5, consumable

Passive Tag

- Battery Free

Bandwidth

- 180KHz for P-IoT carrier

Data Collection

- Temperature, Humidity

Passive IoT Coverage is 10x+ than RFID

Field verification: reach **235m** Passive IoT coverage



Goods inventory



Logistic tracking



Agricultural detecting

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Two categories of use cases for Passive IoT

Use Case #1: Pre-stored data report

- Information (e.g., identity) is pre-stored in a small size, ultra-low cost and batteryless tag
- Example: asset management in manufacturing and logistics industries.



Printed barcode on various parcels



Manual scanning



Current: Barcode

- Handheld LOS scanning (labor intensive)
- Slow one-by-one scanning (time consuming)

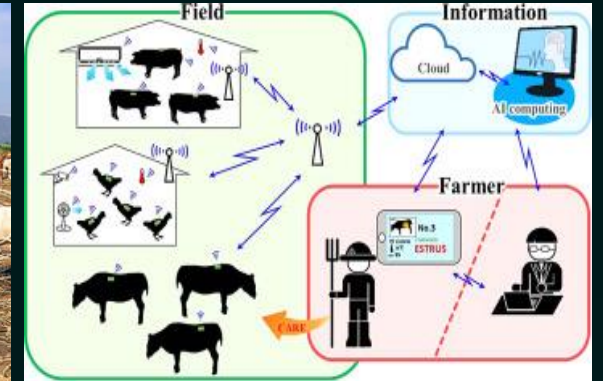


Passive IoT tag

- Automatic remote reading
- Hundred times faster reading

Use Case #2: Real-time data report

- Information (e.g., temperature) is generated and transmitted in real time by a device with no battery replacement during lifetime.
- Example: sensor network in manufacturing and livestock farming industries.



Battery-operated

- Cost for batteries and replacement
- Increased device size
- Infrequent transmissions for battery life
- Environmental issue (Lithium, lead, etc.)



Batteryless operation

- Low maintenance cost
- Miniaturized device
- No limits on transmission period
- Environment friendly (Ambient energy)

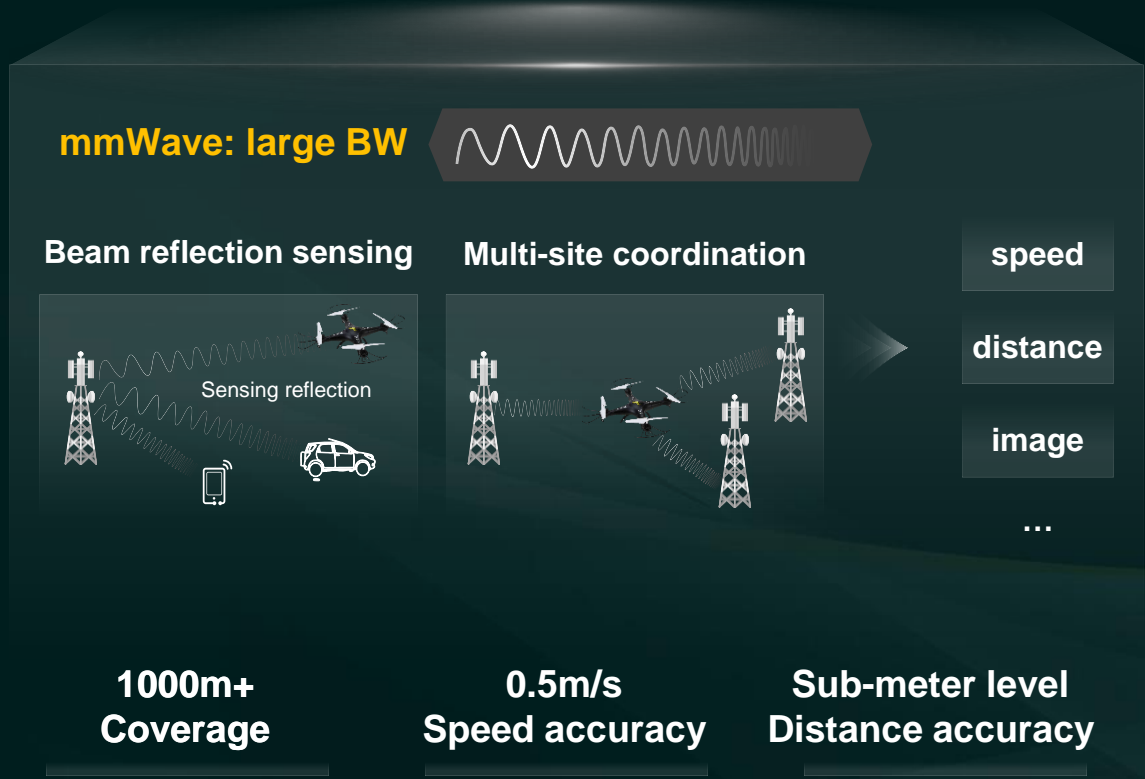


Compared with existing cellular technologies, passive IoT targets at new lower-end IoT markets requiring batteryless device

Sensing & communications integration

Enable new business opportunities beyond connectivity

Large BW mmWave
for high-precision sensing capability



Vehicle Sensing @ Smart Transportation

Smart Traffic

Smart Fencing

Low-sky security

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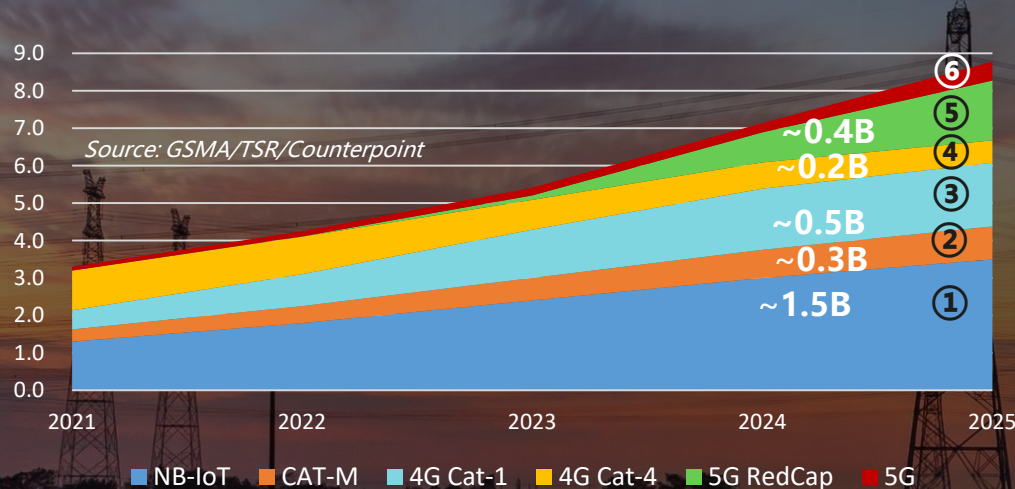
Cellular IoT keep ramping up, NB-IoT and LTE Cat-1 will be dominating at 2025

No. Connections help to drive the module cost down

Capability	NB-IoT	eMTC		CAT1	CAT4	5G	REDCAP		Passive IoT	
Module Cost	~\$2-3	~\$5-8		~\$4.5	~\$9	~\$59	R17~\$9	R18 ~\$4.5	\$0.X	
Peak Throughput (single user)	UL:158.5Kbps DL:126Kbps	CAT M1		CAT M2		UL:5Mbps DL:10Mbps	UL:50Mbps DL:150Mbps	UL:300Mbps DL:1Gbps	UL:120Mbps DL:240Mbps	~ 10Kbps*
		UL:HD 1.1Mbps/FD 2.98M DL:HD 588kbps/FD 1M	UL:HD 2.6M/FD 6.9M DL: HD 1.2M/FD 4M							
Latency	<5s	<1s		>100ms	>100ms	~20ms	~20ms		~10s*	

* Final figures are still under discussion in 3GPP SA1

New Cellular IoT Connections will exceed 2.5 B@2025



Six Major Category UE Trends

	Y20	Y21	Y22	Y23	Y24	Y25~
⑥ 5G	Maximum user experience					
⑤ 5G REDCAP	Low SLA 5G application				Redcap	
④ LTE CAT4	Going down from Y22				Low cost Redcap	
③ LTE CAT1/CAT-M	Medium speed market				Low cost Redcap	
② CAT-M	Low-Med speed market				Low cost Redcap	
① NB-IoT	Low Speed market, evolving to 5G				5G-NB	

**Bring digital to every person, home and organization for a
fully connected, intelligent Switzerland**

