WIRELESS KNOWLEDGE
SUMMIT
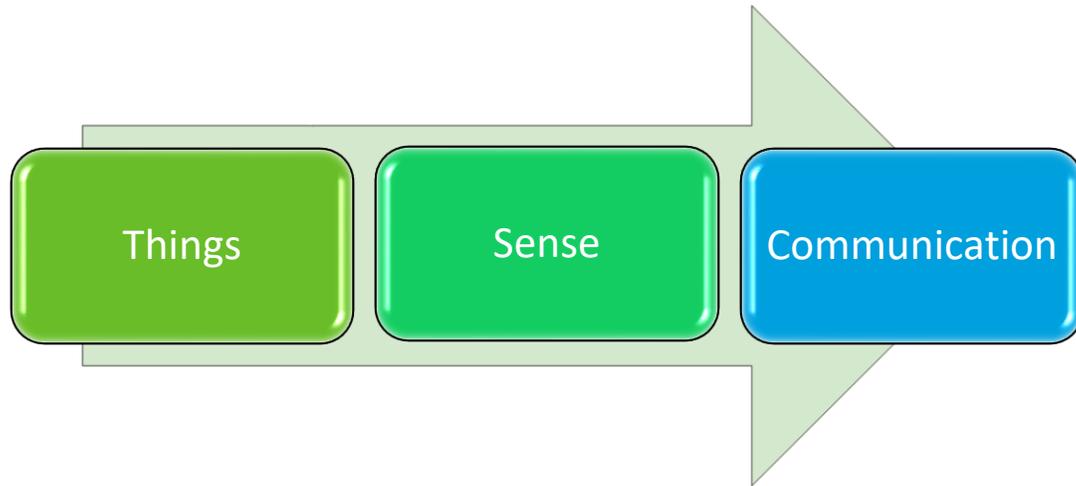
Cellular IOT Solutions
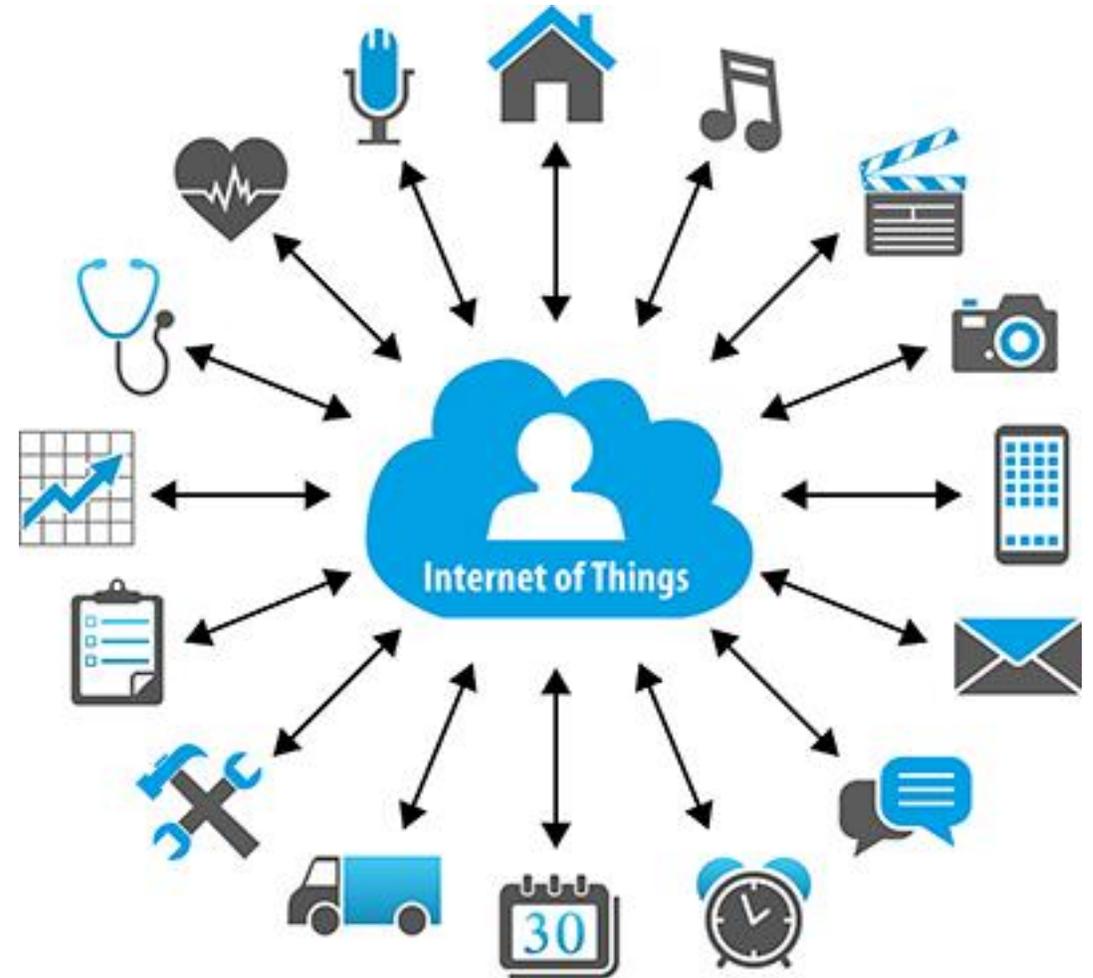
Jiji Jayadevan

Deputy Director of DSP, Wireless Systems

MediaTek

Internet of Things (IoT)

Things | Sense | Communication

- **IoT**
  - **Data service for intelligent applications on things by ability of connectivity and communication**

- **Things**
  - **Machines, parts of machines, smart meters, sensors, or even everyday objects such as retail goods or wearables**

Smart Cities to Enhance People life

M42 Smart Motorway, England

Car accidents lessen by 50%

Waste Management System Cincinnati, US

Waste decreased by 17%
Recycling increased by 49%

Smart Weather Station, Brazil

10% less casualties

Smart Meter Beijing, China

Smart Lighting Barcelona, Spain

30% energy savings per year

Smart Transportation Singapore (ERP)

average road speeds increasing by about 20%

https://www.digi.com/blog/post/iot-smart-city-applications
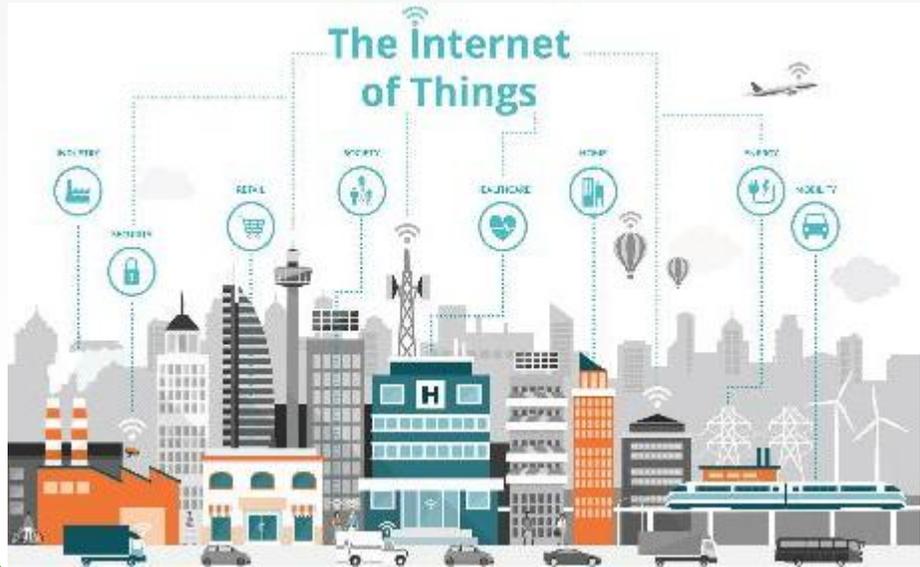
Different Technologies in Today's IOT Domains

Main Targets of Low Power Wide Area (LPWA)

- Low Complexity & cheap devices
- Low power consumption
- Massive number of devices
- Improved coverage with low data rate
- Different use cases can utilize different standards

Short Range in Unlicensed Spectrum

- Bluetooth Low Energy, WiFi IEEE802.11ah, ZigBee, Z-Wave

Unlicensed spectrum LPWA

- Sigfox (uplink only)
- Semtech LoRa (uplink, downlink)

Cellular IoT in licensed Spectrum

- LTE-MTC (Machine Type Communication)
  CAT 1, R12 with Cat 0, Rel 13 to meet LPWA requirement (CAT M)
- NB-IOT
- EC-GSM

Mobile operators wanted a standardized, cellular-based LPWA solution to compete and leverage existing infrastructure.

Cellular IoT Advantages
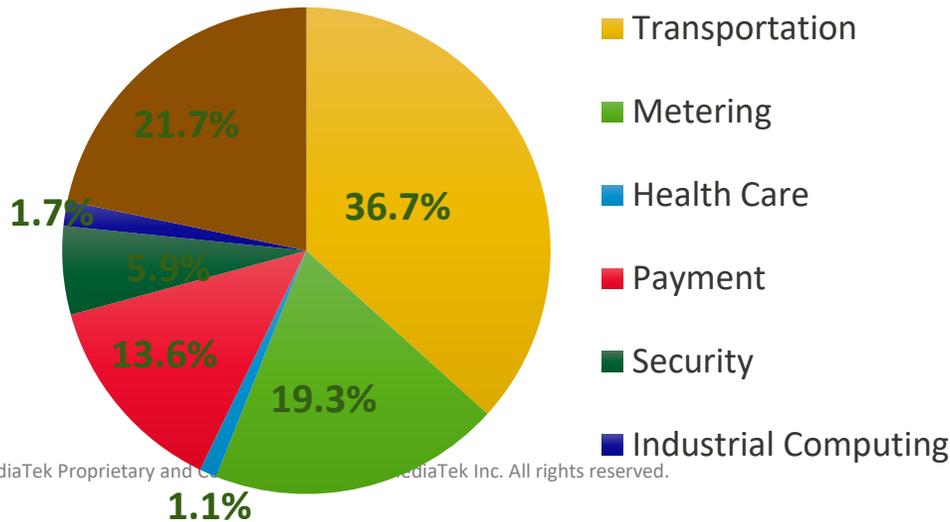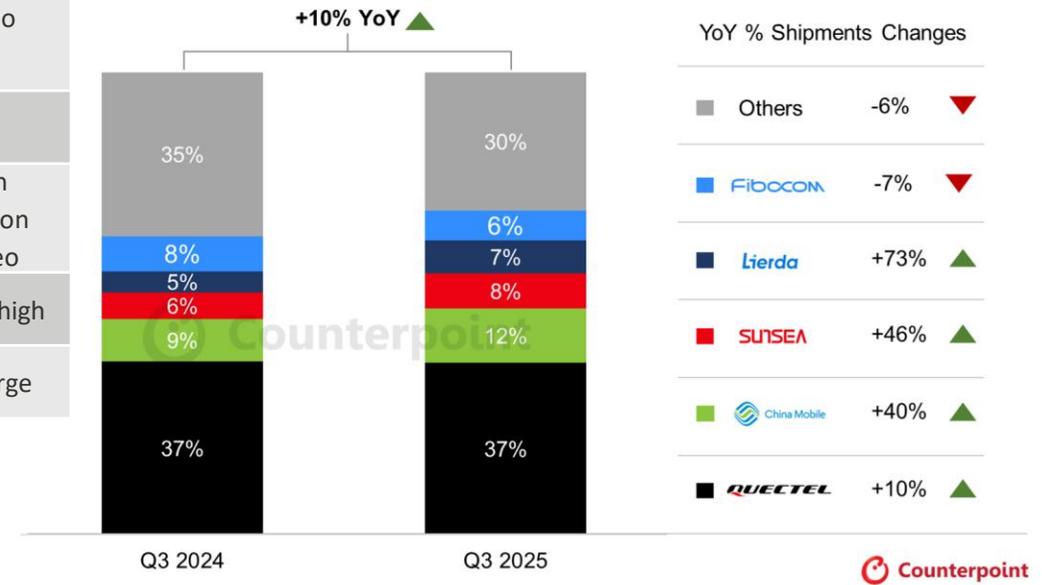
Global Coverage
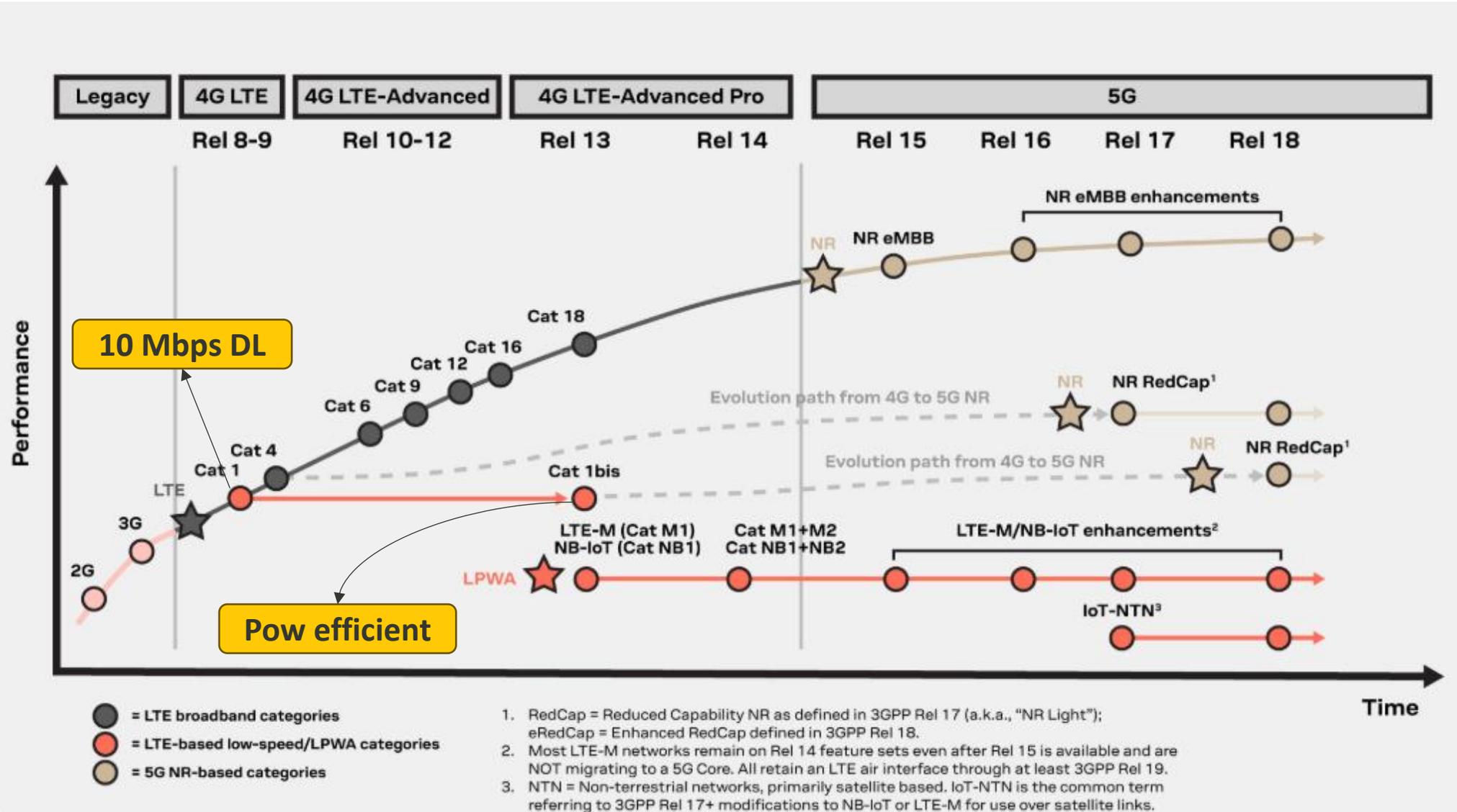
Scalability

High Data Capacity

Mobility

Built-in Security

Cellular-based IoT - Business

Applications	Battery Life <2yrs/ Mid/ >10 (Long)	Coverage	Latency	Mobility	Data rate
Utility meters	Long	Deep indoor coverage (Extreme coverage)	High	Stationary	Low ~ 100bps to some kpbs
Payment transactions (POS terminals)	Wall powered.	Outdoor/indoor, deep coverage	Mid to high	Stationary	Low ~some kbps
Tracking of people, pets, vehicles and assets	Long	Outdoors / indoors (extreme coverage)	Low/Mid	Mobile/ Nomadic	Low ~ up to 100kbps
Wearable	Same as smart phone	Normal coverage	Low	As LTE	High
Home alarm panels with and without voice	High/Mid	Normal to extended	Mid	Stationary	Low/high depending on voice/video
Automotive	On car battery	Normal to extended coverage	Mid to low or very low	Mobility	From low to high
Industrial control	Wall powered	Normal	Low to extremely low	Stationary	Might be large

Pie chart:
- Transportation 36.7%
- Metering 19.3%
- Health Care 1.1%
- Payment 13.6%
- Security 5.9%
- Industrial Computing 1.7%
- (brown) 21.7%

+10% YoY

Q3 2024: 35%, 8%, 5%, 6%, 9%, 37%
Q3 2025: 30%, 6%, 7%, 8%, 12%, 37%

YoY % Shipments Changes
- Others -6% ▼
- Fibocom -7% ▼
- Lierda +73% ▲
- SUNSEA +46% ▲
- China Mobile +40% ▲
- QUECTEL +10% ▲

Counterpoint

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Cellular Technology Evolution

https://www.u-blox.com/en/technologies/lte-cat-4

Comprehensive Comparison of IOT Technologies

Technology	BW	Data Rate	Power	Mobility	Latency	N/W Upgrade	Conn Density	Coverage	Cost	Deployment
Cat-0 (Rel 12)	20 MHz Single Antenna	Upto ~1 Mbps	Low	Yes	Low	**Not Needed**	< 10K devices per cell	Good	Low	Limited
Cat-1 (Rel 8)	20 MHz	**Upto 10 Mbps DL, 5Mbps UL**	Med	Yes	Lowest	**Not Needed**	> 10K devices per cell	Good	Med	**Nearly Universal**
Cat-1bis (Rel 13)	(Single Ant. version of Cat-1)								Lower	
Cat-M (Rel 13)	1.4MHz	~1 Mbps	Low	Yes	Low	Needed	> 10K devices per cell	Very Good (+15dB vs CAT 1)	Low	Widespread (NA, EU)
NB-IoT (Rel 13)	180kHz	~100 kbps	**Very Low**	No	High	Needed	> 50K devices per cell	**Excellent** (+20dB vs CAT 1)	**Very Low**	Global (China, EU, India)

Cellular IoT Use Cases and Performance Radar

- Requirements of different cases are diverse so no one technology can fit into all
- NB-IoT outperforms others on low power, coverage and density
- Cat-1 outperforms on data-rate, mobility
- 5G IoT – RedCap emerging BUT **LTE-IoT will dominate for years**
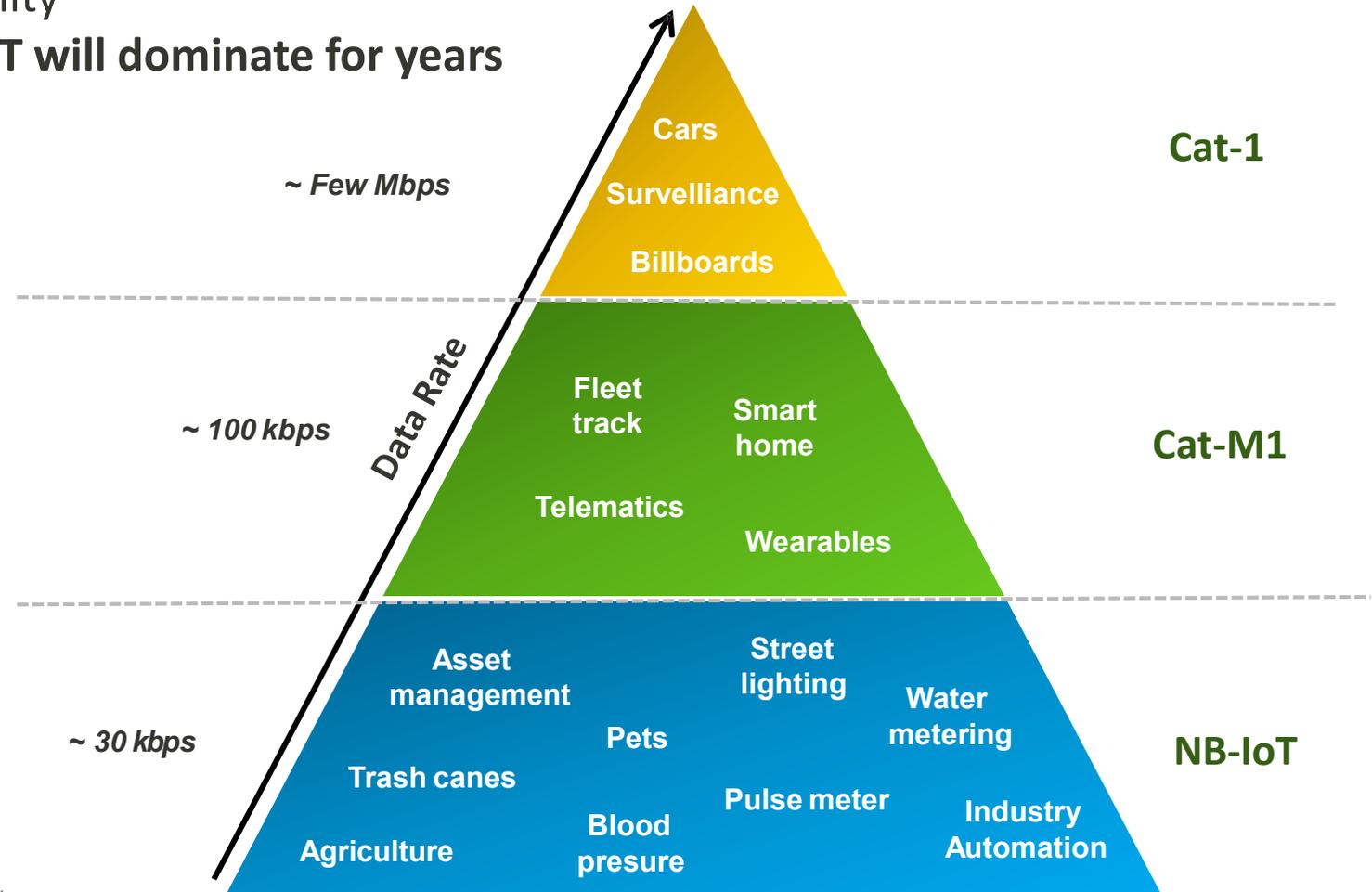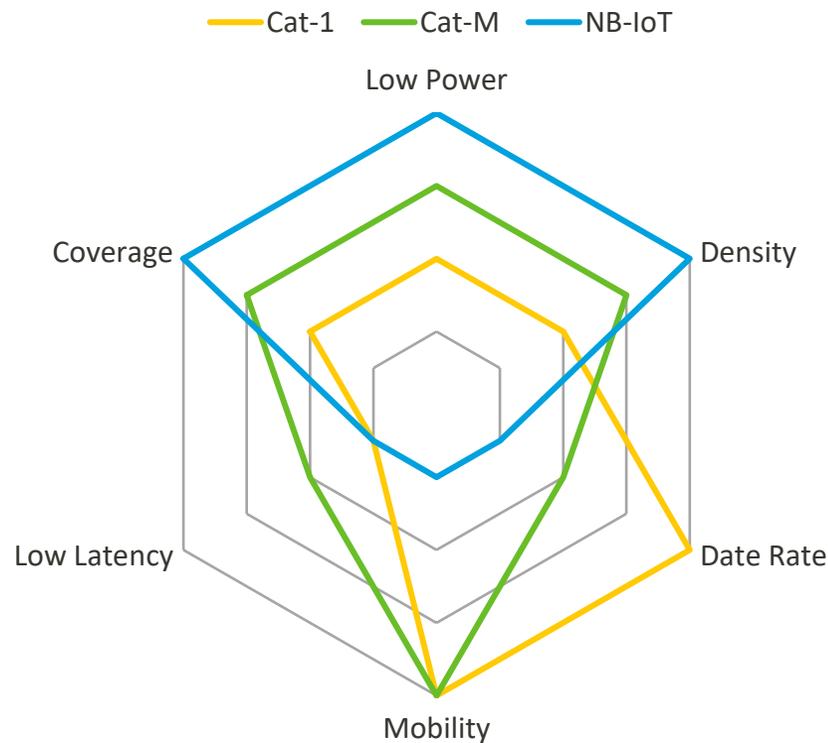
Cat.1-bis vs. Cat.M vs. NB Deployment

- Working everywhere for the entire lifespan of the device - **CAT-1-bis** provide this universal ability
- Cat.M adopted NA, LATAM, JP, AU & EU but limited roaming agreement between region.
- There are countries with NB-only deployment (No Cat.M) mainly for fixed application – CN, India, SEA, Russia Malaysia, Indonesia, Vietnam, no mobility and no roaming.

Legend: Both LTE-M & NB-IoT | LTE-M Only | NB-IoT Only

	Cat.1 bis	Cat.M	NB-IoT
Global Availability	WW > 600 carriers	55 countries, 90 carriers	67 countries, 118 carriers
Cross-Border Roaming	LTE roaming agreement	Complex NB no roaming requirement	
Deployment Cost	LTE BS no changes	Requires base stations upgrades	Requires base stations upgrades network overage is limited
Future Evolution	5G eRedCap	No standard for substitute yet	

Source : GSMA , June.2025

Cross-border multi-mode roaming does not exist between Cat.M and NB-IoT operators

Summary on NA CAT-M and CAT-1Bis Comparison

Operator	AT&T coverage	USA (2025)	
	Operator 1	Operator 2	Operator 3

LTE / CAT-1bis
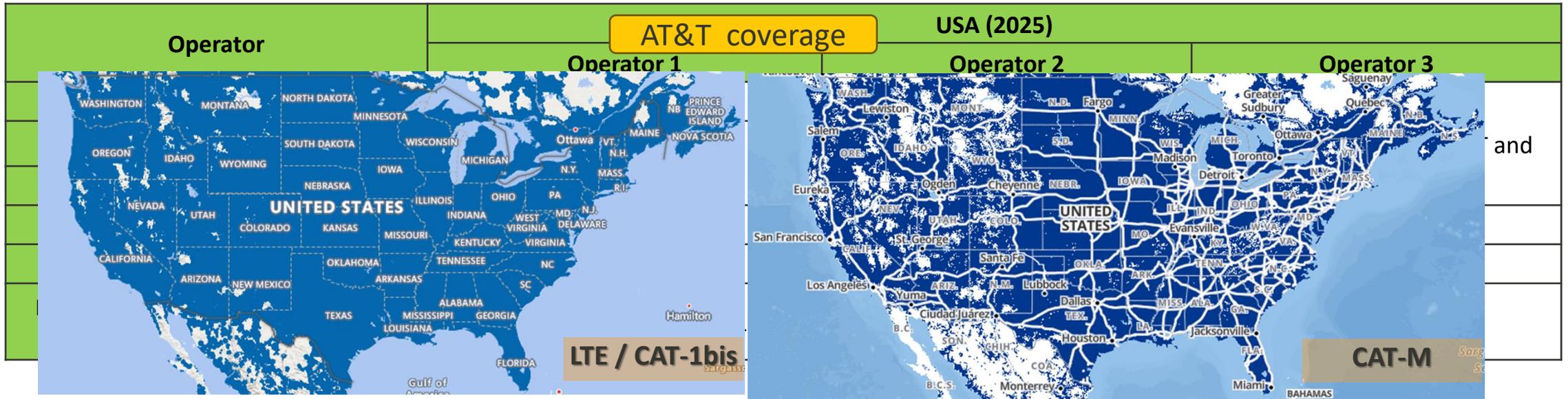
CAT-M

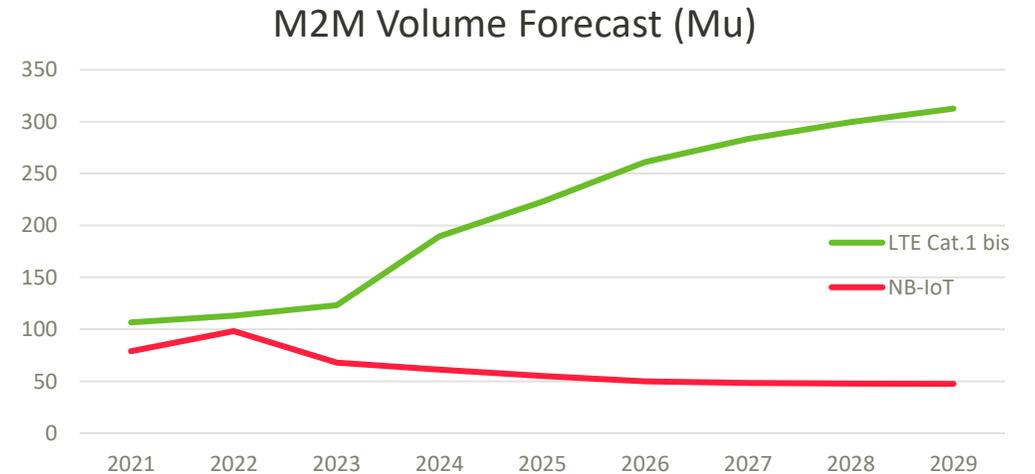Ultimately, US carriers expect the segment served by
- **CAT-1bis** to pivot to eRedCap technology in 5G
- **CAT-M** segment to remain using the same technology until the introduction of 6G

Case Study: Why Cat1bis is More Suitable than NB-IoT for Trackers ?

- **Key Reasons:**

  - **Better Network Coverage:**

    - Utilizes mature 4G LTE networks for wider and more reliable connectivity.

  - **Better Mobility Support:**

    - Provides seamless handover and stable performance for moving devices.

- **Market Selection Reflects Cat1bis' Strength:**

  - Around 2019, there were efforts to use NB-IoT for e-scooters tracking, the results were not satisfactory.

  - Cellular communication functionality on e-scooters has been mandated in CN since 25H2

LTE Cat.1bis becomes the mainstream solution !

https://chinamotorworld.com/chinas-new-national-standard-for-electric-bicycles/#:~:text=Notably%2C%20the%20new%20regulations%20no,safety%20improvements%20will%20proceed%20simultaneously.

M2M Volume Forecast (Mu)

Line chart showing LTE Cat.1 bis (green) rising from ~107 in 2021 to ~313 in 2029, and NB-IoT (red) declining from ~78 in 2021, peaking ~98 in 2022, then falling to ~48 by 2029. X-axis years 2021–2029. Y-axis 0 to 350.

Network Coverage Comparison: LTE Cat1bis vs NB-IoT

- CN achieved an extensive LTE coverage by **7M+** Base stations.

- NB-IoT deployment is much sparser with about **800-900K** sites.

- *Network Planning Map of CMCC*
  - *NB-IoT is enabled on 900MHz ,collocated with LTE eNB.*
  - *Only about 60% of 900MHz LTE eNB have NB-IoT enabled, which account for roughly 20% of all 4G LTE eNBs.*

▲ LTE

▲ NB-IoT

- NB-IoT requires extra investment and spectrum but yields low income.

- CN operators prefer LTE Cat1bis, further squeezing NB-IoT market.

- As a result, the coverage of NB-IoT is unlikely to extend in the future and may even shrink.

Urban coverage

Rural coverage
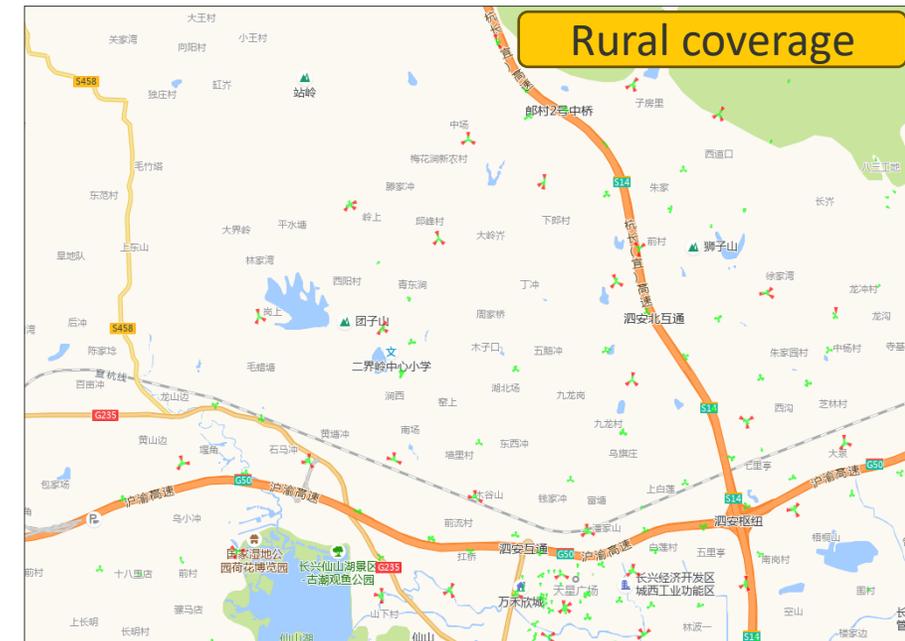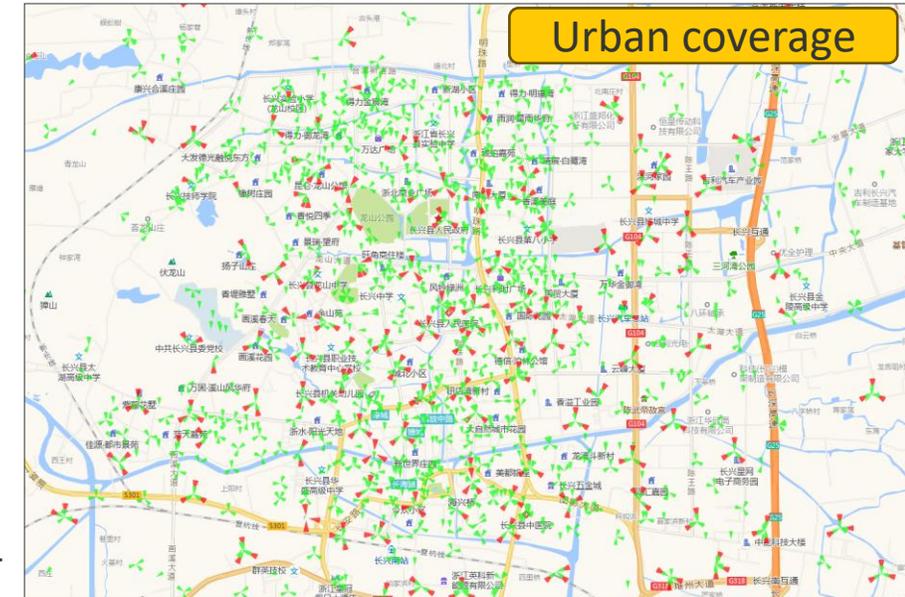
# Mobility Comparison: LTE Cat1bis vs NB-IoT

- NB-IoT does not support HO for connected mode mobility

- NB-IoT relies on RLF and connection re-establishment in connected mode

- Poor mobility experience; not suitable for mobile use cases
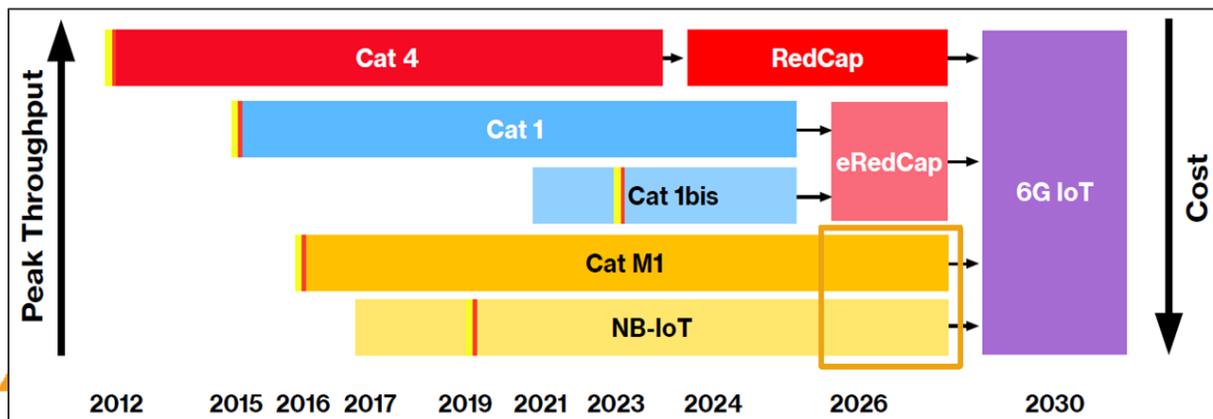
NB-IoT RLF procedure
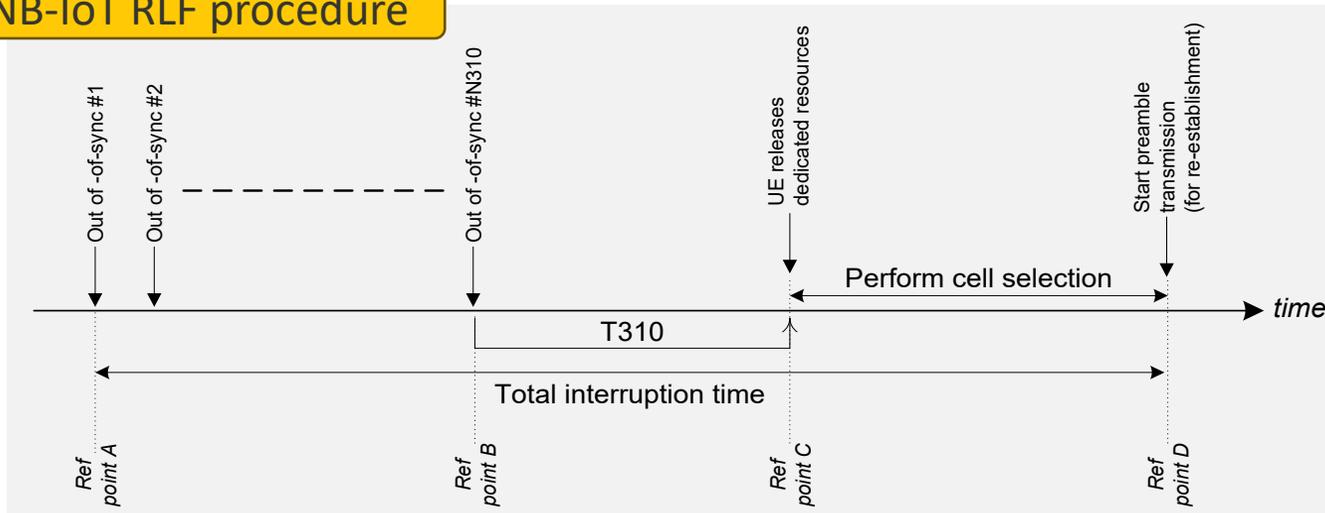
- Interruption time introduced by RLF is much longer than normal HO (30-50ms)

- In a typical configuration
  - T310 is 2000ms and
  - N310 is 10
  - RLF introduces extra latency Ref.A→Ref.C (2.5~6.5 sec) + Ref.C→Ref.D (depends on signal quality, guarded by T311, typical value is 30 sec)

Future Trends

Cellular M2M Module Market Forecast by Standard, 2021-2030

https://iotbusinessnews.com/
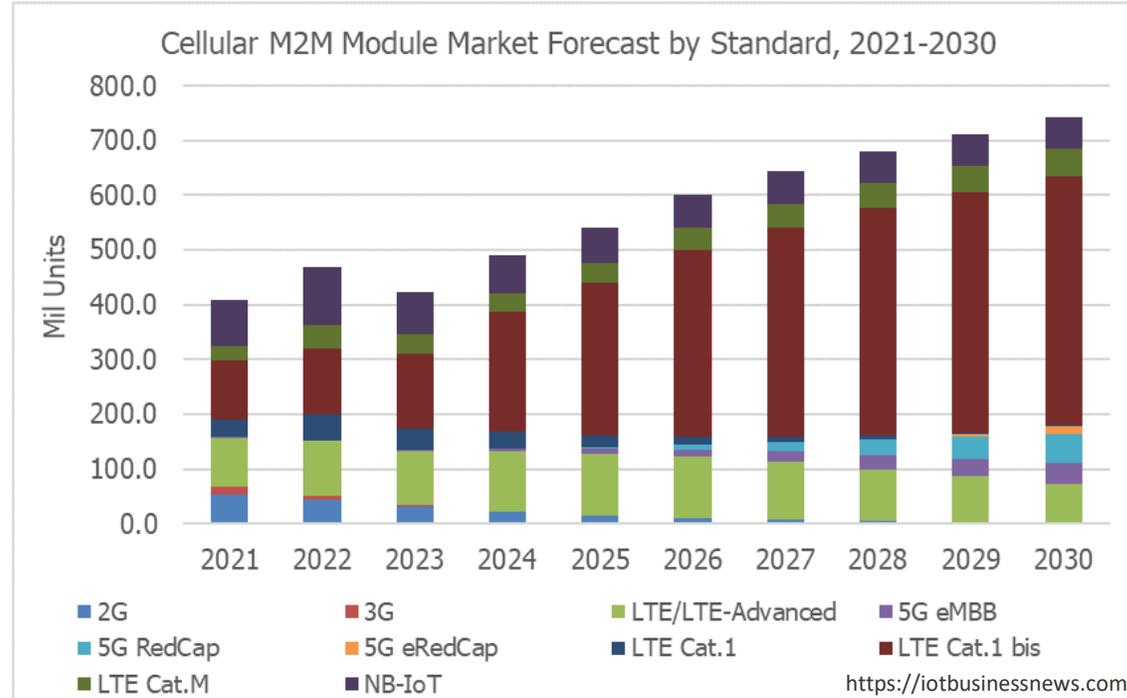
Ultimately 6G IoT may be the single universal solution ?
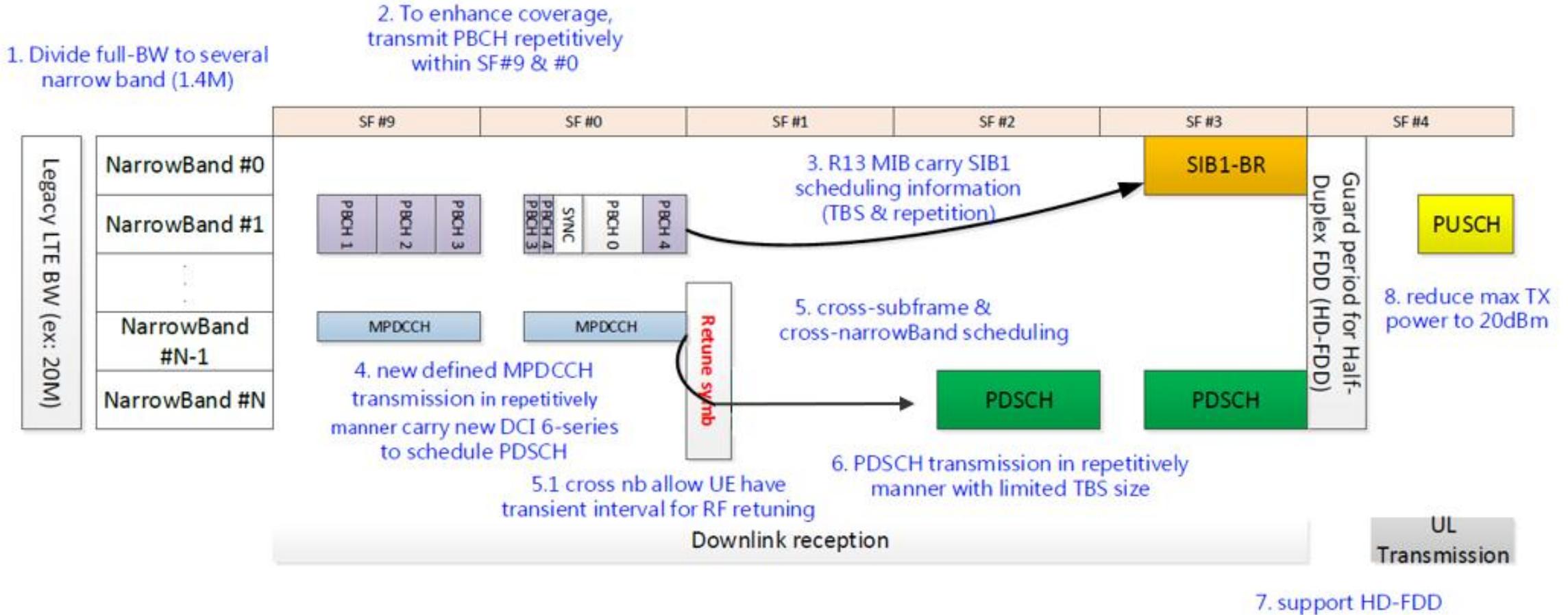

- Verizon considers eRedCap for Cat 1/1bis replacement
- Cat M1/NB-IoT expect to be co-existing with 5G NR RAN and 6G later
- **AT&T Shares the same migration plan as VzW.** AT&T expects eRedCap to be NW ready in 2027

Thank You

CAT-M Feature overview

NB-IOT Feature Overview

- **Main PHY features**
  - Narrow band support of 180 kHz
  - Supports two modes for uplink
    - Single tone with 15 kHz and/or 3.75 kHz tone spacing
    - Multiple tone transmissions with 15 kHz tone spacing
  - No support of Turbo code for the downlink
  - Single transmission mode of SFBC for PBCH, PDSCH, PDCCH
  - New narrowband channels:
    - NPSS, NSSS, NPBCH, NPDCCH, NPDSCH, NPUSCH, NPRACH

- **Main radio protocol features**
  - Single HARQ process
  - Only RLC AM mode with simplified status reporting
  - Two PDCP options:
    1. SRB 0 and 1 only. No AS security (NAS security is used instead). PDCP operating in transparent mode.
    2. SRB 0, 1, 2 and one DRB. AS security, which is cached upon RRC connection release.
  - For PDCP option 2, RRC connection suspend/resume procedures to maintain AS security context.
  - Significantly reduced broadcast system information

AT&T Network Coverage

LTE / CAT-1bis

CAT-M

- CAT-M is approximately 10% less coverage as compared to LTE/CAT-1bis coverage
  - CAT-M is enabled on low-band (B12) and some mid-band (B2 and B4)

- There are distinct service categories between CAT-M and CAT-1bis that AT&T offers
  - Offer is based on cost, power, bandwidth requirements, regardless of coverage

- AT&T expects CAT-M to live much longer even beyond LTE, as they are exploring the possibility of migrating CAT-M to NR
  - CAT-M not expected to be replaced until 6G
  - CAT-1bis expected to be replaced by eRedcap