



Future Technologies

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IoT Gathering Stockholm 2023

telenor IoT

It is time to act!

Over 135 operators have either completed, planned or are in progress with 2G and 3G switch-offs. Many of them have the year 2025 as the goal for this.

"At the end of 2022, there were an estimated 0.9 billion 2G cellular IoT connections worldwide, corresponding to a market share of about 34 percent. 3G accounted for about 5 percent of global cellular IoT connections."

- Berg Insight

High time to investigate what technology to use for replacing your existing 2G / 3G solutions.



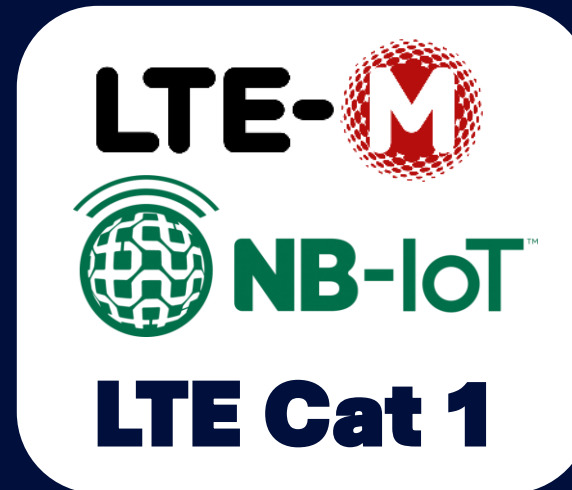
Many aspects to consider

- Technical – Coverage, Energy efficiency, Throughput, Latency, etc.
- Commercial – Total cost of ownership, Scalability, Security, Reliability
- Ecosystem – Future proofness, Global reach and interoperability



Many options

- Traditional Cellular – 4G & 5G
- Other Cellular – LTE Cat 1 & LTE Cat 1bis
- Cellular LPWA – LTE-M & NB IoT
- Proprietary LPWA – LoRaWan & Sigfox
- Short range – WiFi & Zigbee



Most important is your use case



LTE Cat1 & LTE Cat 1bis



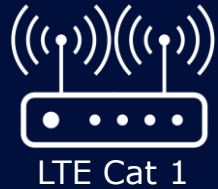
LTE Cat 1 was part of the first launch of LTE (CAT1 – CAT4)



In release 13 LTE Cat 1bis was introduced.

| Technology | LTE-M | LTE Cat 1 | LTE Cat 4 |
|--------------------|----------|-----------|-----------|
| Downlink Peak Rate | 1 Mbit/s | 10 Mb/s | 150 Mb/s |
| Uplink Peak Rate | 1 Mbit/s | 5 Mb/s | 50 Mb/s |
| Latency | <100 ms | <100 ms | <100 ms |

Theoretical maximum values



LTE Cat 1bis = Cat 1 with one antenna

- Smaller and cheaper devices
- Little loss in coverage

The perfect compromise between LPWA and LTE Cat 4!



Medium throughput (much higher than LTE-M)



Better than LTE Cat 4 but not as good as LTE-M



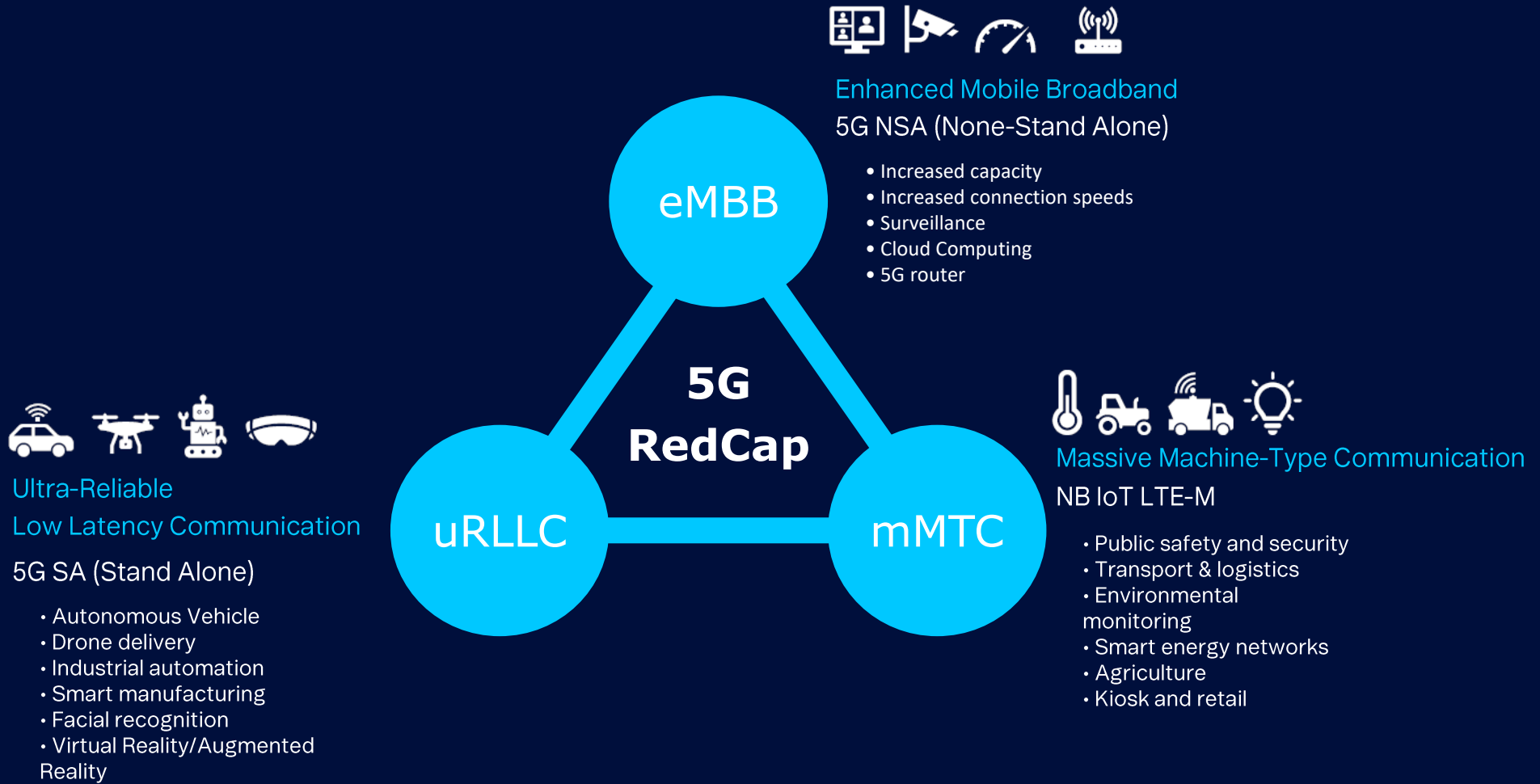
VoLTE, SMS and video streaming



Global coverage



5G



5G RedCap

- 5G RedCap, short for 5G Reduced Capability, also called 5G NR-Light
- Introduced in 3GPP release 17 (2022)
- Will be further enhanced in release 18+
- Natural replacement in the future for LTE Cat1-4 devices
- Still in a very early stage where a few operators have started testing or launched this and devices are still expensive
- Part of 5G SA (Stand Alone) and will therefore take time to become globally available and supported by roaming



| | LTE Cat-1bis | LTE Cat-4 | 5G NR-Light (Rel-17) |
|-----------------------|--------------|-------------|-----------------------|
| Bandwidth | 20 MHz | 20 MHz | 20 MHz (sub-7 GHz) |
| Peak data rate DL/UL | 10/5 Mbps | 150/50 Mbps | 150/50 Mbps or higher |
| Duplexing | FD-FDD, TDD | FD-FDD, TDD | HD-FDD, FD-FDD, TDD |
| Tx/Rx chain | 1 Tx, 1 Rx | 1 Tx, 2 Rx | 1 or 2 Tx, 1 or 2 Rx |
| MIMO layers DL/UL | 1/1 | 2/1 | 1 or 2/1 |
| Maximum coupling loss | 140 dB | 144 dB | 140 dB |



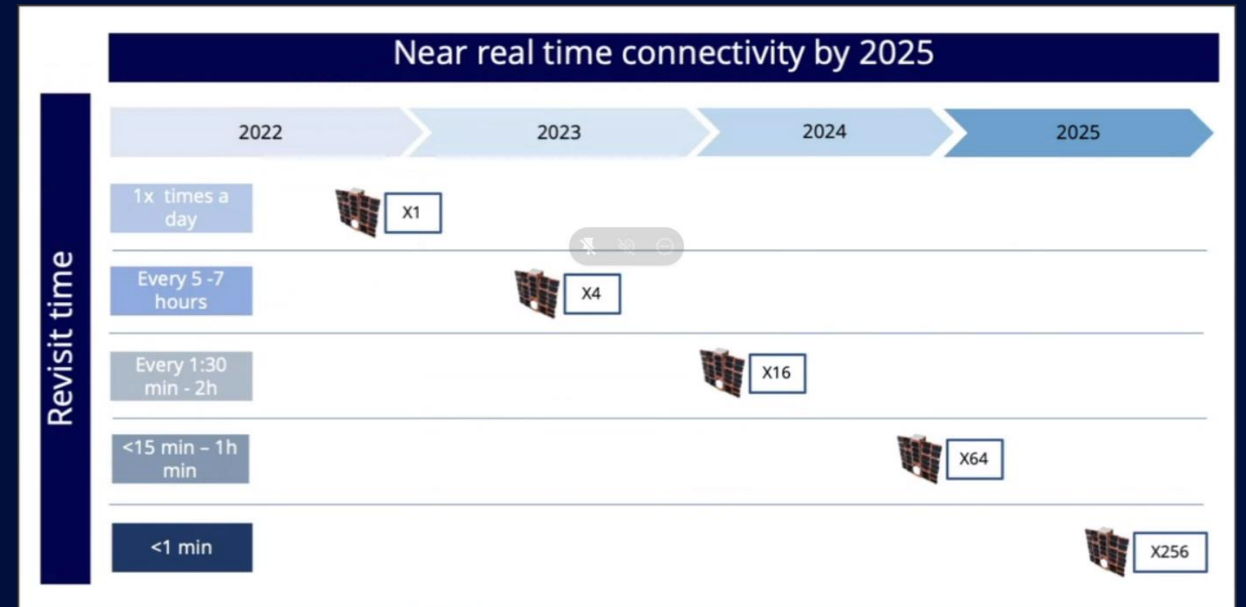
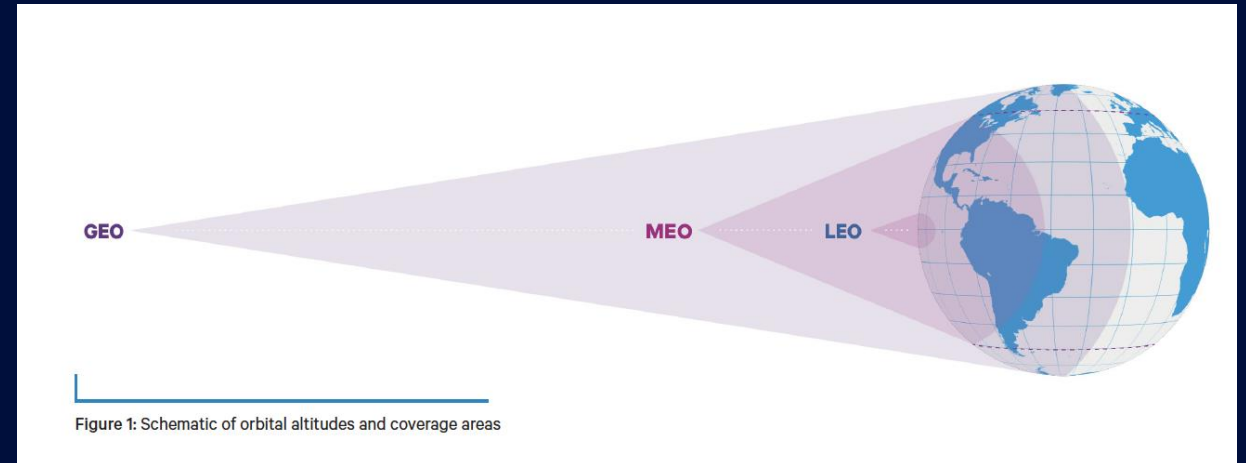
Mobile via Satellite

- 5G NB-IoT NTN
 - 5G NB IoT None Terrestrial Network
 - 3GPP Release 17 (2022)
 - Hybrid scenarios
 - Same terminal for both Terrestrial and non-terrestrial communication
 - Require support of R17 functions



GEO vs LEO

- GEO
 - Always connected
 - Few satellites but big
 - Low data throughput and high latency
- LEO
 - Not continuously connected
 - Possibility to higher data throughput and lower latency
 - NB IoT will still have a long latency
 - Better signal strength that result in better penetration
- Different players have chosen different approaches
 - The Satellite could act as a full base station, or
 - The satellite is a "repeater" relaying the signals from a base station on earth.



What's your use case?

| 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 | High | High | High | High | High | High | High | High | Low | Low | Low |
| Indoor coverage | Low | Low | Low | Low | Low | Low | Low | Low | High | High | High |
| Energy efficiency | High | High | High | High | High | High | High | High | Low | Low | Low |
| Typical uplink data rate | Low | Low | Low | Low | Low | Low | Low | Low | High | High | High |
| Typical downlink data rate | Low | Low | Low | Low | Low | Low | Low | Low | High | High | High |
| Mobility | High | High | High | High | High | High | High | High | Low | Low | Low |
| Positioning | High | High | High | High | High | High | High | High | Low | Low | Low |
| Latency | High | High | High | High | High | High | High | High | Low | Low | Low |
| Device density | High | High | High | High | High | High | High | High | Low | Low | Low |
| 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 | High | High | High | High | High | High | High | High | Low | Low | Low |
| Subscription cost | yes | yes | yes | yes | yes | yes | yes | yes/no | no | no | no |
| Deployment & maintenance cost | High | High | High | High | High | High | High | High | Low | Low | Low |
| Reliability | High | High | High | High | High | High | High | High | Low | Low | Low |
| Security | High | High | High | High | High | High | High | High | Low | Low | Low |
| Scalability | High | High | High | High | High | High | High | High | Low | Low | Low |
| 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 | High | High | High | High | High | High | High | High | Low | Low | Low |
| Global reach & operability | High | High | High | High | High | High | High | High | Low | Low | Low |

Legend: Low (Light Blue), Medium (Medium Blue), High (Dark Blue)

Table 1: Main technologies for IoT with strengths and weaknesses



