3GPP STANDARDS FOR DELIVER LTE CONNECTIVITY FOR INTERNET OF THINGS

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According to Machine research forecast, by 2020 the number of connected devices, other than cell phones, PCs and tablets, will be 15 billion, of which 13.0 billion will use short range technologies, such as Bluetooth Smart, Wi-Fi or Zigbee, and 2.0 billion will use a cellular connection. However this report estimates that 5.5 of the 13.0 billion would be replaced by a cellular connection if that cellular technology could meet the requirements of the IoT.

Source: Nokia
IoT battlefield

- **3GPP**
  - **MTC (Machine Type Communication), eMTC, LTE-M → LTE Cat-M (Cat-M1)**
    - The 1\textsuperscript{st} version was released with 3GPP Rel 8 based on CAT 1 but it does not meet the IoT requirement (battery/cost/range) and a new release is released with R12 with Cat 0 and currently enhanced version (eMTC) is under evaluation in Rel 13 to meet LPWAN (Low Power Wide Area Network) requirement (CAT M).
  - **NB-CIoT and NB-LTE (will be evolved into NB-IoT) as per latest 3GPP RAN meeting and is expected to be released with 3GPP Rel 13.**
    - NB-IoT → LTE Cat-M2
    - This technology can be deployed “in-band”, utilizing resource blocks within a normal LTE carrier, or in the unused resource blocks within a LTE carrier’s guard-band, or “standalone” for deployments in dedicated spectrum.
  - **EC-GSM (Extended coverage – GSM)**
    - Upgrade of GSM by using one carrier for IoT and extending the coverage by (EC-GSM) is expected with 3GPP Rel 13.

- **Proprietary technologies** such as **Sigfox**, **Ingenu** and **LoRa** have already made clear their ambitions to become globally available standards for public LPWA (Low Power Wide Area) networks using **unlicensed spectrum**.
Focus on LTE, why?

- GSM, UMTS, LTE …
  - All of them provide higher coverage however LTE has the greater potential to shake up the Internet of Things
  - Why?
    - Flat and flexible architecture and more efficient signalling
    - **Efficient use of spectrum** → lower operating costs
    - **Higher performance** → LTE provides the fastest and best broadband experiences for applicable IoT services
  - However …
    - The original design of LTE didn’t address all the needs of IoT
# IoT communication requirements

## Cost reduction

<table>
<thead>
<tr>
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<tbody>
<tr>
<td></td>
<td>Cat. 4</td>
<td>Cat 1.</td>
<td>Cat. 0</td>
<td>“Cat. M1”</td>
<td>“Cat. M2”</td>
</tr>
<tr>
<td>Downlink peak rate</td>
<td>150 Mbps</td>
<td>10 Mbps</td>
<td>1 Mbps</td>
<td>1 Mbps</td>
<td>200 kbps</td>
</tr>
<tr>
<td>Uplink peak rate</td>
<td>50 Mbps</td>
<td>5 Mbps</td>
<td>1 Mbps</td>
<td>1 Mbps</td>
<td>144 kbps</td>
</tr>
<tr>
<td>Number of antennas</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Duplex mode</td>
<td>Full duplex</td>
<td>Full duplex</td>
<td>Half duplex</td>
<td>Half duplex</td>
<td>Half duplex</td>
</tr>
<tr>
<td>UE receive bandwidth</td>
<td>20 MHz</td>
<td>20 MHz</td>
<td>20 MHz</td>
<td>1.4 MHz</td>
<td>200 kHz</td>
</tr>
<tr>
<td>UE transmit power</td>
<td>23 dBm</td>
<td>23 dBm</td>
<td>23 dBm</td>
<td>20 dBm</td>
<td>23 dBm</td>
</tr>
<tr>
<td>Modem complexity</td>
<td>100%</td>
<td>100%</td>
<td>40%</td>
<td>20%</td>
<td>&lt;15%</td>
</tr>
</tbody>
</table>
IoT communication requirements

- **Long battery life**
  - Power saving mode (PSM) in Release 12

- **Extended DRX**
  In Release 13

*TAU: Tracking Area Updates*
IoT communication requirements

- Long battery life
  - Device triggering
    - For many use cases, devices in the IoT transmit data only sporadically. Sometimes, data is only transmitted when requested by a server. To optimize these use cases and avoid wasting resources, the network is required to support a device triggering mechanism. This means that the network can request a particular device to establish a connection with its server even when the device is not attached to the network or has not established a data connection.

10 years of battery operation for simple daily connectivity of small packages is obtained
Enhanced coverage

Several techniques are introduced to obtain 20 dB of improvement in the coverage:

- PSD (Power spectral density) boosting
- Design new channels/signals
- Repetition
- Low rate coding
- Spreading
- RS (Reference Signal) power boosting /increased RS density
- New decoding techniques
- Device to device communications
- Proximity Service Relay
- Heterogeneous access
LTE architecture for IoT
LTE architecture for IoT

- **MTC-IWF (Interworking function)**
  - Acts as the sole interface on the control plane for interworking 3GPP core network and M2M service capability layer while hiding 3GPP core network details to service providers.
    - Authenticate connection requests from the SCS to the 3GPP network
    - Accepts device trigger requests form an M2M server or an SCS and selects appropriate delivery methods to forward the request to MTC devices via 3GPP network

- **SCS (Service Capability Server)**
  - The SCS is an entity which connects to the 3GPP network to communicate with UEs used for MTC and the MTC-IWF in the HPLMN. The SCS offers capabilities for use by one or multiple MTC Applications.
The differentiators of CAT-M and NB-IoT are “mobility” and throughput.

Source: Ericsson
## MTC/IoT Terminals

<table>
<thead>
<tr>
<th>Terminal</th>
<th>3GPP Release</th>
<th>Availability</th>
<th>Details</th>
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</table>
| LTE CAT 1  | Rel 8        | Available    | • CAT1 devices have been launched for both data applications and VoLTE/voice applications.  
• CAT1 will continue for VoLTE/voice application devices, i.e., not replaced by NB-IoT/CAT0/CAT-M  
• CAT1 Single Rx also launched for certain application. |
| LTE CAT 0  | Rel 12       | 2H16/1H17    | • Cat 0/Power Save Mode/Half Duplex/Extended ACB/1Rx  
• CAT0 is used for replacing data application devices of CAT1, but cannot replace voice/VoLTE,  
• CAT0 is the interim solution prior to CAT-M rollout, i.e., short lifecycle. It may be dropped and go direct to CAT-M |
| CAT-M      | Rel 13       | 2017/1H18    | • 1.4MHz BW, reduced power, Extended DRX, coverage enhancements  
• CAT-M is used for replacing data application devices of CAT1/CAT0, but cannot support VoLTE either for sure. |
| NB-IoT     | Rel 13/Rel14?| 2017/1H18    | • Overlaps LTE, 1 PRB is used, reduced power, coverage enhancements, 200 Kbps.  
• The differentiators of CAT-M and NB-IoT are “mobility” and throughput. CAT-M is still needed unless the evolution of NB-IoT will provide sufficient motility support. |
NB-IoT evolution

Source: China Mobile
And what about the battle …?

- It is expected that cellular-based solutions will become the most used in few years, but proprietary technologies that are being deployed today such as LoRA and Sigfox will have a good lifetime.
THANK FOR YOUR ATTENTION