Overview of Cat-M and NB-IoT

Standard, Market and OAI perspective

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OpenAirInterface workshop, November 8th, 2017

Outline

• Cat-M and NB-IOT
  – Overview, market
• Sequans and OAI
3GPP releases

<table>
<thead>
<tr>
<th>Release Code</th>
<th>Name</th>
<th>Status</th>
<th>Start date</th>
<th>End date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rel-16</td>
<td>Release 16</td>
<td>Open</td>
<td>2017-03-22</td>
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<tr>
<td>Rel-15</td>
<td>Release 15</td>
<td>Open</td>
<td>2018-06-01</td>
<td>2018-05-14 (E4K31)</td>
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<tr>
<td>Rel-14</td>
<td>Release 14</td>
<td>Frozen</td>
<td>2014-09-17</td>
<td>2017-02-09 (E4K76)</td>
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<tr>
<td>Rel-13</td>
<td>Release 13</td>
<td>Frozen</td>
<td>2012-09-30</td>
<td>2015-03-11 (E4K71)</td>
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<tr>
<td>Rel-12</td>
<td>Release 12</td>
<td>Frozen</td>
<td>2011-08-26</td>
<td>2015-03-13 (E4K87)</td>
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<tr>
<td>Rel-11</td>
<td>Release 11</td>
<td>Frozen</td>
<td>2010-01-22</td>
<td>2013-02-06 (E4K59)</td>
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<tr>
<td>Rel-10</td>
<td>Release 10</td>
<td>Frozen</td>
<td>2009-01-20</td>
<td>2011-05-08 (E4K52)</td>
</tr>
</tbody>
</table>

Main topics per releases

- Continuous evolution of LTE
- Unlicensed spectrum operation
- Better support of mission critical
- MTC, Cellular IoT
- Cellular V2X
- 5G
Evolution of MTC features

- Rel. 12
  - PSM
  - eDRX
- Rel. 13
  - NB-IOT (NB1)
  - eMTC (Cat-M1)
  - EC-GSM
- Rel. 14
  - NBIOT_enh
  - feMTC
- Rel. 15
  - Light connection
  - NBIOT_enh2
  - LTE_eMTC4 (even further enhanced MTC)
- Rel. 16
  - Studies on: fD2D, MBMS, management for IoT

Comparison of LTE IoT

<table>
<thead>
<tr>
<th></th>
<th>Cat 1</th>
<th>Cat M1</th>
<th>Cat NB1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deployment scenarios</strong></td>
<td>In Band FDD, TDD, (HD-FDD)</td>
<td>In-band HD/FD-FDD, TDD (1.4MHz)</td>
<td>Stand-alone, guard-band, in-band HD-FDD</td>
</tr>
<tr>
<td><strong>Bandwidth</strong></td>
<td>Up to 20MHz</td>
<td>1.4MHz</td>
<td>180kHz</td>
</tr>
<tr>
<td><strong>Coverage (MCL)</strong></td>
<td>Up to ~144 dB</td>
<td>Up to ~162 dB</td>
<td>Up to ~164 dB</td>
</tr>
<tr>
<td><strong>Rx Antenna</strong></td>
<td>Baseline is 2 Rx</td>
<td>Single Rx</td>
<td>single Rx</td>
</tr>
<tr>
<td><strong>Mobility</strong></td>
<td>Full Mobility</td>
<td>Full mobility except in CE mode B</td>
<td>Only cell reselection</td>
</tr>
<tr>
<td><strong>Data Rate</strong></td>
<td>UL/DL: 5/10Mbps</td>
<td>UL/DL: 375/300 kbps</td>
<td>UL/DL: 17(63) / 30 kbps (63 in multi-tone)</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>23dBm</td>
<td>23, 20dBm</td>
<td>23, 20dBm</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>VoLTE, LBS, PWS, eMBMS, etc.</td>
<td>VoLTE, LBS, PWS</td>
<td>-</td>
</tr>
</tbody>
</table>
Evolution of Cat-M and NB-IoT

- **Release 14**
  - Single Cell Multicast
  - Positioning support
  - Higher data rate
  - VoLTE improvements (Cat-M only)
- **Outcomes**
  - Improvements for Cat-M1
  - New category: Cat-M2
  - New category: Cat-NB2

- **Release 15**
  - Latency and Power consumption
    - Early data transmission
    - SI acquisition
    - Relaxed monitoring for cell selection
  - Load control
  - TDD support (NB only)
  - Higher spectral efficiency (Cat-M only)
- **Outcomes**
  - On going activity in 3GPP

5G and mMTC

- Cat-M and NB-IoT are good enough to fulfill 5G requirements
- Not expected to see an IoT NR before Rel. 17

Source: ITU
Quick Cellular IoT Market overview
**Key Drivers Converge**

- LTE-M & NB-IoT designed for IoT
- Worldwide network availability
- Data plans adapting to IoT
- Ecosystem now ready

**Cellular vs. non-cellular IoT**

<table>
<thead>
<tr>
<th>THE INDUSTRY</th>
<th>THE NETWORKS</th>
<th>THE TECHNOLOGY</th>
<th>THE OPERATORS</th>
<th>THE ROADMAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Standard</td>
<td>Coverage</td>
<td>Performance</td>
<td>Reliability</td>
<td>Diverse LTE</td>
</tr>
<tr>
<td>Huge Ecosystem</td>
<td>Spectral Efficiency</td>
<td>Low-latency</td>
<td>Managed access</td>
<td>categories</td>
</tr>
<tr>
<td>Longevity</td>
<td>Capacity</td>
<td>All-IP scalability</td>
<td>Security</td>
<td>10+ year</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>battery life</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2G cost parity</td>
</tr>
</tbody>
</table>

Common global standard with a vibrant global ecosystem

- 581 Networks in 186 countries
- 7,037+ Devices from 455+ vendors
- 1,683+ Billion global subscribers

Source: GSA
**Market opportunity**

**LPWA connection Worldwide**

![Bar chart showing LPWA connection worldwide from 2016 to 2022. The chart compares LTE LPWA and Proprietary LPWA connections. The chart indicates a steady increase in connections over the years, with a significant emphasis on Proprietary LPWA by 2022.]

Source: Strategy Analytics, Sequans Estimates

**Market Segmentation**

*(3GPP IoT)*

- **The mature market**
- **The promising one**
- **The challenging one**

![Bar chart showing market segmentation for 3GPP IoT from 2015 to 2021. The chart categorizes the market into Industrial IoT, Track & Trace, and Wearables. The mature market category is represented by Industrial IoT, the promising one by Track & Trace, and the challenging one by Wearables.]

(Images and data visualizations are placeholders for actual content.)
Cellular IoT is happening since long (2G...) and 4G is renewing this position
- Much more connected devices than in proprietary systems

Excellent opportunity for OAI (network side)...
- Could be a solution for private deployments
  - Though would require to implement MuLTEfire specs.

...Unfortunately OAI is not for UE side
- Power consumption, size, cost... will not match the requirements!
Sequans and OAI

- Cooperation since long
- Examples from the past:
  - Development of Carrier aggregation: in front of Sequans UE
  - Development of eMBMS: in front of Sequans UE
  - Extensive use of our internal debug and monitoring tool
- More recently
  - Development of Cat-M: in front of a Sequans UE

Debug and Monitoring tool

- Proprietary Trace tool to collect logs and data from UE
- Wireshark for message decoding
- Quite convenient for IoT and to debug OAI!
Wish list for OAI

• Gain in maturity and features

• To become #1 platform for 5G prototyping

• Possible usages for a chipset company
  – Affordable test equipment for quick non regression
  – Fast prototyping
  – Simulation

Thank You