3GPP Standards for the Internet-of-Things

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Partnership

Organizational Partners (SDOs)

- Regional standards organizations:
  - ARIB (Japan),
  - ATIS (USA),
  - CCSA (China),
  - ETSI (Europe),
  - TTA (Korea),
  - TTC (Japan),
  - TSDDSI (India)

Market Representative Partners

- 16 Market partners representing the broader industry:
  - 5G Americas,
  - COAI (India),
  - CTIA,
  - GCF,
  - GSA,
  - GSMA,
  - IPV6 Forum,
  - MDG (formerly CDG),
  - NGMN Alliance,
  - Small Cell Forum,
  - TCCA,
  - TD Industry Alliance,
  - TD-Forum

NEW:
- Wireless Broadband Alliance
- 5G Infrastructure Association
- Public Safety Communication Europe (PSCE) Forum
Developing internet protocol specs

Developing Mobile application specs

ITU-R/T

Input specs

Developing Wireless LAN/MAN specs

Referring to 3GPP specs (contributed by individual members)

Cross reference

Requirements

Partners of 3GPP

Referring to 3GPP specs for the local specs

Cross reference of specs

Terminal certification based on 3GPP specs

Referring to specs

Market Partners

Developing Recommendations

The 3GPP Eco-system

FII
Japan
Korea
China
North America
India

3GPP Eco-system
3GPP Facts and Figures

- ~400 Companies from 39 Countries
- 50,000 delegate days per year
- 40,000 documents per year
- 1,200 specs per Release
- New Release every ~18 months

Participation by Region

- Europe 41%
- Asia 38%
- North America 21%
Introduction & timeline

In **Release-13** 3GPP has made a major effort to address the IoT market.

The portfolio of technologies that 3GPP operators can now use to address their different market requirements includes:

1. **eMTC**  
   Further LTE enhancements for Machine Type Communications, building on the work started in Release-12 (UE Cat 0, new power saving mode: PSM)

2. **NB-IOT**  
   New radio added to the LTE platform optimized for the low end of the market

3. **EC-GSM-IoT**  
   EGPRS enhancements which in combination with PSM makes GSM/EDGE markets prepared for IoT

The **Release-13** is frozen and additional work is on-going for **Release-14**
## Summary for eMTC, NB-IoT and EC-GSM-IoT

<table>
<thead>
<tr>
<th></th>
<th>eMTC (LTE Cat M1)</th>
<th>NB-IoT</th>
<th>EC-GSM-IoT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deployment</strong></td>
<td>In-band LTE</td>
<td>In-band &amp; Guard-band LTE, standalone</td>
<td>In-band GSM</td>
</tr>
<tr>
<td><strong>Coverage</strong></td>
<td>155.7 dB</td>
<td>164 dB for standalone, FFS others</td>
<td>164 dB, with 33dBm power class 154 dB, with 23dBm power class</td>
</tr>
<tr>
<td><strong>Downlink</strong></td>
<td>OFDMA, 15 KHz tone spacing, Turbo Code, 16 QAM, 1 Rx</td>
<td>OFDMA, 15 KHz tone spacing, 1 Rx</td>
<td>TDMA/FDMA, GMSK and 8PSK (optional), 1 Rx</td>
</tr>
<tr>
<td><strong>Uplink</strong></td>
<td>SC-FDMA, 15 KHz tone spacing Turbo code, 16 QAM</td>
<td>Single tone, 15 KHz and 3.75 KHz spacing</td>
<td>TDMA/FDMA, GMSK and 8PSK (optional)</td>
</tr>
<tr>
<td><strong>Bandwidth</strong></td>
<td>1.08 MHz</td>
<td>180 KHz</td>
<td>200kHz per channel. Typical system bandwidth of 2.4MHz [smaller bandwidth down to 600 kHz being studied within Rel-13]</td>
</tr>
<tr>
<td><strong>Peak rate (DL/UL)</strong></td>
<td>1 Mbps for DL and UL</td>
<td>DL: ~50 kbps</td>
<td>For DL and UL (using 4 timeslots): ~70 kbps (GMSK), ~240kbps (8PSK)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UL: ~50 for multi-tone, ~20 kbps for single tone</td>
<td></td>
</tr>
<tr>
<td><strong>Duplexing</strong></td>
<td>FD &amp; HD (type B), FDD &amp; TDD</td>
<td>HD (type B), FDD</td>
<td>HD, FDD</td>
</tr>
<tr>
<td><strong>Power saving</strong></td>
<td>PSM, ext. I-DRX, C-DRX</td>
<td>PSM, ext. I-DRX, C-DRX</td>
<td>PSM, ext. I-DRX</td>
</tr>
<tr>
<td><strong>Power class</strong></td>
<td>23 dBm, 20 dBm</td>
<td>23 dBm, others TBD</td>
<td>33 dBm, 23 dBm</td>
</tr>
</tbody>
</table>

*In terms of MCL target. Targets for different technologies are based on somewhat different link budget assumptions (see TR 36.888/45.820 for more information).
eMTC

Objectives
- Long battery life: ~10 years of operation with 5 Watt Hour battery (depending on traffic and coverage needs)
- Low device cost: comparable to that of GPRS/GSM devices (as in the 3GPP work item description)
- Extended coverage: >155.7 dB maximum coupling loss (MCL)
- Variable rates: ~10 kbps to 1 Mbps depending on coverage needs

Deployment
- Can be deployed in any LTE spectrum
- Coexist with other LTE services within the same bandwidth
- Support FDD, TDD and half duplex (HD) modes
- Reuse existing LTE base stations with software update

Main PHY/RF features
- Narrowband operation with 1.08 MHz bandwidth
- Frequency hopping with narrowband retuning for frequency diversity
- TTI bundling/repetition to achieve large coverage enhancements
- New UE power class of 20 dBm
- Further cost reduction beyond Cat 0 (no wideband control channel, reduced TM support, reduced HARQ)
Rel-14: eMTC enhancements

Main feature enhancements

• Support for positioning (E-CID and OTDOA)
• Support for Multicast (SC-PTM)
• Mobility for inter-frequency measurements
• Higher data rates
  • Specify HARQ-ACK bundling in CE mode A in HD-FDD
  • Larger maximum TBS
  • Larger max. PDSCH/PUSCH channel bandwidth in connected mode at least in CE mode A in order to enhance support e.g. voice and audio streaming or other applications and scenarios
  • Up to 10 DL HARQ processes in CE mode A in FD-FDD
• Support for VoLTE (technics to reduce DL repetitions, new repetition factors, and adjusted scheduling delays)
NB-IOT

Objectives

- Even lower cost than eMTC
- Extended coverage: 164 dB maximum coupling loss (at least for standalone)
- Long battery life: 10 years with 5 Watt Hour battery (depending on traffic and coverage needs)
- Support for massive number of devices: at least 50,000 per cell

Main simplification

- Reduced data rate/bandwidth, mobility support and further protocol optimizations

NB-IOT supports 3 modes of operation:

- **Stand-alone**: utilizing stand-alone carrier, e.g. spectrum currently used by GERAN systems as a replacement of one or more GSM carriers
- **Guard band**: utilizing the unused resource blocks within a LTE carrier’s guard-band
- **In-band**: utilizing resource blocks within a normal LTE carrier
NB-IoT (cont’d)

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, NPBCCH, NPDCCCH, 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
Rel-14: NB-IOT enhancements

Agreement on NB-IOT positioning

- OTDOA is supported
  - Baseline signal(s) are: NB-IoT Rel-13 signals, LTE CRS/PRS in 1 PRB
- UTDOA positioning is supported under the following conditions:
  - It uses an existing NB-IoT transmission
  - It can be used by Rel-13 UEs
- Any signal used for positioning needs to have its accuracy, complexity, UE power consumption performance confirmed

Main feature enhancements

- Support for Multicast (SC-PTM)
- Power consumption and latency reduction (DL and UL for 2 HARQ processes and larger maximum TBS)
- Non-Anchor PRB enhancements (transmission of NPRACH/Paging on a non-anchor NB-IoT PRB)
- Mobility and service continuity enhancements (without the increasing of UE power consumption)
- New Power Class(es) (if appropriate, specify new UE power class(es) (e.g. 14dBm))
Enhanced DRX for NB-IOT and eMTC

Extended C-DRX and I-DRX operation

• Connected Mode (C-eDRX):
  • Extended DRX cycles of 5.12s and 10.24s are supported

• Idle mode (I-eDRX):
  • Extended DRX cycles up to ~44min for eMTC
  • Extended DRX cycles up to ~3hr for NB-IOT
Main upper layer features for NB-IOT and eMTC

- UE and Network negotiate capabilities and preferences for types of NAS/core network optimizations
  - This may be used for core network selection
  - Changes in Attach procedure required

- There are two different data transfer optimization features agreed for NB-IOT and eMTC:
  - Mandatory for NB-IoT/Optional for eMTC: “CP optimization”
    - Enables Small data over NAS using encrypted NAS PDUs
    - Support for RoHC Header Compression for IP PDN connection
    - Architecture Change: MME, S-GW and P-GW may be combined in one entity (e.g. C-SGN)
  - Optional for NB-IoT and eMTC: “UP optimization”
    - User plane based with RAN context casheing in idle mode to enable connection suspend/resume procedures on radio/S1 interface

- Other optional new features
  - Support for non-IP data (2 flavours: non-IP PDN via P-GW, non-IP via SCEF)
  - Attach without PDN connectivity
  - SMS transfer without combined attach
  - Storing and usage of coverage level in MME to avoid unnecessary repetitions over the air
EC-GSM-IoT

Objectives

• Long battery life: ~10 years of operation with 5 Wh battery (depending on traffic pattern and coverage needs)
• Low device cost compared to GPRS/GSM devices
• Extended coverage:
  • 164 dB MCL for 33 dBm UE,
  • 154 dB MCL for 23 dBm UE
• Variable rates:
  • GMSK: ~350bps to 70kbps depending on coverage level
  • 8PSK: up to 240 kbps
• Support for massive number of devices: at least 50,000 per cell
• Improved security compared to GSM/EDGE
EC-GSM-IoT (cont’d)

Main PHY features
- New logical channels designed for extended coverage
  - Repetitions to provide necessary robustness to support up to 164 dB MCL
  - Overlaid CDMA to increase cell capacity (used for EC-PDTCH and EC-PACCH)

Other features
- Extended DRX (up to ~52min)
- Optimized system information (i.e. no inter-RAT support)
- Relaxed idle mode behavior (e.g. reduced monitoring of neighbor cells)
- 2G security enhancements (integrity protection, mutual authentication, mandate stronger ciphering algorithms)
- NAS timer extensions to cater for very low data rate in extended coverage
- Storing and usage of coverage level in SGSN to avoid unnecessary repetitions over the air
Rel-14: EC-GSM-IoT enhancements

The objective is to specify radio interface enhancements for EC-GSM-IoT, that allow:

• use of alternative mappings of blind physical layer transmissions for higher coverage classes of EC-PDTCH/EC-PACCH

• MCL improvement targeting at least 3 dB for low power devices (i.e. 23 dBm) on all uplink channels

• Support for positioning
For more Information:

contact@3gpp.org  www.3gpp.org

Search for WIDs at http://www.3gpp.org/specifications/work-plan and http://www.3gpp.org/ftp/Information/WORK_PLAN/ (See excel sheet)