3GPP Standards for the Internet-of-Things

Philippe Reininger

Chairman of 3GPP RAN WG 3

(Huawei)

Partnership

Organizational Partners (SDOs)

- Regional standards organizations:

- ARIB (Japan),
- ATIS (USA),
- CCSA (China),
- ETSI (Europe),
- TTA (Korea),
- TTC (Japan),
- TSDSI (India)

Market Representative Partners

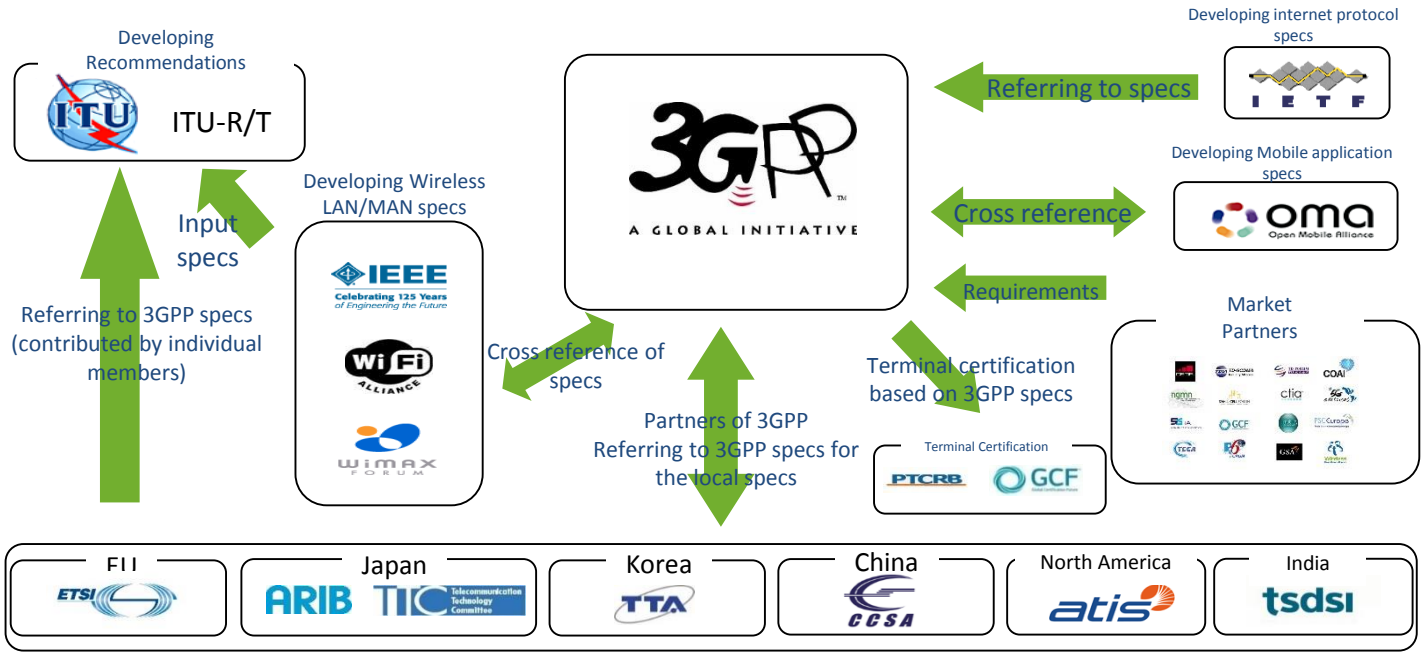
- 16 Market partners representing the broader industry:

- 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:

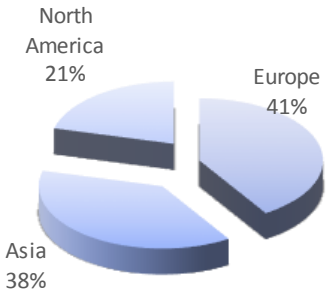
- Wireless Broadband Alliance
- 5G Infrastructure Association
- Public Safety Communication Europe (PSCE) Forum

The 3GPP Eco-system

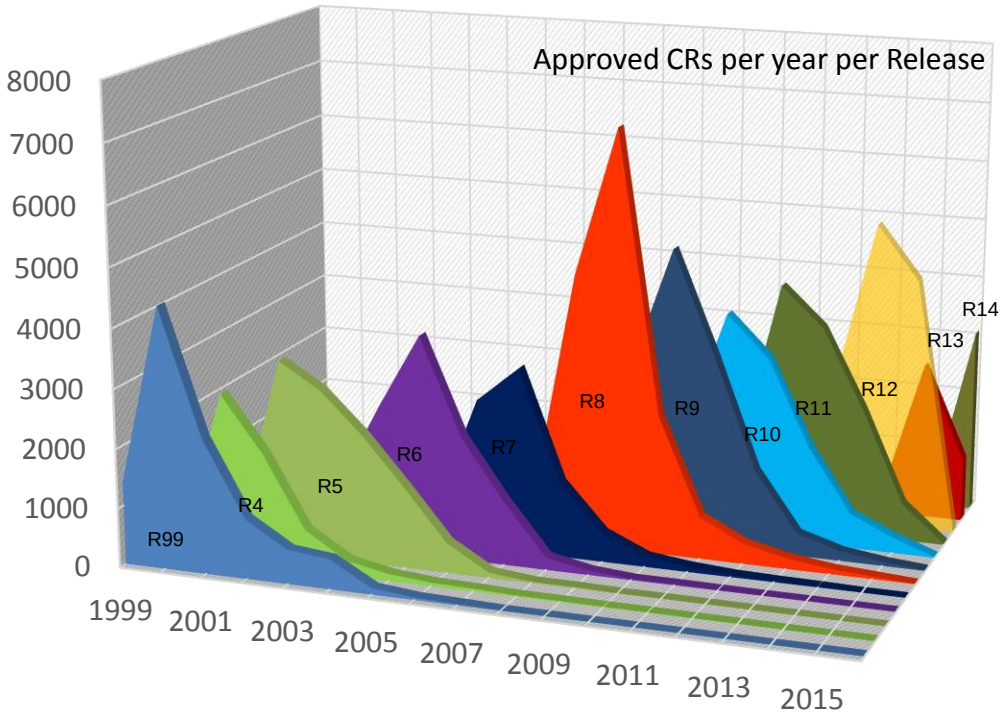


3GPP Facts and Figures

- ~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



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

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

** 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, 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

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)