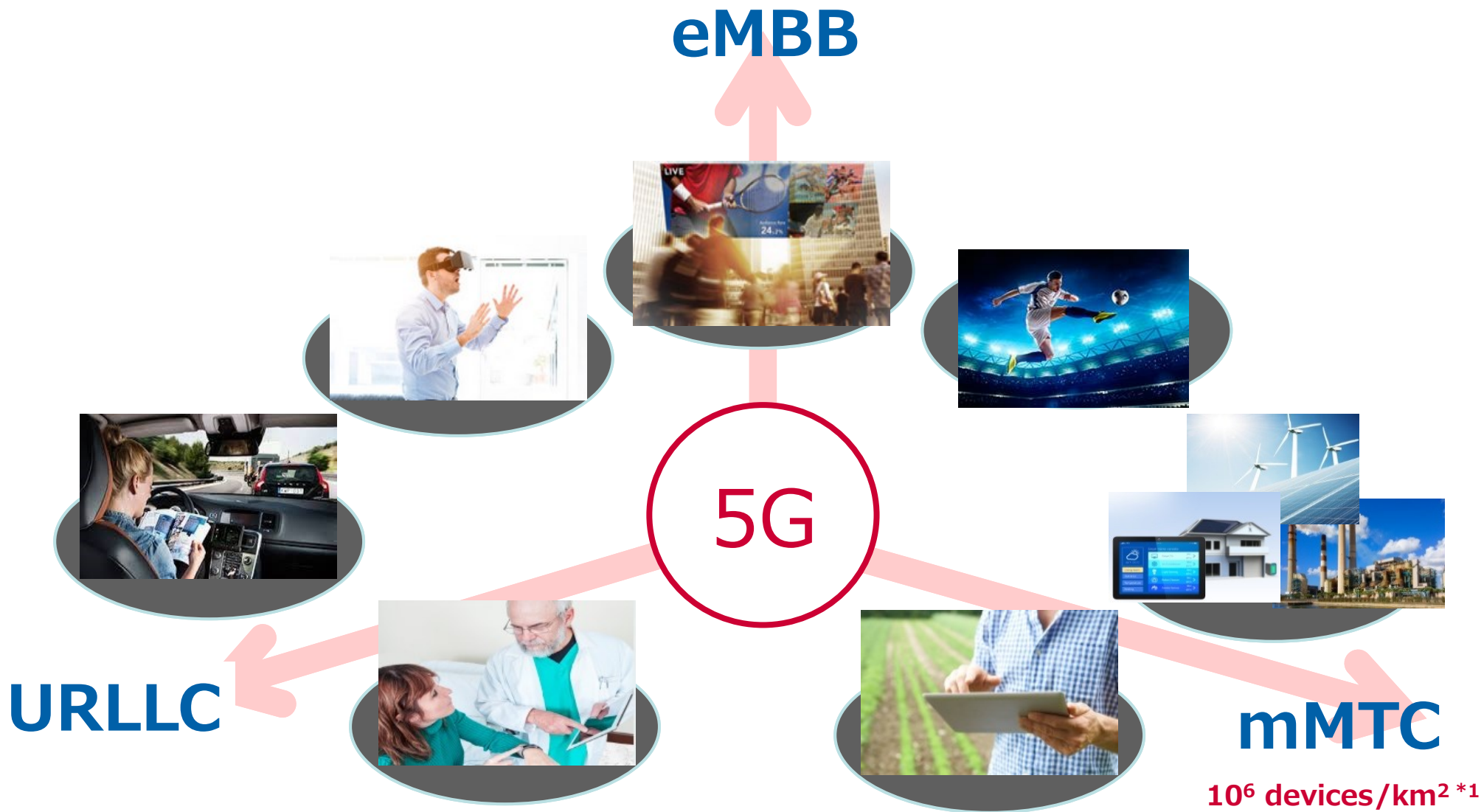
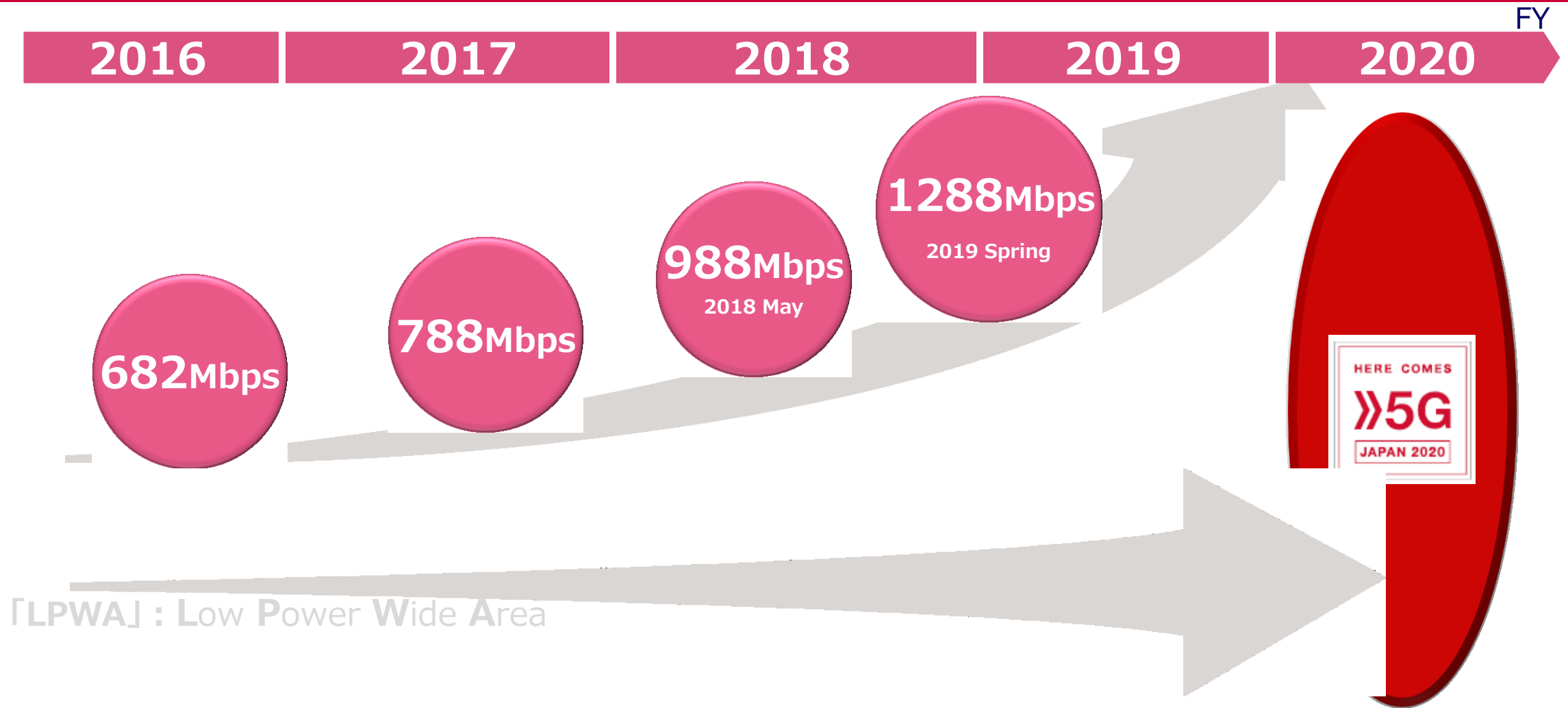


LTE/5G IoT standardization status and NTT DOCOMO activity

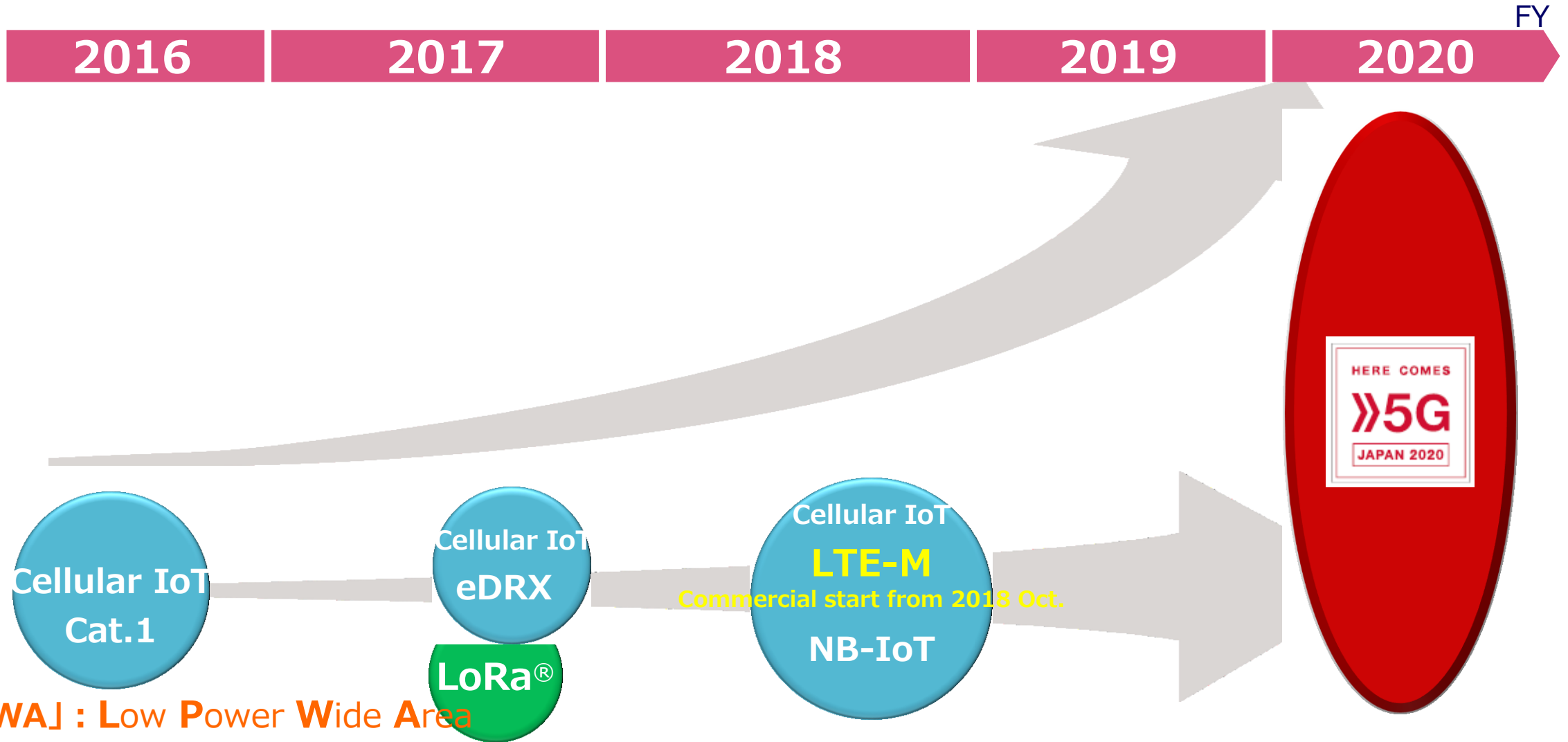
NTT DOCOMO
3GPP TSG-RAN Vice Chairman
Satoshi Nagata



NTT DOCOMO's Activity towards eMBB



NTT DOCOMO's Activity towards IoT



「LPWA」: Low Power Wide Area

IoT related System

	Cellular IoT (Rel-13)			Dedicated NW IoT	
	Cat.1	LTE-M	NB-IoT	LoRA	SIGFOX
Spec.	3 G P P			LoRA Alliance	Specific
Freq.	Licensed band			Unlicensed band	
Peak Rate (DL/UL)	10M/5Mbps	1M/1Mbps	21.25K /62.5Kbps	50K/50Kbps	600/100bps
Voice	Yes			No	
Mobility	Yes			No	

- 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
- Freeze of the protocol specifications is targeted for Q2-16

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, TBCC, 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: ~250 kbps UL: ~250 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).

- 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)

- 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

- 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

- 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

- 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 caching 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

- 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

- 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

いつか、あたりまえになることを。

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