IoT Networks

IoT & Mobile Communication Networks

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❖ 3GPP & IoT

- 3GPP (The 3rd Generation Partnership Project)
  - Refers to 7 telecommunication standardization groups to produce 3GPP standard releases for cellular network services
    - Radio Access, QoS (Quality of Service)
    - Core Transport Network
    - Network Services, Security, etc.
- 3GPP standards are structed as a 'Release'
- Release 8 (and beyond) includes standards for IoT

3GPP's 7 Groups: ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC

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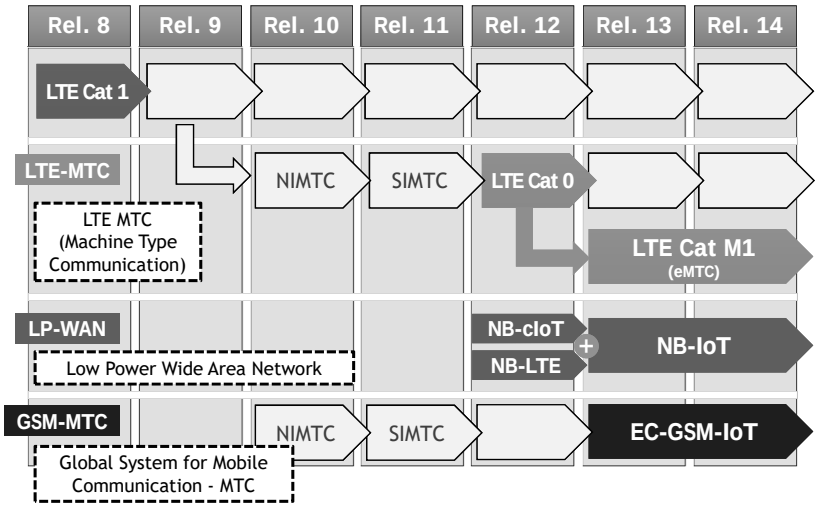
❖ 3GPP & IoT



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❖ LTE Cat 1 (Rel. 8)

- 3GPP's first standard option for IoT
- Includes transitional characteristics
  - Higher data rate than later 3GPP-IoT standards
    - Peak data rate: 10 Mbps (DL), 5 Mbps (UL)
  - UE receiver bandwidth: 20 MHz

Feature/Standard	LoRaWAN	Sigfox	LTE Cat 1 (Rel. 8)
Modulation	CSS	D-BPSK	OFDMA
Bandwidth	125 ~ 500 kHz	100 Hz	20 MHz
Data rate (peak)	50 Kbps	100 bps	10 Mbps
Max. output power	20 dBm	20 dBm	23 - 46 dBm
Power efficiency	Very High	Very High	Low

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❖ NIMTC (Rel. 10) & SIMTC (Rel. 11)

- NIMTC (Network Improvement for MTC, Rel. 10)
  - Specifies requirements for MTC to make the network more suitable for MTC
  - Congestion and overload control in IoT Networks
- SIMTC (System Improvement to MTC, Rel. 11)
  - Device triggering: Higher reachability from the App server to a MTC device
  - Triggering request via SMS (Only LTE possible)

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❖ LTE Cat 0 (Rel. 12)

- Supports a new UE category that can save the battery life significantly
- Suitable for IoT
- Reduced data rate from previous standards
  - Peak data rate: 1 Mbps (DL & UL)
  - UE receiver bandwidth: 20 MHz
  - Duplex type: Half duplex

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❖ LTE Cat M1 (eMTC, Rel. 13)

- eMTC (enhanced MTC) focuses far more on reduction of cost for LTE-IoT Networks
  - Peak data rate: ~1 Mbps
  - UE receiver bandwidth: 1.08 MHz
  - Modulation: OFDMA
  - UE transmit power: 20 dBm (new) or 23 dBm
- Allows a lot more IoT traffic to fit in the same LTE network bandwidth
- Compatible with the existing LTE network

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❖ Rel. 14 eMTC enhancements

- Support for Position Tracking
- Support for Multicasting (group message delivery)
- Support for Higher Data Rates
  - Larger max. channel bandwidth (5 MHz wide signal)
- Support for VoLTE

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❖ NB-IoT (Rel. 13)

- Also known as LTE Cat M2 or LTE Cat NB1
  - Partners include Huawei, Ericsson, Qualcomm, etc.
- Effort to reduce cost
  - Peak data rate: 250 kbps (DL), 250 or 20 kbps (UL)
  - UE receiver bandwidth: 180 kHz
  - Modulation: OFDMA
  - Removing gateways
    - Sensor data can be directly sent to the main server
    - No need for aggregating, format transition, etc.

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❖ NB-IoT (Rel. 13)

- Supports 3 modes of operation
  - Stand-alone
    - Utilizes a stand-alone carrier
      - Uses a GSM carrier
    - Not compatible with the LTE band
  - Guard band
    - Utilizes unused resource blocks within a LTE carrier's guard-band
  - In-band
    - Uses a normal LTE band

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❖ Rel. 14 NB-IOT enhancements

- Support for position tracking
- Support for multicast
- Mobility and service continuity enhancements
- Power consumption and latency reduction
  - Available to define new UE power class(es)
    - Example: 14 dBm

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❖ EC-GSM-IoT (Rel. 13)

- Succeeding standard of GSM in a form of IoT
  - EC-GSM: Extended Coverage GSM
- EC-GSM-IoT Features
  - Peak data rate: 474 kbps ~ 2Mbps (DL & UL)
  - UE receiver bandwidth: 200 kHz
  - Modulation: TDMA/FDMA
  - UE transmit power: 23 dBm or 33 dBm
  - Long battery life: ~10 yrs. operation with 5 Wh battery

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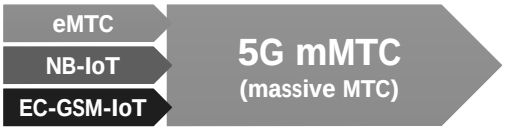
❖ mMTC (massive MTC)

- IMT-2020 defines mMTC as one of the 5G usage scenarios



- Key requirements
  - Wide area coverage: 694-790 MHz
    - Designed for connected cars, fleet service
  - Connection density: 10^6 Device/Km^2
    - Required for smart cities, smart metering

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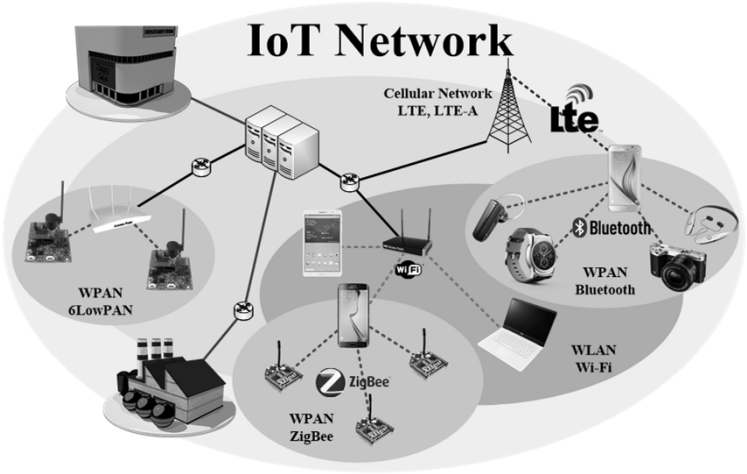
❖ IoT Networks



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