QoS/QoE Developments in 4G-IoT & 5G Technologies

Fernando Rodini
Director, Engineering
Qualcomm
QoS enforced per EPS Bearer:
Main QoS Parameters in 4G LTE

EPS Bearer QoS depends on the resource type: **GBR or Non-GBR**
- A **Default EPS Bearer** is always Non-GBR
- A **Dedicated EPS Bearer** can be GBR or Non-GBR

### EPS QoS Parameters

- **QoS Class Identifier (QCI)**
- Allocation/Retention Priority (ARP)
- Guaranteed Bit Rate (GBR), Maximum Bit Rate (MBR)
  - GBR Bearers only - (Uplink/Downlink)
  - Per UE/APN Aggregate MBR (UE-AMBR, APN-AMBR)
  - Non-GBR Bearers only - (Uplink/Downlink)

### QoS Provisioning & Control

- **Subscribed QoS (S-QoS)**
  - UE-AMBR, per IMSI
  - EPS QoS (QCI, ARP, GBR, MBR), APN-AMBR, per APN

- **EPC**
  - Dedicated QoS: QCI, GBR/MBR
  - Default QoS: QCI, APN-AMBR

- **eNB**
  - QoS (QCI, ARP, GBR/MBR)

- **HSS**
  - S-QoS
Wide range of 5G services require more than optimized waveforms and multiple access

5G NR flexible frame structure to efficiently multiplex services & offer forward compatibility

Need → Flexibility in time domain & also freq domain (with scalable OFDM)
Quality of Service (QoS) Comparison 4G and 5G
Downlink QoS Flow Example (typical apps)
Quality of Experience (QoE)

Services

- Voice
- Video
- VR (MC/URLLC)
- V2X

QoE Attributes

- Voice: MOS, end to end delay, codec and bit-rate
- Video: Initial playout delay, Avg. throughput, Resolution, Frame per second, lip-sync
- VR (MC/URLLC): Delay information, Codec, Resolution, Device type (head mounted or 360 degree)
- V2X: End to end latency (Max. tolerable delay), Reliability (Max. tolerable packet loss)

QoS framework to provide QoE

QCI/5QI Definitions

- Resource Type
- GBR/Non-GBR
- Priority
- PDB, PER
- Time Averaging
- For GBR bearer
- UL Reflective QoS

New in NR

NA for LTE (yet)
Cellular IoT Technologies

Cat-M1 aka Bandwidth Reduced Low Complexity / Coverage Enhancement (BL/CE) UE

- LTE Cat-1 and above
  - n x 20 MHz
  - > 1 Mbps
  - +15 dB
  - Faster data rates
  - Full-to-limited mobility
  - Voice/VoLTE support

- LTE Cat-M1
  - 1.4 MHz
  - Up to 1 Mbps
  - +5 dB
  - Ultra low-cost
  - Ultra low-power
  - Delay-tolerant

- LTE Cat-NB1
  - 200 kHz
  - Up to 1 Mbps
  - Ultra low-cost
  - Ultra low-power
  - Delay-tolerant

LTE Cat-M1 (eMTC)
Broadest range of IoT capabilities with support for advanced features, e.g. voice support

Many IoT devices & LTE networks can benefit from multi-mode operations to optimize for different traffic profiles and RF conditions

LTE Cat-NB1 (NB-IoT)
Scalable to lowest cost/power for delay-tolerant, low-throughput IoT use cases, e.g. remote sensors

Deeper Coverage also depends on IOT device; Cat-NB1 offers 5/20dB wider coverage than CatM/Cat1
Cellular IoT optimizations to network architecture

3GPP Release 13 TS 23.401

The Core Network node involved in the EPS Architecture optimized for CIoT can be deployed as Dedicated Core Networks (DCNs) within a PLMN.

- **More efficient signaling**: To support a larger number of devices per cell with new features such as group-based paging and messaging.
- **Simplified Core Network**: Reduced functionality, e.g., limited mobility and makes possible for integrating network functions into a single entity.
- **Enhanced resource management**: Such as optimizations to allow a large set of devices to share the same subscription, e.g., all the water meters in a city.
Enabling service authorization (e.g. charging to 3rd party, 3rd party request/profiling for QoS, etc.) for specific connections (sessions a-la PDN) creates flexibility and enables new service models.
Thanks