# Demystifying 5G: Understanding Latency

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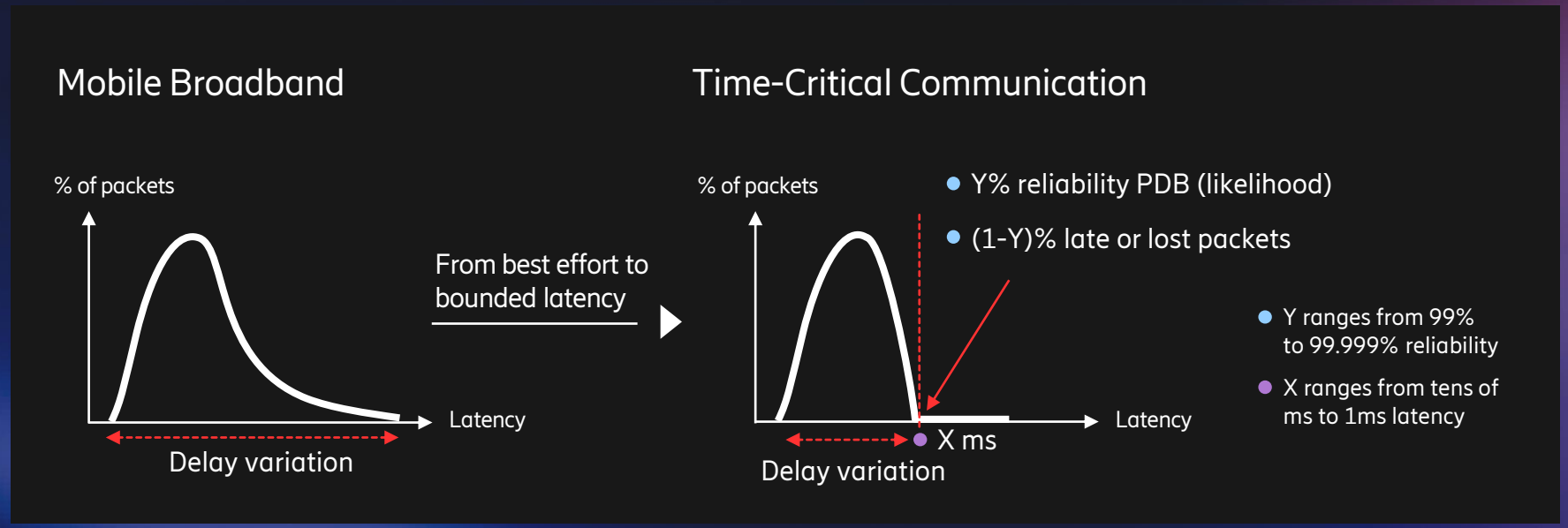
Time-Critical Communications

# Definition of Time-Critical Communication

Data delivery within a specific time window with a required guaranteed level*

* Example: Data delivered within 30ms with 99.9% reliability




Fundamental trade-offs between latency and other KPIs such as throughput, coverage, and energy efficiency

Latency aspect prioritized over throughput => a fundamental difference vs Mobile Broadband

# Time Critical Communication

## Enable new cellular latency critical services bringing benefits to consumers, business and society

### Industrial control

Open or closed-loop control of industrial automation systems

### Real-time media

Real, virtual and combined environments e.g. cloud gaming & cloud AR use cases

### Mobility automation

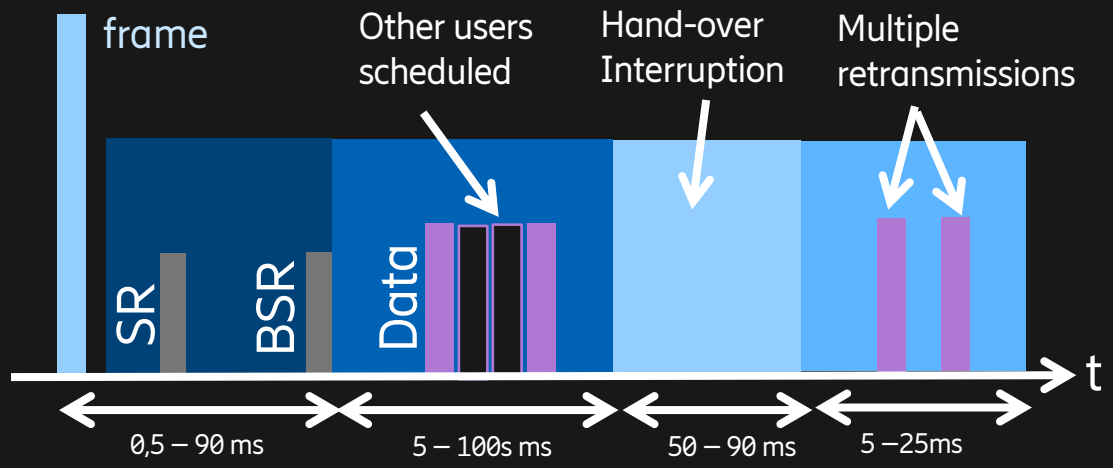
Automated control loops for mobile vehicles and robots

### Remote control

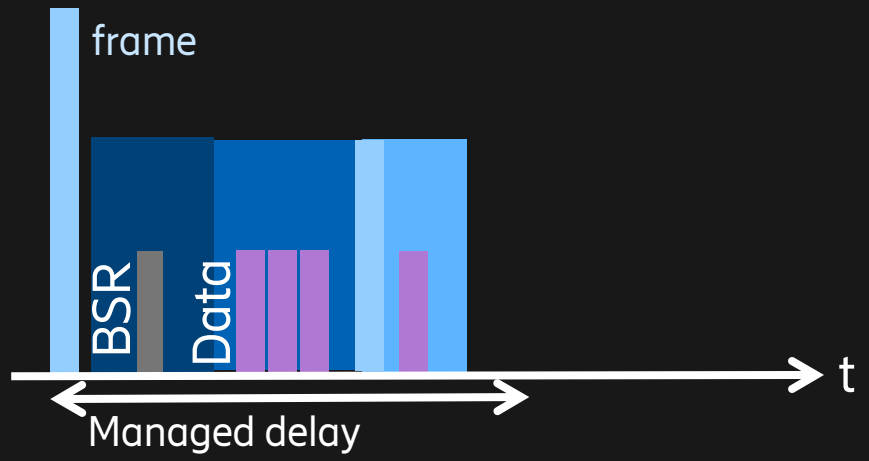
Human control of remote devices

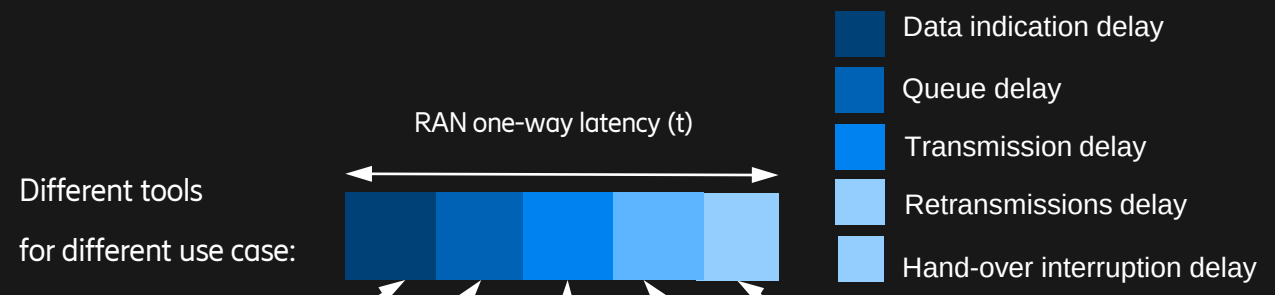
# 5G Cellular Delay components and its features

## Mobile Broadband example:




## Mobile Time Critical example:




**UL data indication delay:**

- Uplink-Configured grant
- Pre-scheduling schemes
- Service adaptive Schedule Request

**Queue delay**

- RAN rate recommendation with L4S

Schedulers:

- Latency Priority
- Rate Controlled
- Priority Controlled

**Transmission delay**

- Frequency band Numerology
- Transmission time length (TTI)
- FDD vs. TDD-patterns

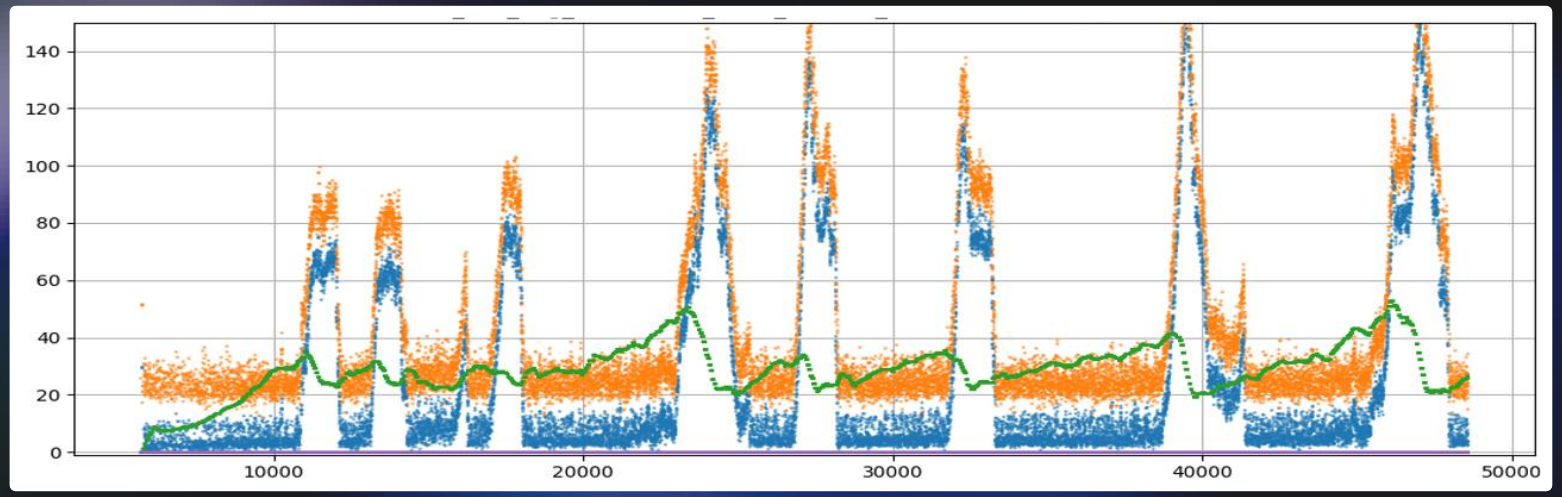
**Retransmission delay**

- Link Adaptation Robustness features
- Robust encoding and modulation schemes

Hand-over interruption delay:

- Low-latency Mobility

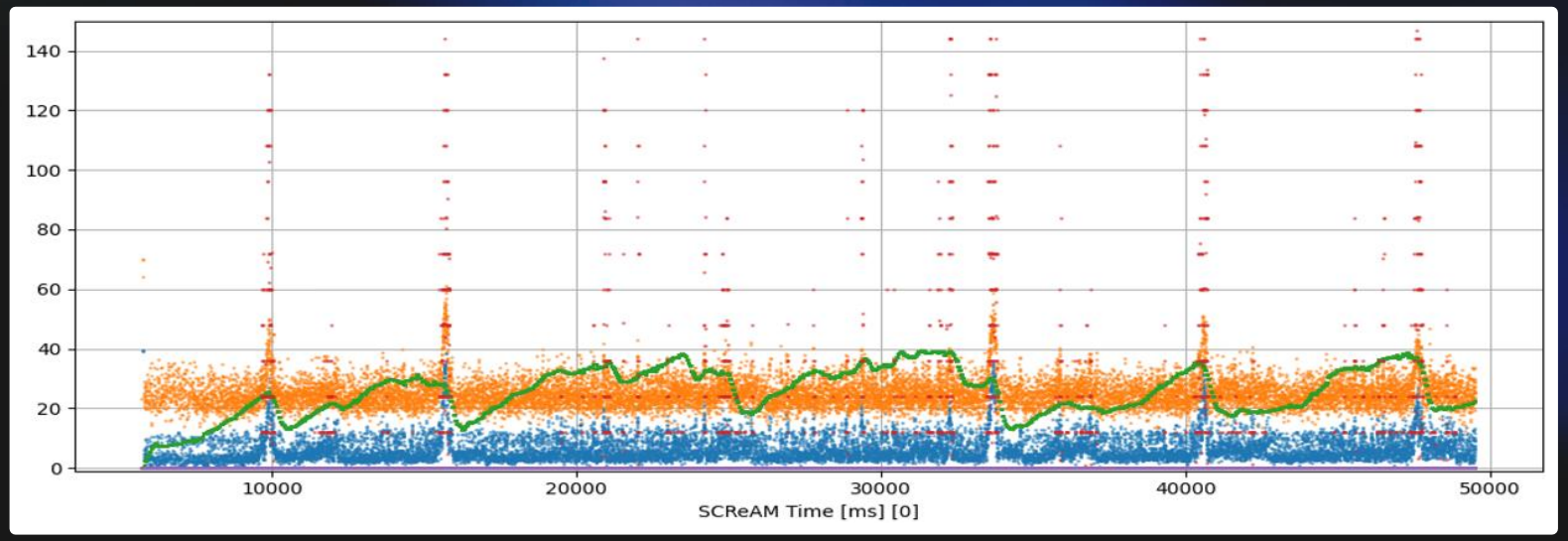
# Gaming application with/without L4S




**Baseline L4S OFF**:

Latency peaks

Bandwidth: 20 MHz
TDD n40 (2.3 GHz)




**L4S ON:**

Rate adapted, stable latency

- DL Q-delay [ms]
- RTT [ms]
- Bitrate [Mbps]
- CE-Marking [B]

# Summary

- We want to enable a service differentiated cellular network being designed for certain performance levels
  - Enable applications to dynamically request mobile networks for a connectivity type that fits these required performance levels.
  - Many emerging and existing use cases requires deterministic latency performance
  - Many features are already implemented addressing different parts of cellular delay
    - Features are primarily developed for 5G Stand-Alone deployments