Ultra-Reliable Low-Latency Communication

A NOVELTY 5G TECHNOLOGY

Group2 – IEMS5701

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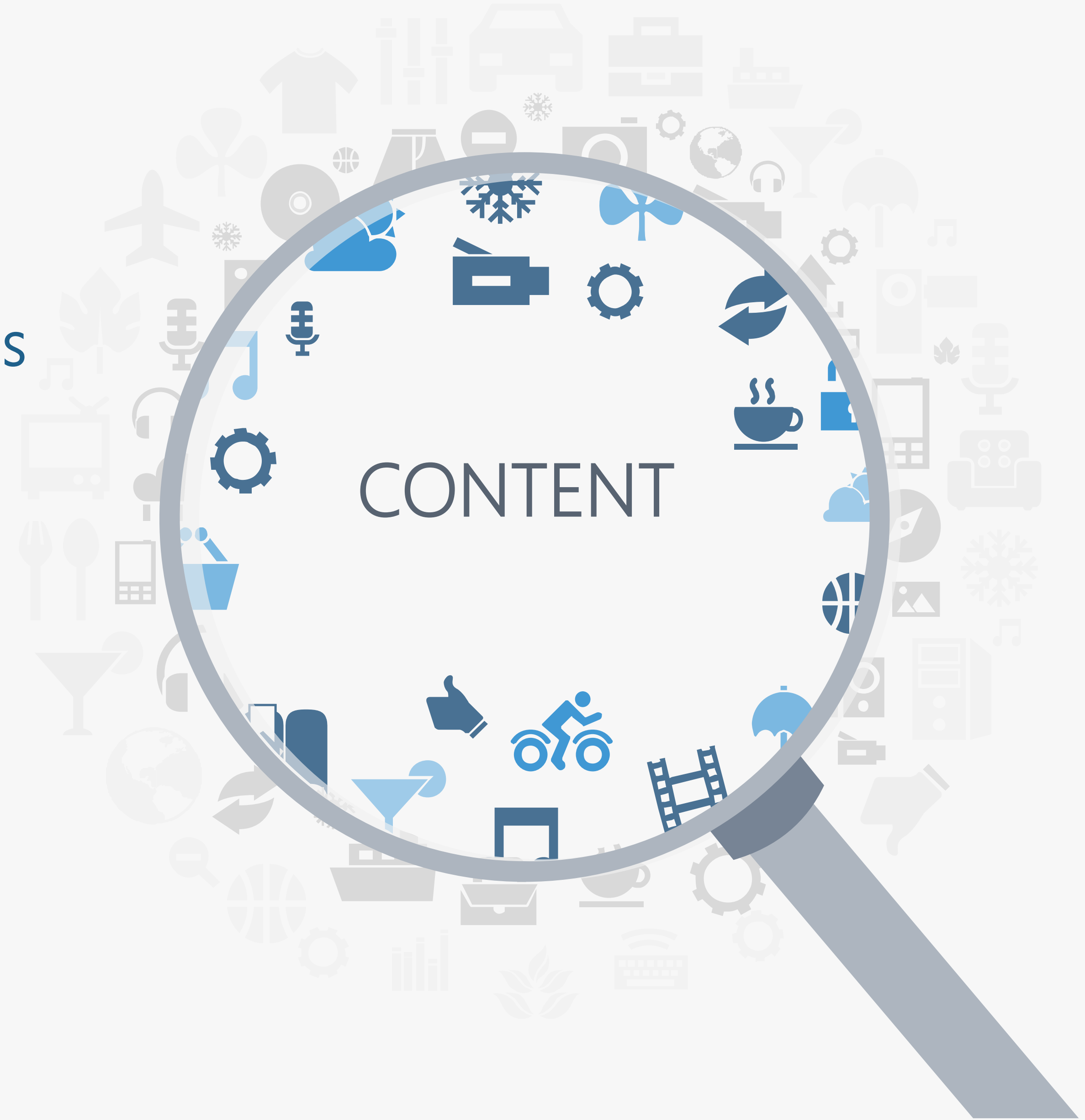
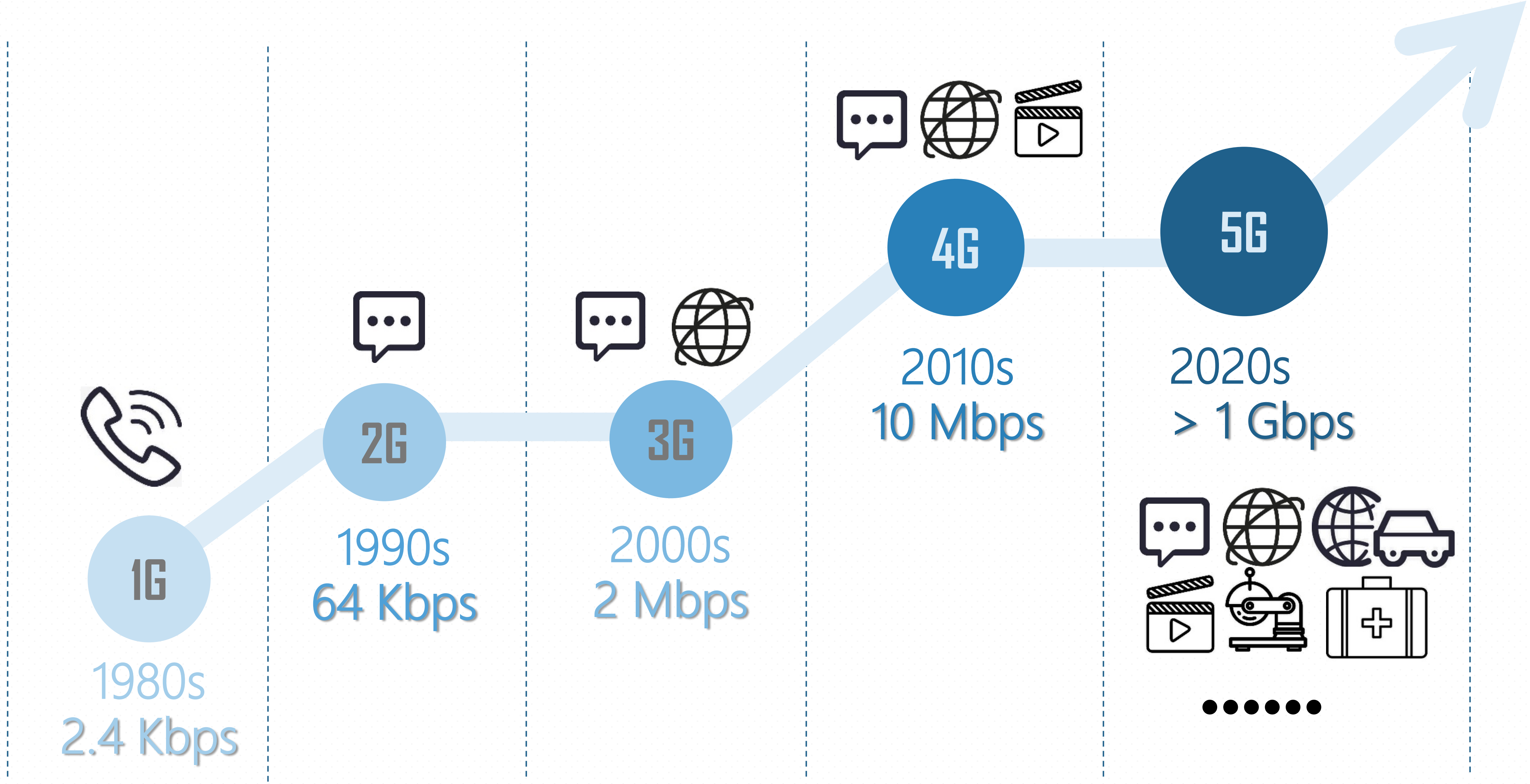
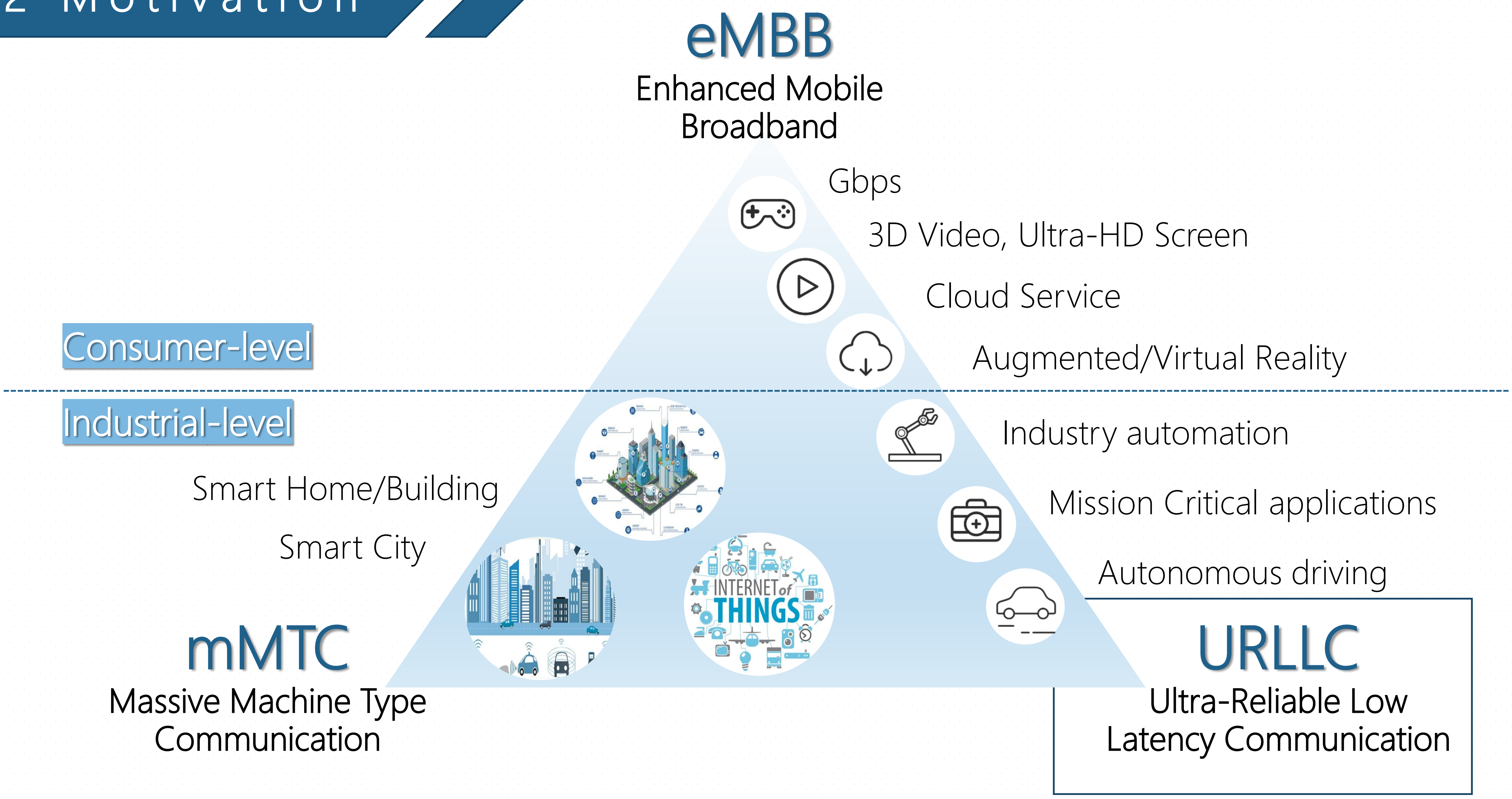

CONTENT

1 Background Motivation

1.1 Background



1.2 Motivation

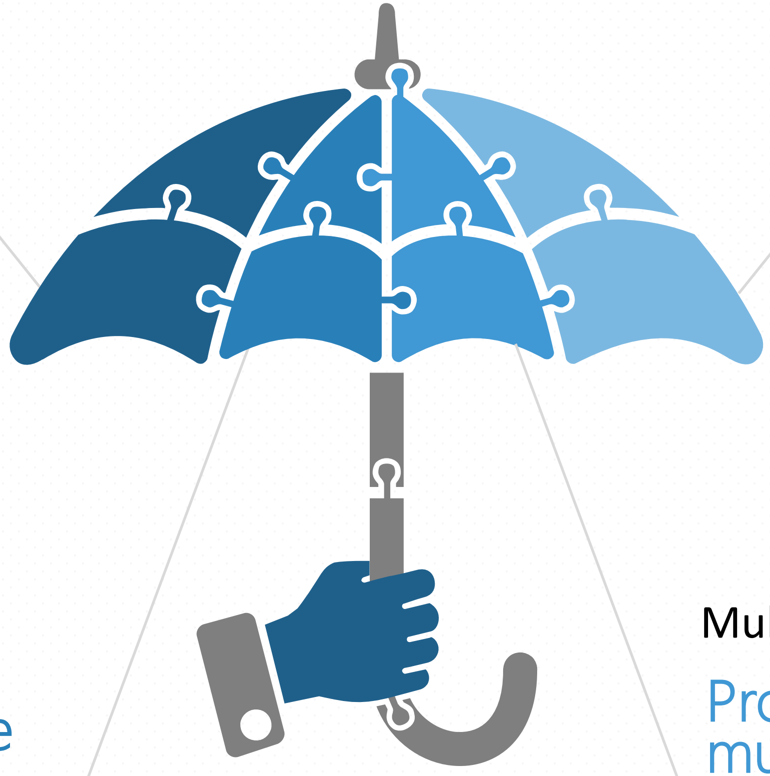


2

Key Design Challenges
Key Principles

Design Challenges of URLLC

High reliability rate 99.999% | **Small latency** period 1ms | 32-byte long **small packet**



Data / Control Channel

The transmitting time of metadata

Accurate / Flexible link adaptation

Conventional Grant-based Method

Collisions with other users

Retransmission time

Multiplexing with 4G LTE, eMBB

Processing time of multiplexing with other services

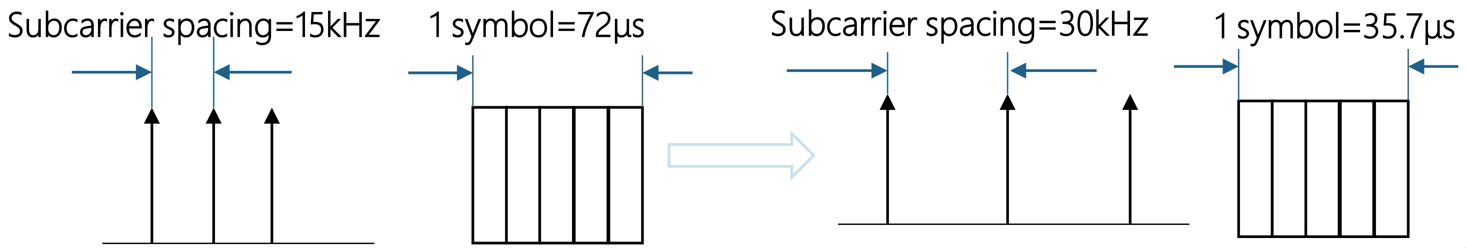
2.1 Low Latency

1 Frame Structure

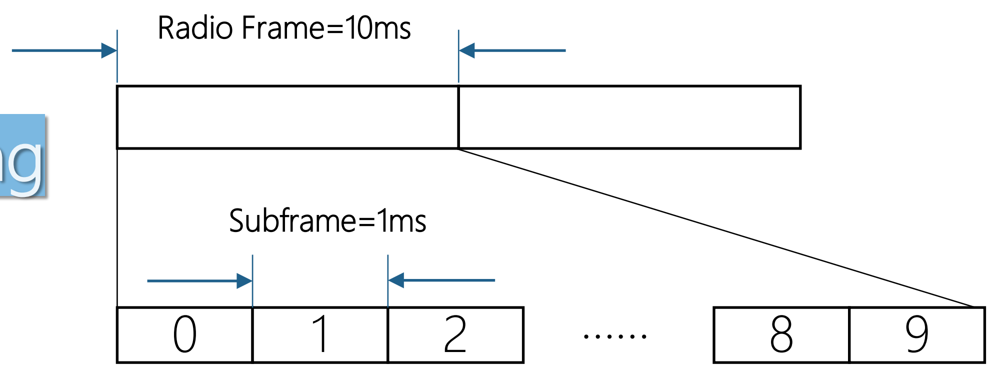
Expanded numerology

N	0	1	2	3	4	5
Subcarrier Spacing(kHz)	15	30	60	120	240	480

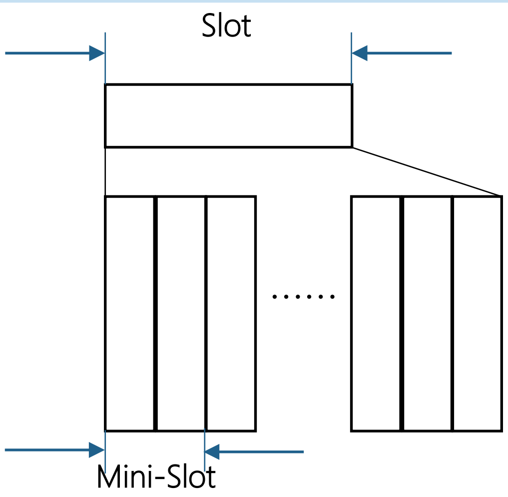
Reduced Transmission Time



Multiplexing



Multiplexing with 4G LTE



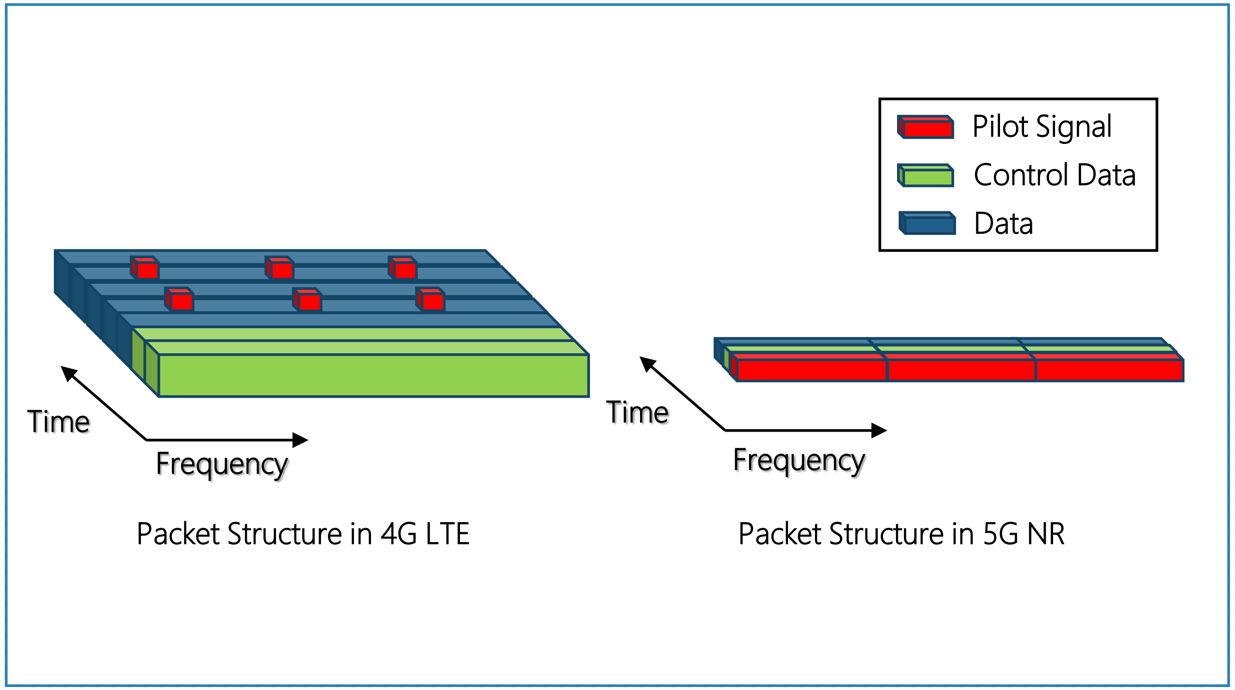
Mini-slot

Preempting

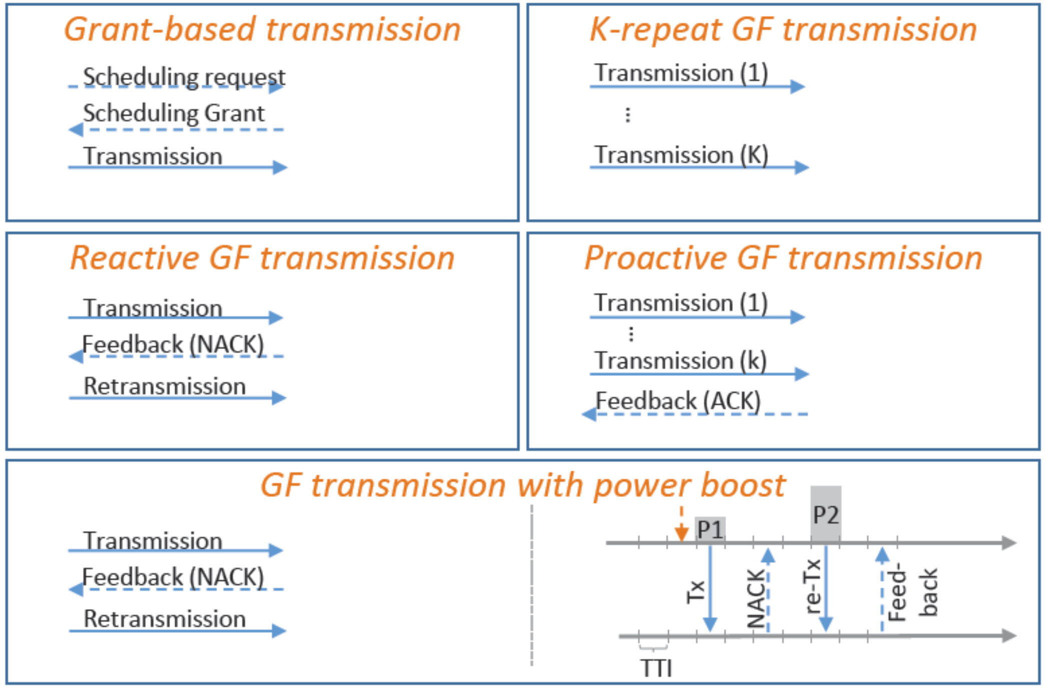
Multiplexing with eMBB

2.1 Low Latency

2 Packet Structure



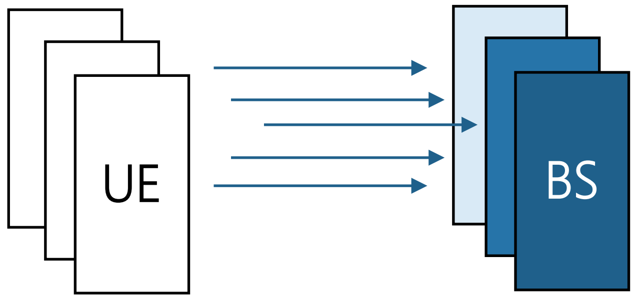
3 Uplink Grant-free HARQ Scheme[1]



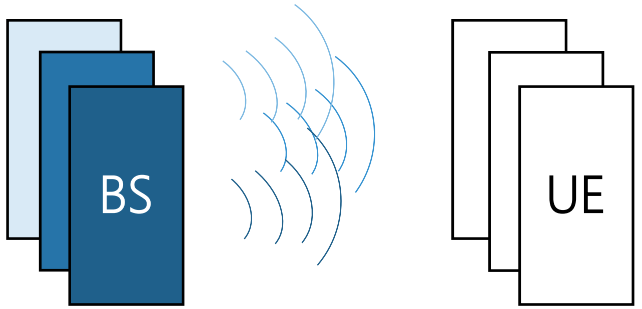
[1] N. H. Mahmood, R. Abreu, R. Böhnke, M. Schubert, G. Berardinelli and T. H. Jacobsen, "Uplink Grant-Free Access Solutions for URLLC services in 5G New Radio," *2019 16th International Symposium on Wireless Communication Systems (ISWCS)*, Oulu, Finland, 2019, pp. 607-612, doi: 10.1109/ISWCS.2019.8877253.

2.2 High Reliability

1 Multi-Antenna Diversity



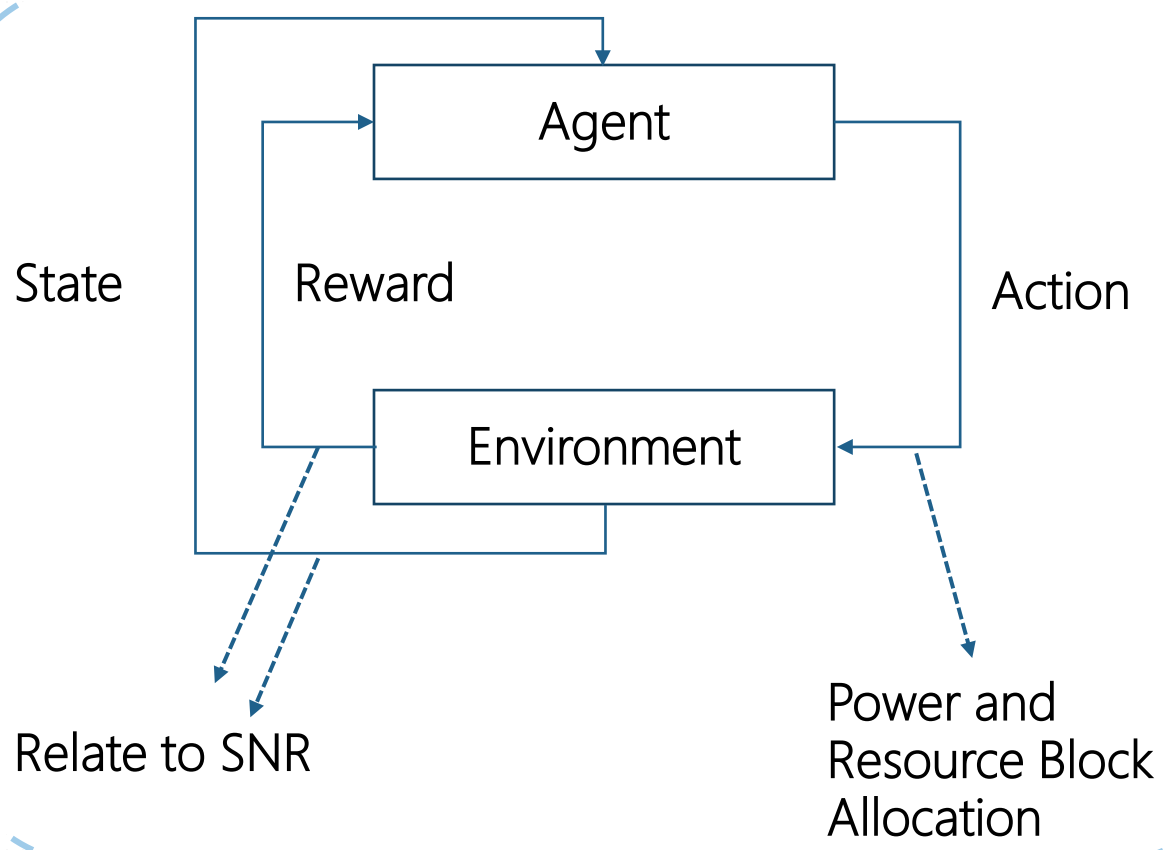
Coherent & Non-Coherent Reception



Beamforming

SVD

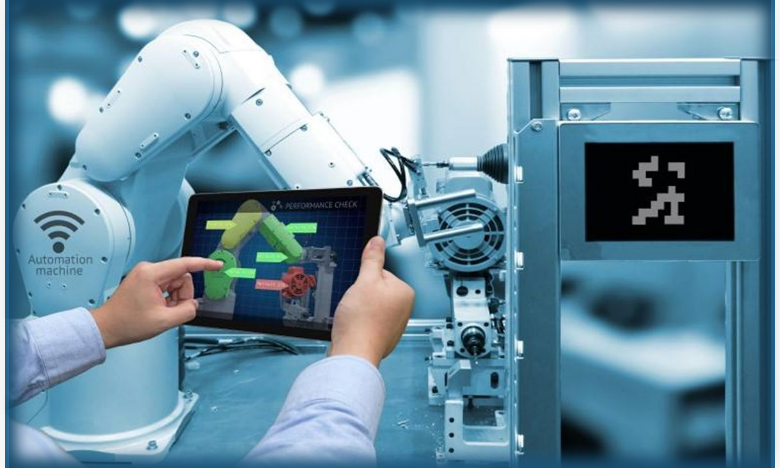
2 Reinforcement Learning



3 Use Cases

Use Cases

Smart Factory



E2E Latency: 1-10ms
Reliability: 99.999%

- Robot Control
- Power System Automation
- Process Control & Safety

Intelligent Transportation

E2E Latency: 3-5ms
Reliability: 99.999%

- Autonomous Driving
- Traffic Management
- Pedestrian Assistance

Remote Healthcare

E2E Latency: 1ms
Reliability: 99.999%

- Remote Surgery
- Online Consultation
- Urgent Scenarios

4 Conclusion

Conclusion

Objective	Methods	Solution	Relations to Design Challenges
Low Latency	Frame Structure	Short time interval ensure fast transmission of data payloads Mini-slot preempting scheduling policy to multiplex with eMBB	Data/Control Channel Processing time of multiplexing with other services
	Packet Structure	Fixed Radio frame and subframe structure to multiplex with 4G LTE New Structure to reduce the processing and transmission delay	Processing time of multiplexing with other services Data/Control Channel
	Uplink Grant-free HARQ Scheme	Short HARQ round-trip time to allow retransmissions within the latency budget	Retransmission time Flexible link adaptation
High Reliability	Multi-Antenna Diversity	Uplink: Coherent vs Non-coherent Downlink: Beamforming & SVD	Processing time of multiplexing with other services
	Reinforcement Learning	An innovative machine learning based trial in communication area	Data/Control Channel

Application		
Smart Factory	Intelligent Transportation	Remote Healthcare

Thanks for Listening