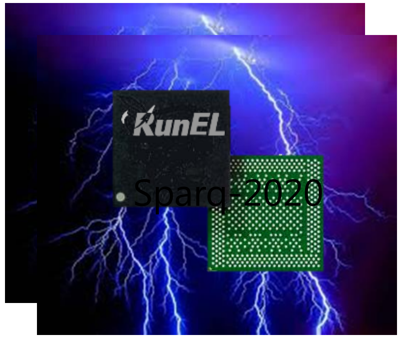


9th FUKUSHIMA FUSECO Forum

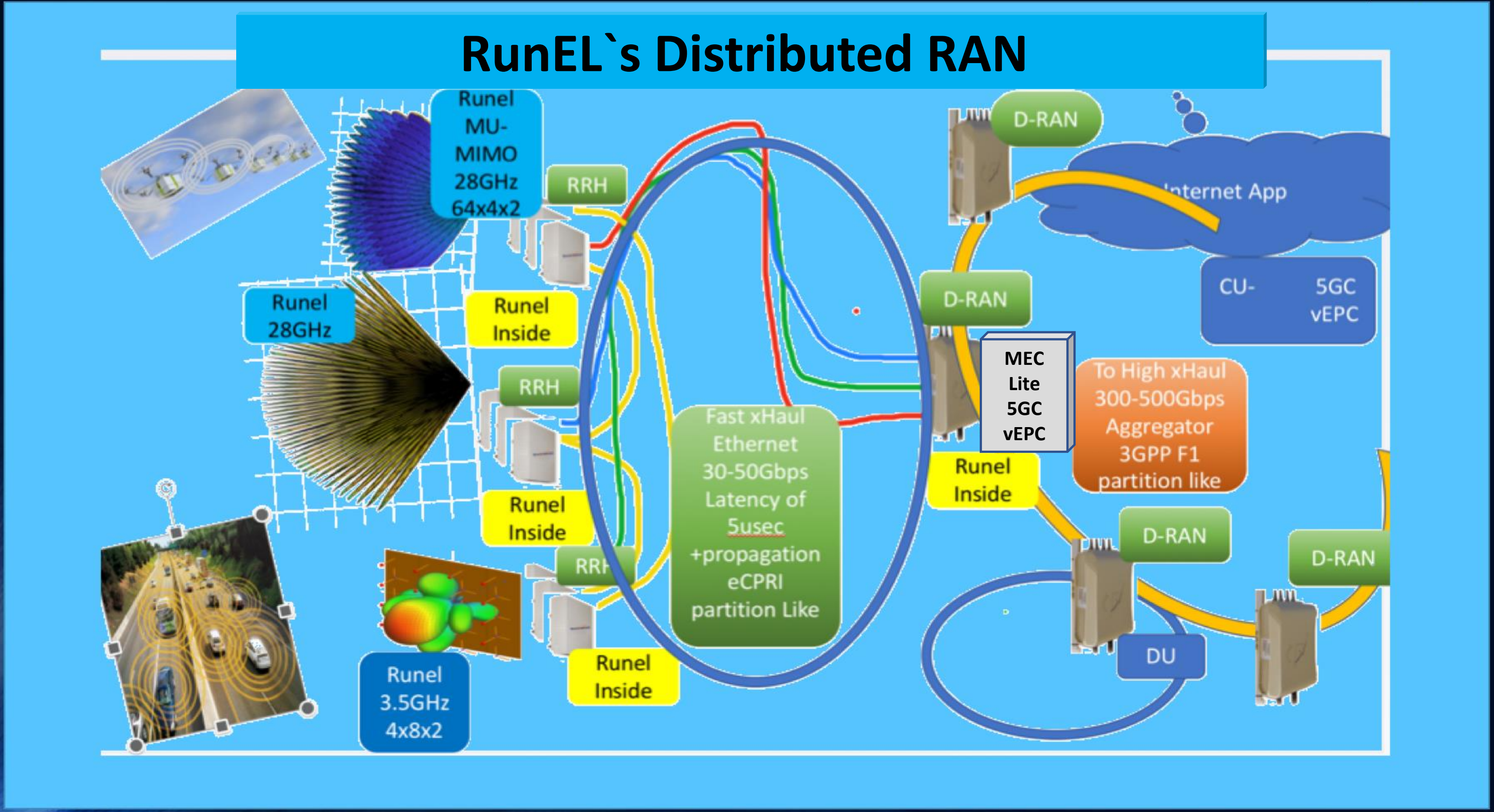
URLLC
Network & RAN
Consideration

By:

Dr. Zion Hadad

RunEL

RunEL`s Introduction
Israeli SME By Dr. Zion Hadad



Runel`s Chipset Based gNB Platform Targets

QoE without compromise

Flexible 5G: - network platform for most use cases/Verticals/slices as a Private/Public Network , Licensed/UnLicensed

Flexible deployment:- In door, out door, mixed. High way, residential /industrial buildings , Macro cell , Small cell.

KPI In Runel`s Based 5G gNB

- ✓ **Distributed gNB - RRHs with 72x2 Distributed cross polarization Beams /streams, peak network data rate 72 Gbps for 100MHz BW ,**
- ✓ **Drives By Runel`s AI/ML Centralized Scheduler.**
- ✓ **Network RTD 125us- 500us (SCS and coverage size dependent) for URLLC & fast eMBB**
- ✓ **Inherent SON, CoMP, DC - Mix overlay Macro cell on Small cells peak throughput of throughput per layer/beam 1 to 10 bps/Hz , system TP x 72 reach =72 - 720 bps/Hz and (No cell edge , Cell - Less).**
- ✓ **Supports comunication with 4000 cars at a 500us time interval.**
- ✓ **Supports High accurate Location (few cm) and its derivative for Location/drive App's**

3GPP TR in process

3GPP TR 22.804 V16.1.0 (2018-09)

Technical Report

3rd Generation Partnership Project;
Technical Specification Group Services and System Aspects;
Study on Communication for Automation in Vertical Domains
(Release 16)

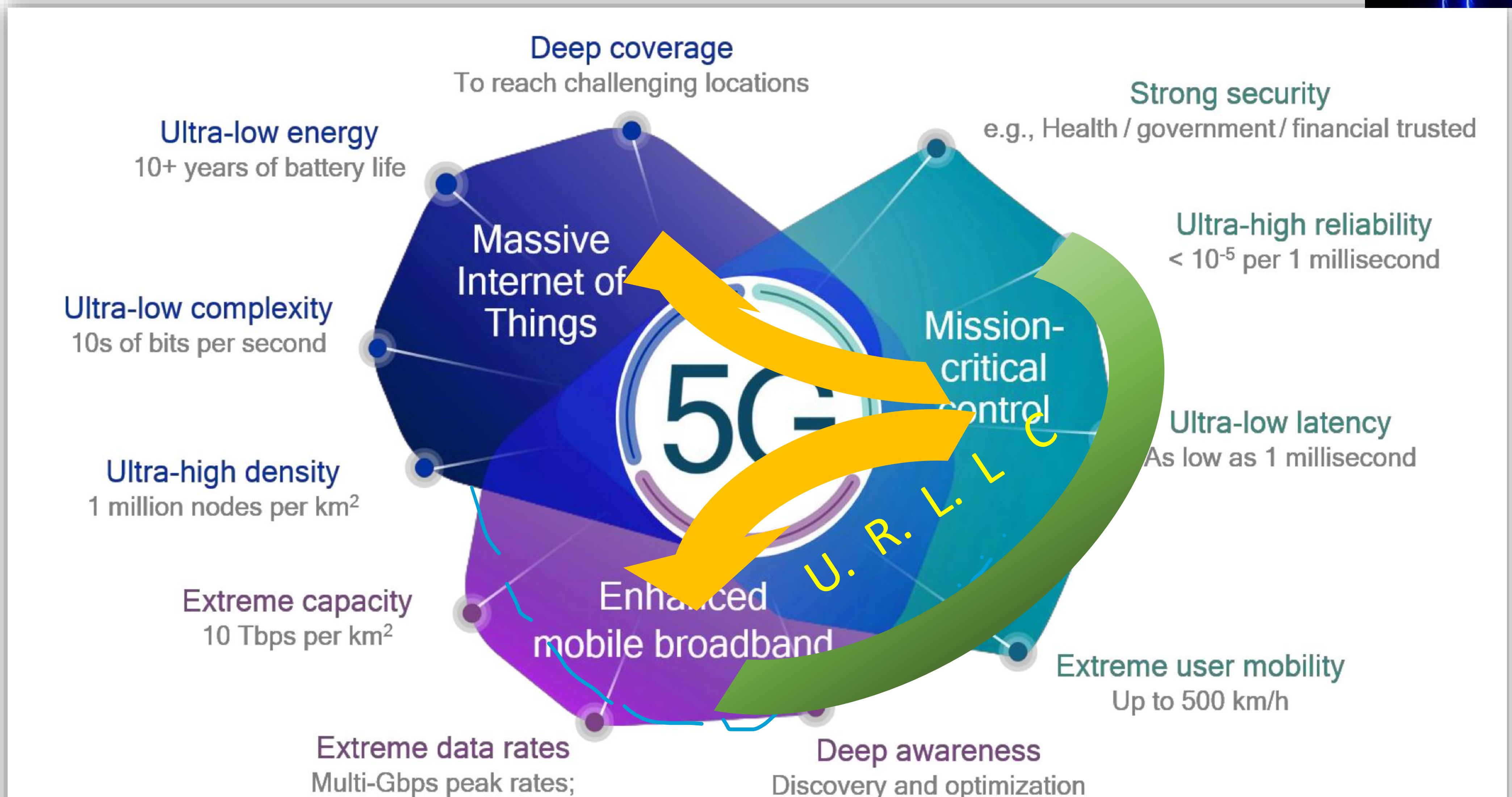
3GPP TR 38.824 V0.0.3 (2018-11)

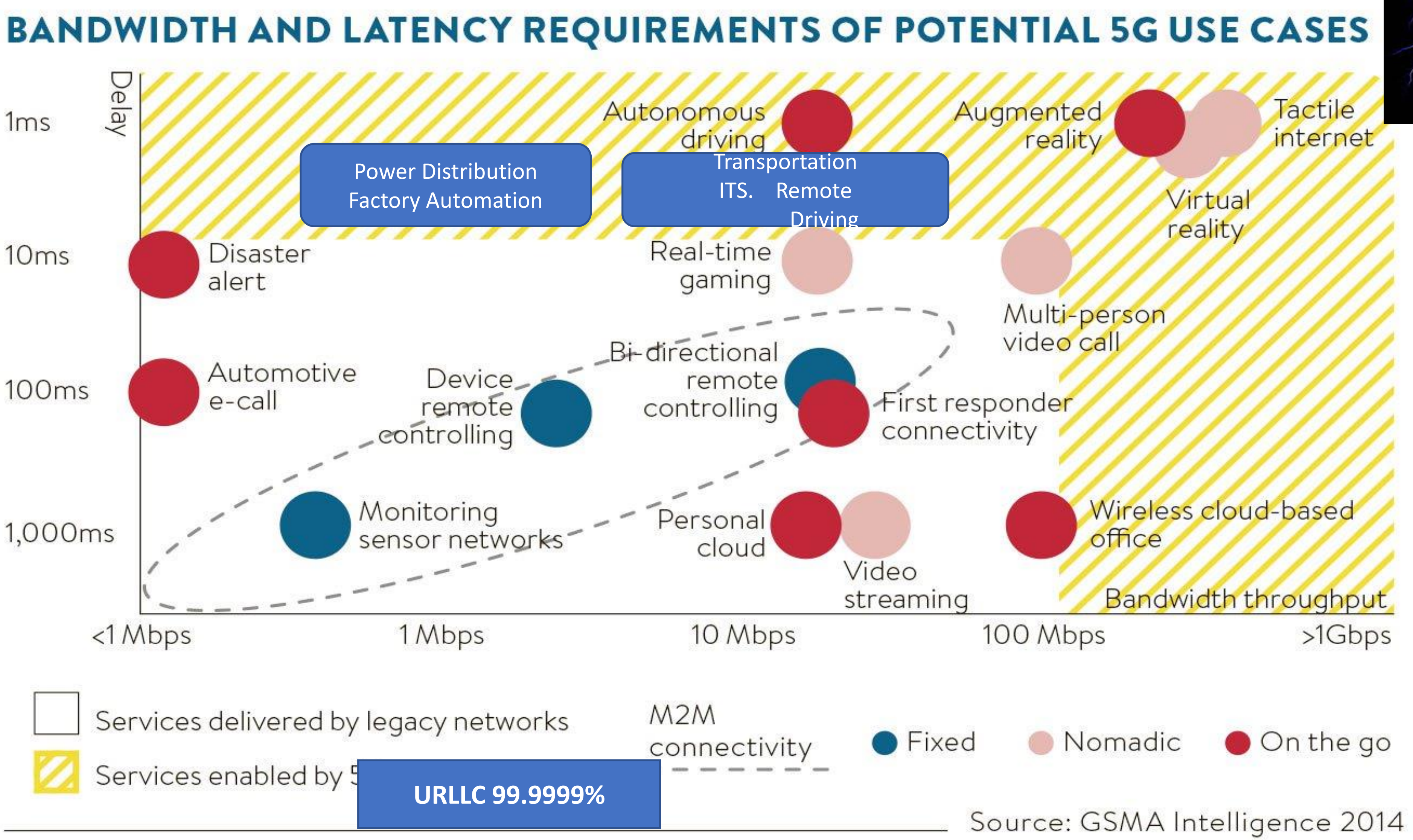
Technical Report

3rd Generation Partnership Project;
Technical Specification Group Radio Access Network;
Study on physical layer enhancements for NR ultra-reliable low latency communication (URLLC)
(Release 16)

A GLOBAL INITIATIVE

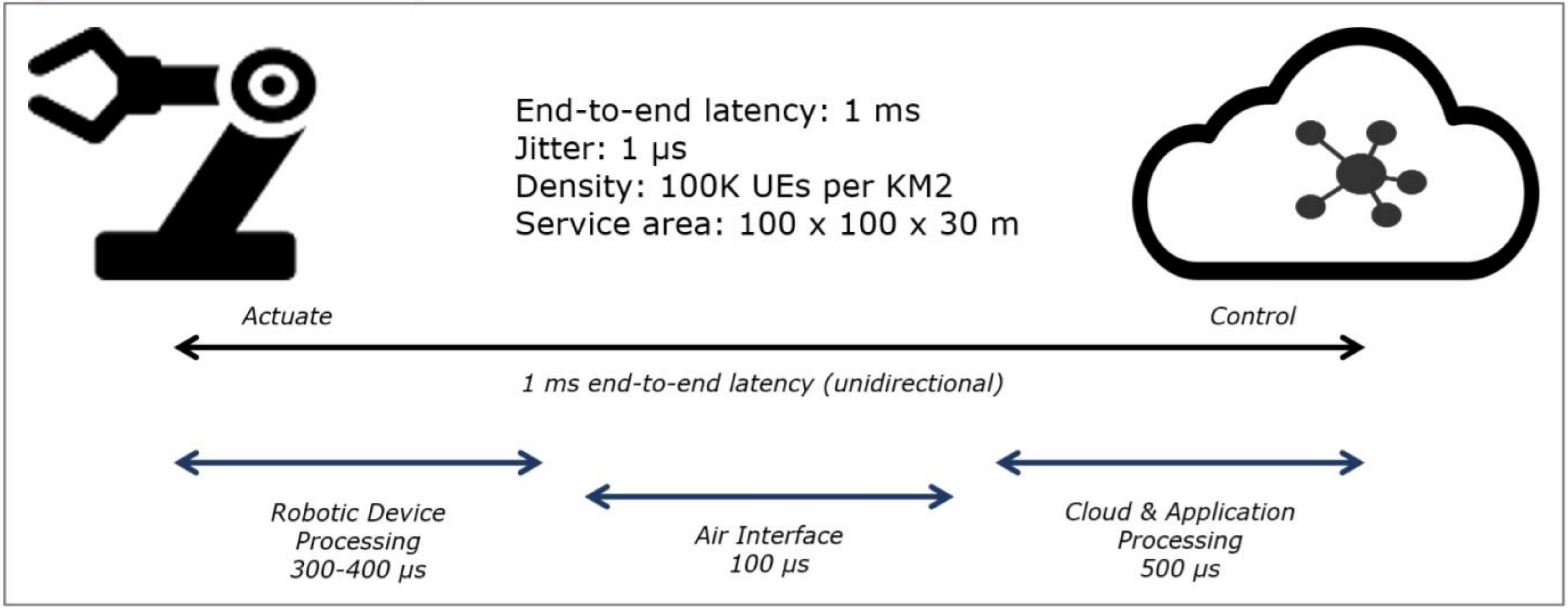
ITU Requirements
URLLC ➔>> eMBB
➔>> mIoT




BANDWIDTH AND LATENCY REQUIREMENTS OF POTENTIAL 5G USE CASES
Delay
1ms
10ms
100ms
1,000ms
Power Distribution
Factory Automation
Transportation
ITS. Remote
Driving
Autonomous driving
Augmented reality
Tactile internet
Virtual reality
Disaster alert
Real-time gaming
Multi-person video call
Automotive e-call
Device remote controlling
Bi-directional remote controlling
First responder connectivity
Monitoring sensor networks
Personal cloud
Video streaming
Wireless cloud-based office
Bandwidth throughput
<1 Mbps
1 Mbps
10 Mbps
100 Mbps
>1Gbps
Services delivered by legacy networks
Services enabled by 5
URLLC 99.9999%
M2M connectivity
Fixed
Nomadic
On the go
Source: GSMA Intelligence 2014

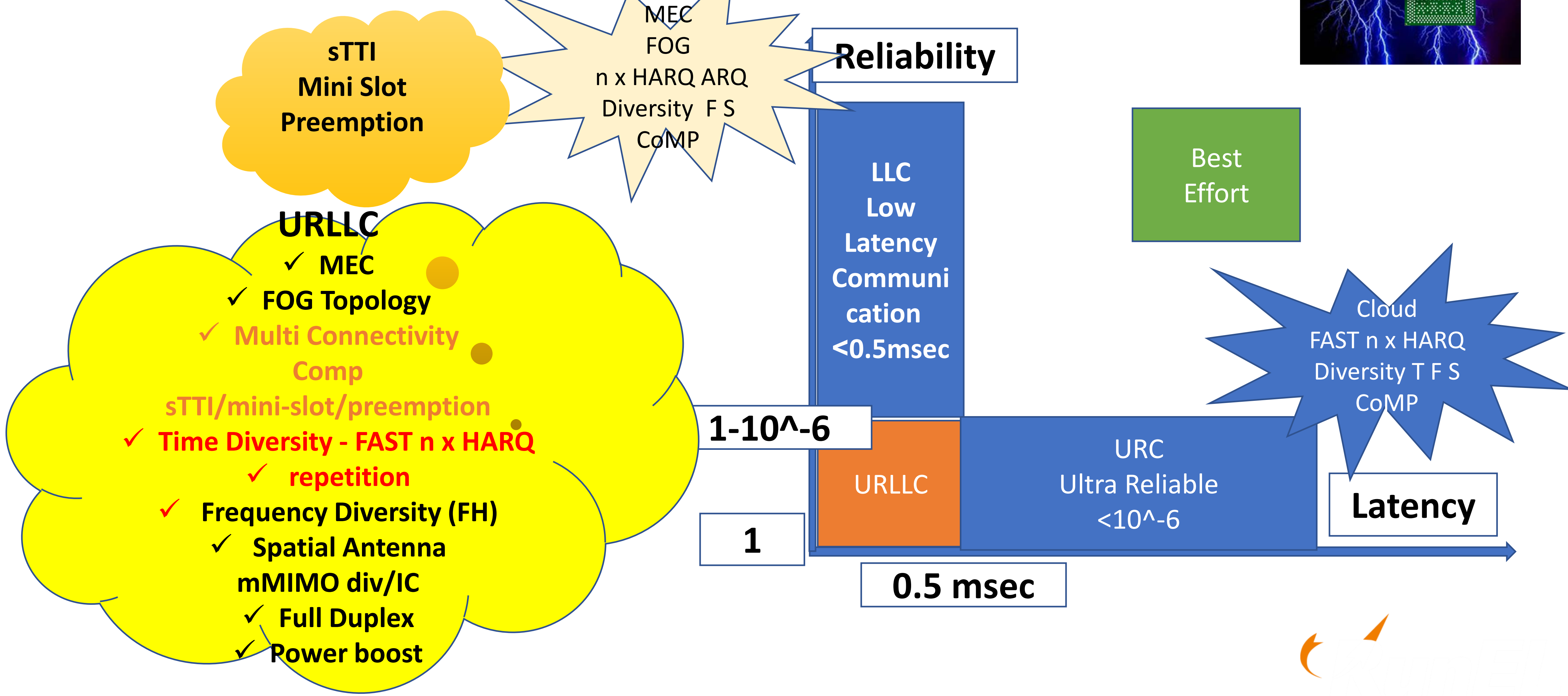

KunEL
• Sparq 2020

Figure 8: URLLC Example – Motion Control

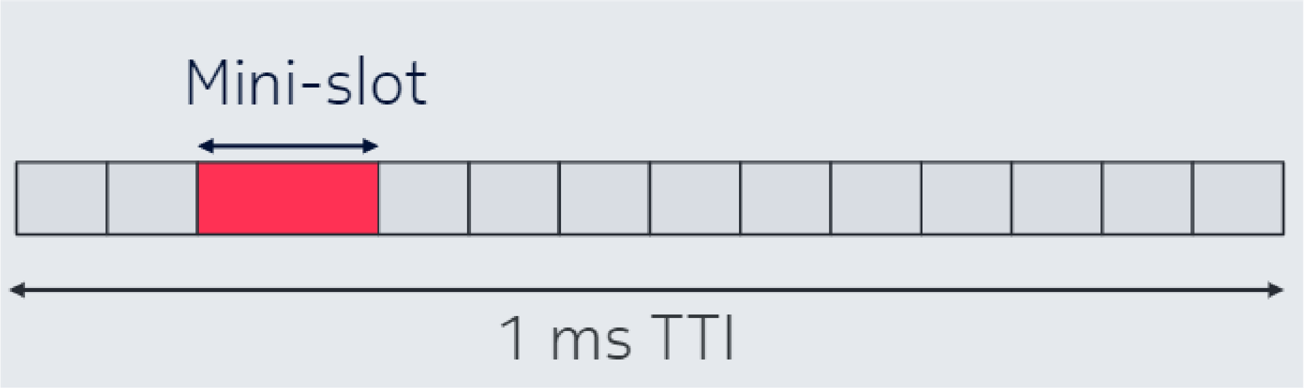


Source: Heavy Reading

Reliability, Latency , Data rate Considaration



5G Mini-Slot solution and use cases

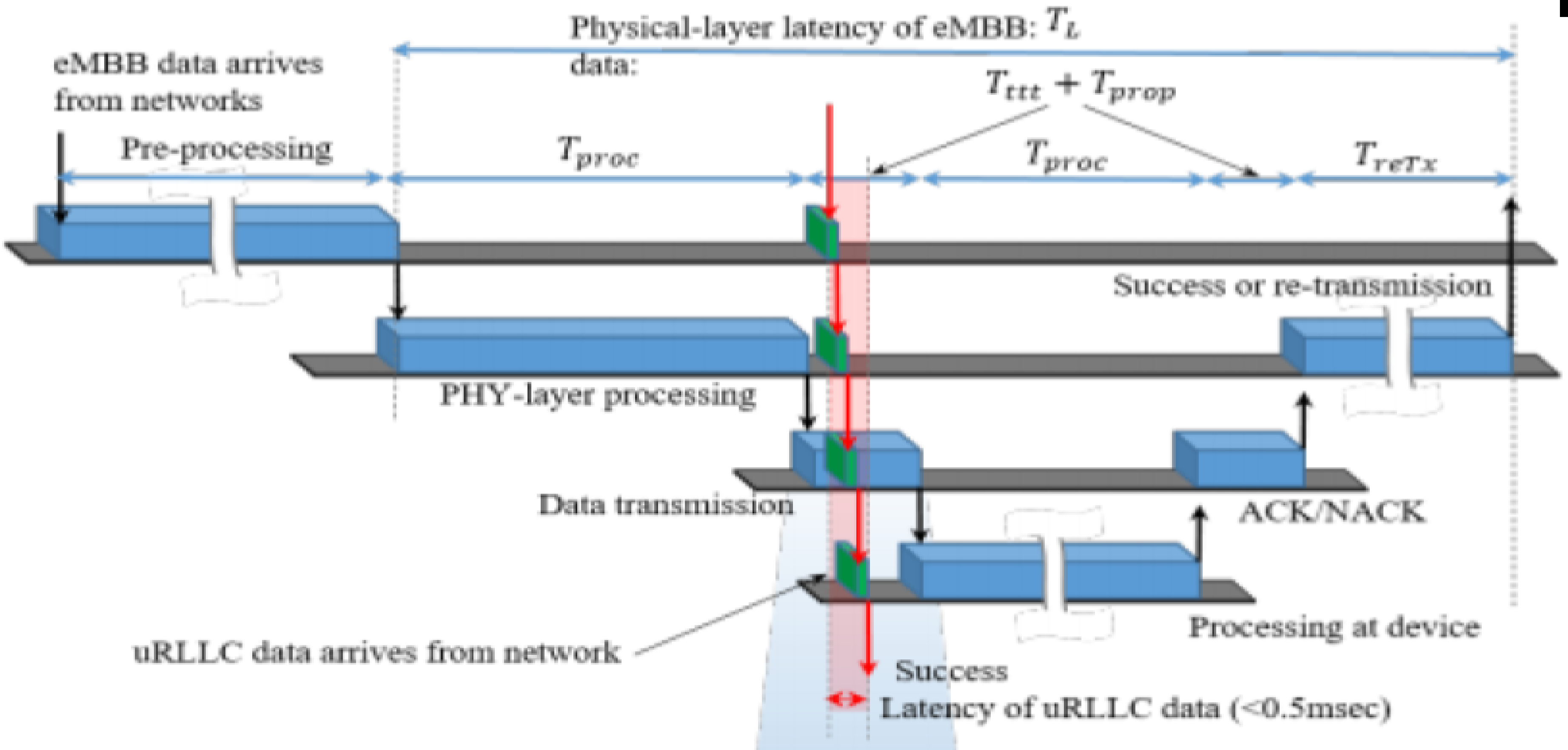


- Mini-slot is defined in 5G Release 15
- Mini-slot can overrun longer allocation to achieve low latency (punctured scheduling)

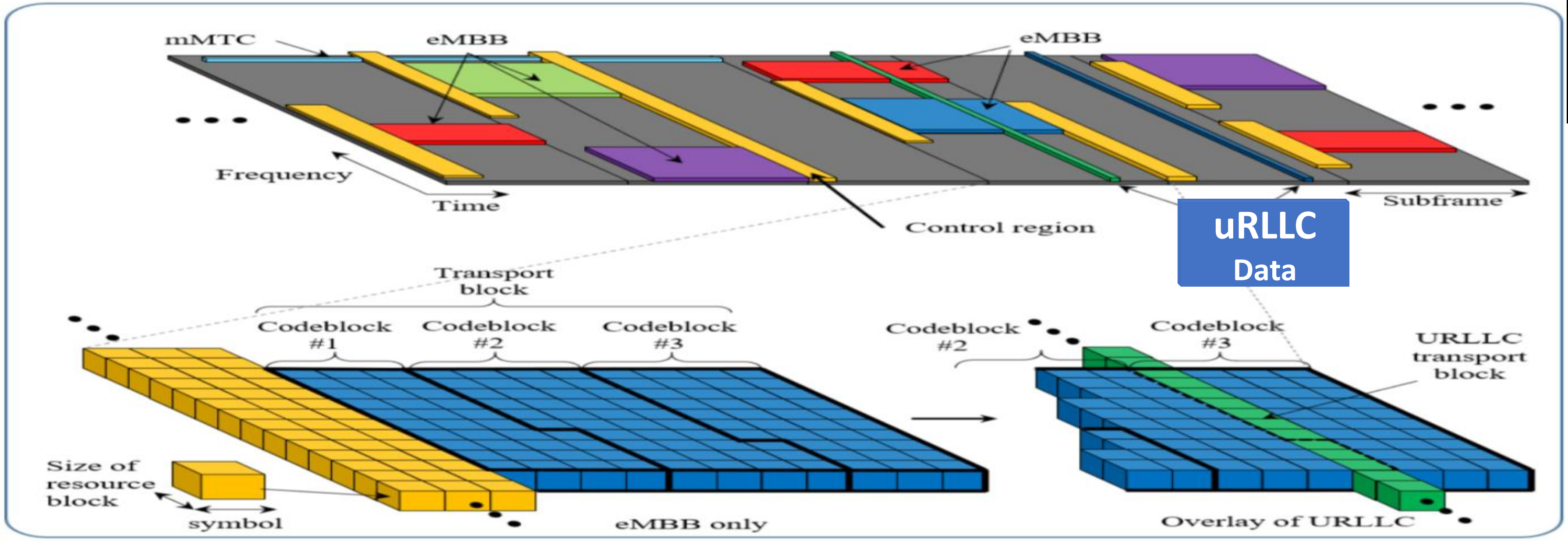
Use cases

- Low latency services to achieve 1 ms round trip time
- Shorter round trip time for mobile broadband
- Faster TCP ramp-up
- Time division multiplexing of small packets in analog beamforming

The Preemption



The Preemption OFDMA mapper

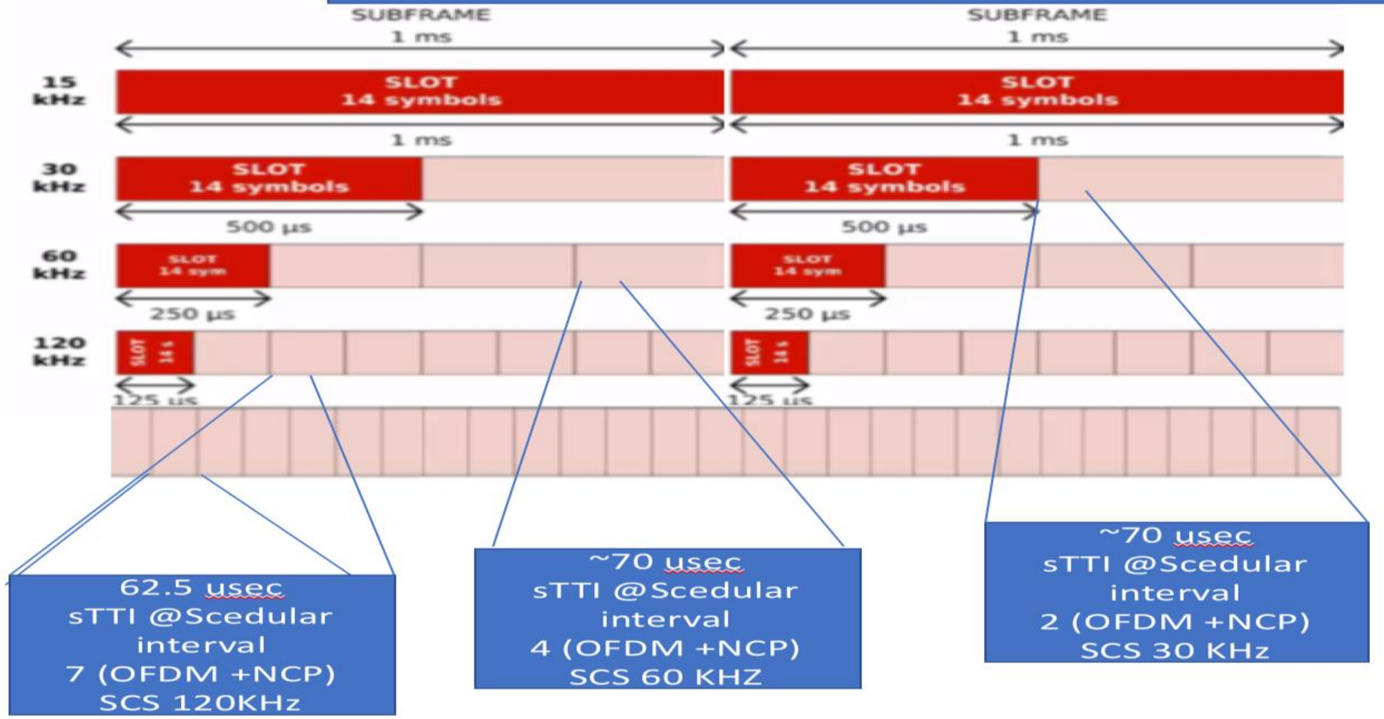


URLLC preempts broadband data transmission (credit: URLLC in Downlink)

Pros : enable good Virtualization to the Cloud mixed with solving URLLC delay problems.

- ✓ Cons - big # of PRB`s dropped for big video Packet in exchange for short URLLC message
- ✓ Confusion to Resolve overruns in the user side and in the Base. Create more URLLC control messages
- ✓ Need to Inform scheduled UL eMBB users not to transmit during URLLC UL Ack transmission .
- ✓ Jitters due to video message repeat with long delay
- ✓ Require Scheduler function Split between the Cloud and the edge and coordination for collision cases
- ✓ Required bigger memory size in the user and in the network.
- ✓ Limits the multi connectivity .

The sTTI Approach



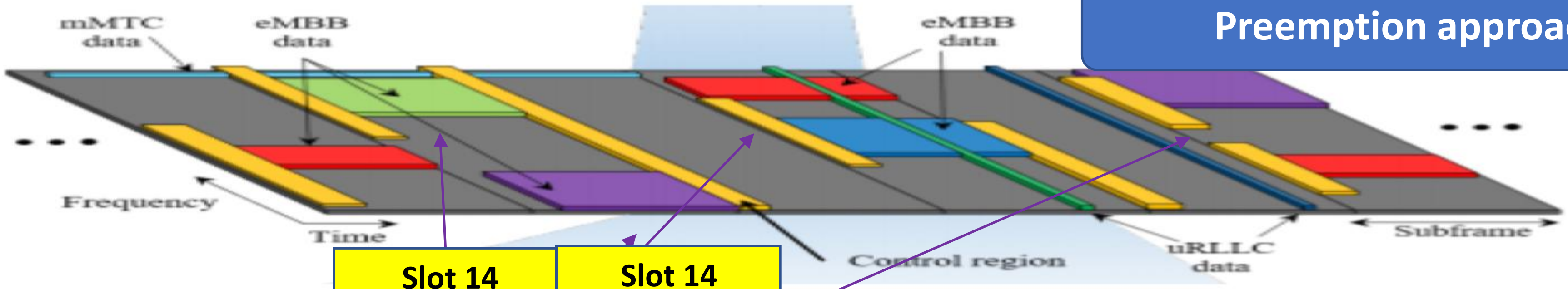
Waveform, Numerology and Frame Struc

- Frame: 10 ms
- Subframe: Reference period of 1 ms
- Slot (slot based scheduling)
  - 14 OFDM symbols
  - One possible scheduling unit
    - Slot aggregation allowed
  - Slot length scales with the subcarrier spacing
    - $Slot\ length = {}^{1\,ms}/_{2^{\mu}}$
- Mini-Slot (non-slot based scheduling)
  - 7, 4 or 2 OFDM symbols
  - Minimum scheduling unit

100 MHz example

# of OFDM Symbols.	STTI	SCS	# of RB OFDM	# of SC available per Scheduled STTI
14.	62.5u	240KHz.	275/8=~34.	34x12x14=5712
7.	62.5u	120.	275/4=~ 68.	5712.
4.	~70u	60	137	6576
2	~70u	30.	=~ 275	6600
1.	~70u	15.	=~ 550	6600.
14	LTE	15	100	16,800.

Preemption approach



Slot 14 OFDM

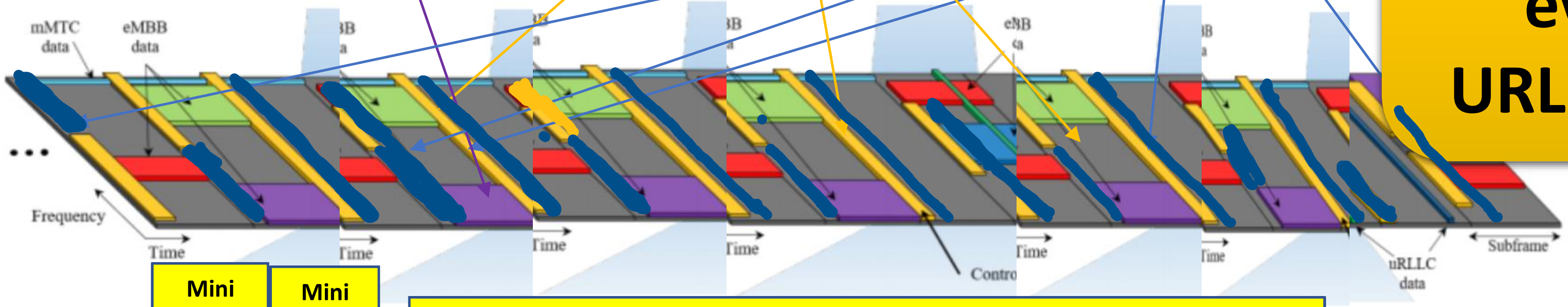
Slot 14 OFDM

eMBB data

PDCCH/ Corset

uRLLC Scheduled at start of STTI data

Short TTI/Mini Slots approach Scheduling every ~62.5u for URLLC, eMBB and IoT

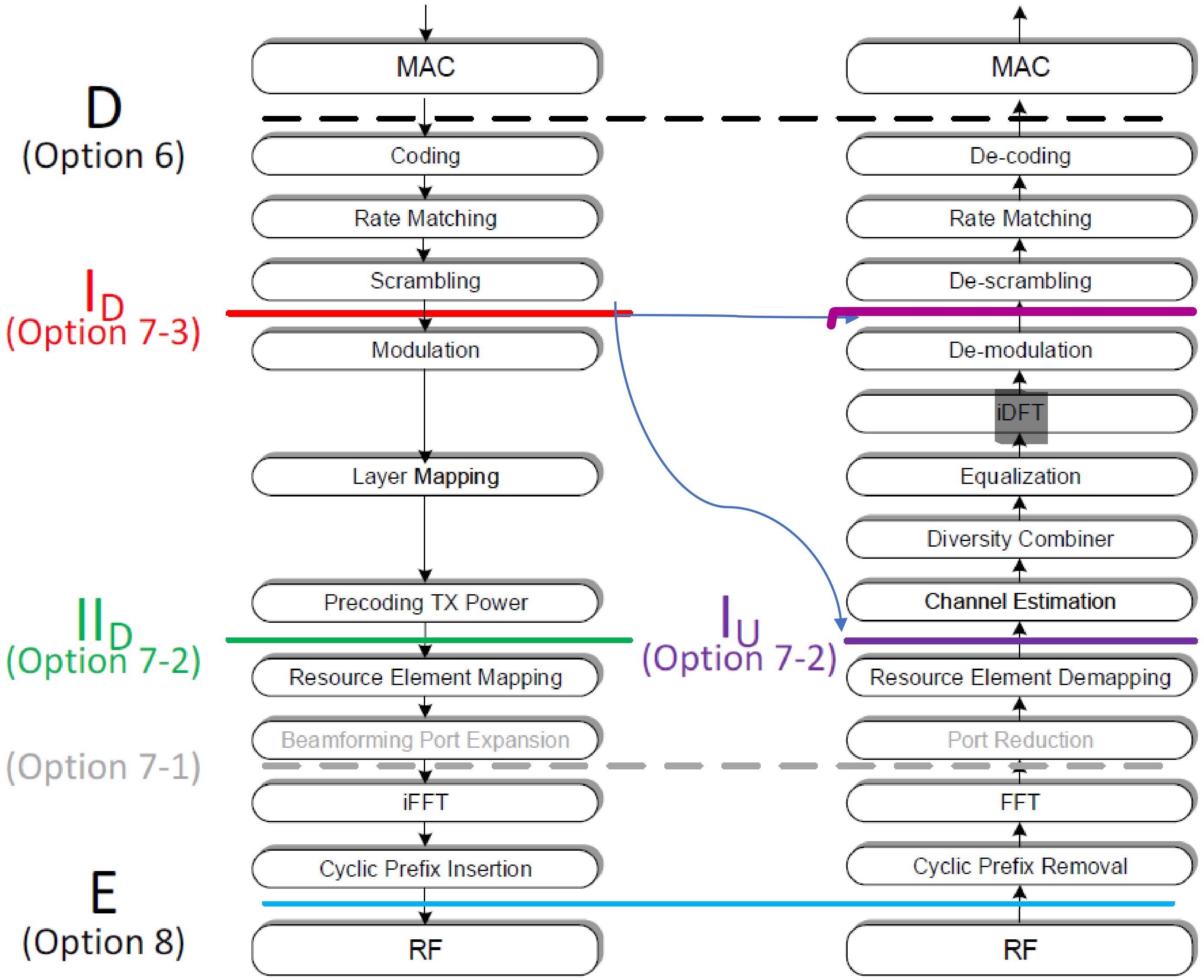


Mini Slot 7 OFDM sTTI ~62.5 usec

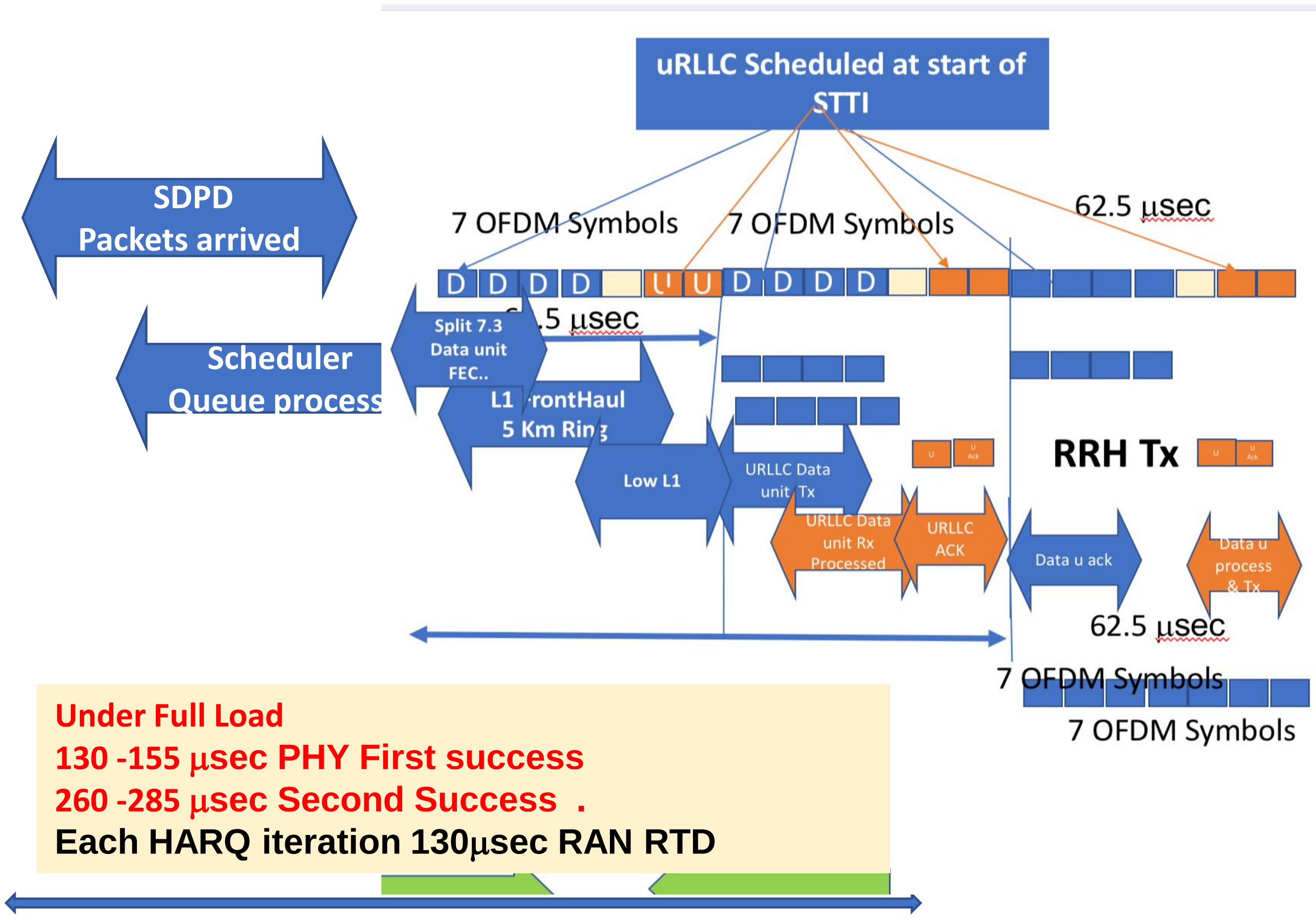
Mini Slot 7 OFDM sTTI

No Overruns Collisions
Basic RTD 100-150uS enable several HARQ

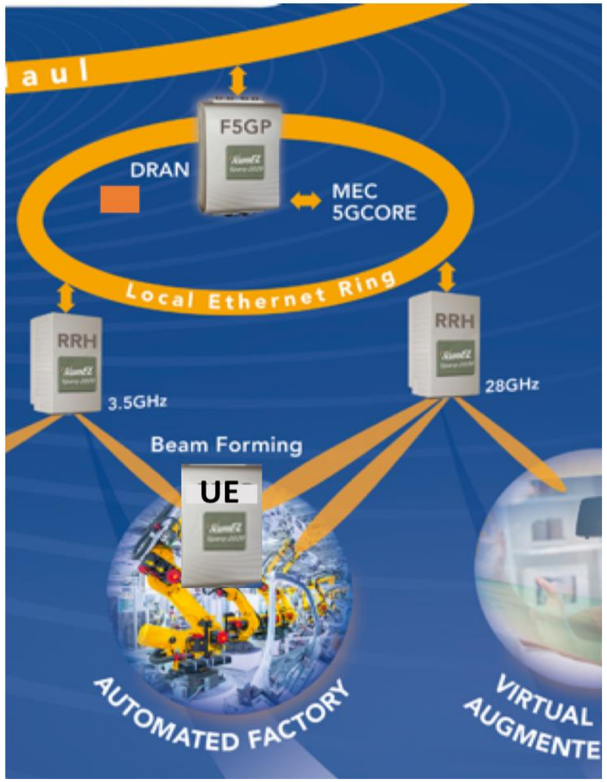
FrontHaul PHy Split (ORAN)



The 7 OFDM sTTI achieve Low Delay for all eMBB and URLLC and fast IoT

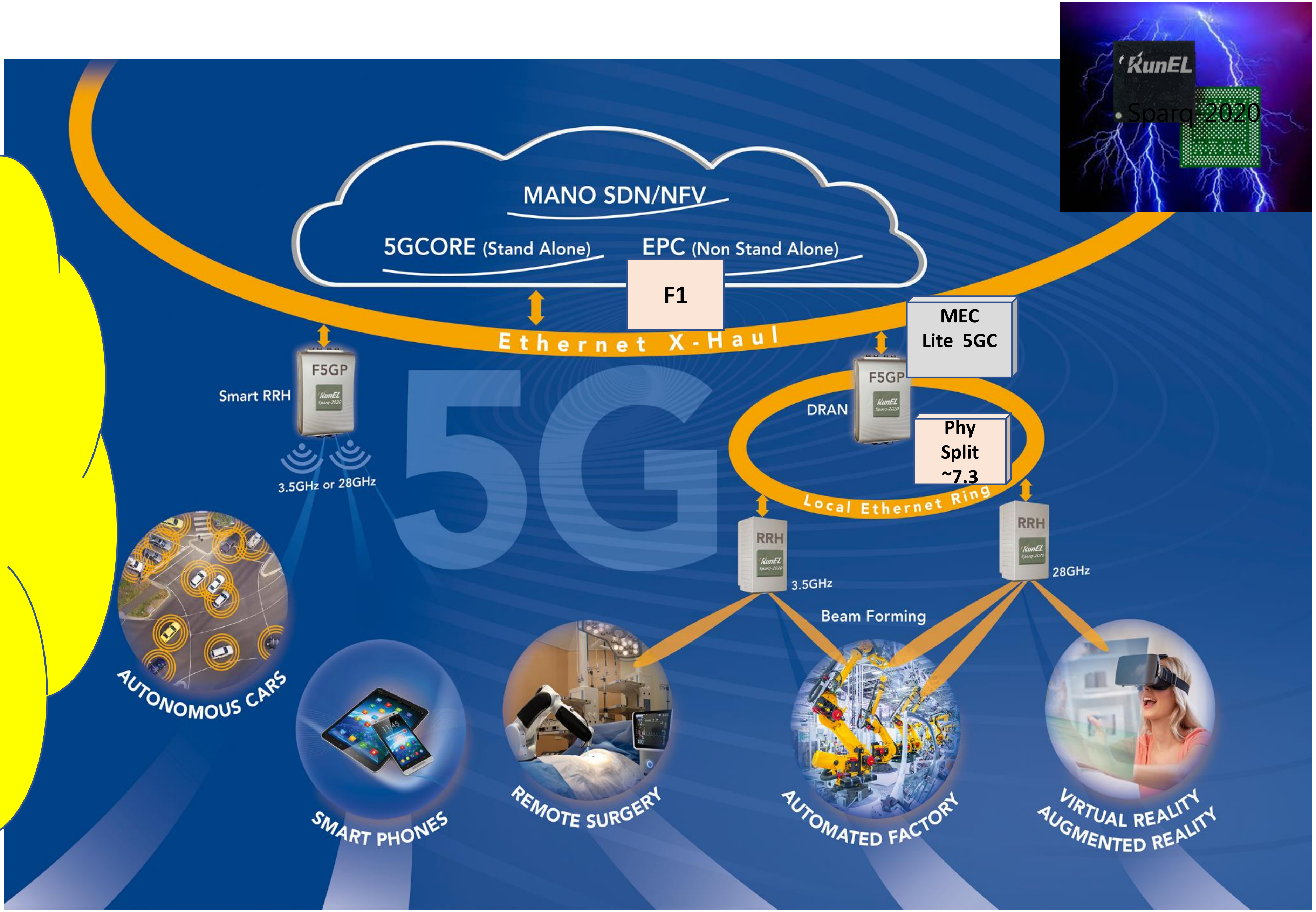


Under Full Load
130 -155 µsec PHY First success
260 -285 µsec Second Success .
Each HARQ iteration 130µsec RAN RTD

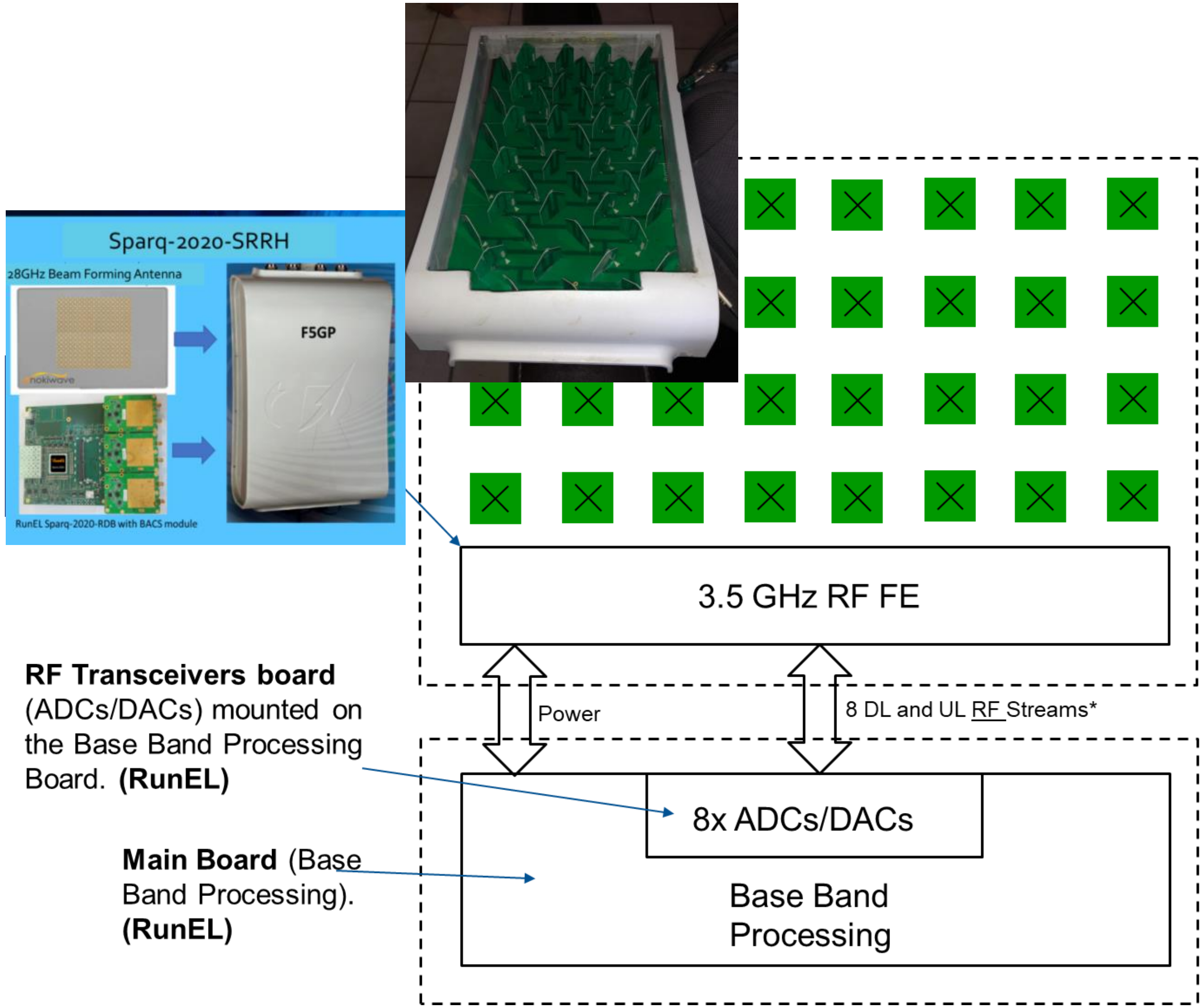


URLLC

- ✓ MEC
- ✓ FOG Topology
- ✓ sTTI
- ✓ Multi Connectivity Comp
- ✓ Time Diversity - FAST n x HARQ
- ✓ repetition
- ✓ Frequency Diversity (FH)
- ✓ Spatial Antenna mMIMO div/IC
- ✓ Full Duplex
- ✓ Power boost



RunEL` SPARQ Based sRRH



Block Diagram

Parameter	Requirements	Comments
Frequency Range	3.3-3.8 GHz	28 GHz
Channel BW	100MHz	200MHz (400MHz)
MIMO/MU-MIMO scheme	Support of up to 4 cross-pole spatial streams	16 streams
single cross pole Beam stream Throughput	1Gbps (@ 100MHz BW Full DL)	2 Gbps (4 Gbps)
Sub-carrier spacing's	15/30/60	60/120/240
Highest Modulation	256-QAM	256-QAM
Duplexing	TDD	TDD
Roundtrip Latency	< 0.5msec	using STTI
Transmit Patch power	1/8 W 32x2 Elements	4 mW 256x2 El
EIRP (12.5 x25 degree)	56 dBm for all in 1 Beam 50 dBm for 4 Eq Transmit power beams/Pattern	60 dBm for 1 Beam 48 dBm for 16 beams
Range LOS	> 10Km	> 200m

Main Specifications

Horizon-2020 – 5Genesis

5G KPI measurements in 5 European test beds: Malaga/Spain, Berlin/Germany, Surrey/UK, Limasol/Cyprus, Athens/Greece

www.5genesis.eu

The 5GENESIS project has received funding from the EU Horizon 2020 research and innovation programme under grant agreement No815178.

RunEL
NGMT-Next Generation Mobile Technology

RunEL Collaboration- IoRL

Internet of Radio-Light in Buildings – 5GPPP

IoRL Internet of Radio Light

https://iorl.5g-ppp.eu/

This work has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 761992, project IoRL. This presentation RunEL view only, and the Commission is not responsible for any use that may be made of the information provided.

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RunEL is a partner in HERON Consortia 2016-2019

For 5G and beyond Next Generation

Heron focus is on 5G and beyond research, aiming at innovative solutions and contributions to the world wireless community

14 Companies
6 Universities

Partner

13

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Thank you!
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