5G 2.0: Evolving the URLLC Use Case

From Design – Prototyping – Test

James Kimery

Director of Wireless Research

NI 5G Lead User Program has enabled critical research since 2010

NI and 5G

1st 100 antenna Massive MIMO

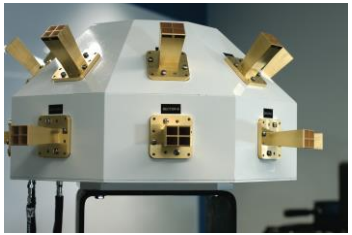
Bristol: Spectrum Efficiency Record
BT Field Trials

Verizon 28 GHz

1st Field Trial w/ KDDI

Nokia: 1st E-band demo
10 Gb/s OTA

Nokia: 15 Gb/s OTA. New Record!



AT&T: World's Fastest Channel Sounder

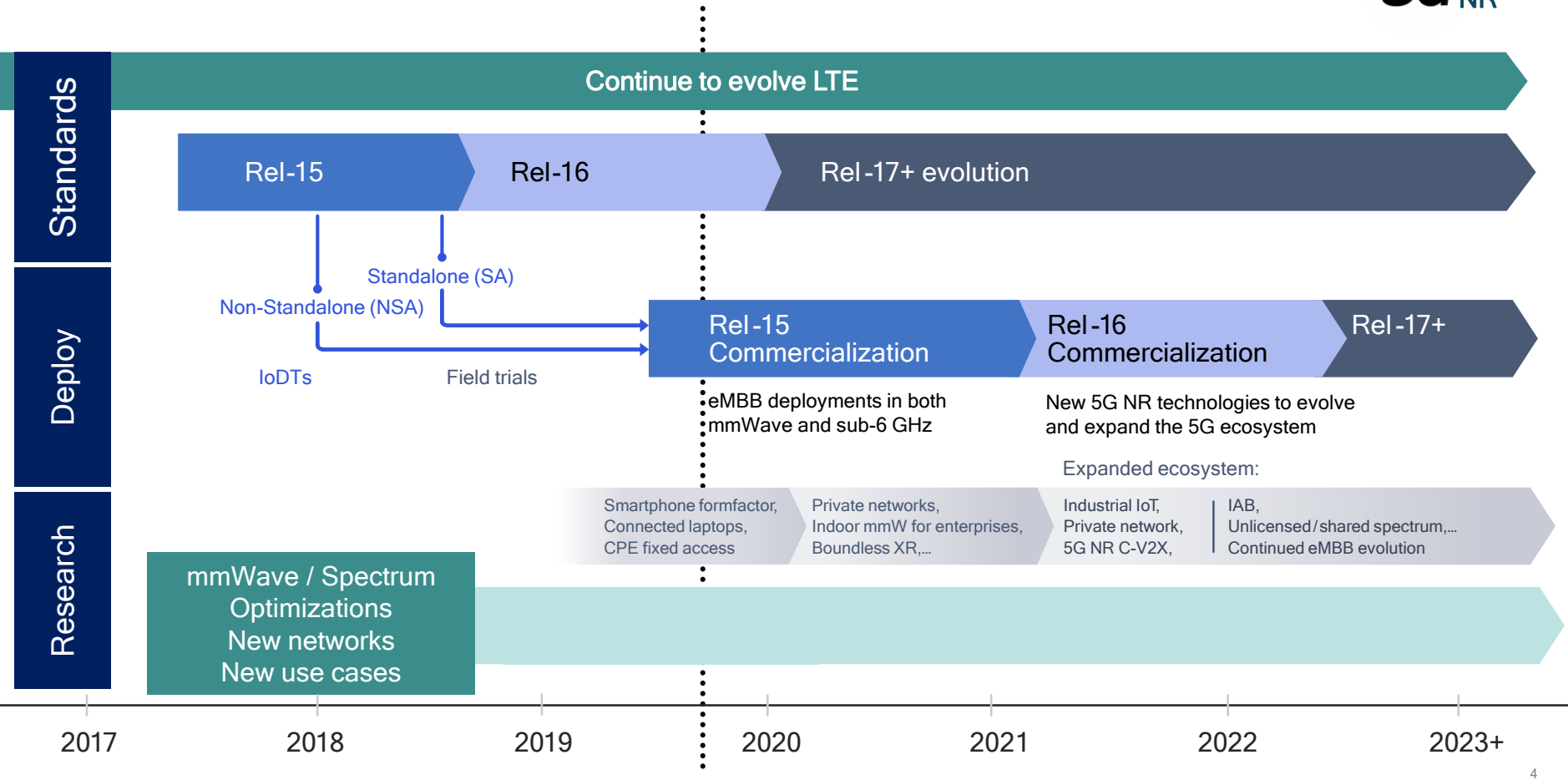
Prof. Ted Rappaport

Samsung: 1st FD MIMO demo

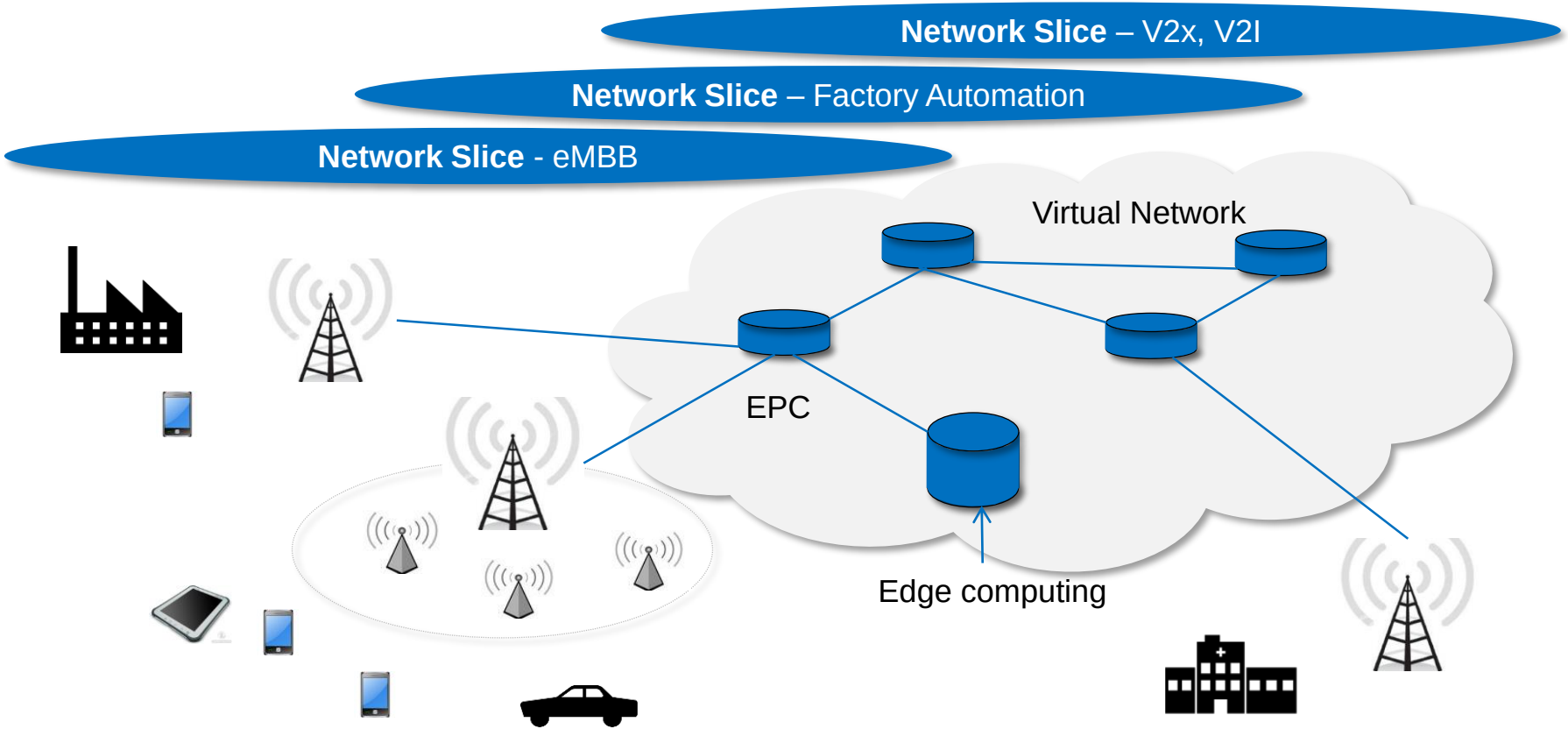
World's 1st Real-time GFDM system

1st CRAN Massive MIMO

3GPP 5G Timeline



Network Optimizations



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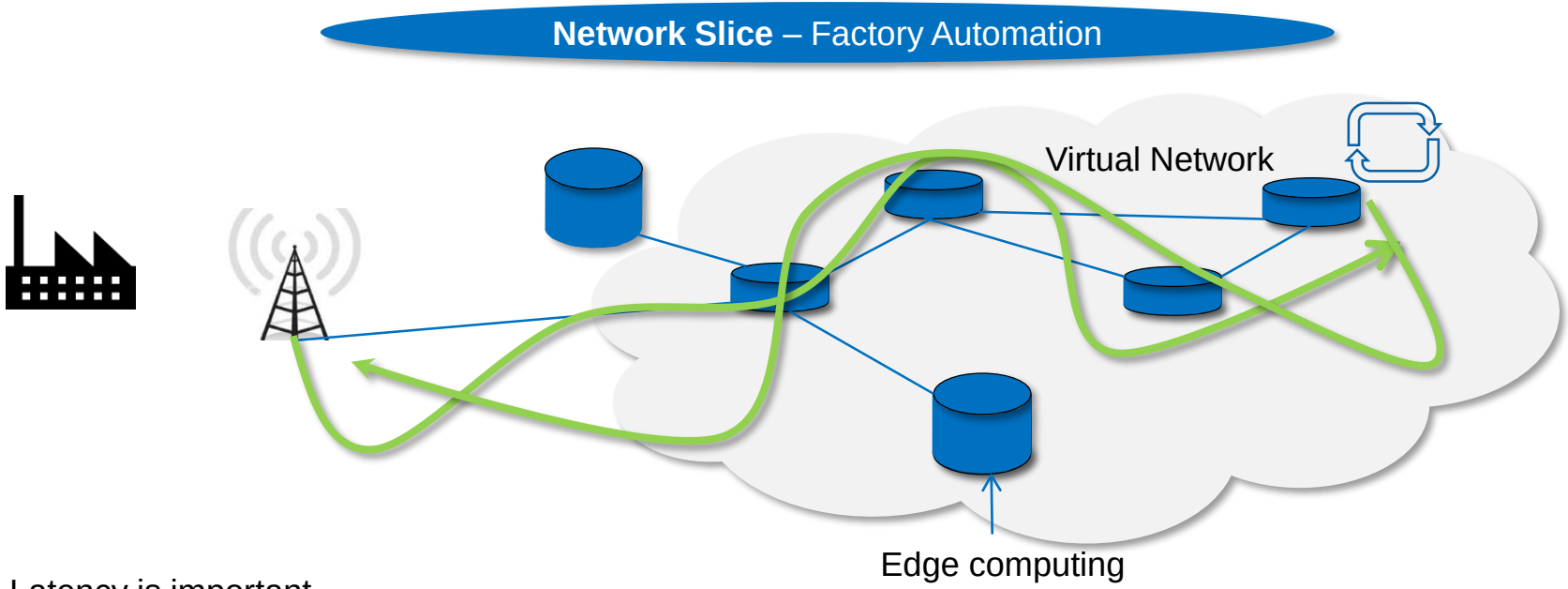
URLLC: Ultra-Reliable Low Latency Communications

IIoT Manufacturing



Latency is important
But the control topology may be more important
E2E latency is the roundtrip time

What is the E2E Latency?

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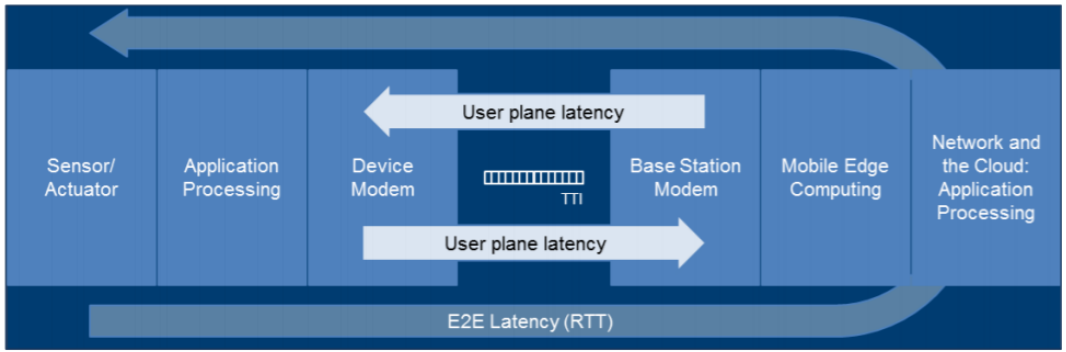
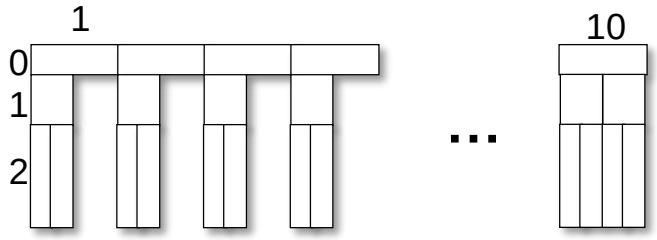
URLLC: Ultra-Reliable Low Latency Communications

MAC/PHY Perspective

- Flexible numerology
- Grant-free transmissions
- Optimized DCI / UCI formats
- Mini-slots
- Repetitions





SCS	Slot Duration	Symbol Duration (us)
15 kHz	1000 us	71.43
30 kHz	500 us	33.33
60 kHz	250 us	17.86
120 kHz	125 us	8.93

3GPP Rel 15 provides the framework for lower latency

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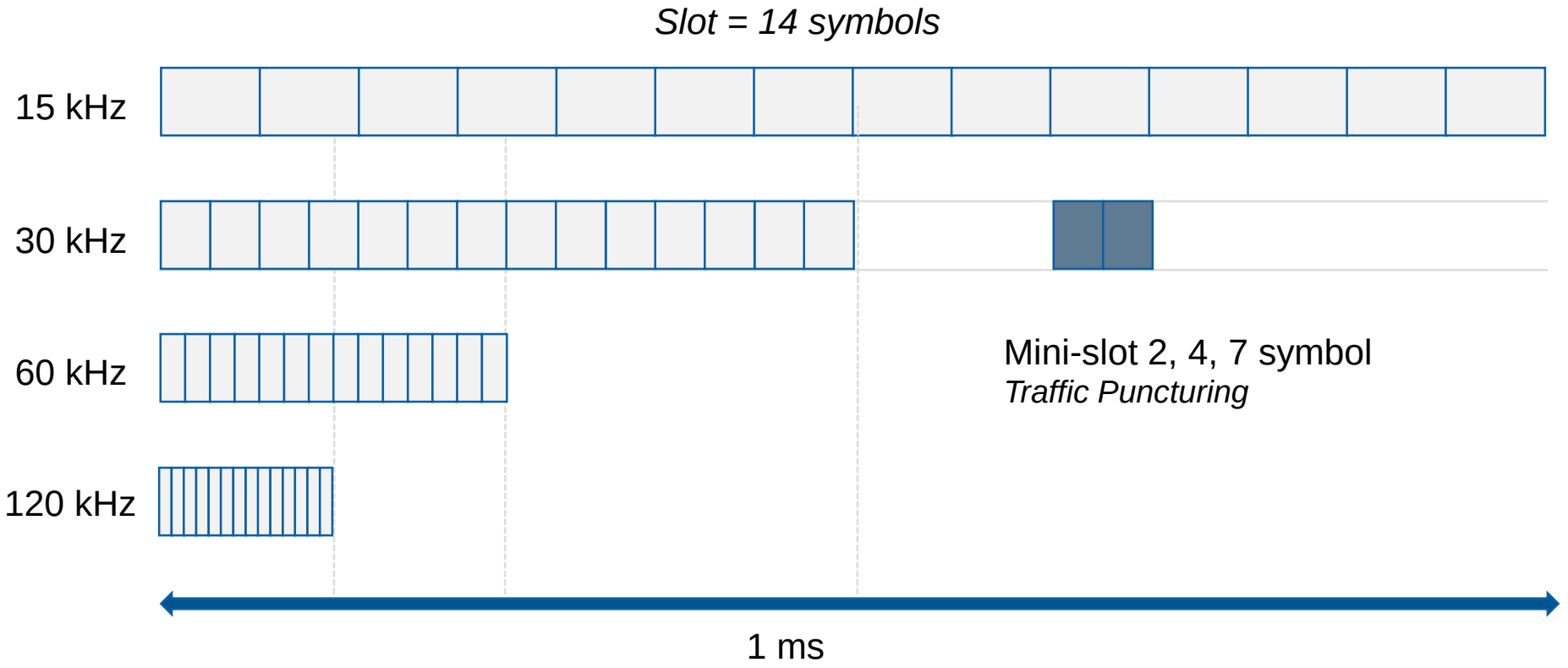
Slot Structure and Timing



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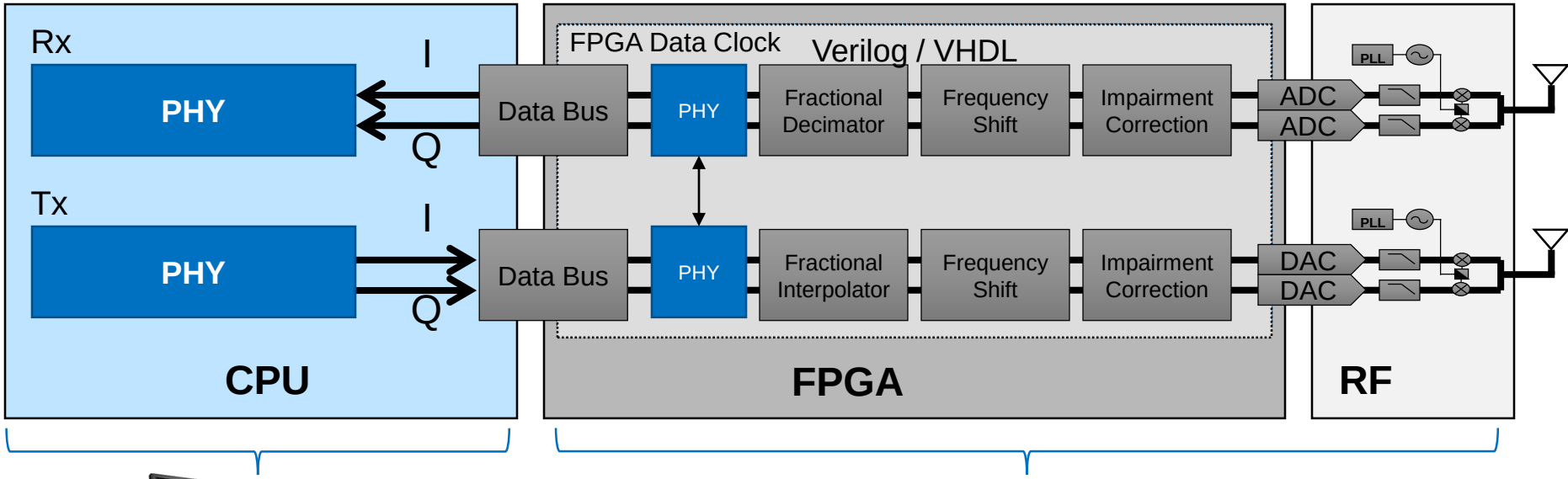
Mini-slots Impact on Timing

Symbols per slot			14	7	4	2
SCS	Symbol Duration (us)	Slots / Frame	Slot Duration (us)	Slot Duration (us)	Slot Duration (us)	Slot Duration (us)
15 kHz	71.43	10	1000	500	285.72	142.86
30 kHz	33.33	20	500	250	133.32	71.43
60 kHz	17.86	40	250	125	71.44	35.72
120 kHz	8.93	80	125	62.5	35.72	17.86
240 kHz	4.46	160	62.5	31.25	17.84	8.93

4G and Prior Signal Processing Architectures



CPU

SDR

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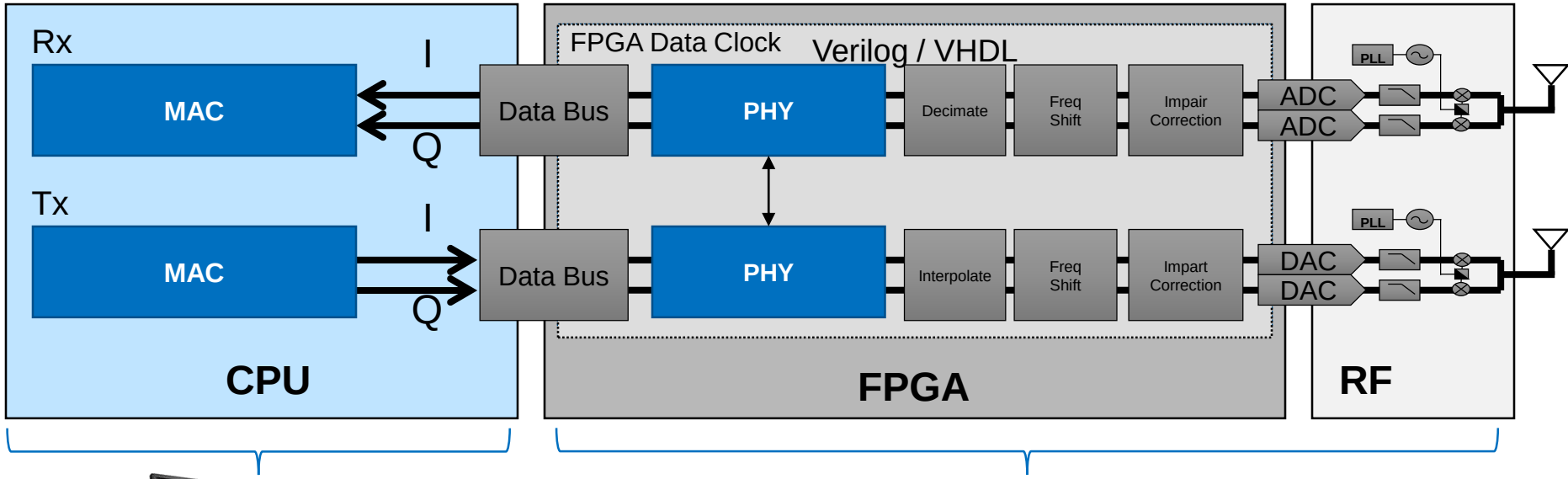
5G Requires Partition Shift – FPGAs Essential



CPU

SDR

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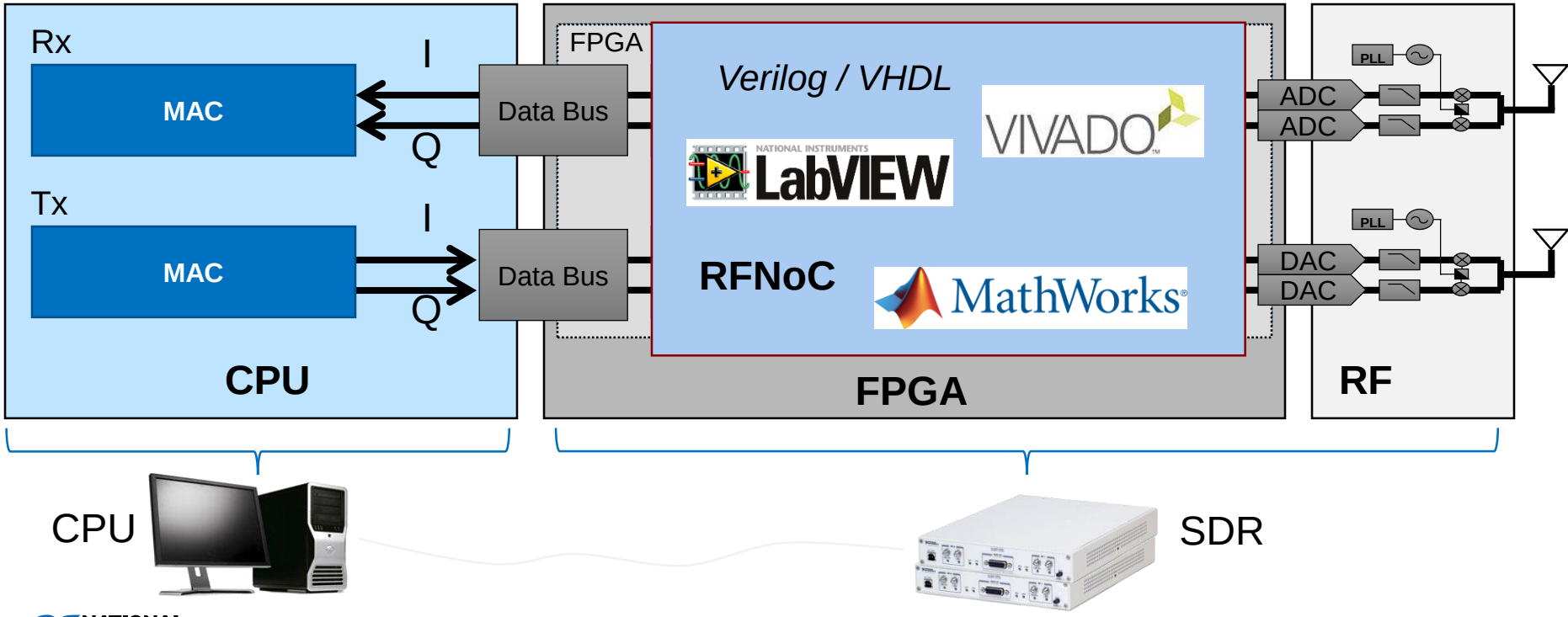
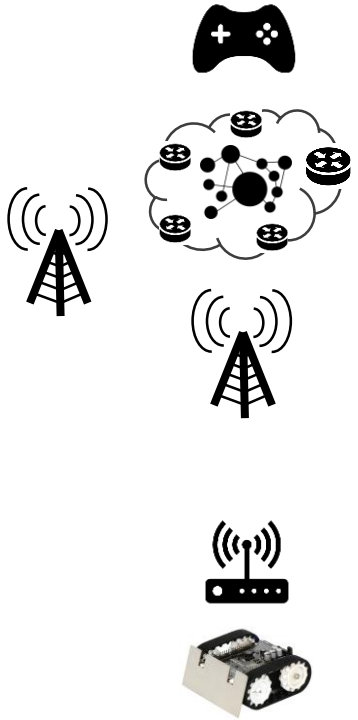
Tools are Very Important to 5G



NI Perspective: Tools, Hardware, and IP



Application

Core Network

Layer 3

Layer 2 / MAC

Layer 1 / PHY

ABB

RF

LabVIEW Comms based MAC

Flexible protocol stack Options

L1-L2 API

NI AFW PHY

NI SDR/RF HW

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NI Driving 5G 2.0

New Applications	New Spectrum	Optimizations	Diverse Deployments
eMBB mMTC **URLLC**	mmWave TeraHz Unlicensed Re-farming LTE	Power Reliability Latency Efficiency Coverage	Disaggregation of the functional elements of the RAN ORAN NFV SDN MEC

3GPP Compliant PHYs – highly capable

Open Source Compatibility

High performance, flexible, FPGA based Platforms

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