

5G

What to expect and where to start

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Outline

Why

The human possibilities of 5G

What

5G key technologies

When

5G success factors

Nokia

Geared to lead in 5G

How 5G will blend into everyday's life

Is it possible to coordinate millions of sensors in a cell?

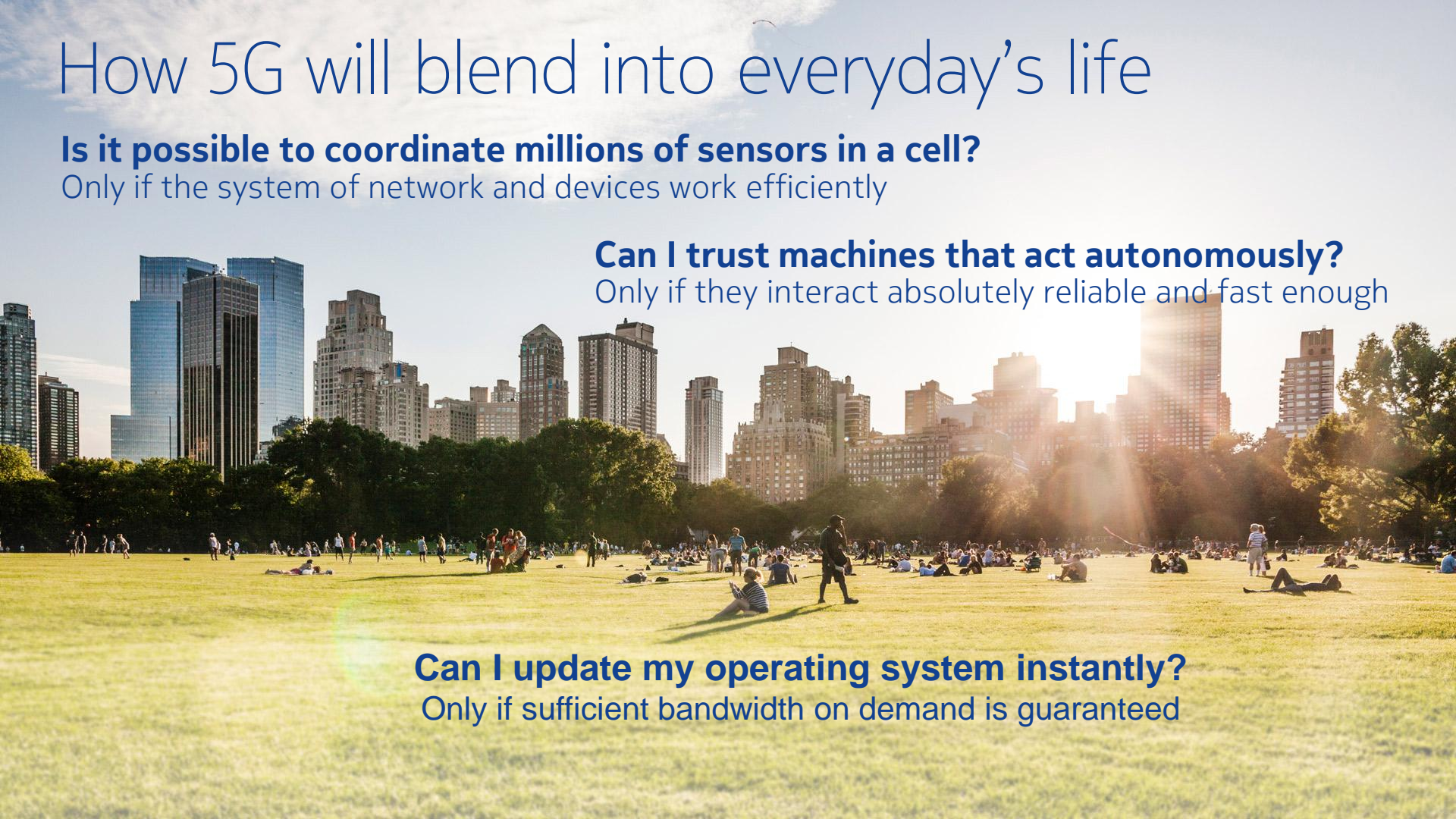
Only if the system of network and devices work efficiently

Can I trust machines that act autonomously?

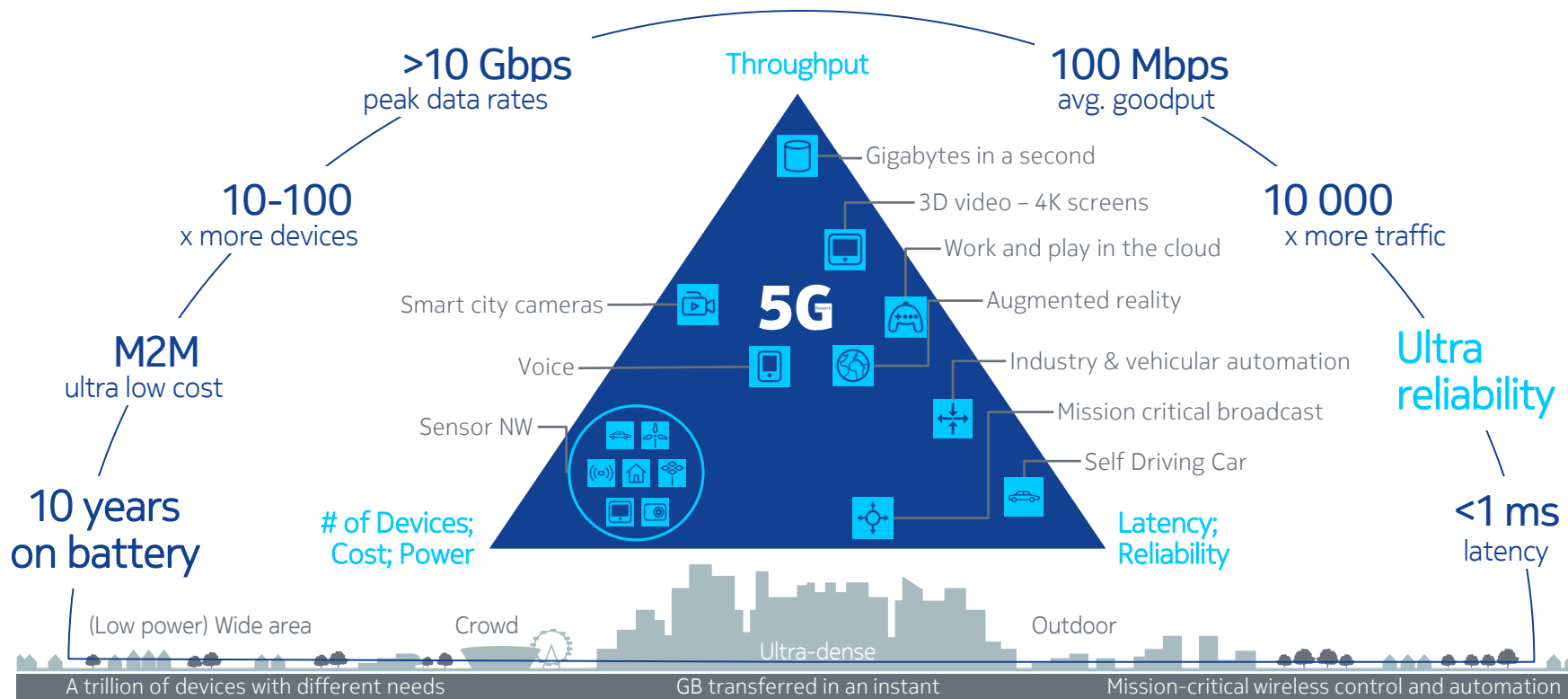
Only if they interact absolutely reliable and fast enough

Can I update my operating system instantly?

Only if sufficient bandwidth on demand is guaranteed



5G will expand the human possibilities of the connect world



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What 5G is NOT

Myth #1

5G = millimeter wave only



Myth #2

5G = utilizes above 6 GHz only



Myth #3

5G = will use totally new access



Myth #4

5G will be fully specified by 2018



What 5G is ...

5G might have one UDN access technology leveraging mmW to complement other lower band wide area/cellular access technologies

5G will use existing and new IMT spectrum below 6 GHz as well as above 6 GHz (WRC2019)

5G is expected to leverage OFDM and cyclic-prefix single carrier for best massive-MIMO and beamforming support as well as cost and energy efficiency

3GPP 5G releases 14 and 15 last into 2018/19
World Radio Conferences takes place in 2019
IMT process for “5G” runs till 2020.
First commercial 5G deployments in 2020

5G system vision

A symbiotic integration of novel and existing access technologies

5G Wide area deployments

Scalable service experience anytime and everywhere

4G 'massive mobile data and M2M'

3G 'voice, video and data'

2G 'high quality voice and M2M'

Wi-Fi 'best effort data'

Fixed access

Zero latency and GB experience – when and where it matters

5G Ultra dense deployments

Architecture

For end user:

5G will provide ubiquitous connectivity as well as high and consistent user experience

Unified solution

For operator:

a tight integration enabling simplified network mgmt of the whole access portfolio and gradual introduction of 5G

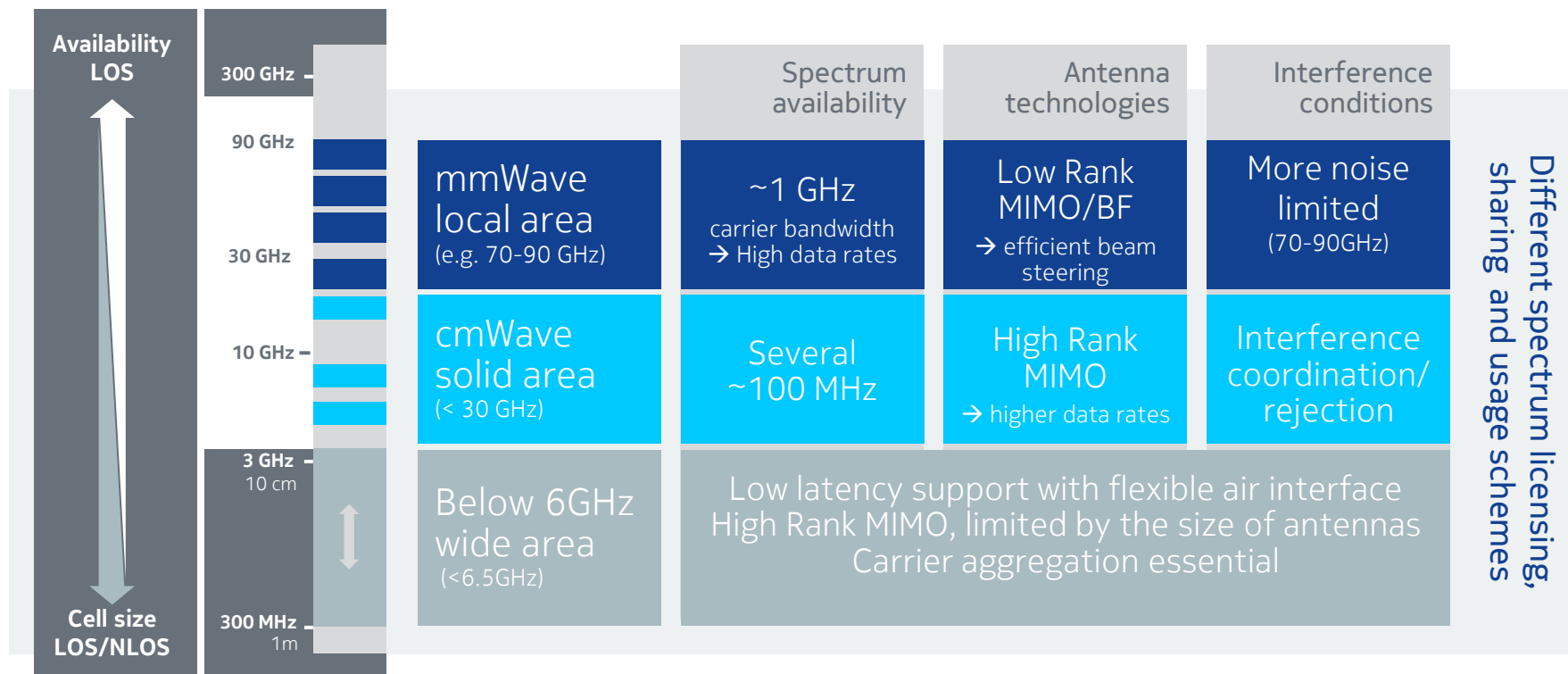
Integration enabling seamless user experience and efficient operation with cloud and SDN technologies as underlying principles

5G technologies under study

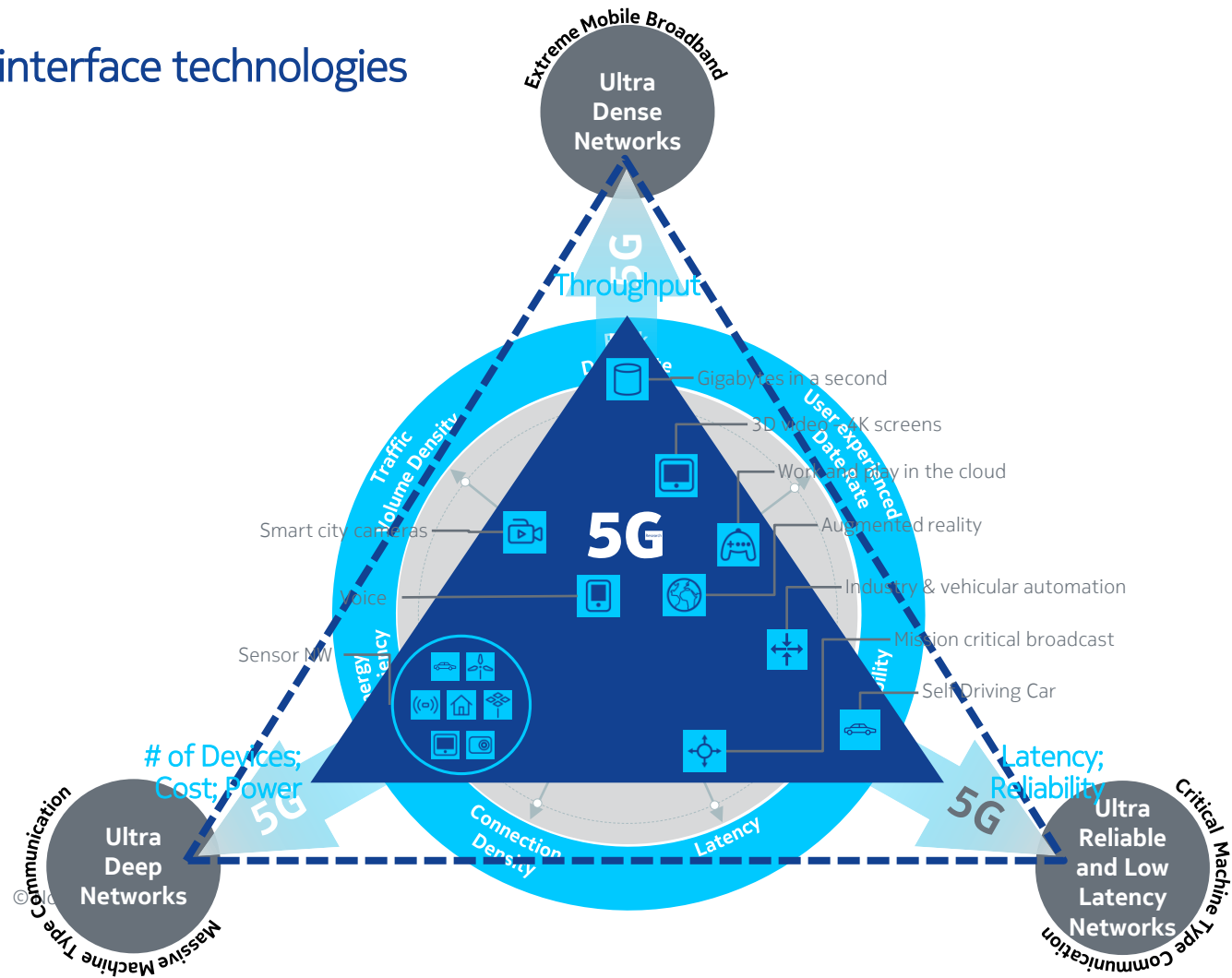
Spectrum access and efficiency	<p>Massive MIMO and massive beam forming</p> <p>3...6 GHz: Spectral efficiency (MIMO), >> 6 GHz more about path gain (BF)</p>	<p>Centimeter-Wave and Millimeter-Wave</p> <p>Spectrum access, for dense deployments</p> 	<p>New waveforms and modulations</p> <p>Must be justified by gains, compatibility with MIMO essential</p>	Reliability – Flexibility – Scalability	
	<p>Multi-RAT integration</p> <p>5G is integrating novel and existing radio access technologies</p>	<p>Radio virtualization</p> <p>Parts of radio will be virtualized, need for specialized L1 HW may still persist</p>	<p>Flexible Networking</p> <p>Local gateway/services Per-service tailored feature set (mobility, QoS, latency etc.)</p>		

5G is to optimize below 6 GHz access and enable above 6 GHz access

Expanding the spectrum assets to deliver capacity and experience



5G radio interface technologies



5G technology summary

- 1 Spectrum (below and above 6 GHz)
- 2 New tailored Radio Interface Technologies
- 3 Optimized for low latency, reliability and throughput
- 4 Architectural evolution with multi-technology integration
- 5 Design for Flexibility, Reliability and Scalability

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What is needed to make 5G a true global success?

Growth and Enabler of societal innovation

Flagship of
Digital Agenda

Cross region
collaborative
research and
pre-consensus

Market driven
competition and
consolidation

Legislation on
Net Neutrality

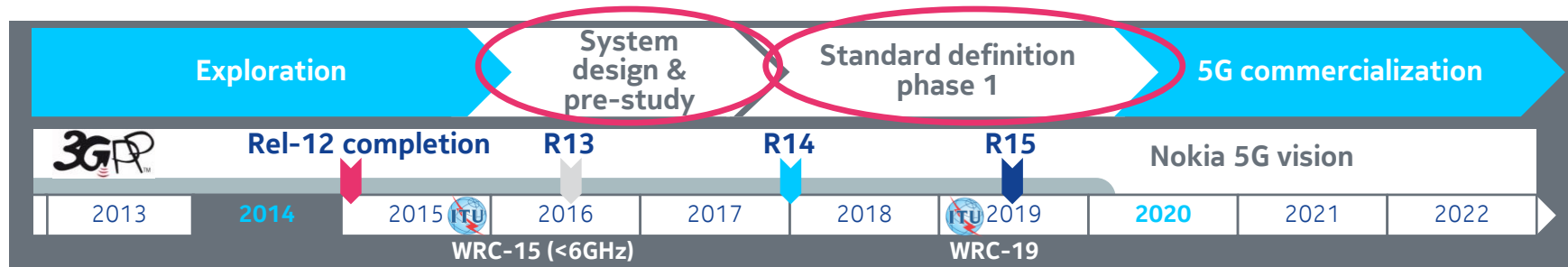
Drive global
standardization

More globally
harmonized
spectrum
(for LTE and 5G)

Data Protection
for information
centric networks

Fair rules for
standard
essential patents

5G from research to standards



Release 13: Clean LTE-A evolution release
5G research progressing outside 3GPP

Release 14: The 5G study phase
leading to Rel-15 work item phase

Release 15: The first phase of 'The Real 5G';
completion between 2018 and 2020

“5G starts early 2016 in 3GPP
with Release 14 and then into
Release 15”

“ITU-R processes for IMT2020
run in parallel in close synch”

Note: Future 3GPP release timing uncertain

Success factors

Summary

- 1 Pre consensus building among players during explorative research and requirements phases.
- 2 Global regulatory approach and aim for harmonized spectrum incl. its timely availability.
- 3 Focused standardization in 3GPP without reducing attention and bandwidth for LTE work.
- 4 Early sharing of technology feasibility and evaluation results to avoid design at the €dge.



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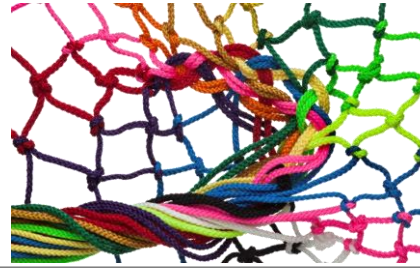
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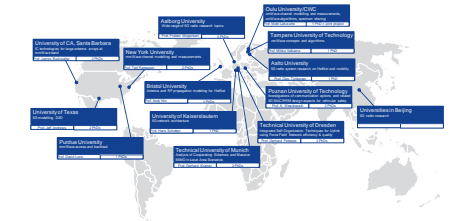
"If you want to go fast, go alone but if you need to go far, go together"

NOKIA

- Collaborative research
e.g. 5G PPP, 863 5G
- Customer collaborations
e.g. DOCOMO, CMCC, ...
- Drive regulatory and industry work e.g. ITU-R



- University collaborations
e.g. NYU, TUD, Aalto etc.
- Holistic systems research,
prototyping & development
- Leverage One Nokia e.g.
Technologies and HERE



Q&A