

**NOKIA**

5G

What to expect and where to start

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# How 5G will blend into everyday's life

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

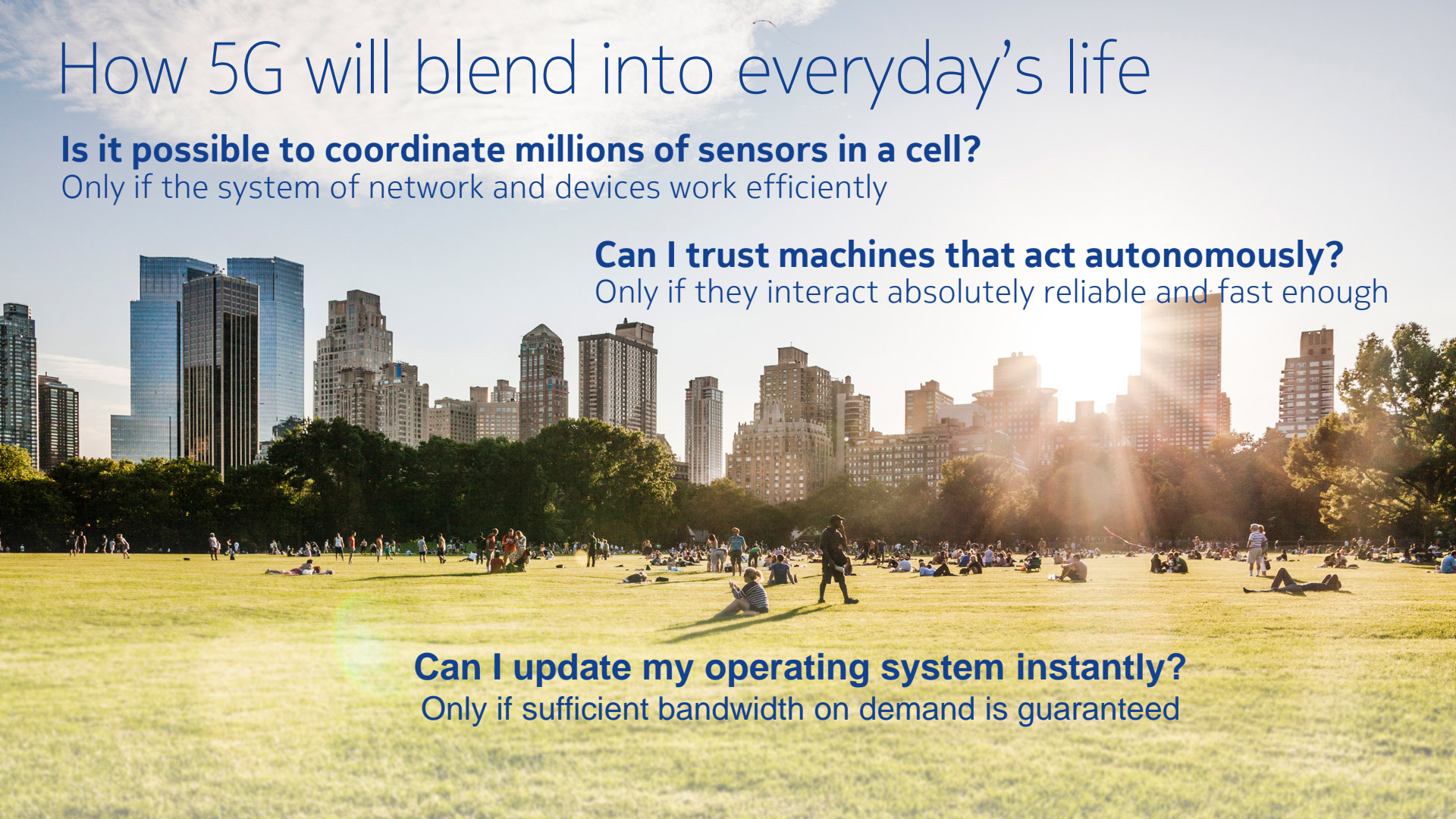
Only if the system of network and devices work efficiently

**Can I trust machines that act autonomously?**

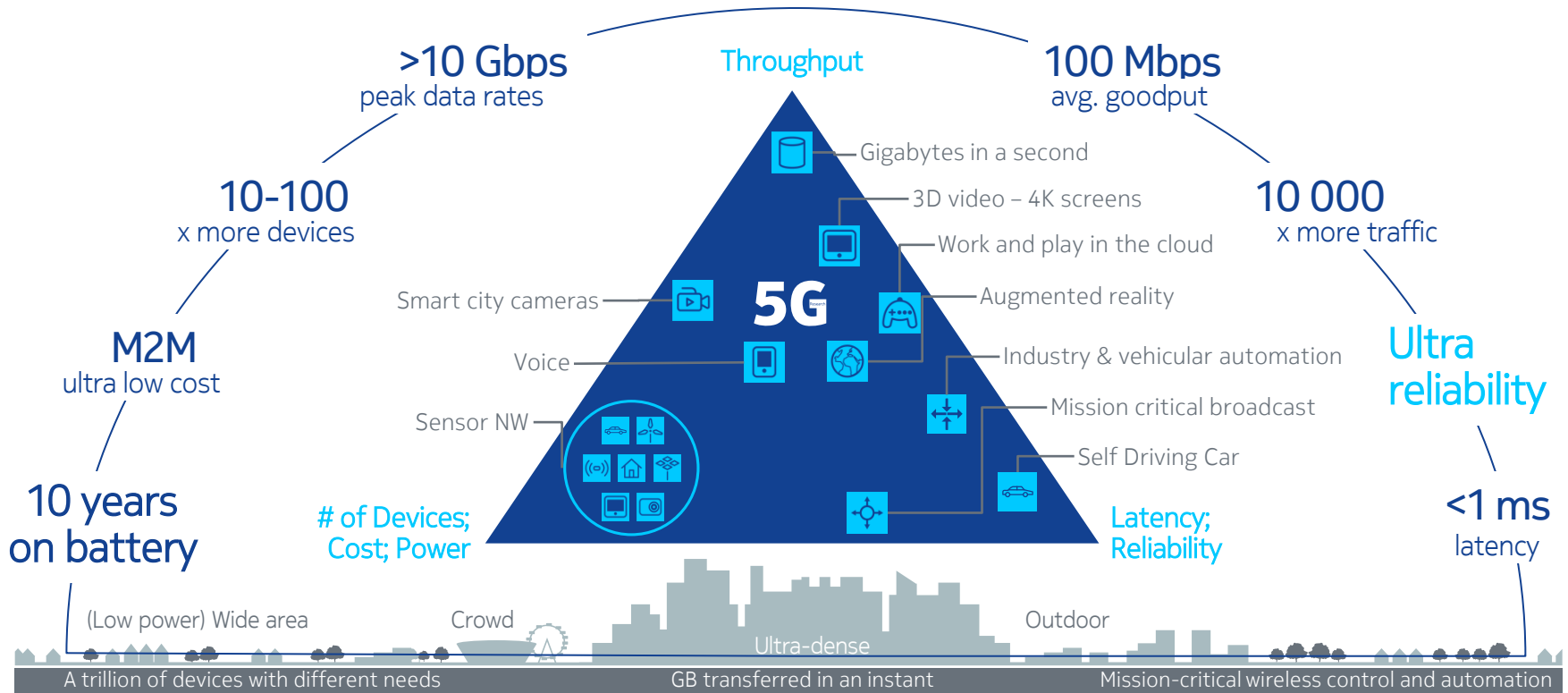
Only if they interact absolutely reliable and fast enough

**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



# 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

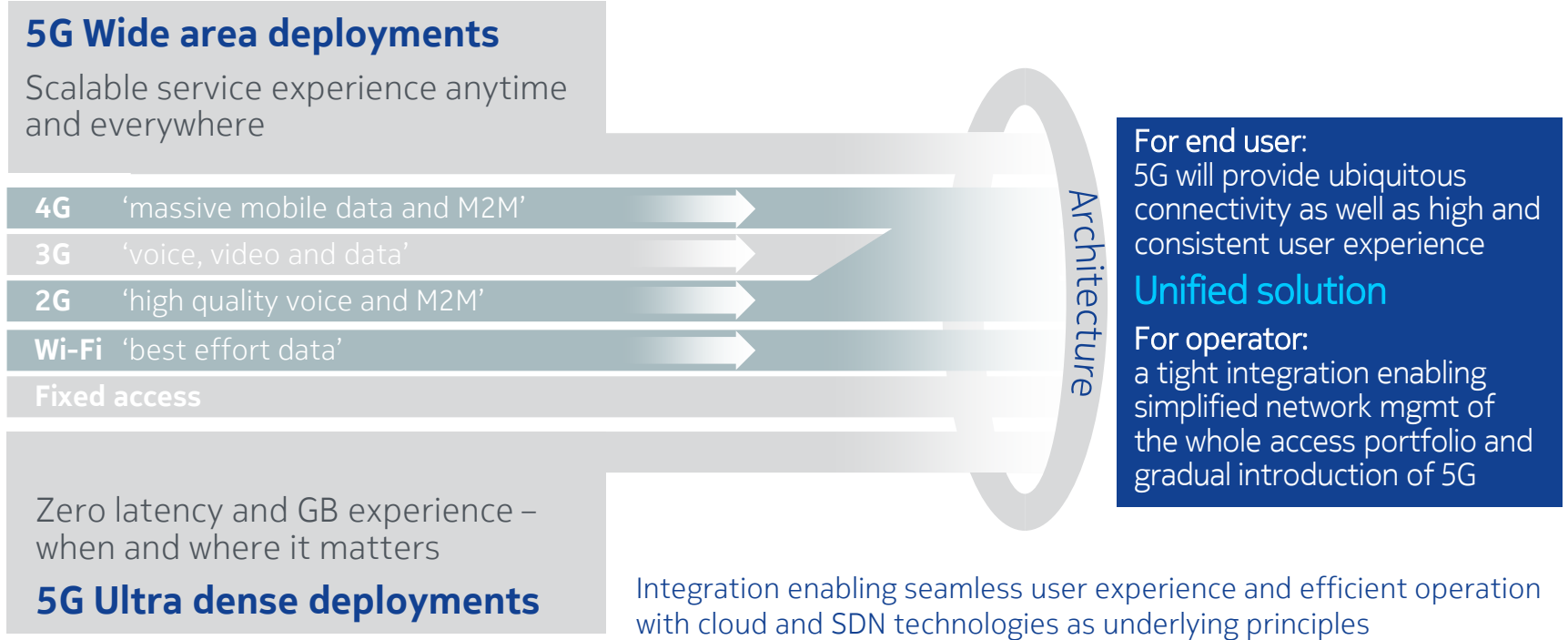
5G will use existing and new IMT spectrum below 6 GHz as well as above 6 GHz (WRC2019)

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

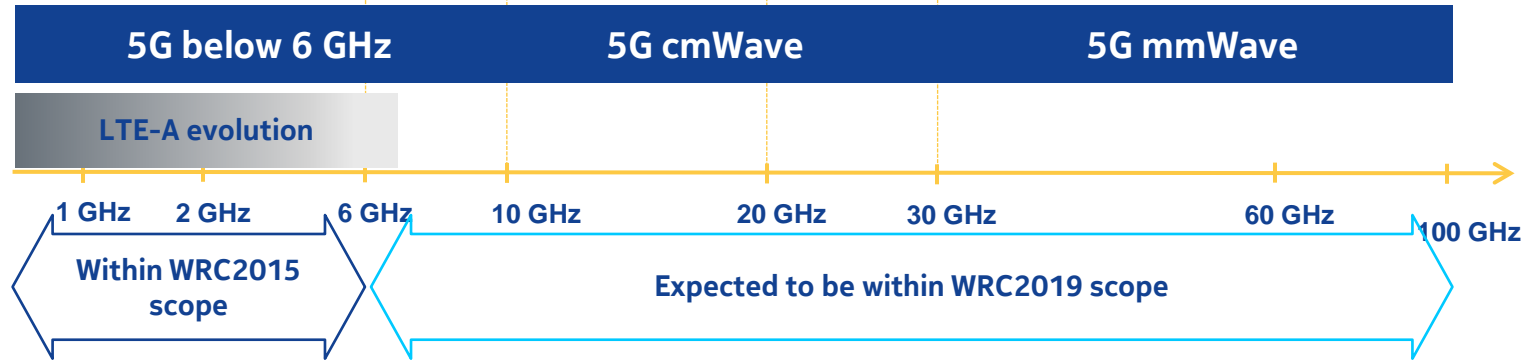


# 5G radio access to match the available new and old frequency bands

A new RAT may be motivated by new spectrum allocation (bands above 6GHz), lower latency, or specific use cases.

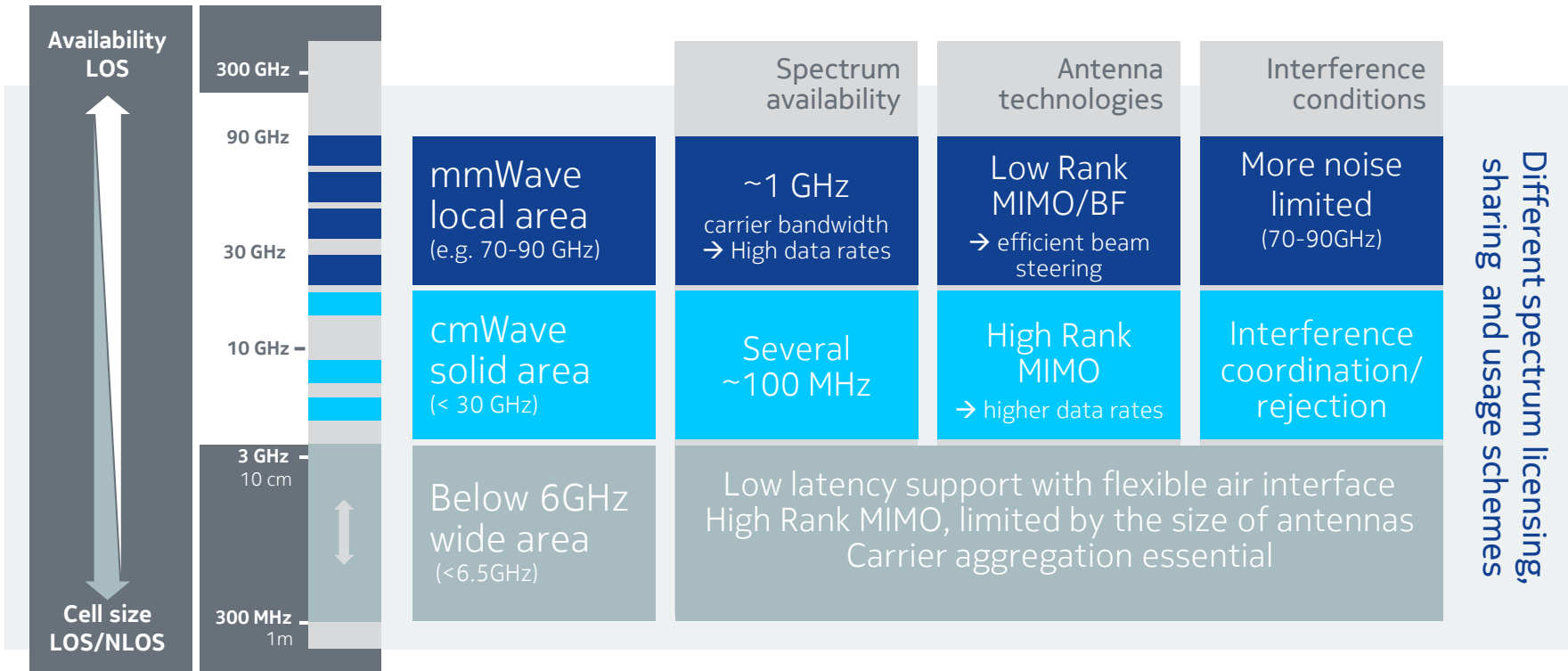
LTE-A will be essential foundation of the integrated 5G system – must continue to evolve in parallel to 5G

LTE-A evolution beyond 3GPP Rel-12 needs to be backwards compatible, meaning: “Legacy LTE devices must be able to access the system without degradation in performance”  
Backwards compatibility requirement may be relaxed, if specific needs (e.g. new bands without legacy devices), such as LAA-LTE, are identified and agreed on





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

Expanding the spectrum assets to deliver capacity and experience

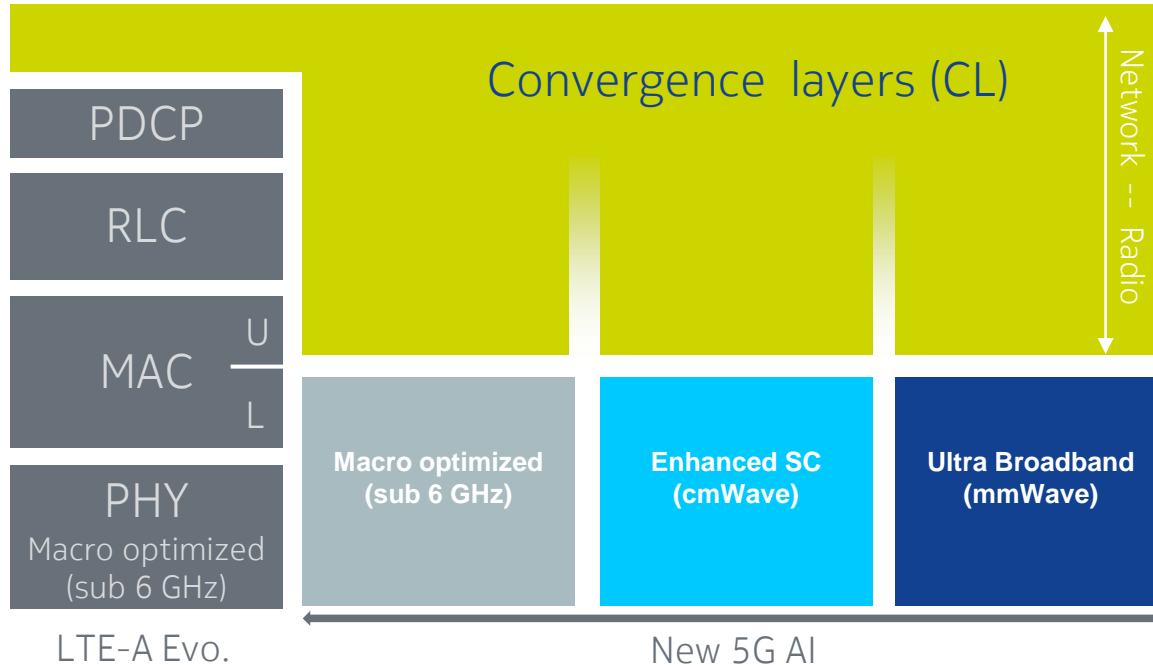


# 5G technologies under study

Spectrum access and efficiency	<p><b>Massive MIMO and massive beam forming</b></p> <p>3..6 GHz: Spectral efficiency (MIMO), &gt;&gt; 6 GHz more about path gain (BF)</p>	<p><b>Centimeter-Wave and Millimeter-Wave</b></p> <p>Spectrum access, for dense deployments</p> 	<p><b>New waveforms and modulations</b></p> <p>Must be justified by gains, compatibility with MIMO essential</p>	Reliability – Flexibility – Scalability	
	Deployment	<p><b>Multi-RAT integration</b></p> <p>5G is integrating novel and existing radio access technologies</p>	<p><b>Radio virtualization</b></p> <p>Parts of radio will be virtualized, need for specialized L1 HW may still persist</p>		



# Specialized RAN technologies managed as one system



## Harmonization

Aim for as much harmonization of upper layers as possible to have one common solution for all 5G RIs, perhaps even common with LTE-A if feasible

## Dedicated characteristics

- Frequency band
- Propagation characteristics
- Cell size
- Lower layer design: PHY numerology, mux of PHY data/control, frame design

# 5G architecture – integrating novel and legacy technologies

## Key requirements

1. Multi Service Network
2. Network Flexibility

## Operator benefits

- Support for future applications
- Per service tailored network
- New services & business models
- Quicker service time to market



# 5G 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.





# Q & A