

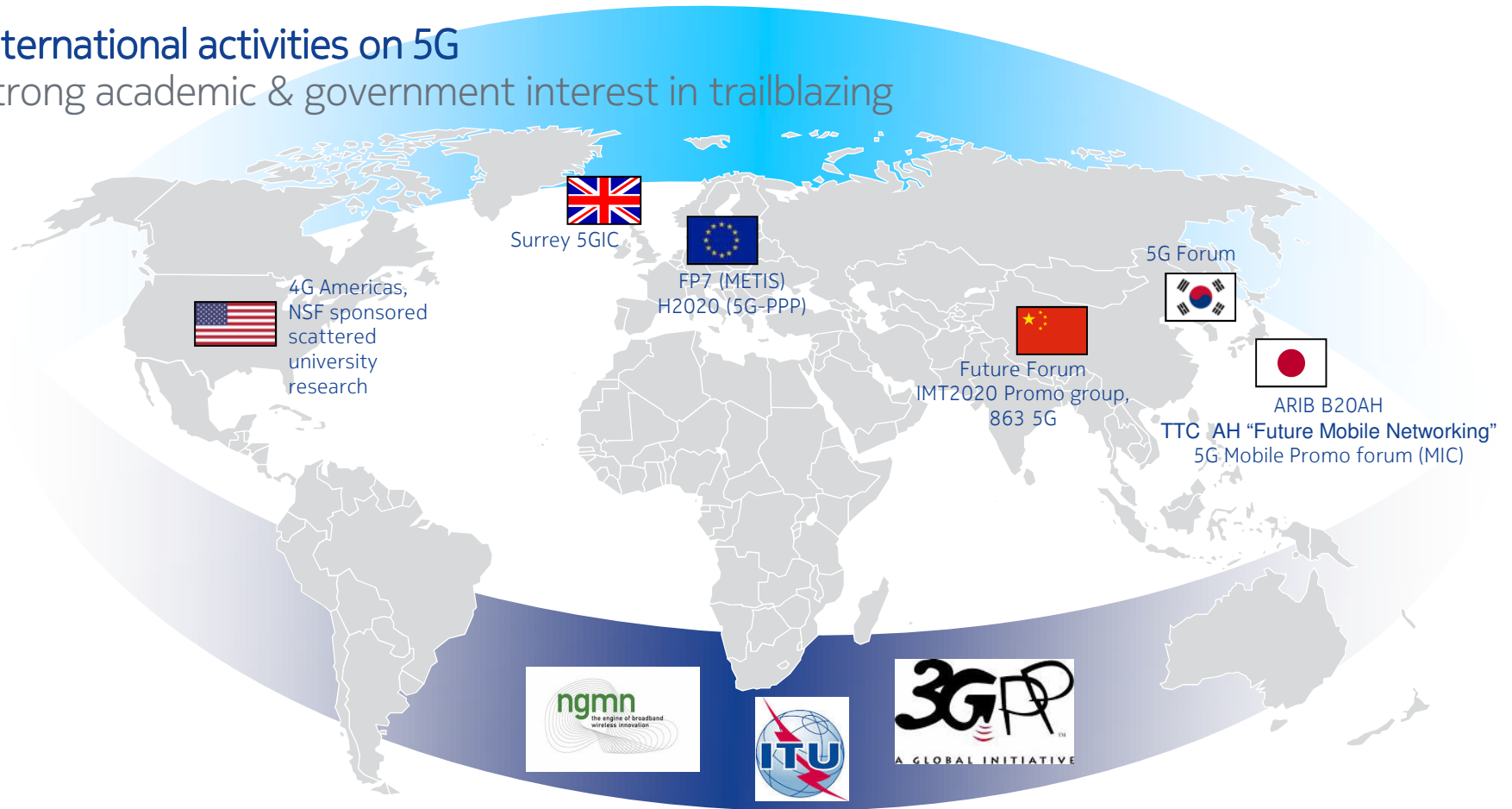
5G the next major wireless standard

Klaus Doppler
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DREAMS Seminar, Jan. 13, 2015

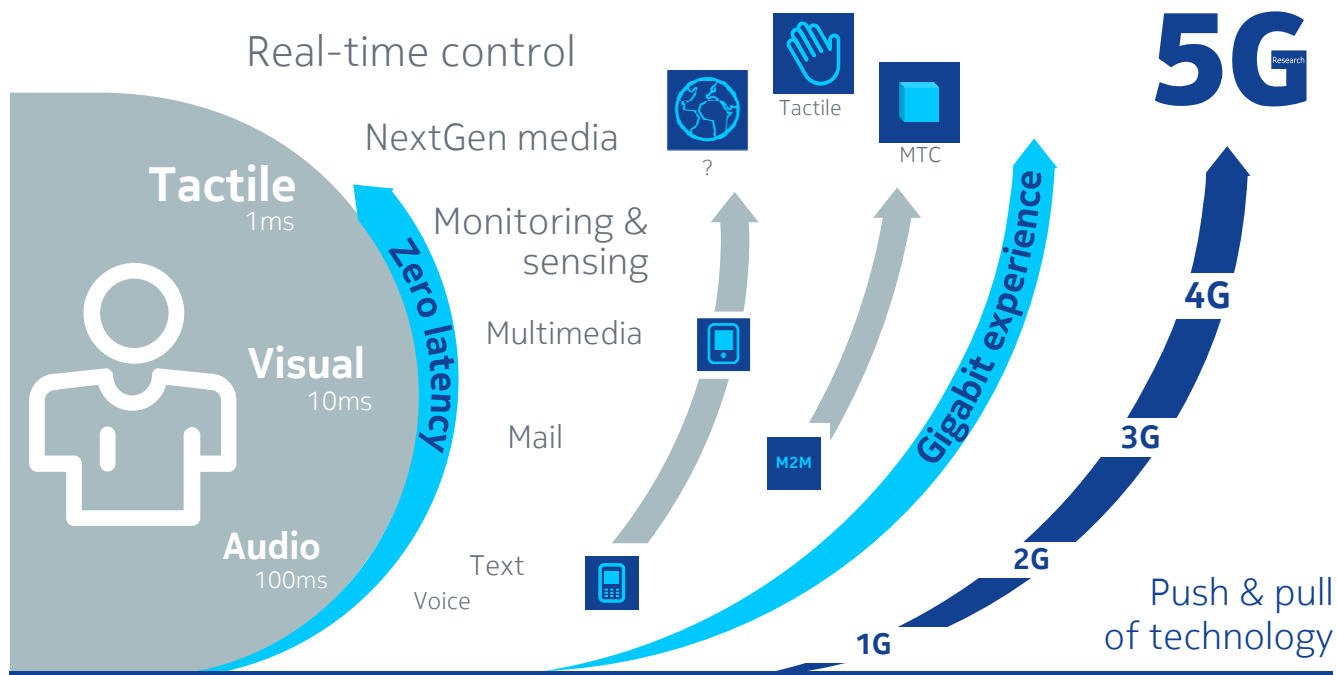
International activities on 5G

Strong academic & government interest in trailblazing



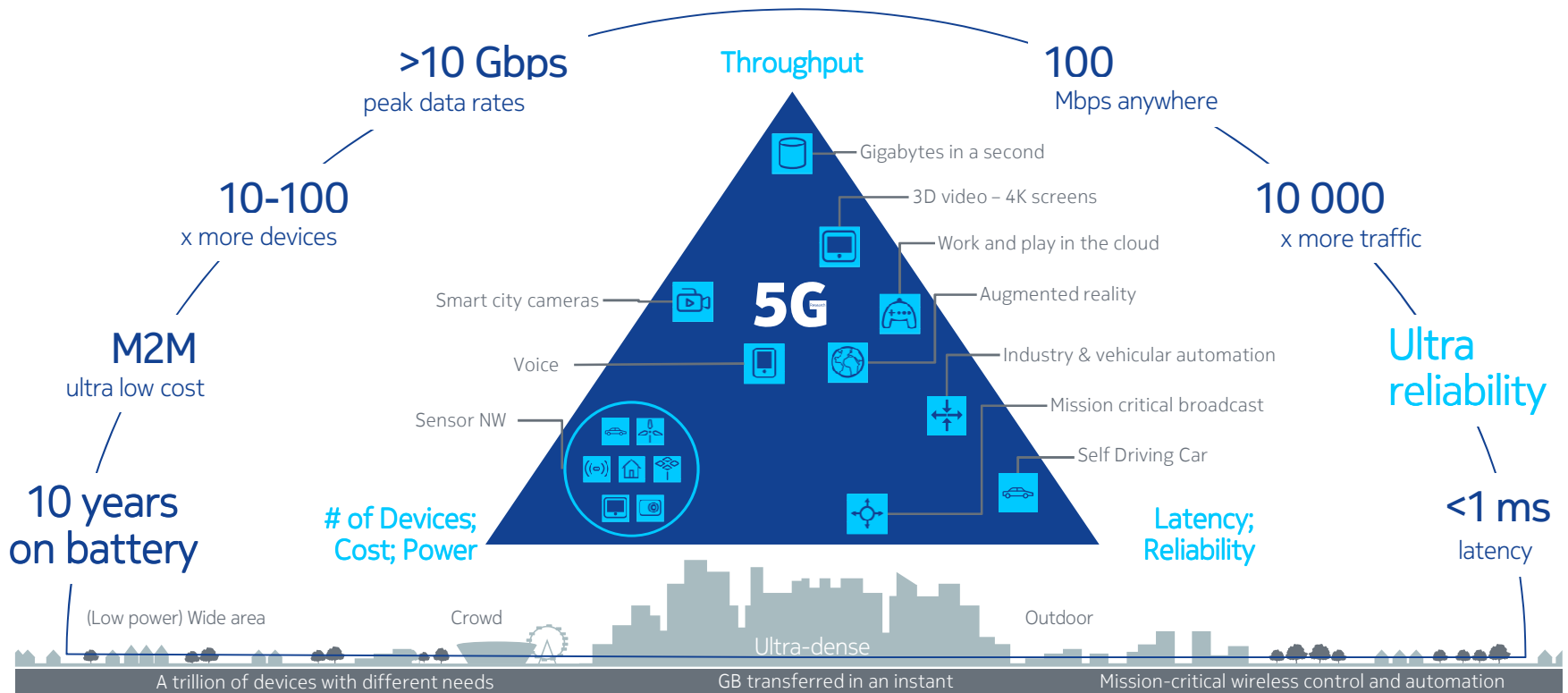
What we know about 5G demands

Higher capacity, lowest latency and more consistent experience



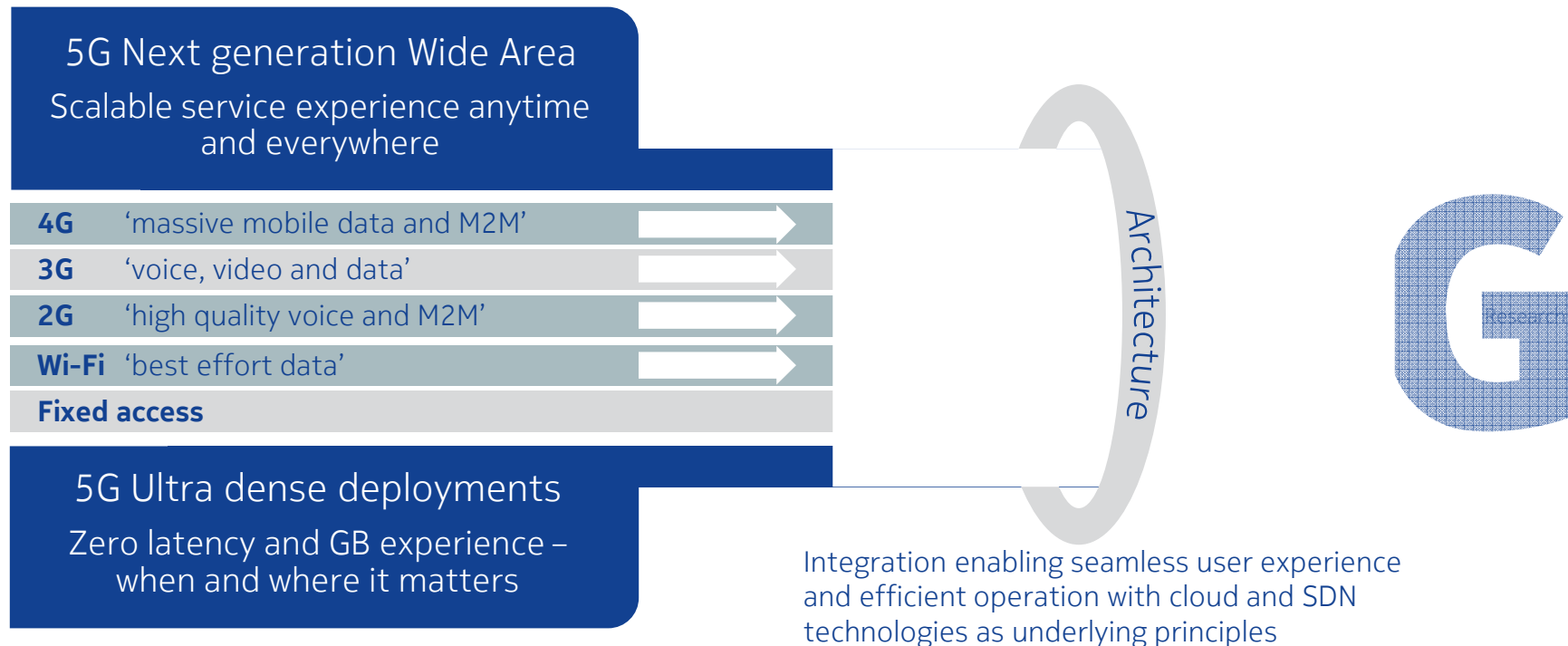
Flexibility
for what is
unknown
today

5G will enable very diverse services and use cases with extreme range of requirements

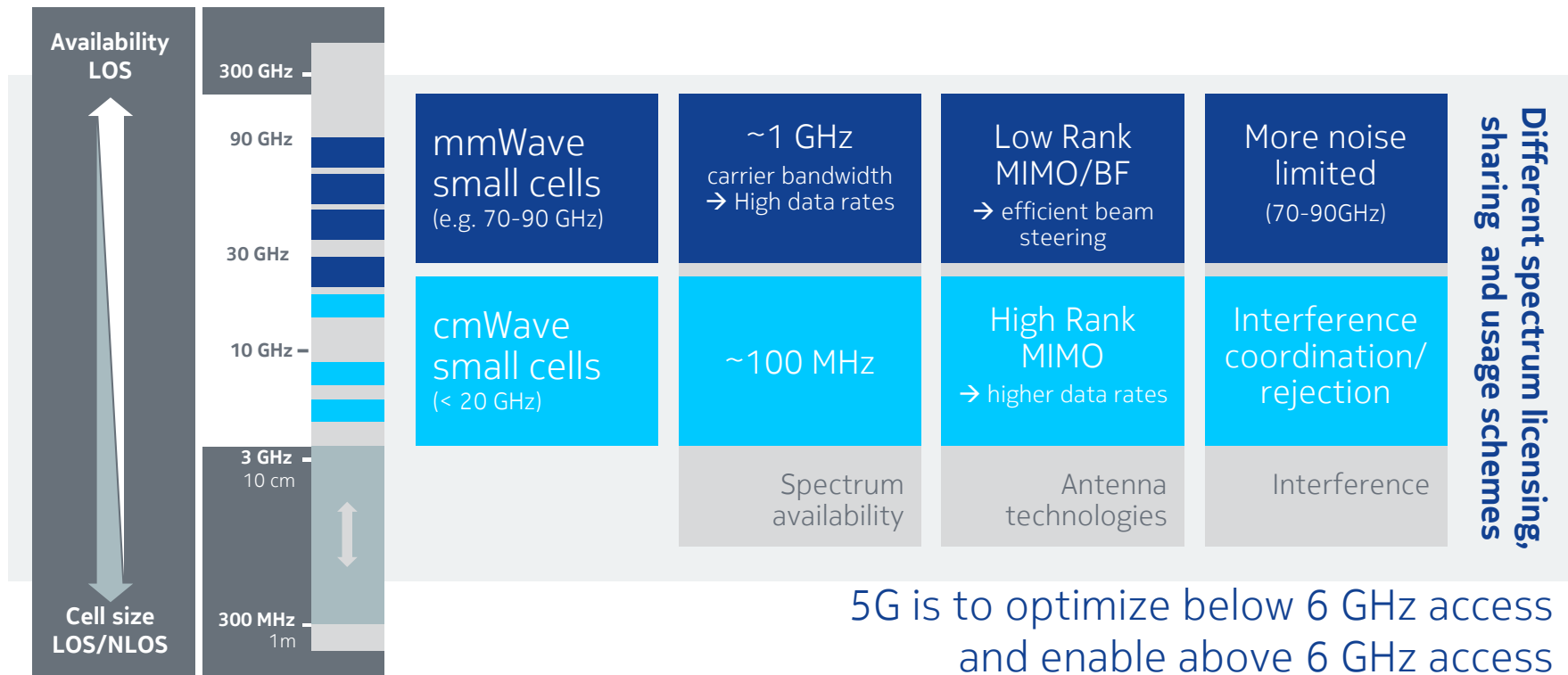


5G overall system vision

A symbiotic integration of novel and existing access technologies



Bridging the spectrum gap to deliver capacity and experience



Various 5G technologies / components / systems under study

Spectrum access and efficiency	Massive MIMO and massive beamforming 3...6 GHz: SE (MIMO), >> 6 GHz more about path gain (BF)	Centimeter-Wave and Millimeter-Wave Spectrum access, dense deployments	New waveforms and modulations Must be justified by gains, compatibility with MIMO essential	Reliability – Flexibility – Scalability	5G <small>Research</small>
	Deployment Multi-RAT integration 5G is integrating novel and existing radio access technologies	Radio virtualization Parts of radio will be virtualized, need for specialized BBU HW may still persist	Ultra-high speed Train/plane scenarios covered with a moving relay or concentrator		

5G architecture – integrating novel and legacy technologies

Key requirements

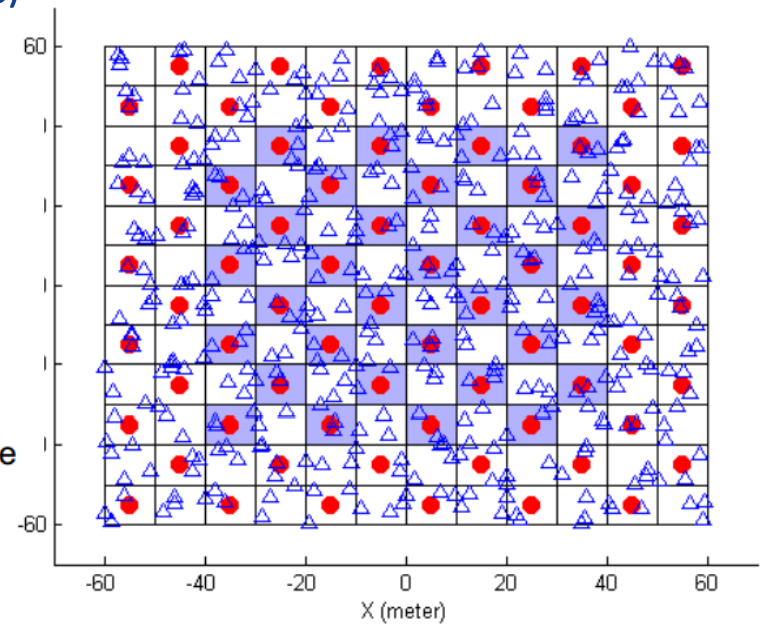
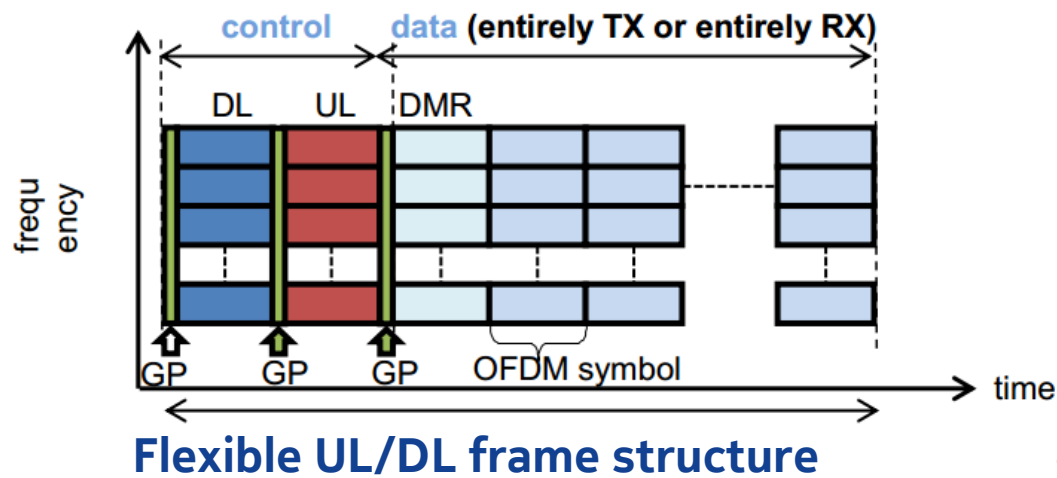
Multi Service Network
Network Flexibility

Benefits:

- Future applications support
- Per service tailored network
- New services & business models
- Quick service TTM

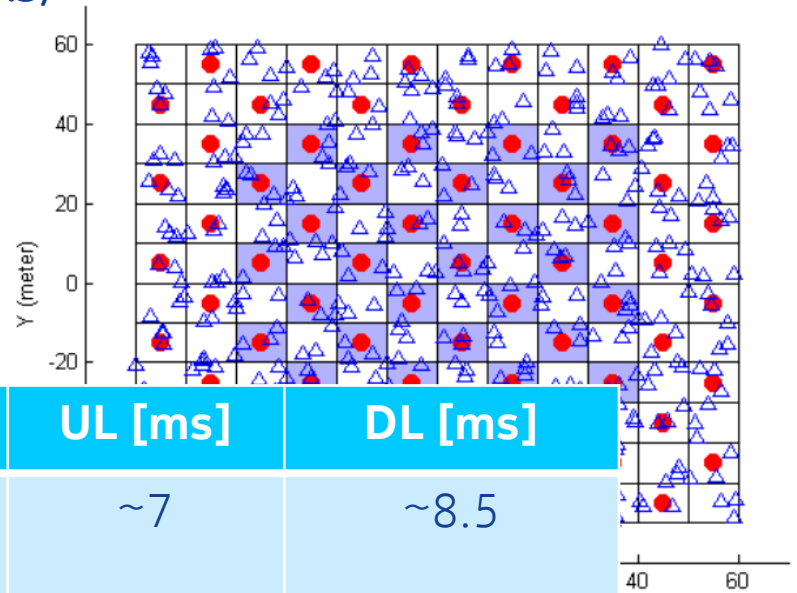
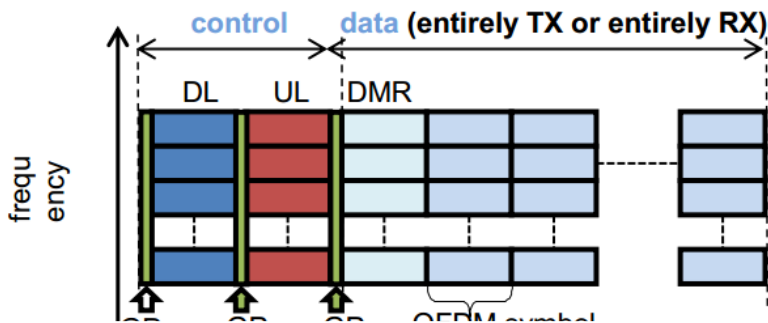


Selected results: Ultra Dense Networks (METIS D6.3)



144 rooms, 532 users

Selected results: Ultra Dense Networks (METIS D6.3)

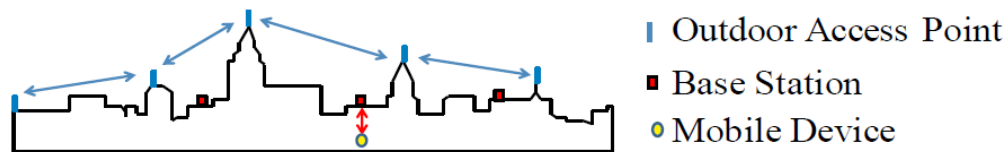


Technology	UL [Mbps]	DL [Mbps]	UL [ms]	DL [ms]
LTE-A every 4 th room (20MHz)	15	55	~7	~8.5
5G every 4 th room (20MHz)	60	71	~1.7	~7.1
5G every room (40MHz)	300	436	~0.6	~2.1

5th percentile of user data rate

Median packet delay

Selected results: Massive MIMO (METIS D6.3)



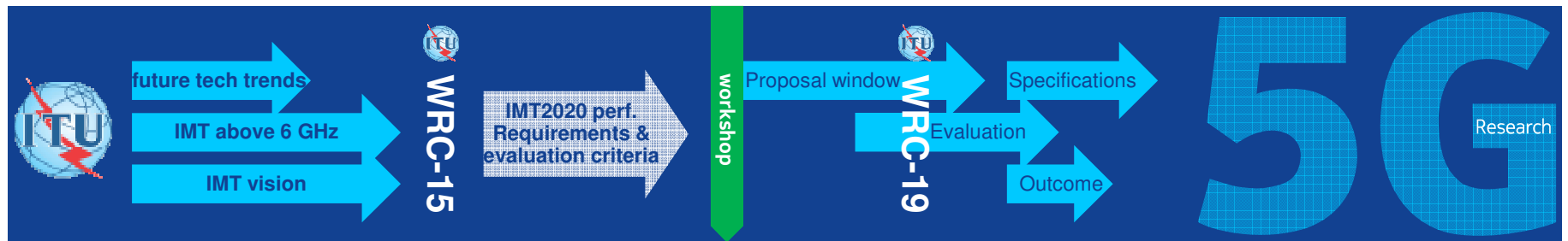
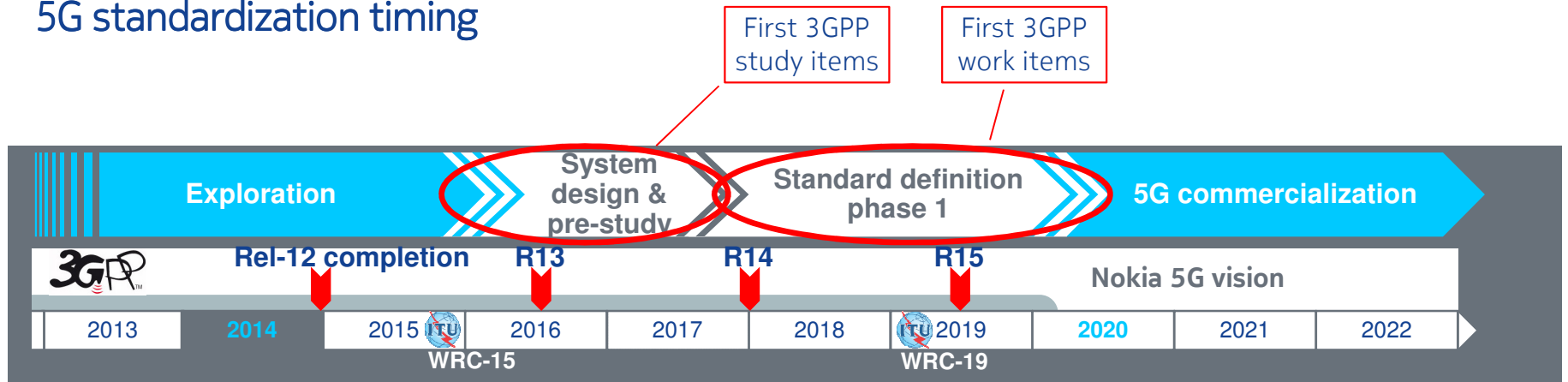
Wireless backhaul links in an ultra-dense network



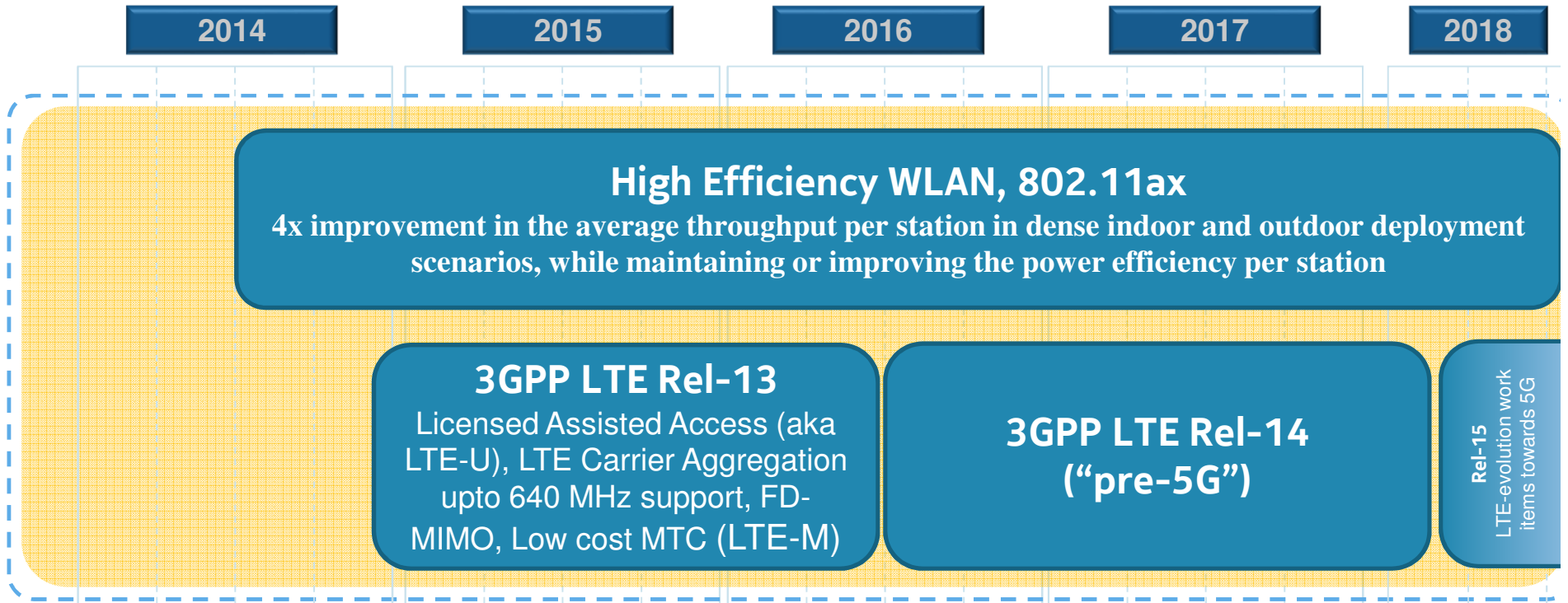
Data streams mapped onto angles of arrivals for linear arrays

- mmWave allows for very large antenna arrays, e.g. 512
- Spectral efficiency $> 100\text{b/s/Hz}$
- Need for low complexity schemes
- Efficient MU-MIMO

5G standardization timing



What else is happening?



A symbiotic integration of evolved and new technologies

2020+
5G
Research

A scalable service experience everywhere and anytime where people and objects will obtain virtual zero latency gigabit experience when and where it matters.

Ultra dense small cells

Wide area

Architecture

Reliability

Flexibility

Driven through collaboration

NOKIA

More 5G from Nokia, check out:

<http://networks.nokia.com/innovation/5g>

Thank you for your attention