

5G: Radio goes to cloud, core goes alone

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Aji Ed

CTO Middle East and Africa

Nokia

8 key drivers for introducing 5G

1 Market and/or technology leadership
Brand boosting

2 Capacity vs. demand
LTE congestion
Traffic growth

3 National or government ambition

4 Global standards and new spectrum

5 Rise in value chain
from connectivity to added value solutions

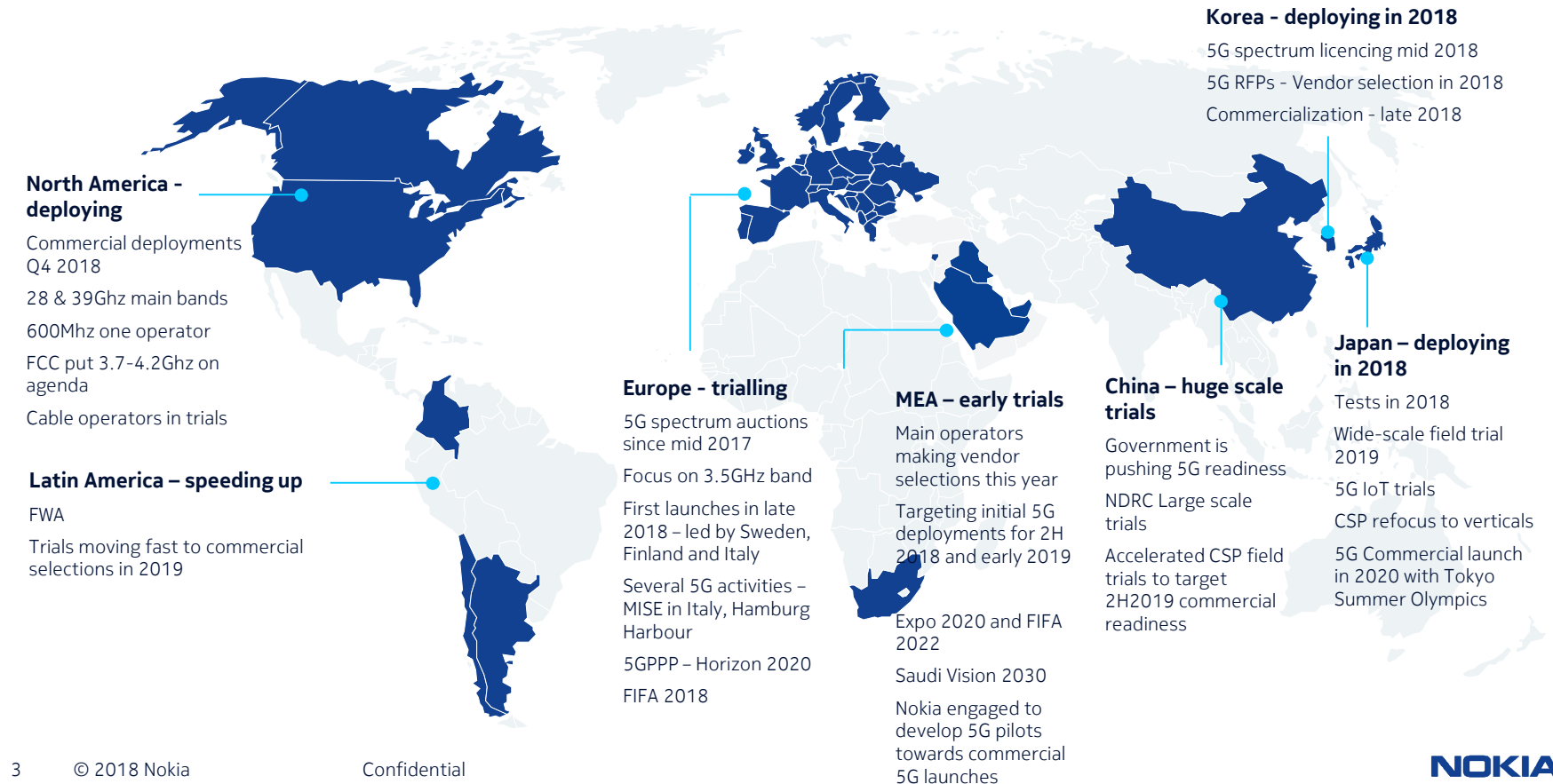
6 New use cases
AR/VR with 4K/8K video and event experience

7 Fixed Wireless Access (FWA) over 5G
to avoid deploying fiber to the home

8 Lower TCO of transferring 1 GB over the air compared with 4G/LTE

5G market traction – the market is accelerating

Nokia is leading 5G innovation with over 60 current agreements



5G use cases materializing and evolving

5G smart sea port



Traffic lights management, data processing from mobile sensors and virtual reality



5G showcase events



KT 5G trial before and during the winter olympic games in PyeongChang 2018: 5G-driven visual demos such as 360° virtual reality and 3D live performance



5G industrial automation



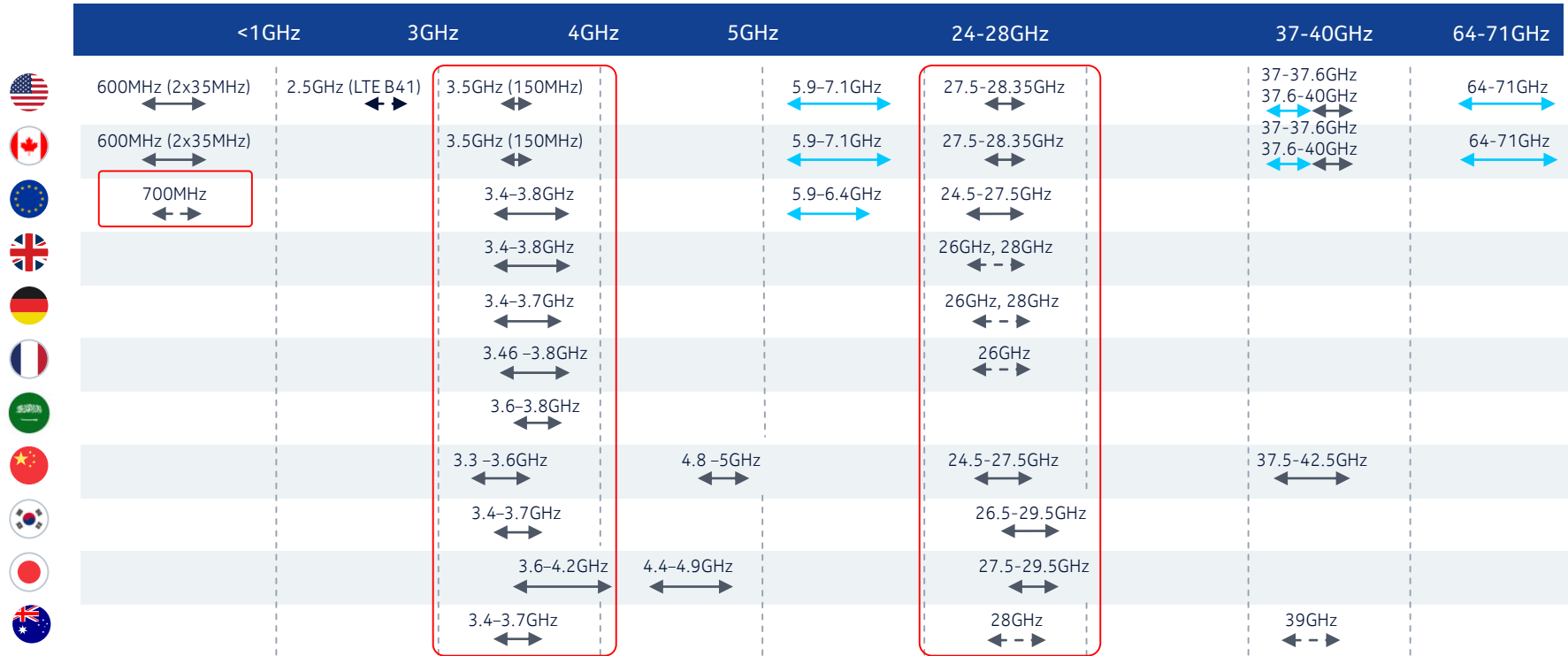
Coupling advanced interactive robots with wireless perimeter intrusion detection



Global snapshot of 5G spectrum

Around the world, there's a pattern of band allocation

New 5G band



5G Deployment – start on one band and evolve to combination of bands

Starting 5G on 3.5 GHz (on existing urban/metro base station grid)
in combination with LTE on lower-band (e.g. LTE-1800 / LTE-700)
– then expanding 5G into other bands for capacity and coverage



5G 26/39 GHz



Extreme data rates locally

10-20 Gbps

- Extreme local capacity on 26/39 GHz
- 5G 3.5 GHz massive MIMO matching 2G/3G/4G coverage
- Full coverage with 600/700 MHz

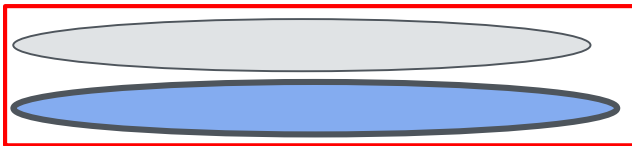
5G 3500 mMIMO
LTE1800



10x capacity on LTE grid with massive MIMO

1- 2 Gbps

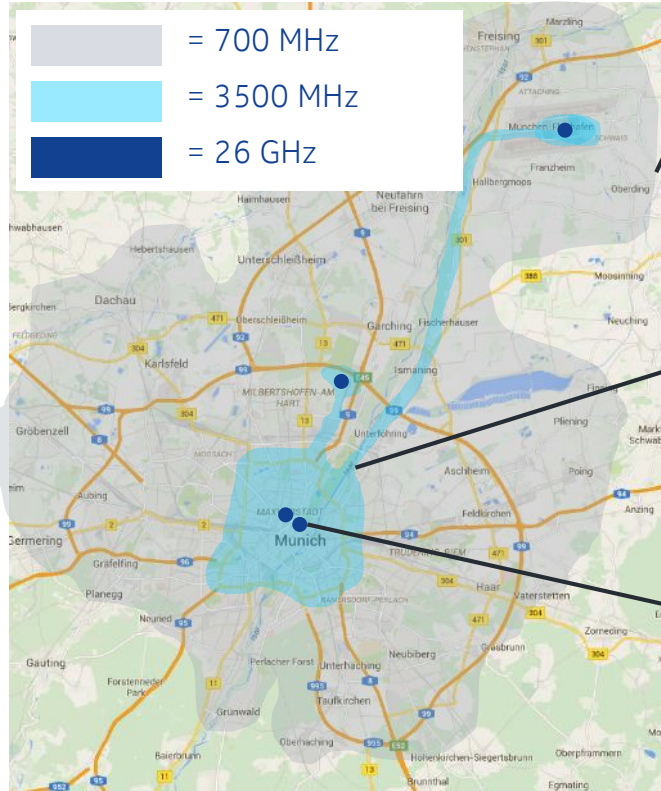
LTE700
5G 600/700



IoT and critical communication with full coverage incl. Deep indoor

100-200 Mbps

Example for expected 5G Spectrum Usage in a major European City



700 MHz layer

- Wide coverage with indoor penetration
- Massive IoT and ultra reliable low latency
- Reusing existing sites for 800/900 MHz

3.5 GHz layer

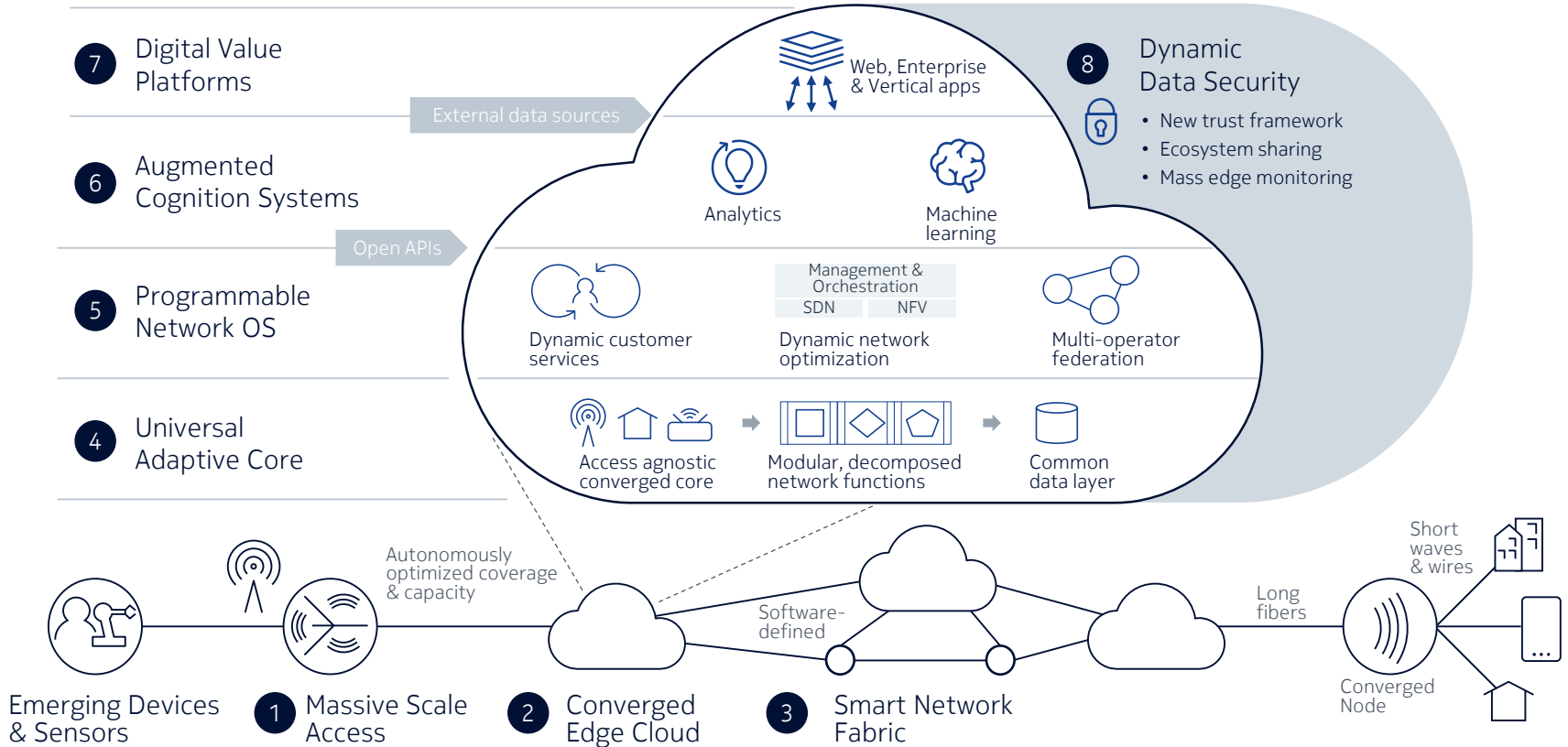
- Dense urban coverage
- Supports enhanced mobile broadband
- Reusing existing sites for 1800/2100/2600 MHz

26 GHz layer

- Hot spots like shopping malls, airports and stadiums
- Supports full enhanced mobile broadband
- Data rate 10 Gbps

European 5G-pioneer bands : 700, 3500, 26 GHz

Nokia's E2E 5G capability is based on Future X architecture



Nokia 5G Future X architecture - end-to-end portfolio – open, AI enabled

Powerful

breaks limits



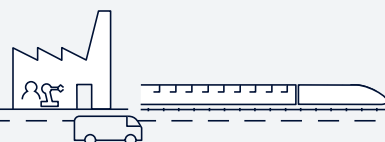
Flexible

scales and adapts to you



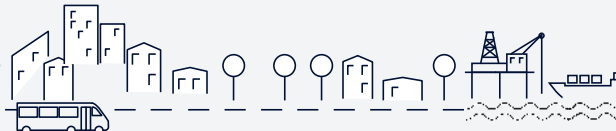
Intelligent

nurtures and optimizes itself



Efficient

green and sustainable



Massive scale access

- 5G NR
- 5G18 release
- AirScale
- Small cells
- Fiber
- DSL
- Cable
- Wireless PON

Cloud

- AirGile cloud-native core
- Shared data layer
- 5G registers
- Cloud packet core
- Edge Cloud incl MEC
- Cloud infrastructure

AnyHaul

- Wavence
- IP Routing – powered by FP4 processors
- Optical Networking
- NG-PON, Lightspan

Automation

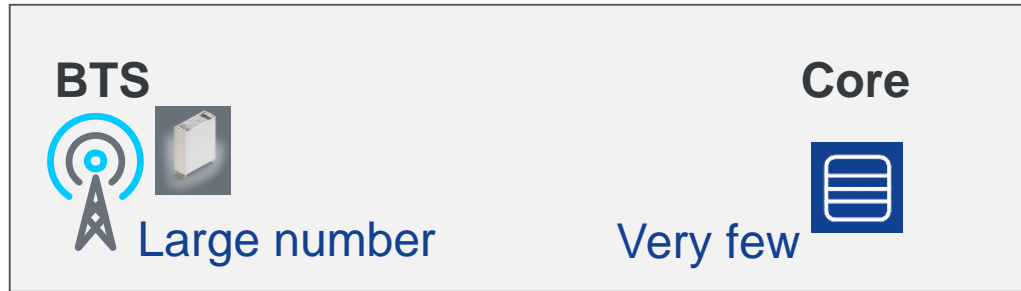
- Digital Experience
- Digital Operations
- Digital Intelligence

5G acceleration services

- Business strategy
- Prototyping – 5G Labs
- Design
- Build
- System Integration

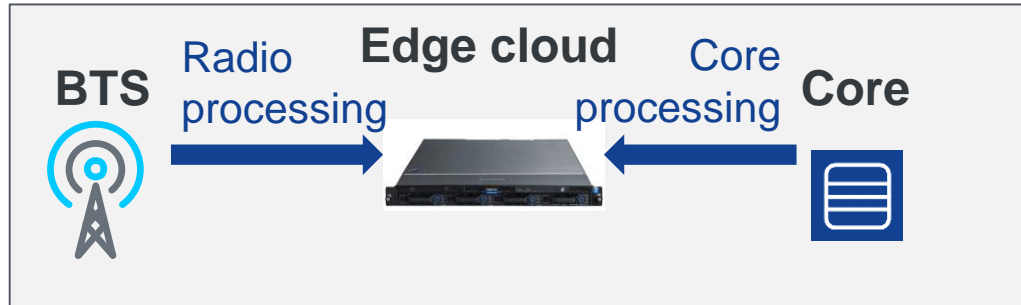
Network Architecture Evolution Towards 5G

Today



- Current radio is distributed
- Current core is centralized

Target

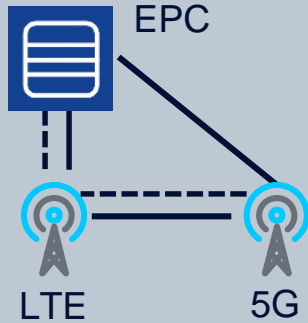


- Radio more centralized for faster scalability
- Core more distributed for low latency

5G Architecture Options in Release 15

Non-standalone (NSA)

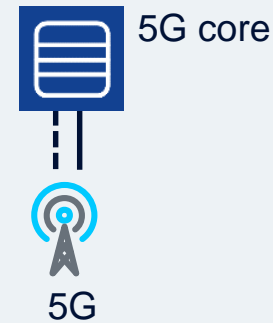
Option 3x | LTE+5G under EPC



- New high data rate 5G radio
- Existing LTE packet core (EPC)
- 3GPP specs September 2018

Standalone SA

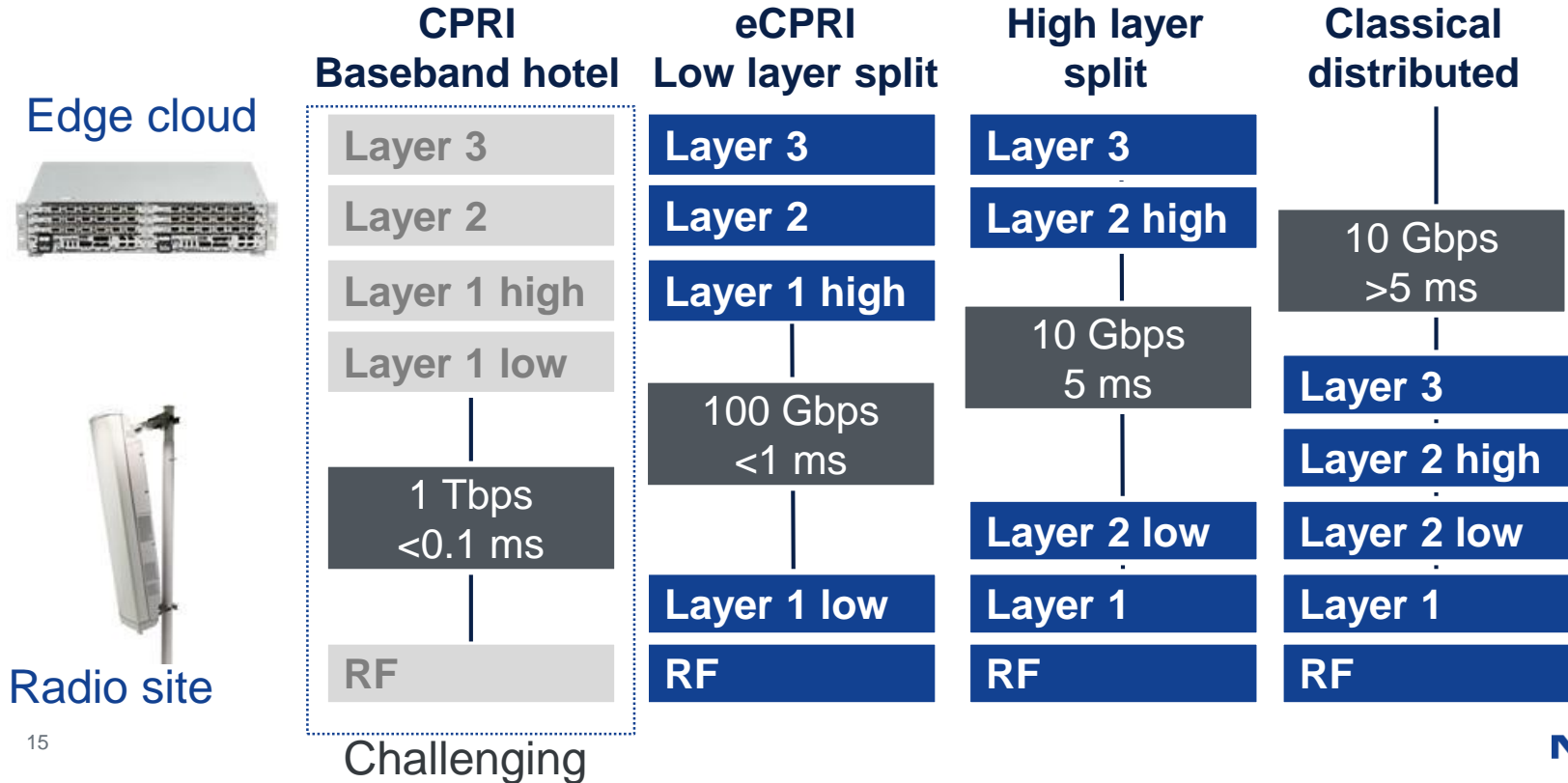
Option 2 | SA 5G under 5GC



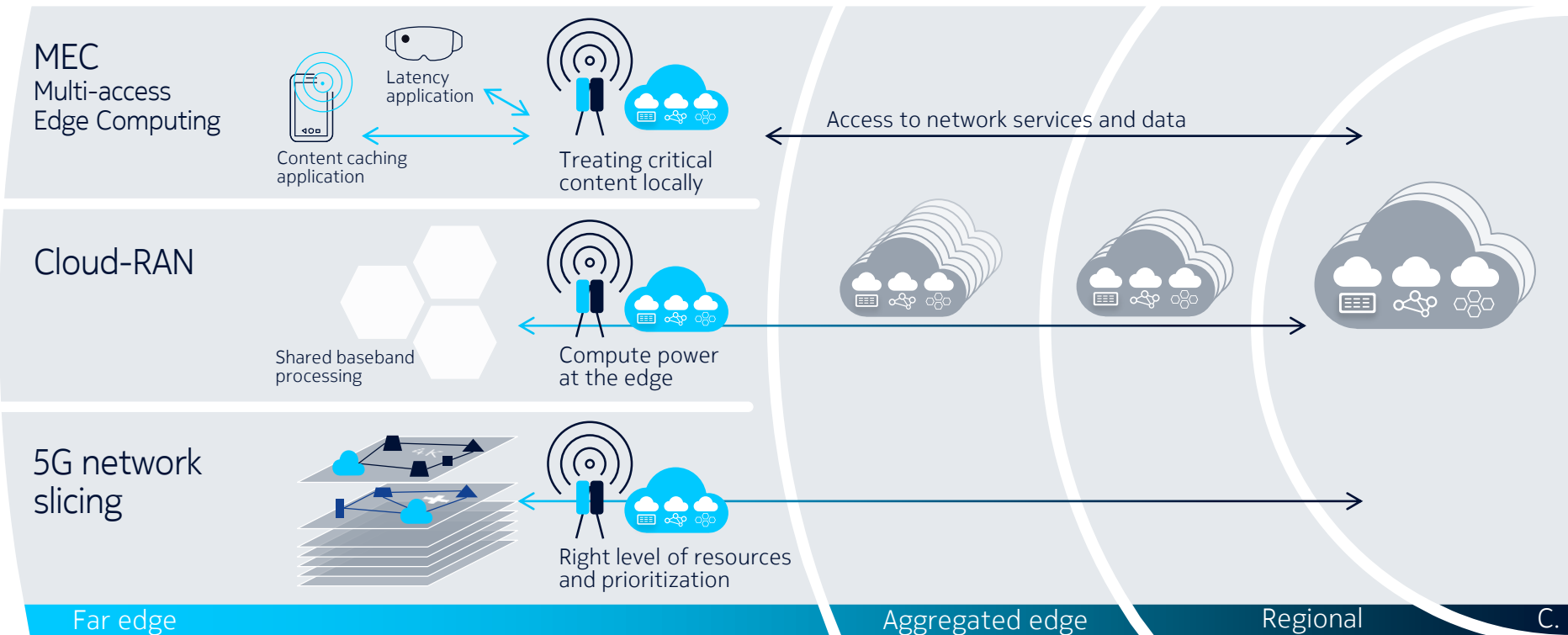
- 5G end-to-end for new services
- Lower latency without LTE leg
- 3GPP specs December 2018

5G Radio Architecture Options

100 MHz, 3-sector, 64TX/RX Massive MIMO, 16 Layers



Distributed Cloud for new latency critical and uses case specific 5G Services



Network and Service Automation is essential for a sustainable business case

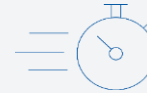
E2E Network Slice automation



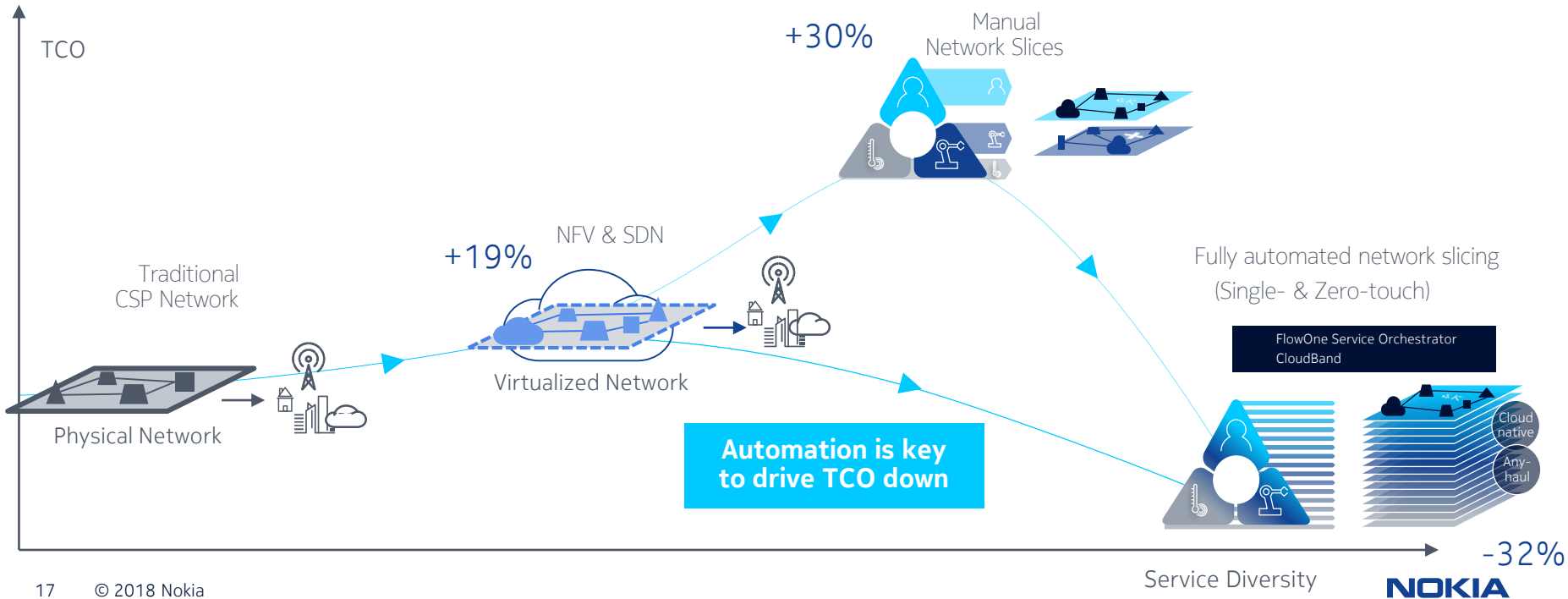
For automated customer Self-management



For policy driven automated network operation



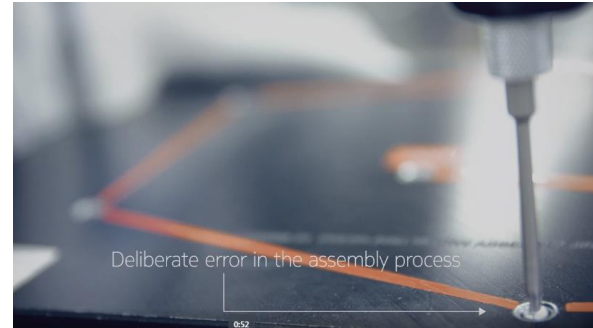
For faster time to market and service onboarding



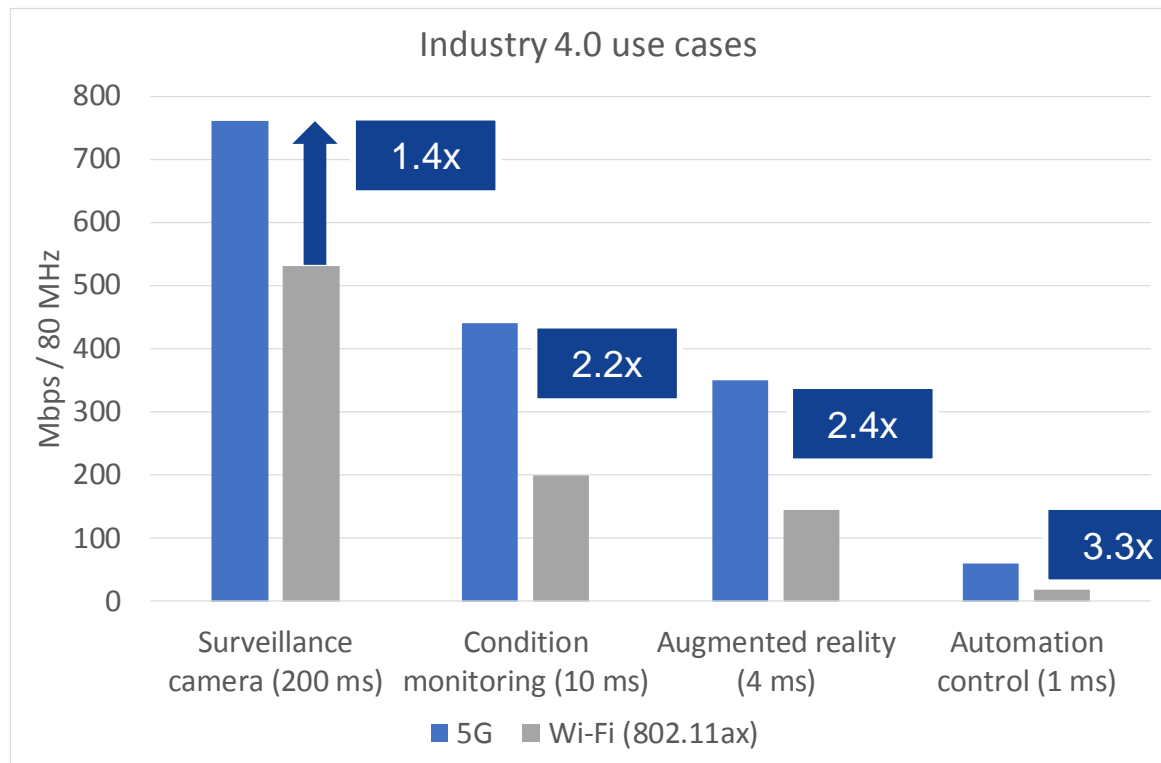
Industry 4.0 in Nokia Factory Oulu

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Nokia and Telia conduct Industry 4.0 trial in Finland leveraging low-latency and high-bandwidth of 5G technology



Benchmarking of 5G and WiFi in Industry Environment



- 5G gives 1.4 – 3.3x higher efficiency than WiFi 802.11ax for Industry 4.0 use cases
- 5G benefit is largest compared to 802.11ax when the delay requirement gets tough (10 ms or less)

Assumptions: 80 MHz, 4x4 SU-MIMO, 2 streams, 1024QAM in Wi-Fi, 256QAM in 5G

A wide-angle photograph of a rugged, arid landscape. In the foreground, a dirt road winds through a valley. The middle ground is dominated by several sharp, dark, rocky peaks. The background shows more distant, hazy mountains under a clear blue sky with some light clouds. The overall scene is one of a remote, high-altitude environment.

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