



Private Wireless Solutions

Accelerating industries digitalization to Industry 4.0
with Industrial-Grade Private Wireless Networking

Agenda

1.

Why Private
Wireless
Key Enablers

2.

Spectrum &
Deployment

3.

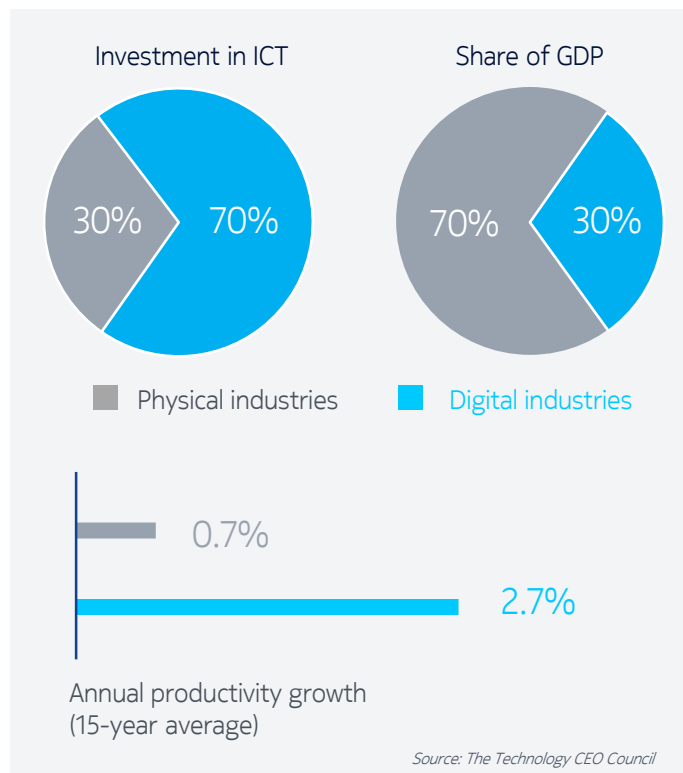
Verticals
Use Cases

4.

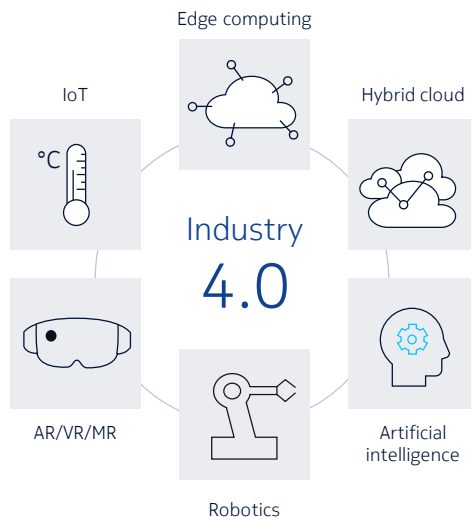
Solutions
Portfolio

On the cusp of the 4th industrial revolution

...and this is happening NOW



Confluence of key technologies enablers create the perfect environment for Industry 4.0



>70%

enterprise are investing in IIoT today

<https://www.pwc.pt/pt/temas-actuais/pwc-apresentacao-iiot.pdf>

49%

IT are reporting working closer with OT on IIoT projects (32% in 2018)

451 research - Internet of Things, Organizational Dynamics 2019

Industry 4.0 will deliver massive increase in productivity & economic value creation



Enhance efficiency
with process automation



Increase agility
to meet fast changing requirements



Better decision
making via intelligent insights

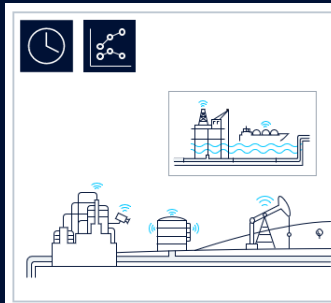


Increase worker safety & productivity



Sustainability
efficiency helps lower environmental impact

...while maintaining asset heavy industries
“Must-have” needs



What our customers need from us today



Automated falling conductor disconnect to avoid fire

Maintain **grid reliability** with growing **distributed renewables / storage**

Wind turbine monitoring for predictive maintenance

FAN convergence and automation



Fix Wi-Fi related **autonomous truck crashes**, downtime & resulting wear & tear

Drivers' **tiredness monitoring**

Increase safety with **remote drilling**

Introduce **wall-slope & environment sensors**



Connectivity inside the plane (pilots, crew, workers, etc..)

Plane departure time prediction using **cameras & analytics**

Replace Wi-Fi and PMR for reliable **airfield marshal work-orders & PTT**



Real-time **work- order system** for cranes & AGV drivers

Automated site access system and parameter **security**

Reefer monitoring

Remote control, autonomous cranes and AGV



Legacy assets digitalization for predictive maintenance

Fix **AGV Wi-Fi imposed low speed & reliability issues**

Digital twin **Machine connectivity**

Workers' **connected tools & safety**

"Lot-size one" manufacturing

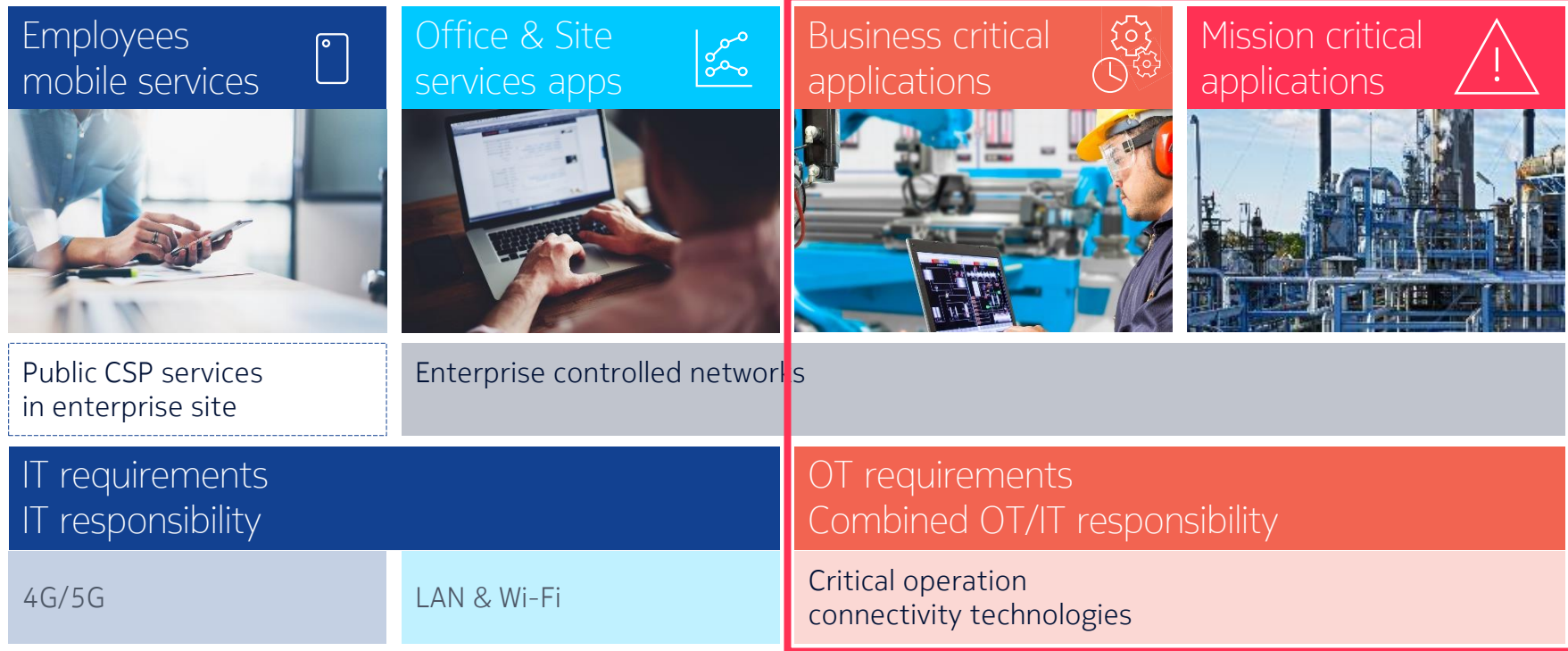
1st Step of industry 4.0

Digitalization by connecting
all assets.

74% of today's data
not yet collected!

Different application domains in same industrial site

Different technologies for different requirements



Critical operations requires industrial-grade connectivity

Existing



Security



Reliability & availability



Predictable high performance (data-rate and latency)

INDUSTRY 4.0
digitalization
additional
connectivity
requirements

Cost effective, easy to connect all assets

Pervasive – **wide and deep coverage**

Connect **moving assets**

Replace **aging PMR systems** (Push-to-Talk)

Support for **lower power sensors**

Wireless

1
wireless
network
for all critical
applications

Industry 4.0: The time is now

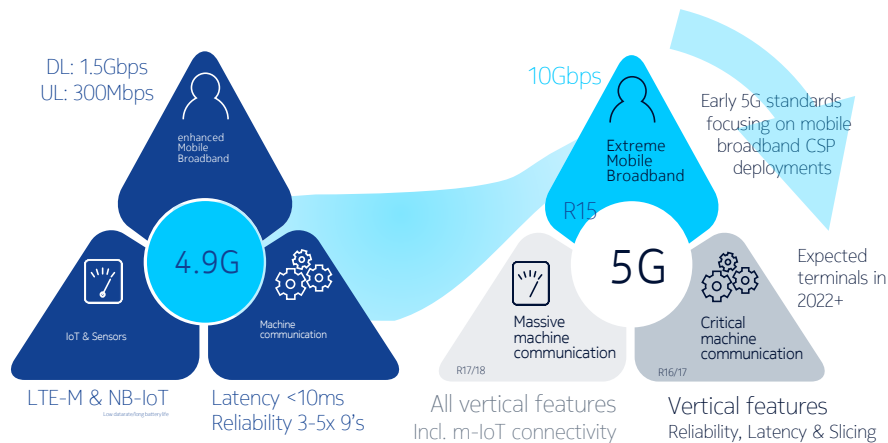
All stars align (digitalization needs, spectrum, ecosystem, solutions) to start NOW

Reliable wireless is critical for digitalization NOW!

Private 4.9G {

- Major leap compared to Wi-Fi
- >85% of industrial applications

Deployable solutions are ready NOW, 5G ready for NEXT



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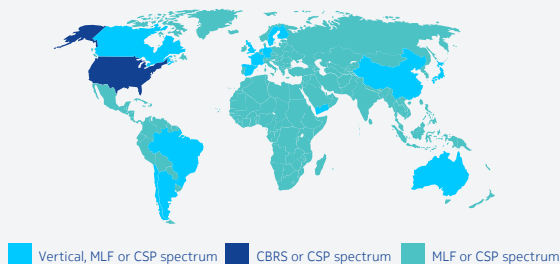
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Eliminating the barriers to adoption

Industrial-strength private wireless is here today and easier than ever

Spectrum availability

- CSP
- Vertical
- Unlicensed



Simple & easy to use

2-3 elements + Plug and Play



Ecosystem of LTE/4.9G industrial devices

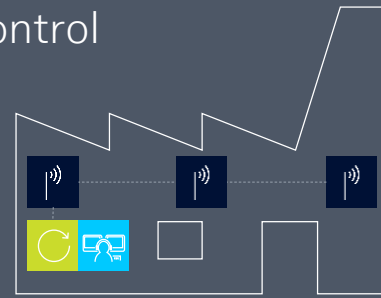


>2500 non-phone form factor LTE devices

GSACOM data, 03/2019

...while keeping full control

- Dedicated network
- Enterprise data stays local even in cloud architecture
- Full visibility and control from enterprise management interface



Providing choice to suit all requirements

Variety of needs that generally breaks into 2 categories:

Focus on simplicity



Digital Automation Cloud (DAC)

- Integrated **Plug&Play as-a-service** solution
- **Digitalization/automation platform** with ready-to-run applications
- **Enterprises & partners**

Need for full control



Modular Private Wireless (MPW)

- **End-to-end customizable** solution for most **demanding enterprise requirements**
- **Enterprises & partners**
- **CSP private wireless offering**

- **Latest generation LTE: 4.9G** and smooth **5G evolution**
- **Leading small cell portfolio & cloud core**
- Largest **range of spectrum options**
- Complete **IP-MPLS and optical transport** solutions
- **End-to-end Management and orchestration**

Complementary solutions

WING Worldwide IoT Network Grid

Services Deploy, Managed services, Integrated operation centers

Comprehensive portfolio to support your needs

Private wireless but end-to-end at the essence

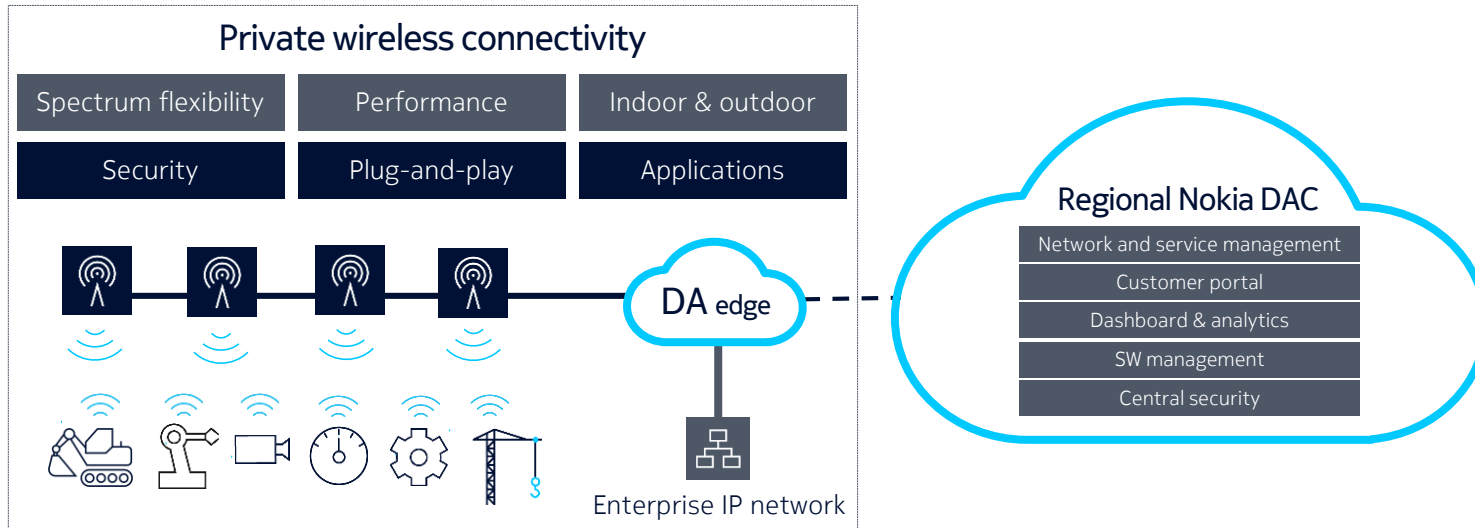


Single end-to-end management and orchestration

Nokia Digital Automation Cloud

Enterprise "own" network
Core as Managed Service

<https://www.youtube.com/watch?v=WvZBLWyoFNQ>



Enterprise managed IP network, radio deployment, applications, users

Nokia managed core, radio spectrum, SIM cards

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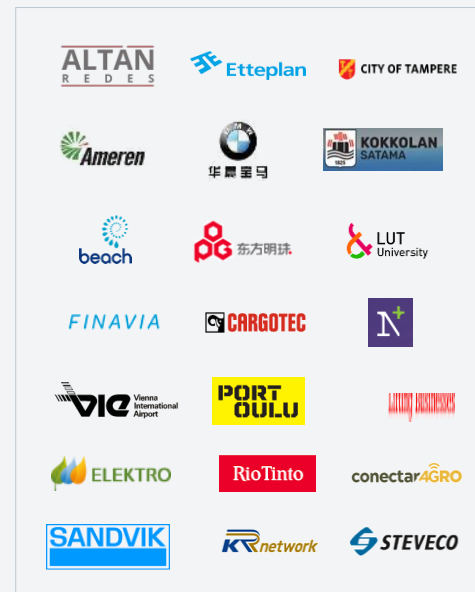
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Nokia Private wireless momentum

0120+
and counting

Segment	 Transportation 24	 Energy 35	 Public sector & smart cities 32	 Manufacturing 11	 Other industries 18
Region	NAM 27%	LATAM 10%	Europe 37%	APAC 20%	MEA 8%

Over 120 enterprises deploying Nokia private wireless on their premises



Delivering many industry requirements with 4.9G TODAY



Brazil, World largest wind generator

- Grid monitoring to prevent illegal tapping and increase grid reliability
- Grid automation for maintaining quality

Regional private wireless network coverage (5% coverage from CSP network)

- 78,000 smart meters
- 1,300 load balancers
- 850 concentrators



Peru, World 9th biggest copper mine.

- PMR replacement for voice communications
- Improve worker safety with smart garments
- Future automation solutions (AHS)

Mining site coverage utilizing Telefonica core slice

- IP-MPLS over private LTE for enhanced reliability



Austria, 24M passenger per year.

- Gates and airside operational efficiency for below-wing process (faster plane turn-around)
- Airside coverage for vehicles connectivity

Autonomous private wireless, with triple back up from A1 core

- % of private network also used for A1 subscriber capacity boost
- Triple core redundancy



Finland, 9th & 10th container port wins.

- Port digitalization
- One wireless network to replace all legacy networks and to support all operational applications

Hybrid edge cloud as-a-service private wireless via Ukkoverkot

- IT driven operation, looking for fast deployment and private wireless benefits without the complexity

Private Networks

Improving Airport operator efficiency for shorter aircraft turnaround times

Solution drivers

Business needs

- Wireless LTE connectivity for airport operator:
 - Vehicles
 - Tenants
 - Security @ airfield, apron, hangars & carpark
- Improved service efficiency for reducing airplane turnaround times

Nokia solution and benefits

- Quick & easy Nokia Small Cell deployment ensuring reliable LTE coverage in all areas of airfield and airport premises
- Wireless data and communication for airport operator service units and security as well as introducing new application use cases enabled by wireless connectivity

Deployment example



Unprecedented connectivity at Helsinki Airport with private LTE

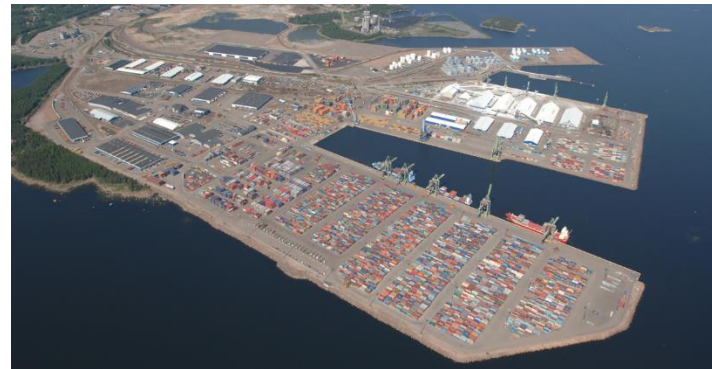
<https://youtu.be/tdBpIOIVd-E>

Use Case: Port

Initial applications

Ship-to-shore cranes mounted video cameras to record status of containers at arrival and after crane handling

- Inform end-customers early if container damaged
- Faster insurance treatment (clear responsibilities)



Background, challenges and private LTE drivers

Digging fiber to cranes not an option

- Operational disruption
- Possible cable reliability issues with crane repeated movements
- Not giving full terminal coverage for future expansion / new cranes

Current Wi-Fi/Wi-MAX based network not meeting needs

- Full terminal coverage difficult
- Not enough capacity to support video traffic
- Truck mobility connectivity issues



Private Networks

Improving security with video surveillance and nB-IoT

Solution Drivers

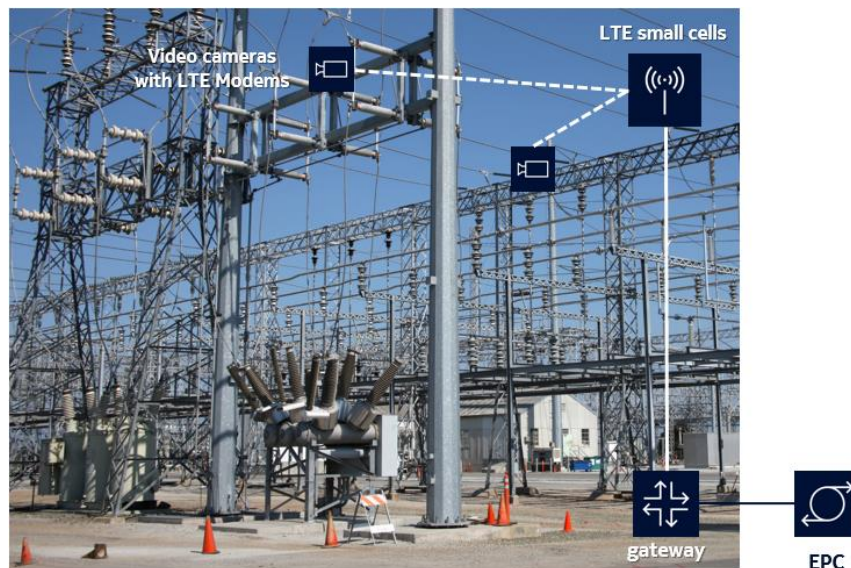
Business needs

- Power grids & distribution vital for modern society
- Security is paramount for ensuring uninterrupted service
- Reliable wireless connectivity enables:
 - real time video analytics against vandalism
 - remote substation meter readings (nB-IoT) for preventive maintenance
- improving security without need for on-site presence

Nokia solution and benefits

- Nokia small cells can be easily installed into existing towers in area covering power/distribution plant
- UE relays can be used for video camera connectivity to the small cell
- LTE connectivity for collection and transfer of measurement data from grid equipment

Deployment example



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Vertical specific blueprints

Developed by segment practices



Business needs

Use cases 1 2 3 ..

- S/W IoT platform
- Device eco-system
- 3rd party systems
- Peripheral technology

Customization, integration
and deployment services



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Customization, integration
and deployment services

Common industrial-grade
private wireless solution elements



Private Wireless Solution

Radio



Small Cells BTS

- LTE/4.9G & 5G
- Indoor & Outdoor
- 250mW, 5W & 20W
- Up to 840 users per BTS
- LTE-M, NB-IoT support



AirScale Macro BTS

Backhaul/
Transport



Transport:

- IP Routing



Backhaul:

- Wireless Backhaul



Enterprise
Packet Core



Nokia Enterprise Core



- Leverages CMG and CMM software from industry-leading Nokia Cloud Packet Core Solution
- Supporting mobile broadband, industrial IoT, MC-PTT, voice and video with engineered QoS

Nokia Enterprise Core Solution

Continuous Evolution

Nokia Enterprise Core Solution Today

- Comprehensive 3GPP compliant mobility feature set that's optimized for Enterprise premise deployments
- High capacity, performance and availability
 - 50k SAUs, 10 Gbps throughput, 250 eNodeBs in three 1RU servers
- Leverages Nokia Packet Core network function software for leading 3GPP feature delivery
- Integrated IP/MPLS networking products
- End to end network management

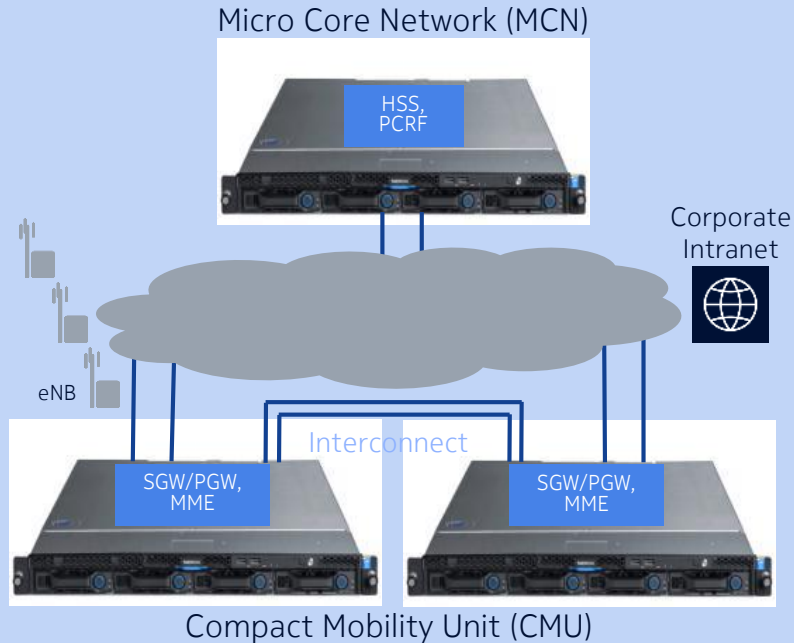
Nokia Enterprise Core Evolution

- Continuous 3GPP feature delivery
 - NSA opt. 3x for 5G NR integration with existing deployed eNodeBs
 - LTE CUPS for optimal local break-out with GW-U at distributed sites
 - 5G SA with delivery of integrated UPF, SMF, AMF, PCF & AUSF/UDM
- 5G-ready integrated MG, MM, PC & SDM network functions on statefully redundant, two 1RU server footprint
- Throughput increase to 20 Gbps
- On-board, local GUI management for ease of operations
- End to end network management via NSP

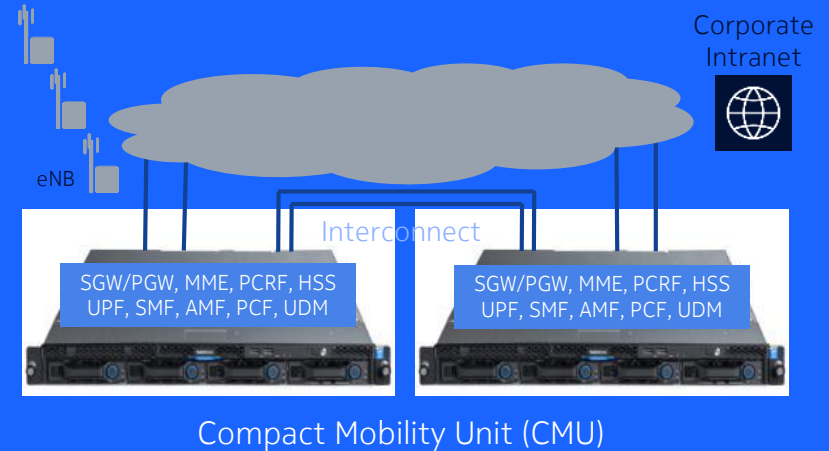
Nokia Enterprise Core Solution

Continuous Evolution

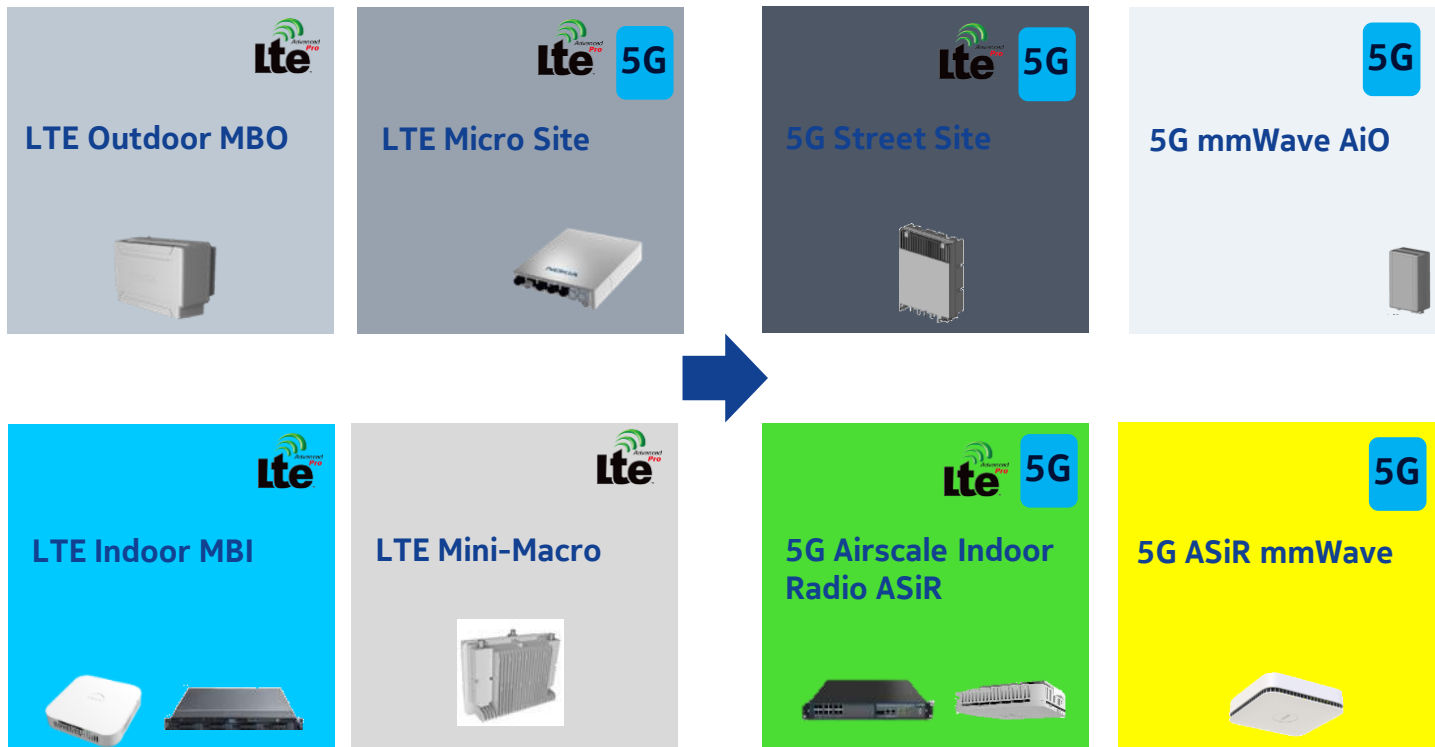
Nokia Enterprise Core Solution Today



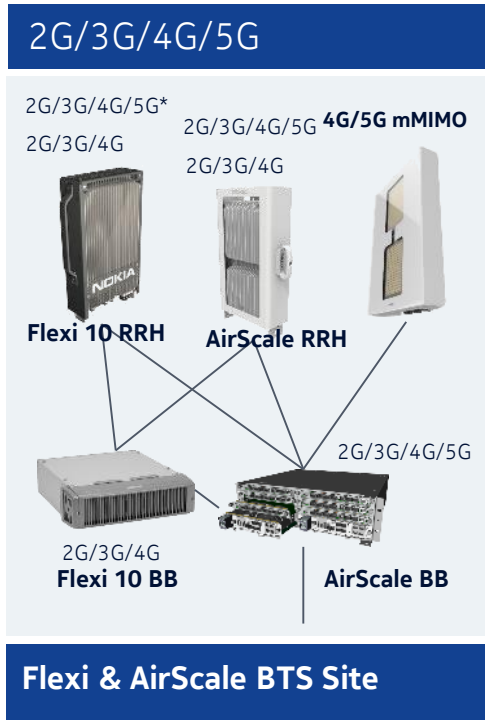
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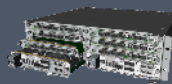
Nokia Small Cells



Nokia BTS



New development focus



AirScale SM

Multi-RAT: 2G, 3G, 4G, 4.5G, 4.5G Pro, 4.9G

5G Roll-outs

- Wide bandwidth support
- mMIMO support
- Adaptability to 3GPP specification evolution

4G high capacity optimization

- New sites and site expansions
- Centralized baseband

Outdoor installation optimization

Go Allwhere.

Networking solutions for the new age of industry.

nokia.com/networks/go-allwhere

NOKIA