5G and the Impact on Infrastructure Deployment
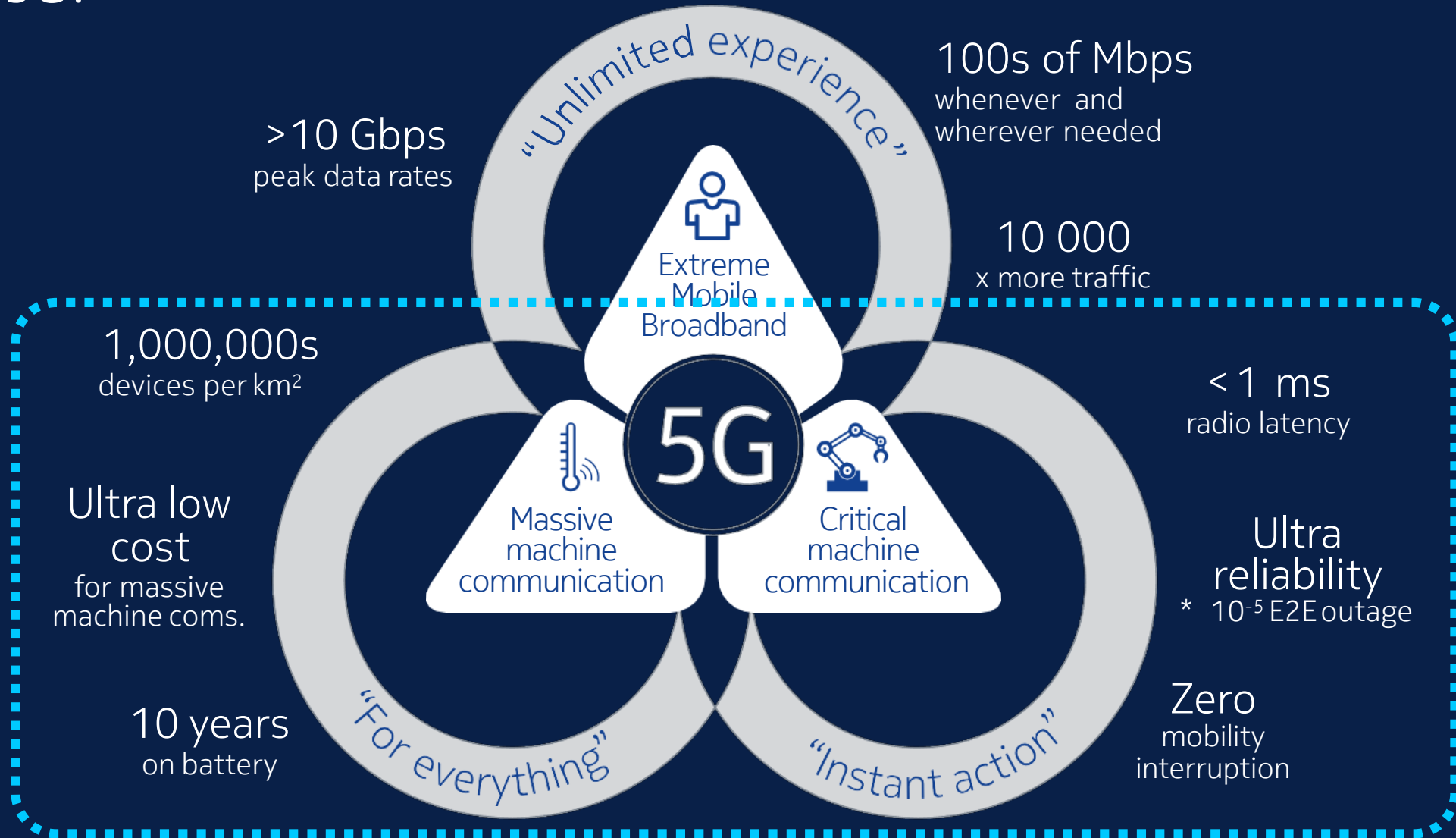
Mauricio SUBIETA, Ph.D.
Regional CTO – Energy Sector
August 8, 2019

Path to 5G
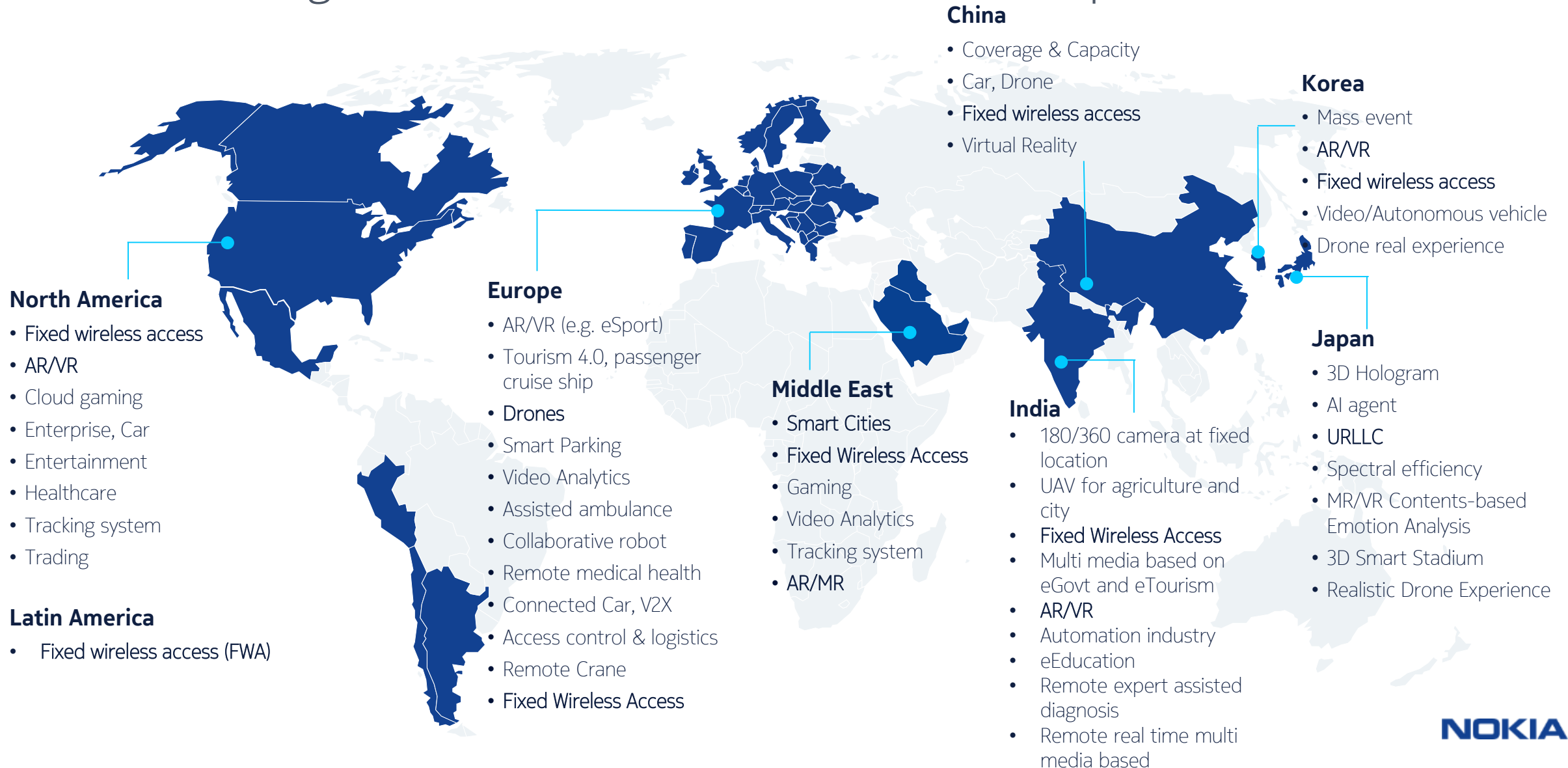
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What is 5G?

"Unlimited experience"

>10 Gbps
peak data rates

100s of Mbps
whenever and wherever needed

10 000
x more traffic

Extreme Mobile Broadband

1,000,000s
devices per km^2

5G

< 1 ms
radio latency

Ultra low cost
for massive machine coms.

Massive machine communication

Critical machine communication

Ultra reliability
* 10^{-5} E2E outage

10 years
on battery

"For everything"

"Instant action"

Zero mobility interruption

3GPP Features for Mission Critical Applications

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Already in the early stage 5G enables numerous use-cases
Markets and segments have different use-case focus & priorities

China
- Coverage & Capacity
- Car, Drone
- **Fixed wireless access**
- Virtual Reality

Korea
- Mass event
- **AR/VR**
- **Fixed wireless access**
- Video/Autonomous vehicle
- Drone real experience

North America
- **Fixed wireless access**
- **AR/VR**
- Cloud gaming
- Enterprise, Car
- Entertainment
- Healthcare
- Tracking system
- Trading

Europe
- AR/VR (e.g. eSport)
- Tourism 4.0, passenger cruise ship
- **Drones**
- Smart Parking
- Video Analytics
- Assisted ambulance
- Collaborative robot
- Remote medical health
- Connected Car, V2X
- Access control & logistics
- Remote Crane
- **Fixed Wireless Access**

Middle East
- Smart Cities
- **Fixed Wireless Access**
- Gaming
- Video Analytics
- Tracking system
- **AR/MR**

India
- 180/360 camera at fixed location
- UAV for agriculture and city
- **Fixed Wireless Access**
- Multi media based on eGovt and eTourism
- **AR/VR**
- Automation industry eEducation
- Remote expert assisted diagnosis
- Remote real time multi media based

Japan
- 3D Hologram
- AI agent
- **URLLC**
- Spectral efficiency
- MR/VR Contents-based Emotion Analysis
- 3D Smart Stadium
- Realistic Drone Experience

Latin America
- Fixed wireless access (FWA)

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5G E2E Future Network requirements

Extreme Performance	On Demand Slices	Self-driving
10 – 20x capacity (80% driven by Video consumption)	Cloud Native	TCO gain
<1ms network latency (driven by industrial automation)	Efficient	AI/ML driven
6x9 reliability (driven by industrial automation)	Service based	Open Architecture

Today's architectures require transformation

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5G is a Giant Leap

Endless possibilities		

	Today	2020-25
Users	10M people	+100M 'things'
Speed	100 Mbps	100x faster
Latency	>>10 ms	10x less
NW service level	Best effort for all	Committed SLAs
Logical networks	1	Many (slices)

Smart home

Mobile gaming

Industry 4.0

Connected cars

Drones

IoT wearables

5G is powered by a set of new or enhanced technologies

Endless possibilities

New technologies

Requirements

Capacity

>10 Gbps
peak data rates

100s Mbps
whenever and
wherever
needed

5G

Latency

<1 ms
radio latency

Connectivity

1,000,000s
devices per km²

10 years
on battery

Reliability
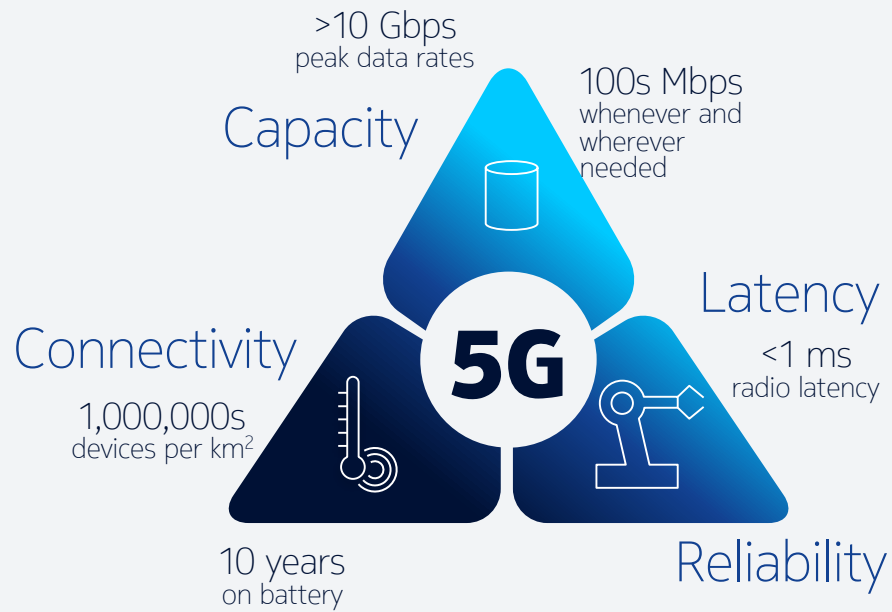
New 5G technology building blocks

New spectrum options

<3 GHz, 3-6 GHz, cm/mmWave

Massive MIMO & beamforming

Flexible air interface
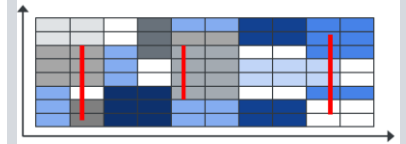
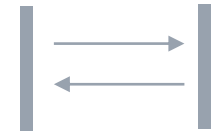### Multi-connectivity

Aggregation and duplication

Cloud native & network slicing

eMBB
URLLC
mMTC

Centralized and distributed

Connectionless communication

Efficient massive IoT

5G Future X architecture for an E2E solution
Bell Labs Research
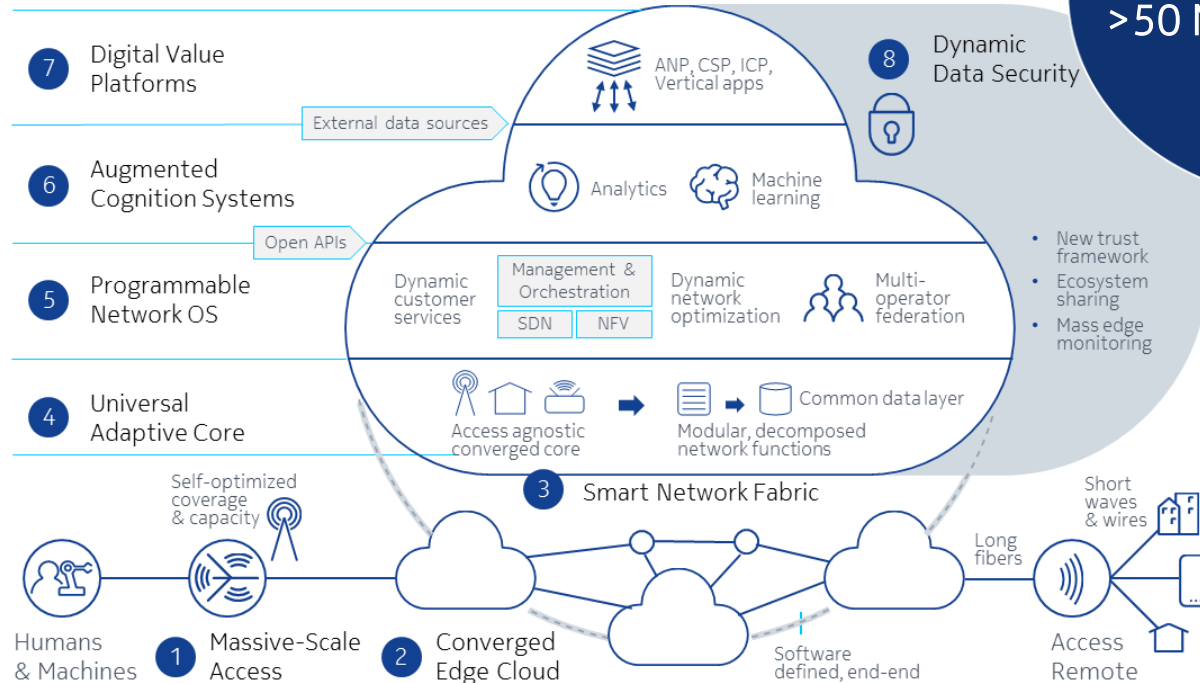
5G E2E Network Solution >50 Nokia & 3rd party products

Pre-tested / validated: time-to-market, TCO savings

E2E Convergence: SDN, services, security

Full cloud-native: Infrastructure to orchestration

7 Digital Value Platforms

6 Augmented Cognition Systems

5 Programmable Network OS

4 Universal Adaptive Core

External data sources

Open APIs

ANP, CSP, ICP, Vertical apps

8 Dynamic Data Security

Analytics

Machine learning

Dynamic customer services

Management & Orchestration

SDN   NFV

Dynamic network optimization

Multi-operator federation

- New trust framework
- Ecosystem sharing
- Mass edge monitoring

Access agnostic converged core

Modular, decomposed network functions

Common data layer

Self-optimized coverage & capacity

3 Smart Network Fabric

Humans & Machines

1 Massive-Scale Access

2 Converged Edge Cloud

Software defined, end-end

Long fibers

Short waves & wires

Access Remote

Simplifying 5G Network Deployment Supporting DSP Differentiation

Convergence
across access, platforms and services

Cloud-native
Automation and microservices

Openness
Interfaces, Analytics & community support
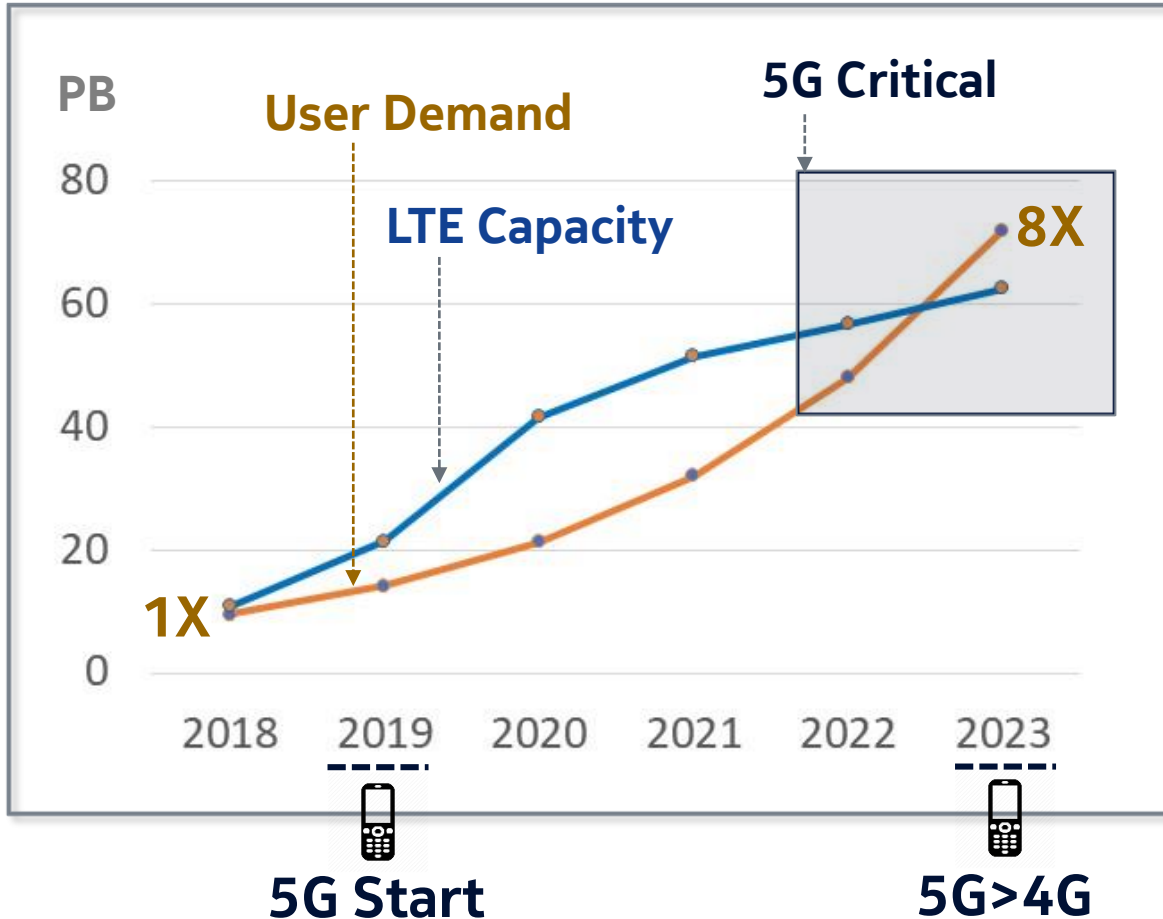
Efficiency
For time-to-market and TCO

Innovative portfolio
Leverage advances in AI & ML

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Capacity forecast - Driver for infrastructure change and evolution
US Customer Example

Highlights

McKinsey shows 2020

- LTE exhaust in 2022
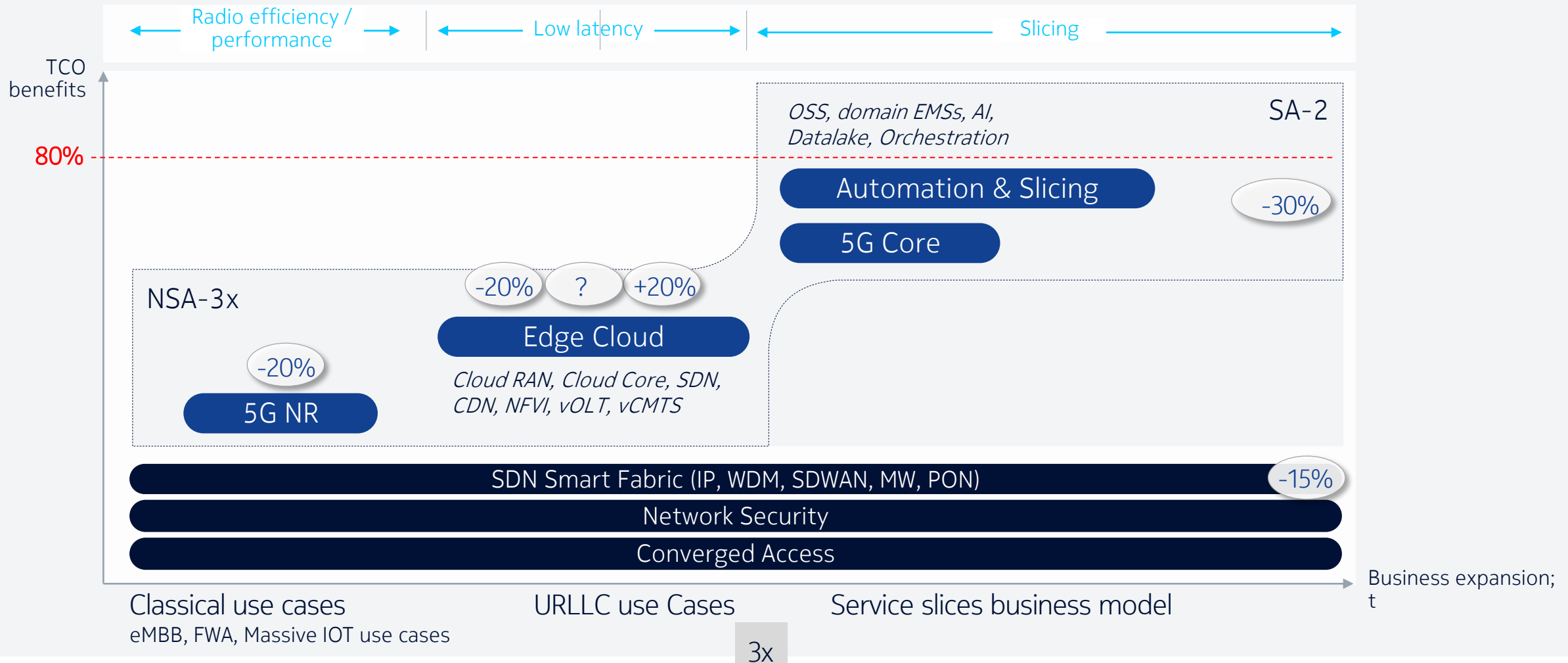- 5G devices dominate by 2023
- LTE+5G capacity plan needed

LTE capacity growth, with 5G acceleration.
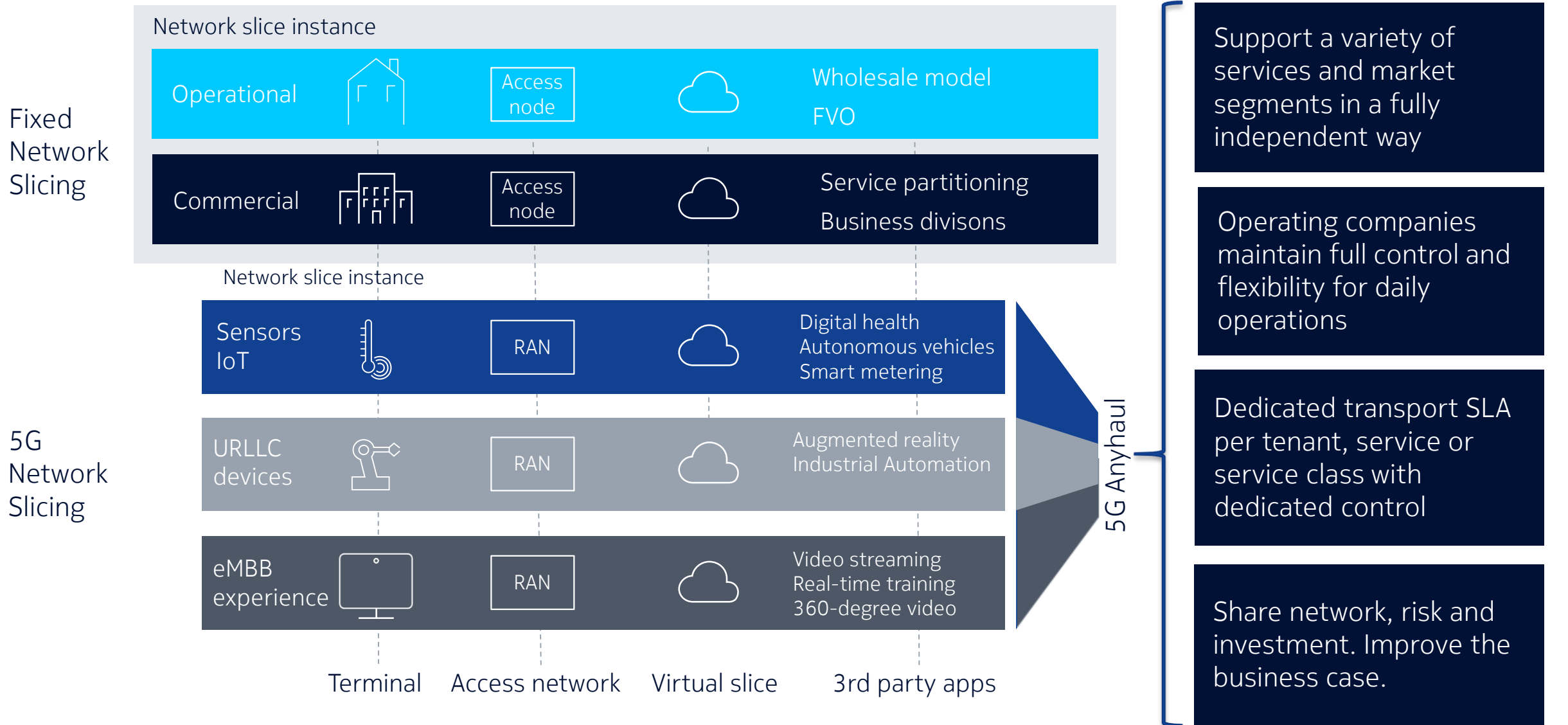
No other options!

*mMIMO applied on >1GHz, LTE @5% densification/yr.
*Mobile churn rate @21%

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Evolution Towards an Open, Cloud Native and Dynamic Architecture
Driven by use cases and business strategy

Radio efficiency / performance — Low latency — Slicing

TCO benefits

80%

OSS, domain EMSs, AI, Datalake, Orchestration

SA-2

Automation & Slicing

5G Core

-30%

NSA-3x

-20% ? +20%

Edge Cloud

Cloud RAN, Cloud Core, SDN, CDN, NFVI, vOLT, vCMTS

-20%

5G NR

SDN Smart Fabric (IP, WDM, SDWAN, MW, PON)   -15%

Network Security

Converged Access

Business expansion; t

Classical use cases
eMBB, FWA, Massive IOT use cases

URLLC use Cases

Service slices business model

3x

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Network Slicing Goes Beyond Traditional Wholesale Models

Fixed Network Slicing

Network slice instance

Operational	🏠	Access node	☁	Wholesale model FVO
Commercial	🏢	Access node	☁	Service partitioning Business divisons

Network slice instance

5G Network Slicing

Sensors IoT	🌡	RAN	☁	Digital health Autonomous vehicles Smart metering
URLLC devices	🦾	RAN	☁	Augmented reality Industrial Automation
eMBB experience	🖥	RAN	☁	Video streaming Real-time training 360-degree video

Terminal   Access network   Virtual slice   3rd party apps

5G Anyhaul

- Support a variety of services and market segments in a fully independent way

- Operating companies maintain full control and flexibility for daily operations

- Dedicated transport SLA per tenant, service or service class with dedicated control

- Share network, risk and investment. Improve the business case.

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5G as foundation to evolve 4G and new markets

MBB   Evolution   Expansion   Diversification

4G → 5G → 5G → 5G

capacity speed

FWA, AR/VR, mIoT

Industrial automation

With more options for better network economics

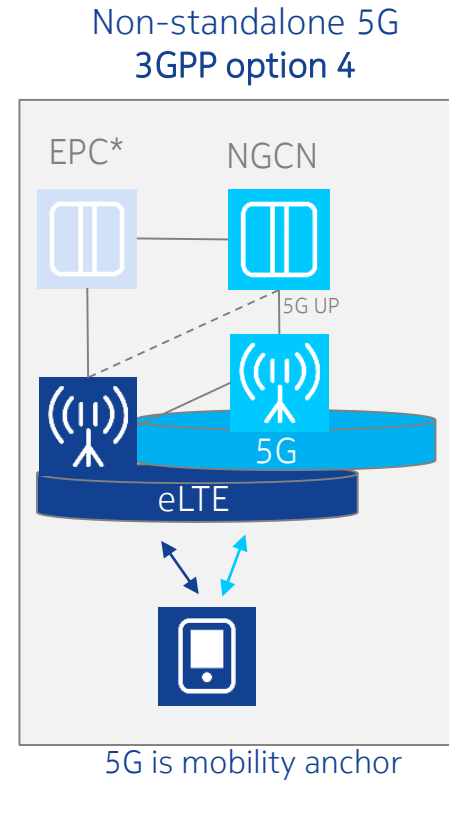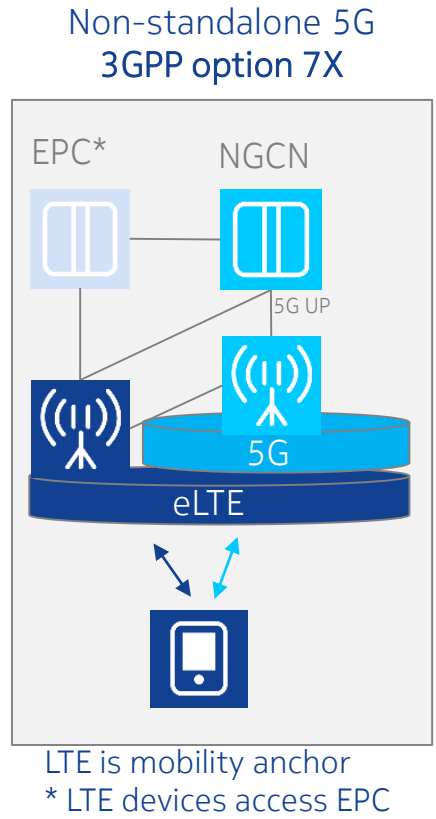**1** Traffic
Demand satisfied
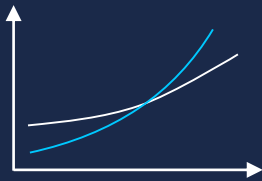
2 P&L
Improvement
REVENUE

COST
Network & Operations

3 Assets
Better use
- Spectrum
- Real estate
- Subscribers

5G enables creation of the new network value

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Main 3GPP architecture options for 5G deployment

Non-standalone 5G
3GPP option 3X

EPC

5G UP

LTE UP

5G

LTE

LTE is mobility anchor

Non-standalone 5G
3GPP option 7X

EPC*   NGCN

5G UP

5G

eLTE

LTE is mobility anchor
* LTE devices access EPC

Non-standalone 5G
3GPP option 4

EPC*   NGCN

5G UP

5G

eLTE

5G is mobility anchor

Standalone 5G
3GPP option 2

NGCN

5G

5G is mobility anchor
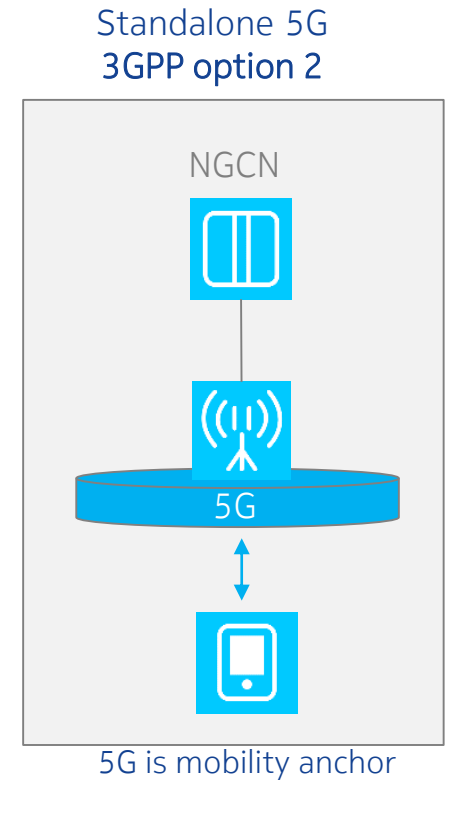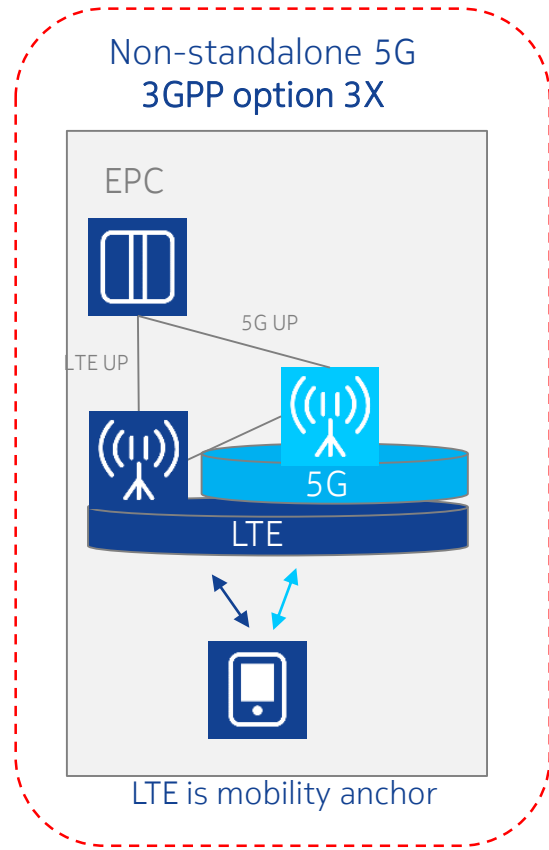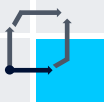
3X is starting
point for many

Many see 2 as
their end target

- 5G relies on LTE network and coverage
- Enhanced mobile broadband

- Ubiquitous 5G coverage
- Full support for 5G services (high bit rate, ultra low latency and reliable)

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It's all about user experience gain – driven by edge cloud processing

New augmented experiences

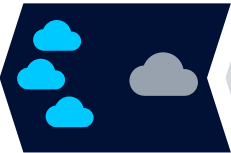Augmented, Virtual and Mixed Reality

Cloud gaming
Fixed/mobile services

Up to 70% less user device power consumption

Enabling new mass markets

Users

Operator
Latency & localization

Webscale players & App community

Optimal datacenter topology deployment, example US
Minimal latency, geo-redundancy and capacity sharing among clouds

~30000
far edges

~4000
aggregated edges

1 ms latency

in cities >10 000 inhabitants

● City >10 000 inhabitants

● Edge-cloud

Source: Nokia BellLabs & TUM Technical University of Munich
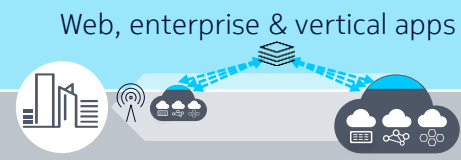
Edge clouds for distributed processing

Key success factors

Edge deployment & operation

E2e design tools and operation

Openness to onboard new VNFs and apps

Web, enterprise & vertical apps

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5G Migration Path Requirements

Migration to 5G – Streams and Steps

Access Site **Edge Site** **Central Site**

4G
LTE RAN
EPC Core — Apps/Contents

5G (with down arrow)
LTE RAN
5G C-plane via LTE → 5G NR
EPC Core — Apps/Contents

5G
Multi Access / Multi Use cases
centralization → ← distribution
Automation/Analytics/AI
Distribution/Local
NW Slices
Apps/Contents
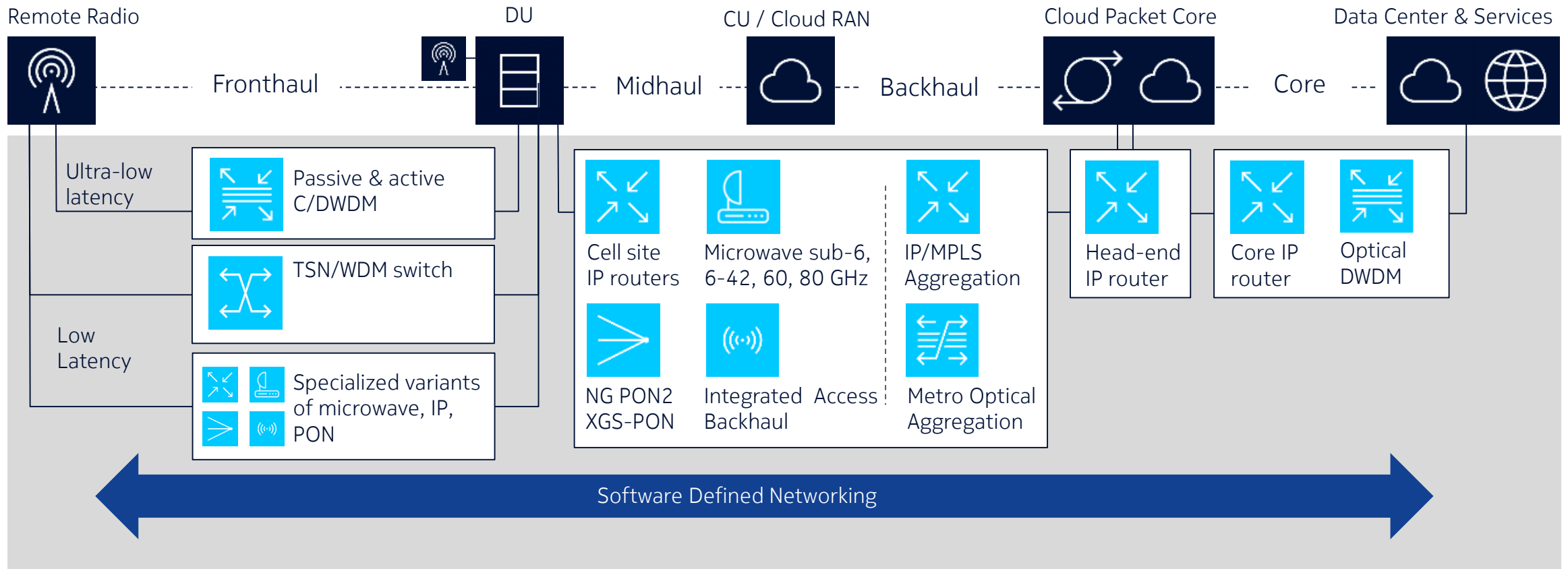C-plane
U-plane
5G Core
Smart Fabric (SDN, IP/MPLS, Optical)
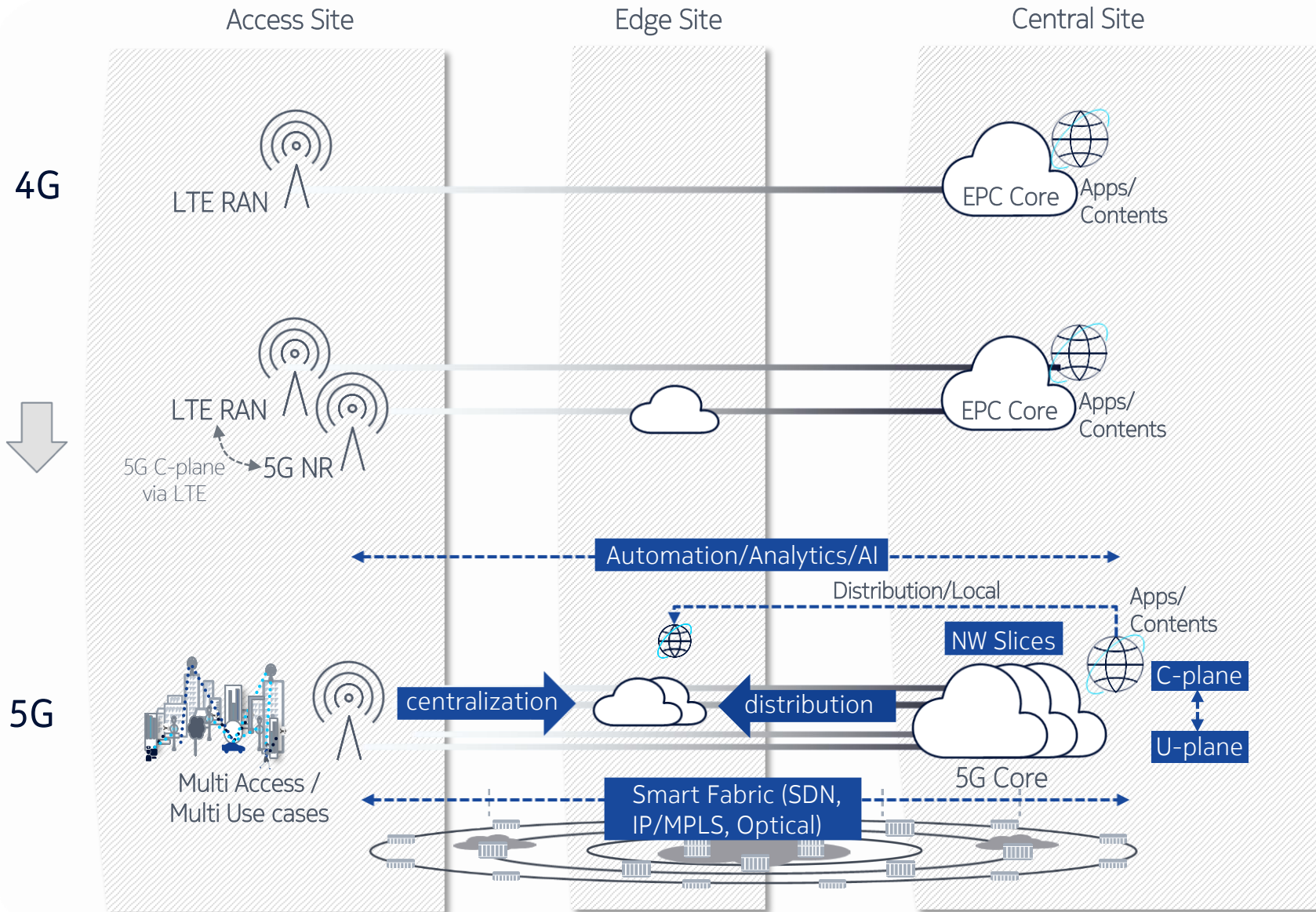
The 6 streams towards 5G E2E

1. DC infrastructure (distributed and cloud native)

2. Centralized Radio

3. Transport transformation (Smart Fabric)

4. Separation from User and Control Plane

5. Distribution - content, functions & services

6. Automation, orchestration incl. AI
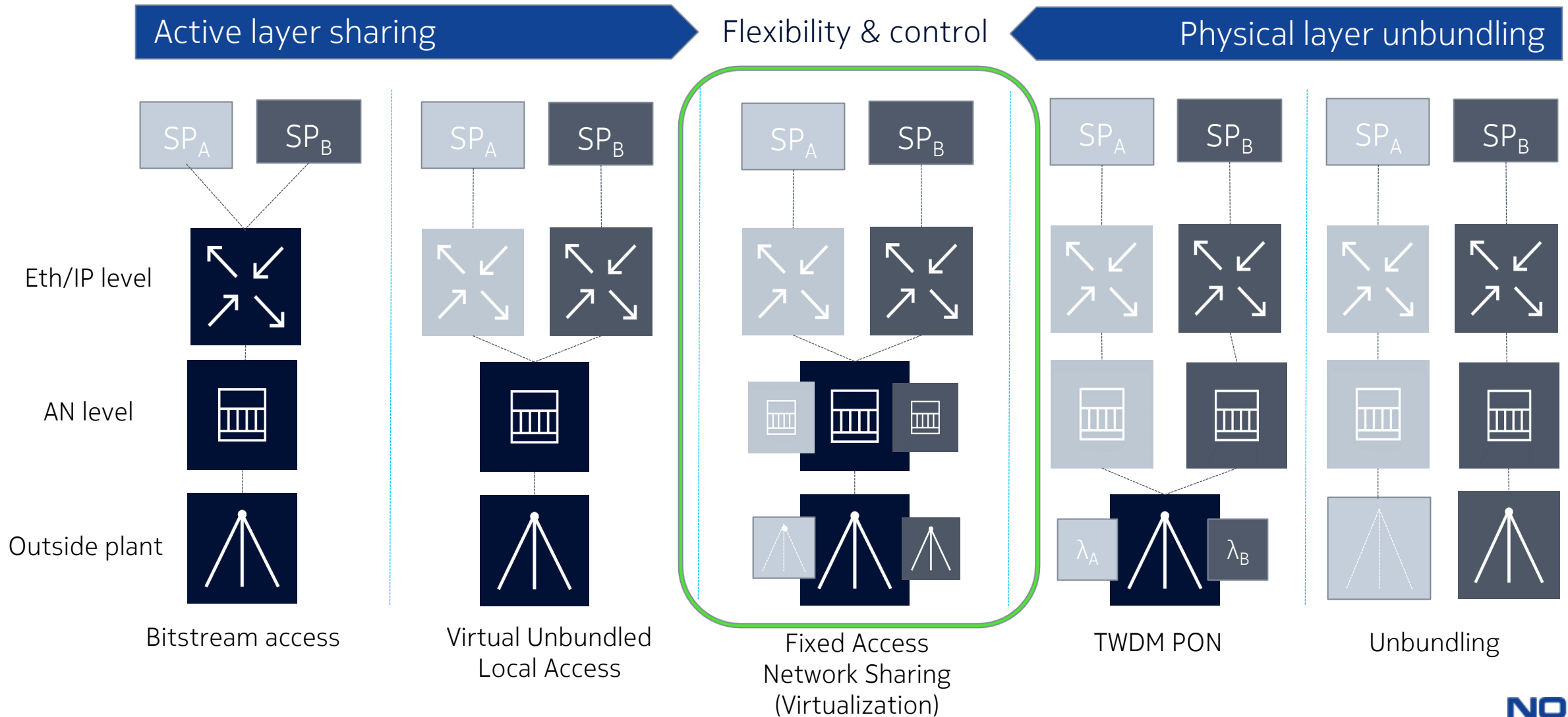
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Cloud RAN and 5G Transport Requirement Overview
End-to-end programmability, flexibility and performance

Remote Radio | DU | CU / Cloud RAN | Cloud Packet Core | Data Center & Services

Fronthaul ---- Midhaul ---- Backhaul ---- Core ----

Ultra-low latency

Passive & active C/DWDM

TSN/WDM switch

Low Latency

Specialized variants of microwave, IP, PON

Cell site IP routers

Microwave sub-6, 6-42, 60, 80 GHz

IP/MPLS Aggregation

NG PON2 XGS-PON

Integrated Backhaul   Access

Metro Optical Aggregation

Head-end IP router

Core IP router

Optical DWDM

Software Defined Networking

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Sharing network infrastructure tomorrow
Virtualization and Slicing

Active layer sharing ▶ Flexibility & control ◀ **Physical layer unbundling**

Eth/IP level

AN level

Outside plant

Bitstream access	Virtual Unbundled Local Access	Fixed Access Network Sharing (Virtualization)	TWDM PON	Unbundling

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5G - Key considerations about site solutions
Nokia will help to define an optimal deployment

Key Aspects to be considered while defining 5G Greenfield / Overlay sites

New massive MIMO adaptive antennas with radio units:

- Mast / tower strengthening
- Wind load assessment
- Energy consumption
- Power back-up
- Fronthaul requirements
- Site solutions

AirScale system modules: New, sharing & expansions

- Cabinet requirements
- Additional Common & capacity modules

5G Edge cloud & Far Edge cloud

- Backhaul requirements
- Power back-up
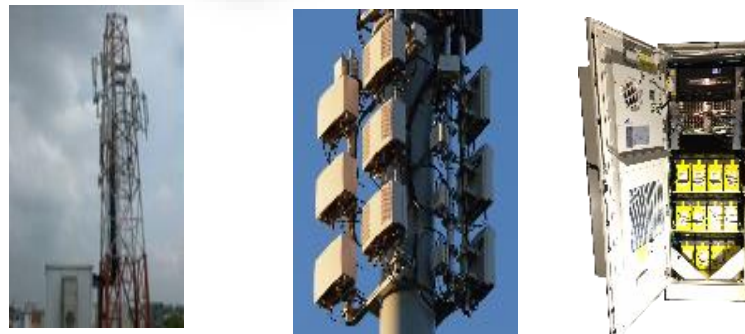- Data center requirements

Modernization of existing RATs

Upgrade infrastructure to optimize tower space, power, cabinets etc.

- Upgrading radio units
- Antenna modernization
- Power back-up expansion
- Backhaul upgrades
- Cabinet upgrades
- Site solutions
- Implementation options

Nokia 5G Deploy Services will help to find the optimal site solutions

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Evolution to 5G – Implementation Scope
Deployment scenarios, network elements and migration steps
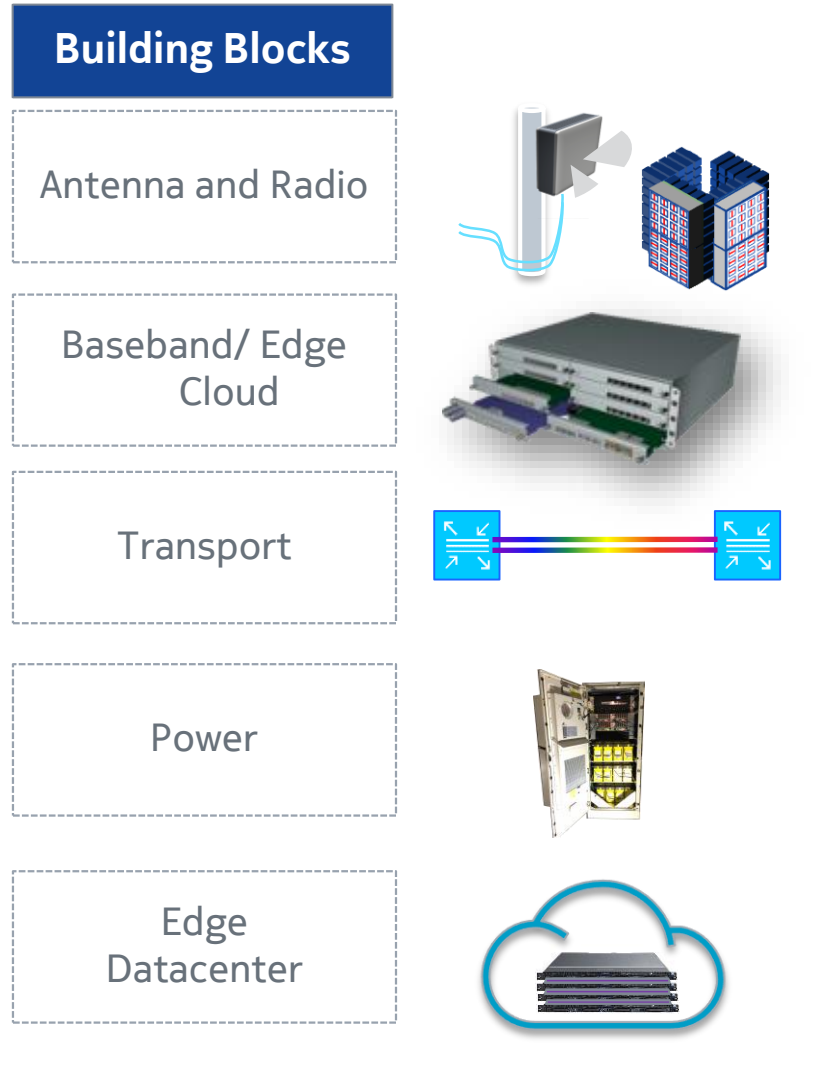
Building Blocks		Activity	Product	Services
Antenna and Radio		Antenna addition or Swapping	Mounting brackets for mMIMO Antenna; Cable and connectors	Implementation Services: o Tower strengthening, Windload analysis, Multiple Radio, Antenna mounting options. o Installation and Integration services
Baseband/ Edge Cloud		Baseband for SA, NSA in cloud and classic scenarios	QSFP Cables, Connectors, Cabinets	Cable installation, heat dissipation and mechanical compliances
Transport		Transport Augmentation / Modernization	Installation material, cables and connectors	o Installation, commissioning and integration
Power		Energy Augmentation /modernization	Rectifiers, batteries, e-fuse, inverters, cabinets & associated ancillaries	o Consultation related to grid specific solutions. o Installation commission and integration services
Edge Datacenter		Datacenter Services	Airframe Installation material, Cables, Spine racks HVAC, Security services	Installation commissioning and integration

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5G Site Evolution Consulting for cost-efficient introduction of 5G
Ensure future-proof site designs with optimized

Site Evolution Consulting for optimal 5G site build

- Site evolution for 5G introduction
- Define future-proof site designs for 5G deployment
- Site infrastructure re-use to optimize TCO

1 Antenna and radio Modernization

Antenna Optimization

Radio optimization/upgrade

2 Structure Space & Capacity

Static Wind load analysis & strengthening

Space limitation solutions; parapet/pol

Zero site densification

3 Baseband Housing & Connections

ID/OD housing scenarios

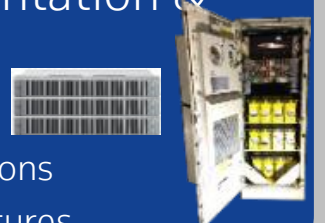Heat dissipation/mechanical compliancy

Fiber cabling eCPRI/QSFP

4 Backhaul Modernization

Upgrade the transport network to support backhaul, fronthaul or Midhaul as required by the RAN architecture
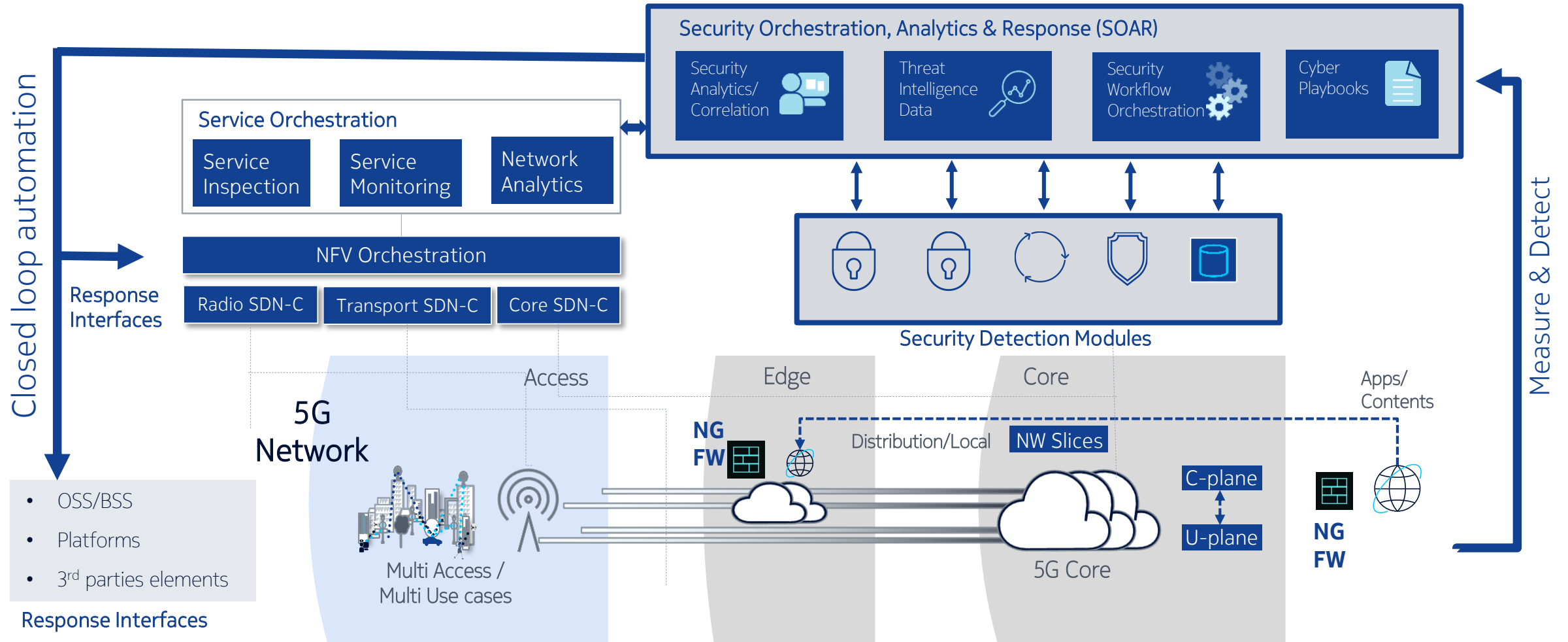
5 Energy Augmentation & Modernization

Zero footprint solutions

Related grid specific solutions

All in One Opex saving features

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5G E2E Network Security

Security Orchestration, Analytics & Response (SOAR)

Security Analytics/ Correlation

Threat Intelligence Data

Security Workflow Orchestration

Cyber Playbooks

Service Orchestration

Service Inspection

Service Monitoring

Network Analytics

NFV Orchestration

Radio SDN-C | Transport SDN-C | Core SDN-C

Security Detection Modules

Closed loop automation

Response Interfaces

Measure & Detect

Access

Edge

Core

Apps/ Contents

5G Network

NG FW

Distribution/Local

NW Slices

C-plane

U-plane

NG FW

Multi Access / Multi Use cases

5G Core

- OSS/BSS
- Platforms
- 3rd parties elements

Response Interfaces

Fusion of Threat Intelligence, Analytics & Automated Predictive Response to protect mobile network from advanced cyber-attacks

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Thank you!

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https://www.linkedin.com/in/msubieta