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5G INTRODUCTION

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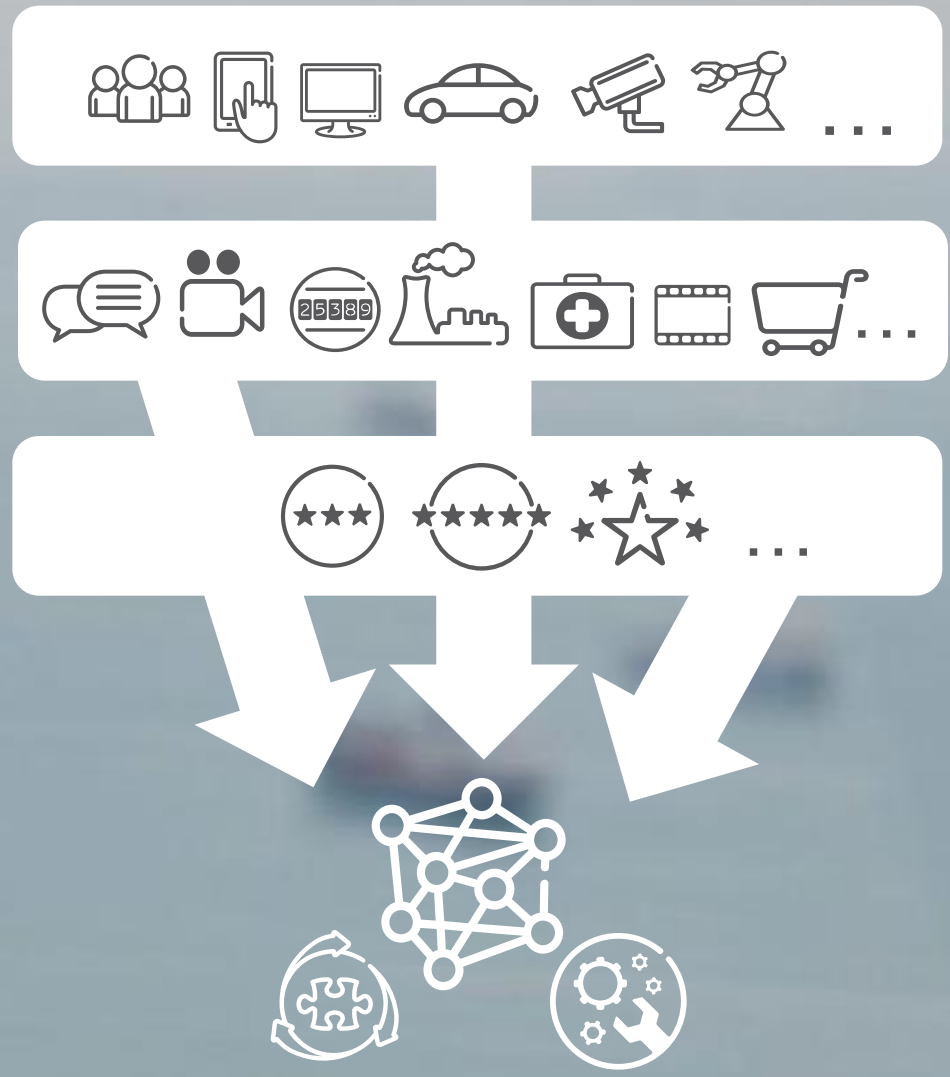
DEMAND 2020



Devices & Consumers

Applications & Industry

Service Providers

Network

INDUSTRY TRANSFORMATION

Traditional Industries

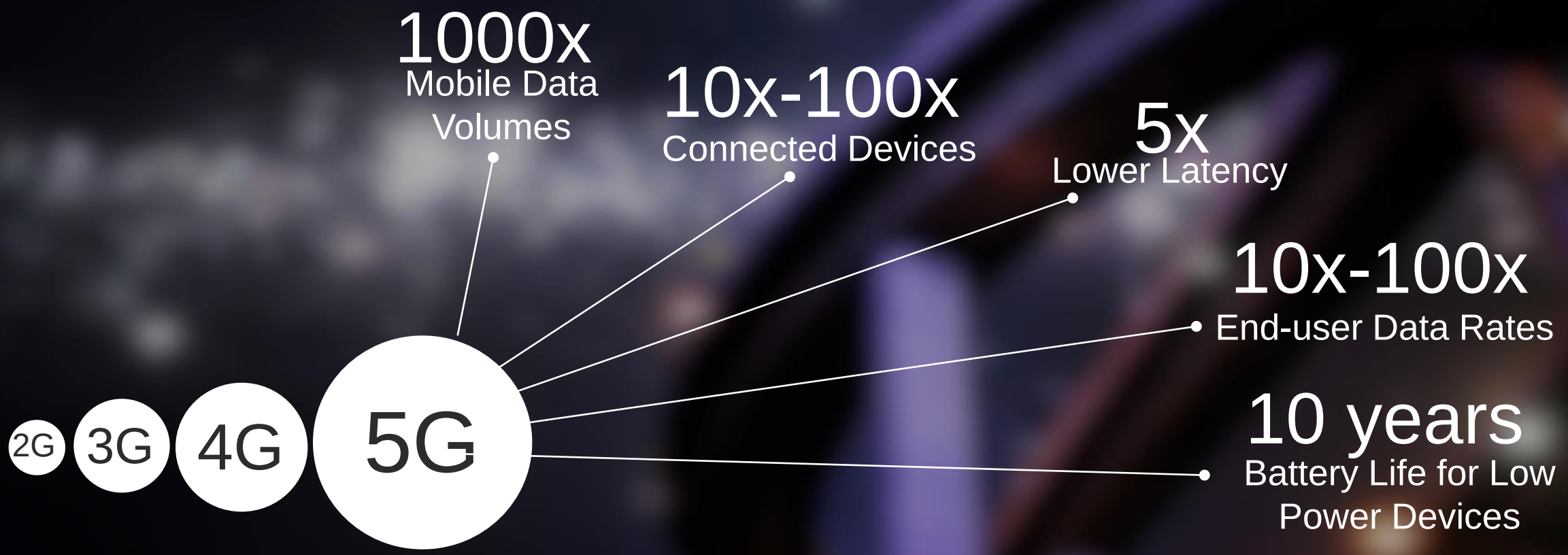
Digitalize & Mobilize

Transformed Industries

5G USE CASES

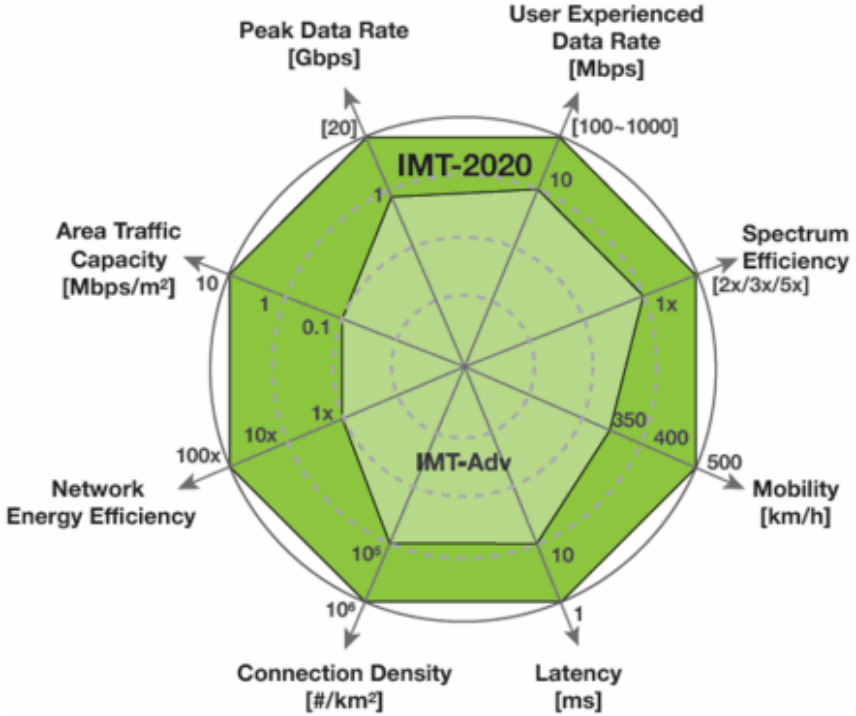
- SENSORS EVERYWHERE
- BROADBAND AND MEDIA EVERYWHERE
- SMART VEHICLES, TRANSPORT
- INFRASTRUCTURE, MONITOR AND CONTROL
- CRITICAL CONTROL OF REMOTE DEVICES
- INTERACTION HUMAN-IOT

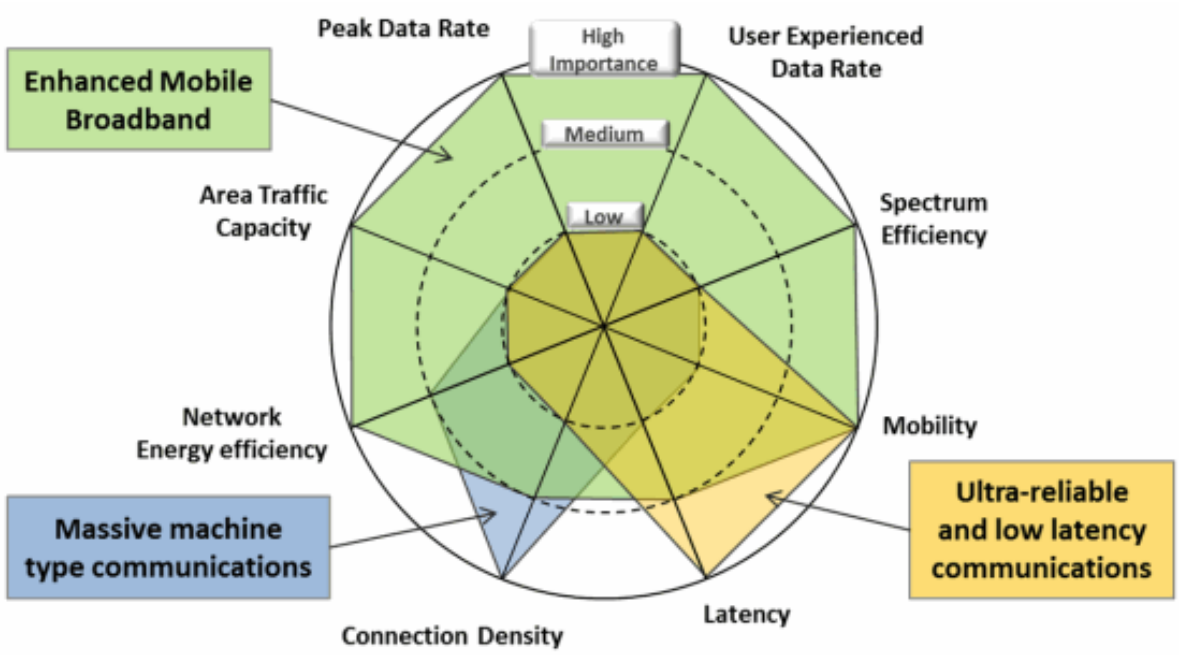
EVOLUTION TOWARDS 2020



Source: METIS, Ericsson AB

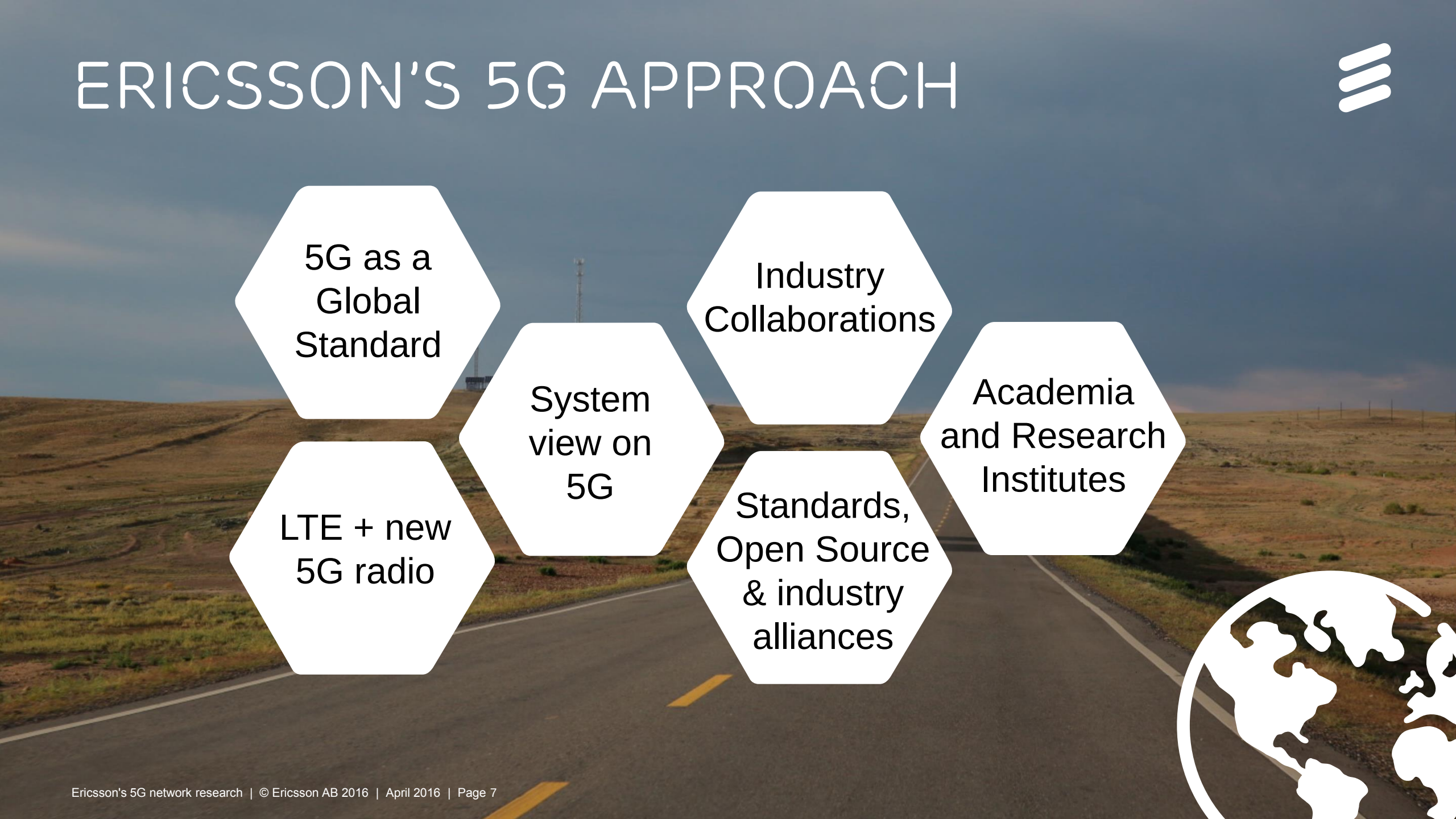
5G REQUIREMENTS





3GPP requirements expected in end-2016
IMT-2020 requirements expected finalized in mid-2017

ERICSSON'S 5G APPROACH



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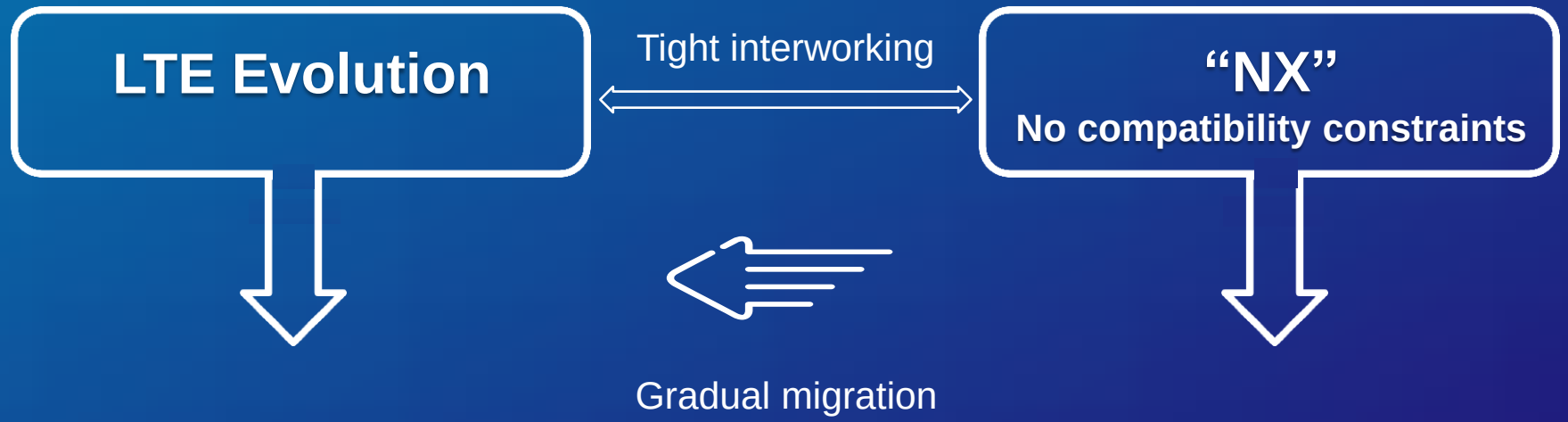
5G RADIO CONCEPT

5G RADIO ACCESS ~2020



"Existing" spectrum

Below 6 GHz

"New" spectrum

Above 6 GHz
New spectrum below 6 GHz

NX – KEY TECHNOLOGY FEATURES
MANY ALSO APPLY TO LTE EVOLUTION

Flexible, scalable and future-proof design

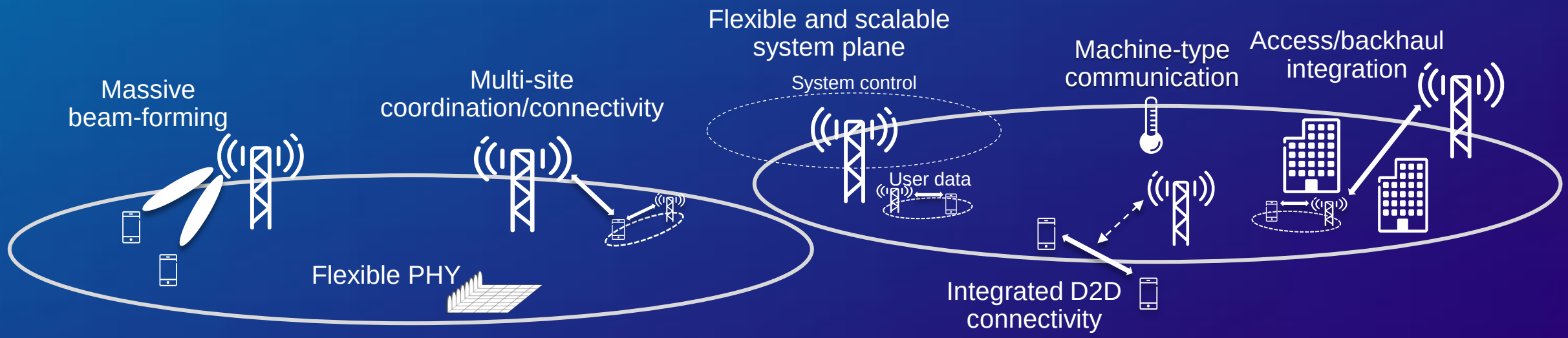
Spectrum

Deployment

Use cases

Ultra-lean design

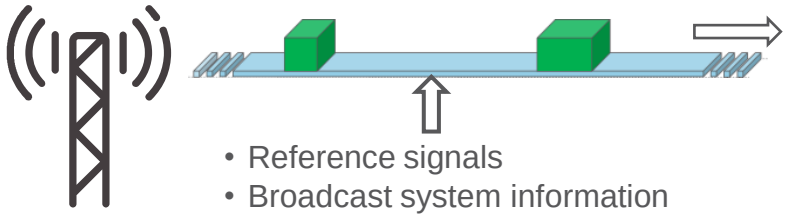
Energy efficient: minimize network transmissions not directly related to user data delivery



ULTRA-LEAN DESIGN

Minimize network transmissions not directly related to user-data delivery

Today



- Reference signals
- Broadcast system information
- ...

Ultra-lean

- No ”always-on” refeference signals
- Minimum amount of ”always-broadcast ”system information
- ...

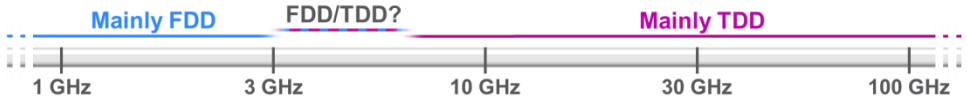
- Higher achievable data rates
- Enhanced network energy performance
- Future-proof design

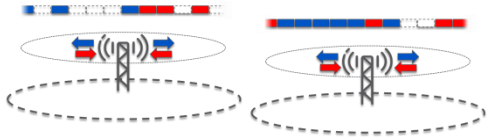
NX PHY DESIGN

High degree of symmetry

- Low-power base stations similar to devices
- Integrated D2D and radio based backhaul

Access schemes

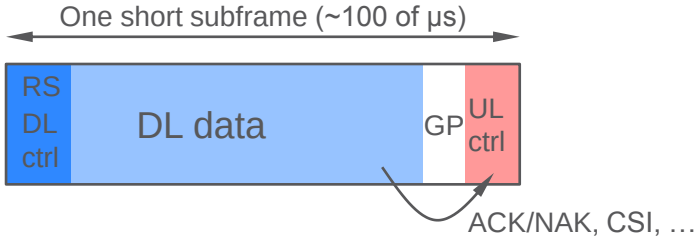




Time-domain structure

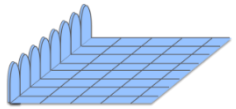
- Physical mapping enabling fast detection/decoding
- Self-contained subframes
- Avoid strict timing relations between subframes

Example: TDD

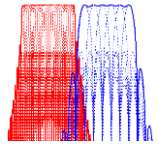


Waveform

- OFDM with flexible numerology



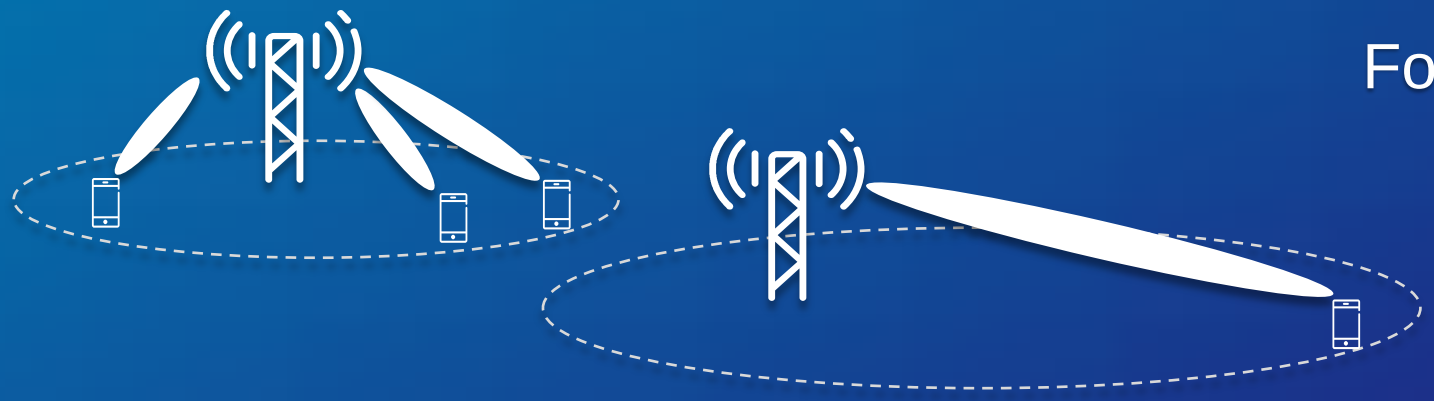
OFDM



Mixed numerology

BEAMFORMED TRANSMISSION

To enable the capacity, data rate, and coverage needed in the 5G era



For both high and low frequencies

For both NX and LTE

Beam-centric NX design

- Self-contained data transmissions
- “Beam mobility” – mobility between beams rather than nodes
- System plane matched to beam-formed user plane

ACCESS/BACKHAUL INTEGRATION

Today: Extensive use of radio backhaul

- Line-of-sight links to macro sites using dedicated technology in dedicated high-frequency spectrum

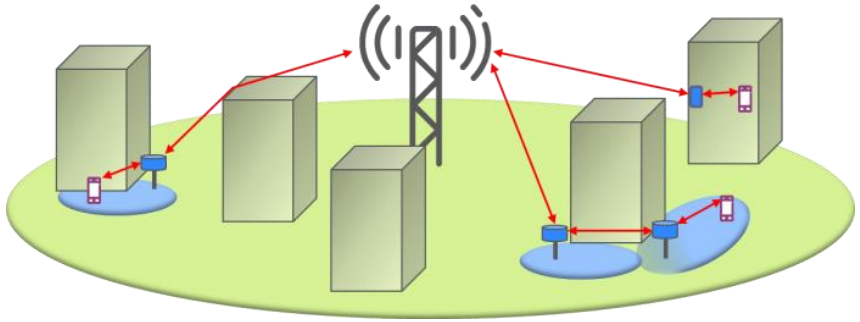
Tomorrow: Large number of low-power nodes

- Wireless backhaul must extend to non-LOS conditions
- Access link will extend to higher frequencies

Access and backhaul are becoming more similar

Access/Backhaul integration

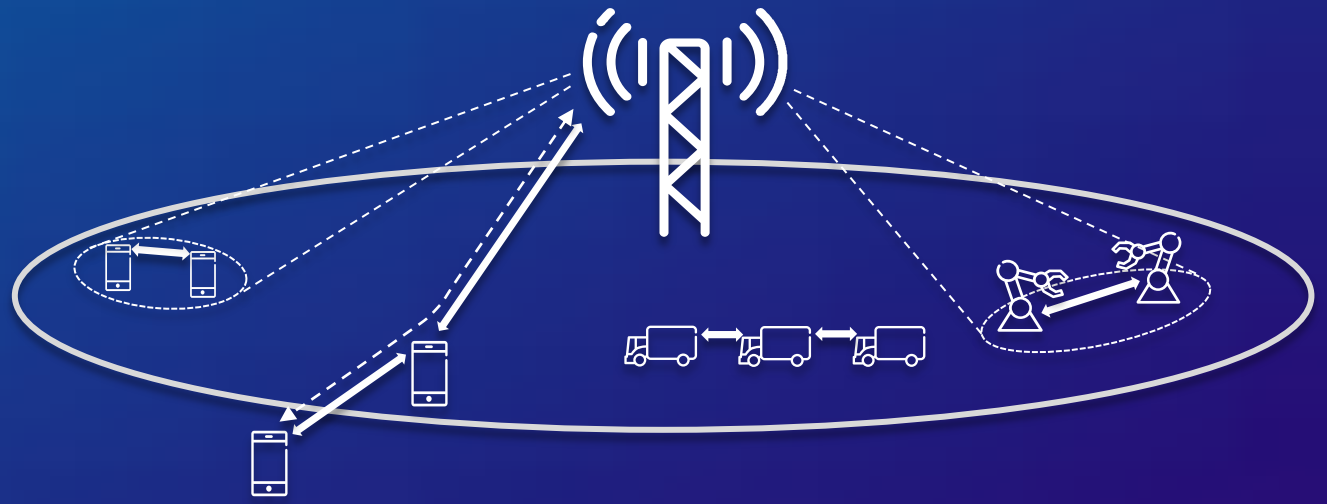
- Same technology for access and backhaul
- Joint spectrum pool for access and backhaul



- More efficient utilization of available spectrum
- Reduced operation and maintenance effort

DEVICE-TO-DEVICE CONNECTIVITY

- Device-to-device connectivity as a further step of extreme densification
- An integrated part of the overall radio-access network
- Under network control
- When beneficial from an efficiency or service-level point-of-view



HIGH FREQUENCY CHARACTERISTICS

Propagation

Diffraction

Outdoor-to-indoor penetration

Rain/atmospheric attenuation

(Less of an issue for small cells)

Body loss

Regulation

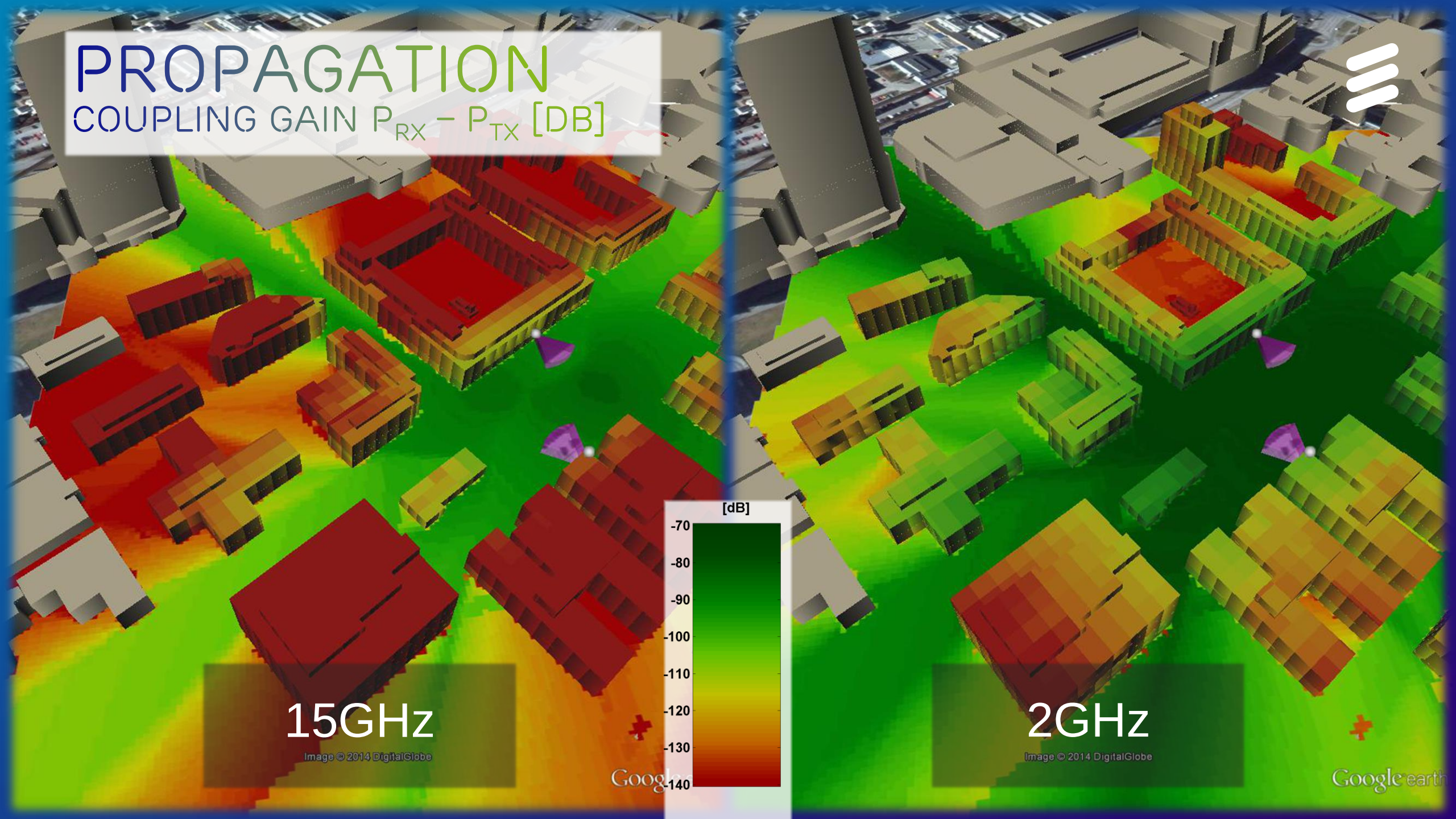
Tx power limitations above 6 GHz

Implementation

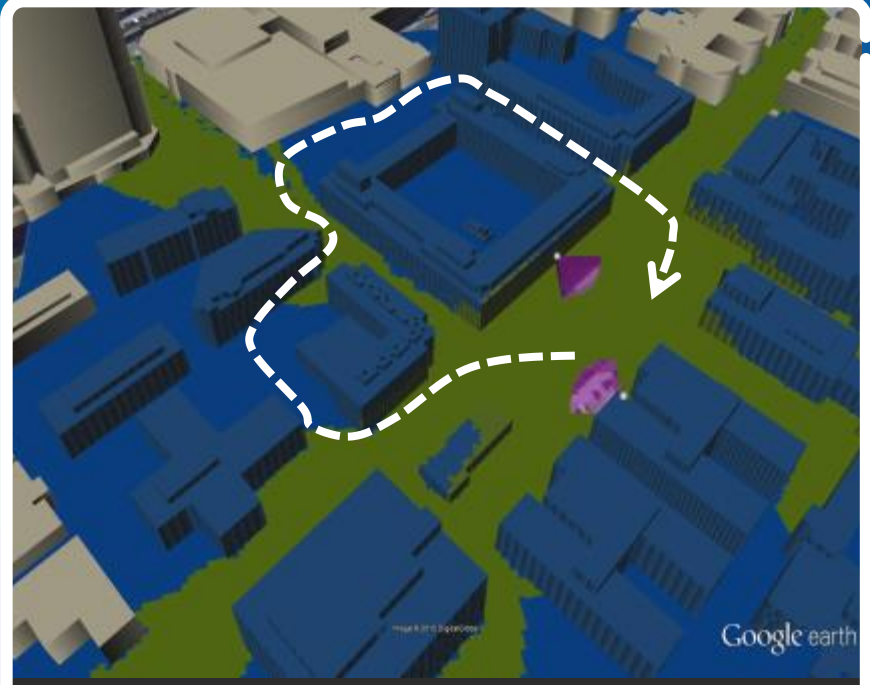
Efficiency, dynamic range, output power, antenna element size, …

PROPAGATION

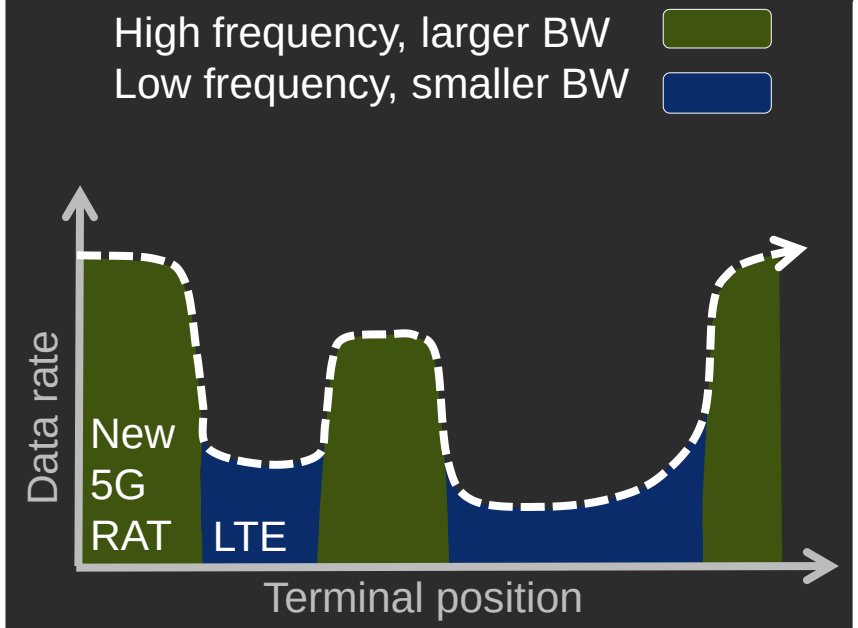
COUPLING GAIN $P_{RX} - P_{TX}$ [DB]



NX/LTE INTERWORKING



Example of possible RAT selection

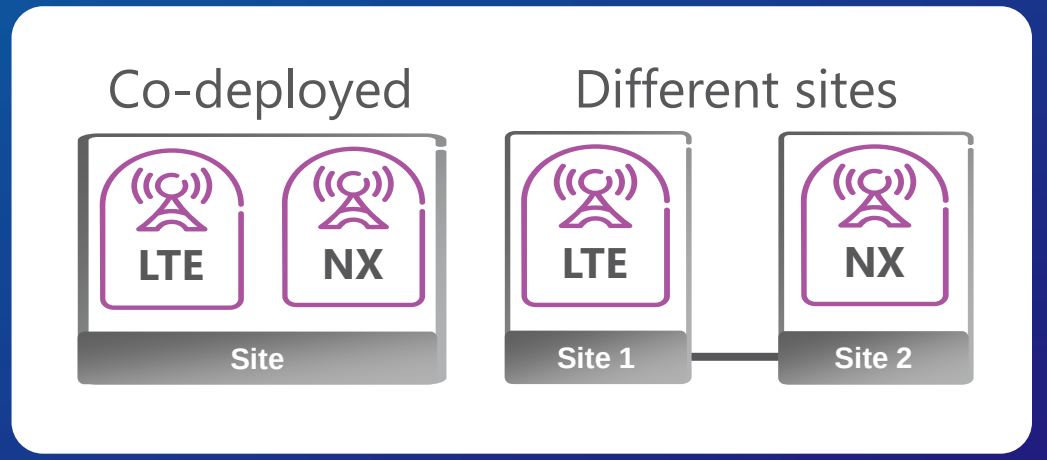


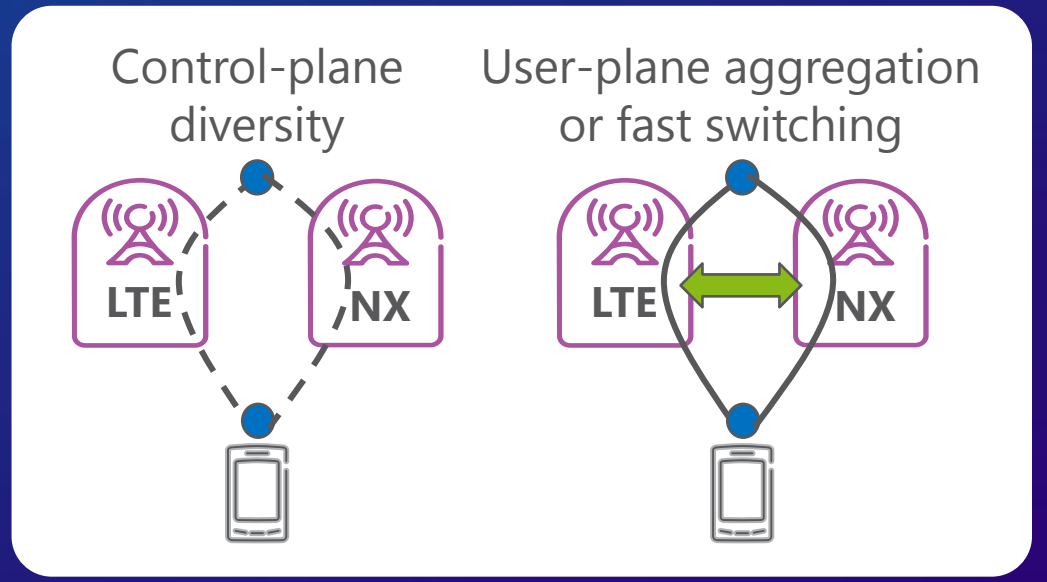
Combining low and high frequencies essential for end user experience

Tight interworking between LTE and NX is key to great end user experience

NX/LTE INTERWORKING

- Leverage LTE deployments when deploying NX on the higher frequency ranges
  - Coverage and performance reasons
- Support co-sited and non-co-sited deployments
- Supported using dual connectivity solutions
  - excellent mobility support using control-plane diversity
  - high user-plane throughput using user-plane aggregation or fast switching (depending on the scenario)





WIDE RANGE OF REQUIREMENTS

MASSIVE MTC

SMART BUILDING

LOGISTICS, TRACKING AND FLEET MANAGEMENT

SMART METER

SMART AGRICULTURE

CAPILLARY NETWORKS

CRITICAL MTC

REMOTE HEALTH CARE

TRAFFIC SAFETY & CONTROL

INDUSTRIAL APPLICATION & CONTROL

REMOTE MANUFACTURING, TRAINING, SURGERY

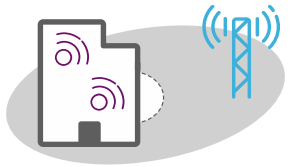
LOW COST, LOW ENERGY
SMALL DATA VOLUMES
MASSIVE NUMBERS

ULTRA RELIABLE
VERY LOW LATENCY
VERY HIGH AVAILABILITY

SOLUTIONS FOR CELLULAR IOT

GSM-EC

Global solution for Cellular IoT

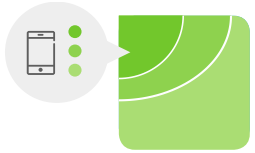


Supported on legacy GSM equipment

- GSM network efficiency
- No GSM unique HW
- GSM automation

THIN LAYER GSM

Leverage existing module eco-system

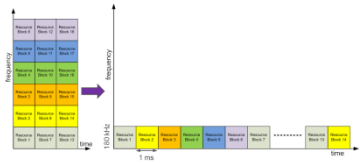


NB-IoT

Scalable ultra low-end Cellular IoT solution

Ultra-low bit rates & extreme coverage

Native narrowband LTE solution



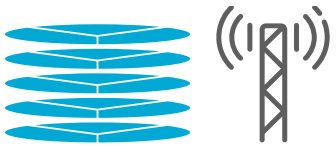
Part of LTE evolution to 5G

LTE CAT-M

Broadest range of Cellular IoT capabilities

Wide range of bit rates enabling advanced applications

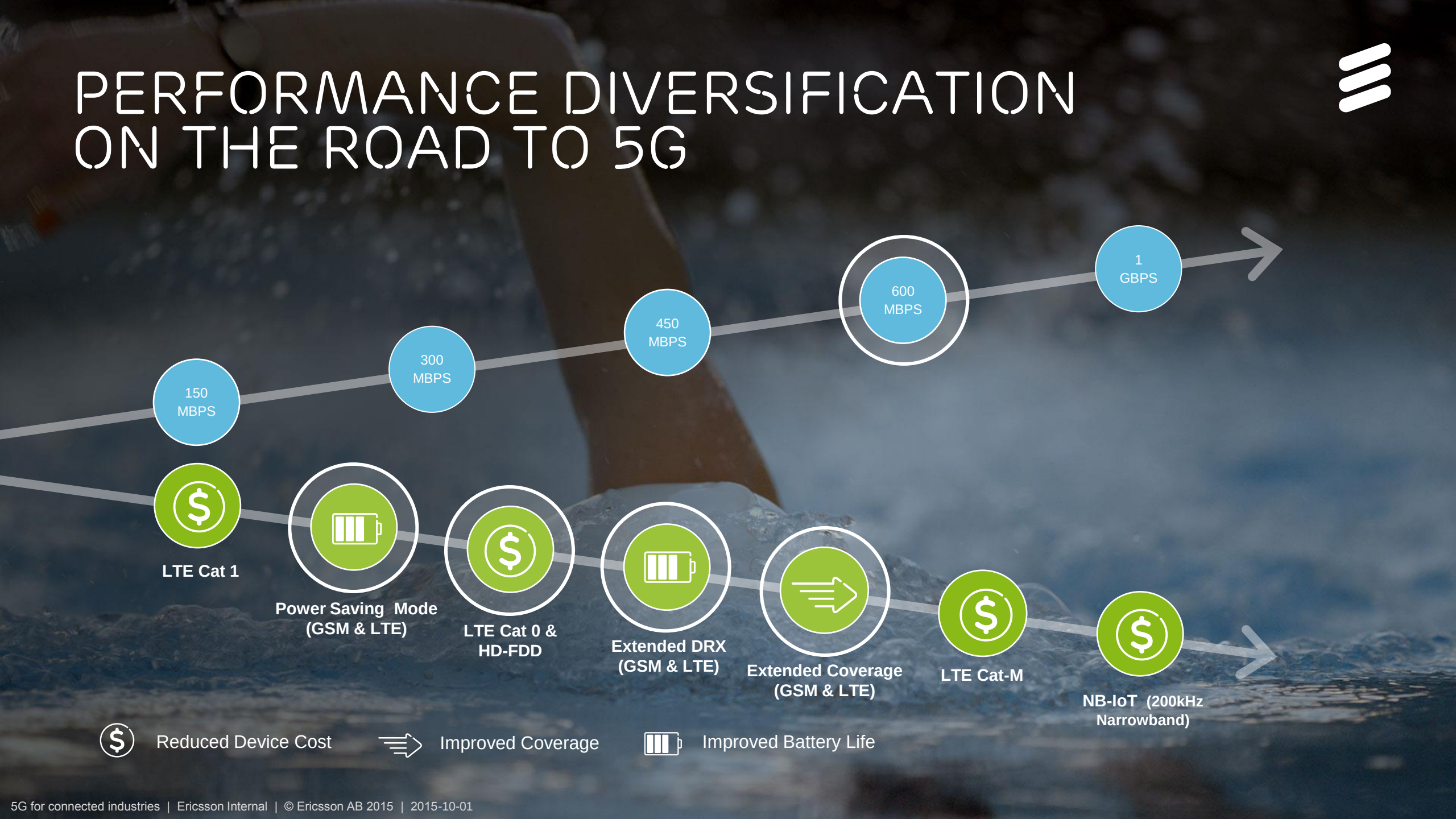
Efficient co-existence with MBB traffic



- Reduced Device Cost
- Improved Coverage
- Improved Battery Life

OPERATE AS ONE NETWORK

PERFORMANCE DIVERSIFICATION ON THE ROAD TO 5G

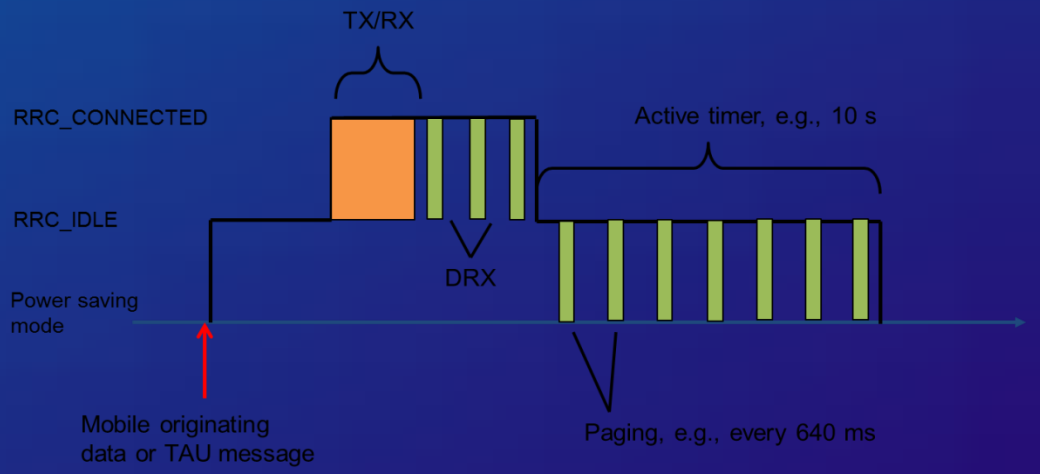


DEVICE ENERGY EFFICIENCY

- Example: LTE Rel-12 power-saving mode
  - UE performs periodic tracking area update (TAU) after which it stays reachable for paging during a configurable time
  - Otherwise the UE stays in a power-off like mode, not reachable, but still registered

Reachability (TAU cycle)	UL data inter-arrival time		
	15 min	1 hour	3 hour
15 min	9.2 years	10.0 years	10.2 years
1 hour	9.2 years	16.1 years	16.7 years
3 hour	9.2 years	16.1 years	19.4 years

Cell edge, 64/84 kb/s UL/DL, 2xAA with 4% self-discharge



- (Rel-8 LTE can achieve 1.1 years with max DRX cycle 2.56 s)

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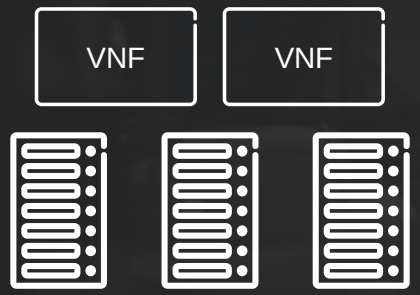
NETWORK ARCHITECTURE

5G READY CORE NETWORK COMPONENTS

Management & Orchestration, Analytics & Exposure

Virtualization

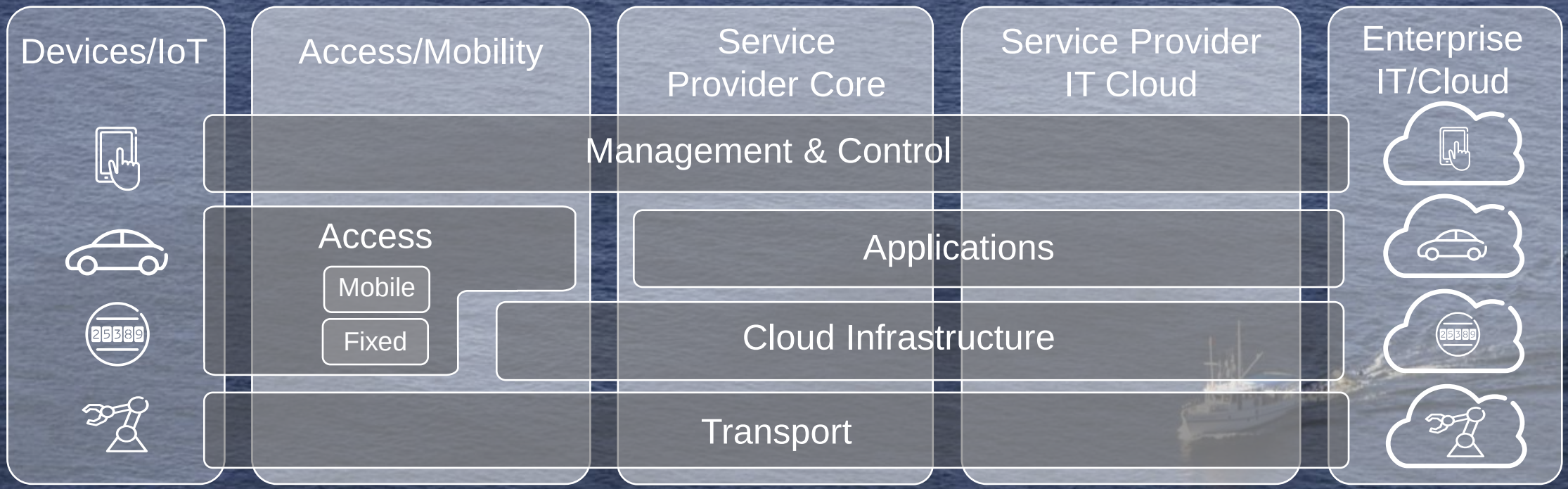


Software Defined Networking (SDN)

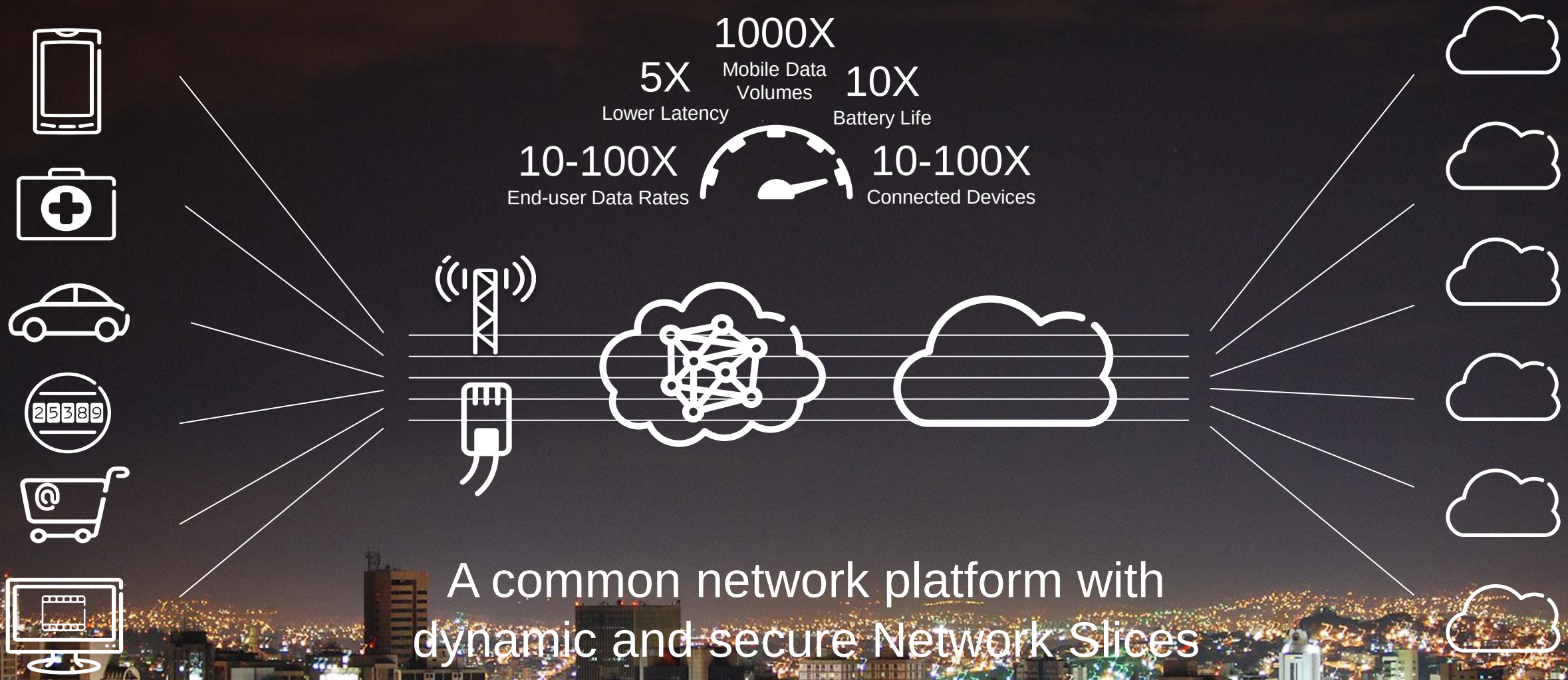
Distributed Cloud

Network Slicing

EVOLUTION OF THE CONVERGED NETWORK

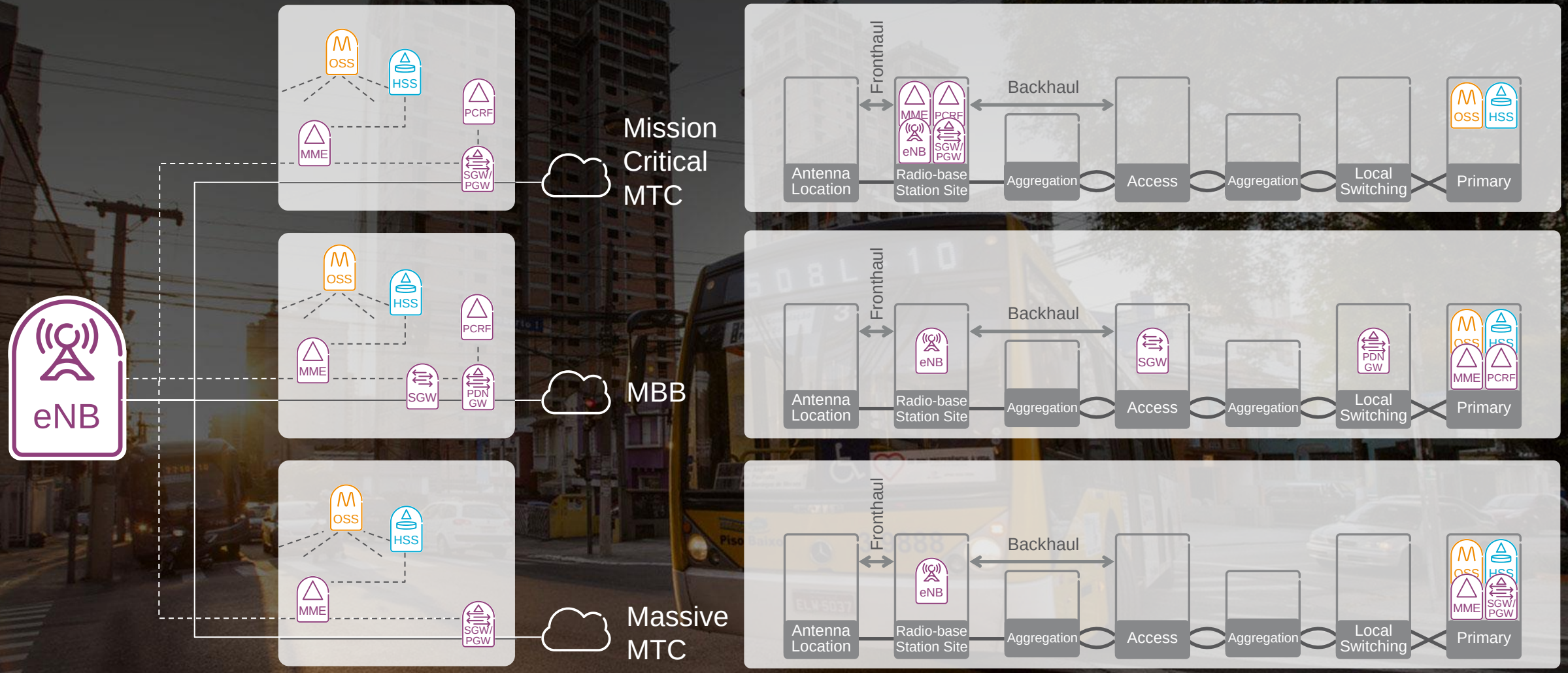


NETWORK SLICING



A common network platform with dynamic and secure Network Slices

NETWORK SLICING



ORCHESTRATION

Network Slice Blueprints:

- Mobile Broadband
- Industry Automation
- Media
- Enterprise Communication
- Massive Sensors/Actuator
- ....

Retail Customer

Whole Sale Customer

Network Slice Resources

- Access
- Nw Function
- OSS/BSS
- Transport
- Cloud

Service n

Health

Robotic communication

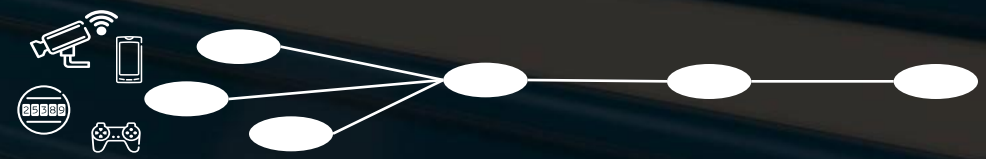
Premium Communication

Media

MBB Basic

Network Slices

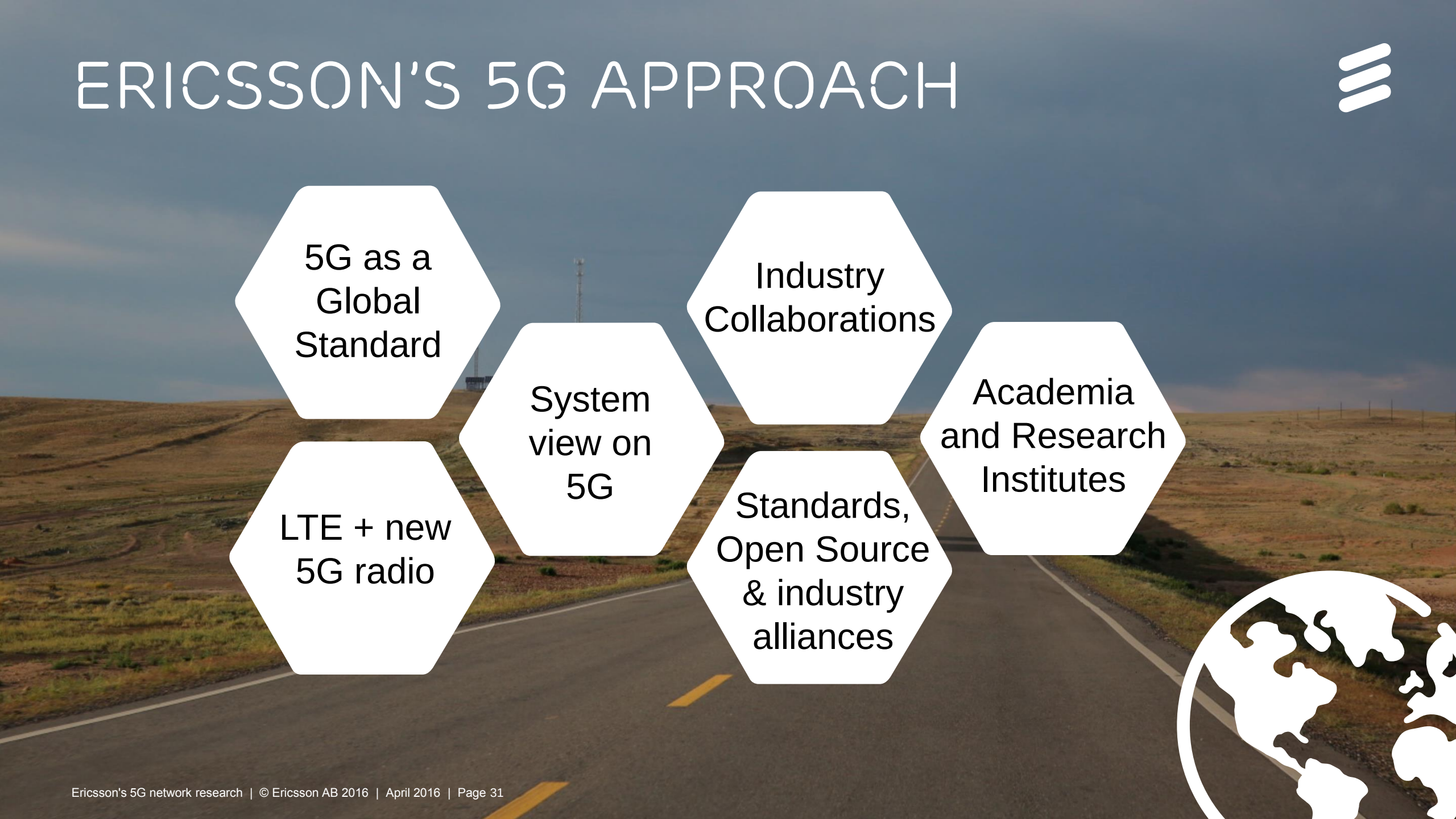
Physical Resources



WHAT IS IN THE SLICE? - PRINCIPLES

- The architecture shall be flexible
  - It shall not mandate certain combination and/or location of functions
    - Today we have to co-locate all functions of a node
    - Any change must go through 3GPP
    - Look, what it led to in case of LIPA or SIPTO
  - It shall not mandate the existence or lack of any function
    - Should be easy to add/remove functions
      - E.g., no mobility support for this device
  - It shall be able to utilize distributed cloud (easy deployment of VMs)
  - It shall enable programmatic composition
    - Even on a per-flow basis

ERICSSON'S 5G APPROACH



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