SoftCOM '18
tutorials

5G Technologies and Use Cases

by

Benedek Kovacs

Budapest University of Technology and Economics, Hungary

September 13 - 15, 2018.

5G Technologies and Use Cases

Presenter:
Bendek Kovács, PhD
(Senior Specialist, Network Performance, Ericsson)

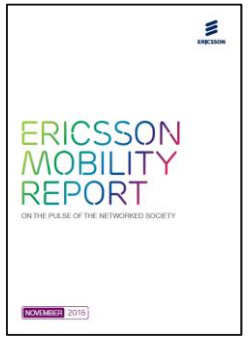
Connected devices in 2022

29 billion:

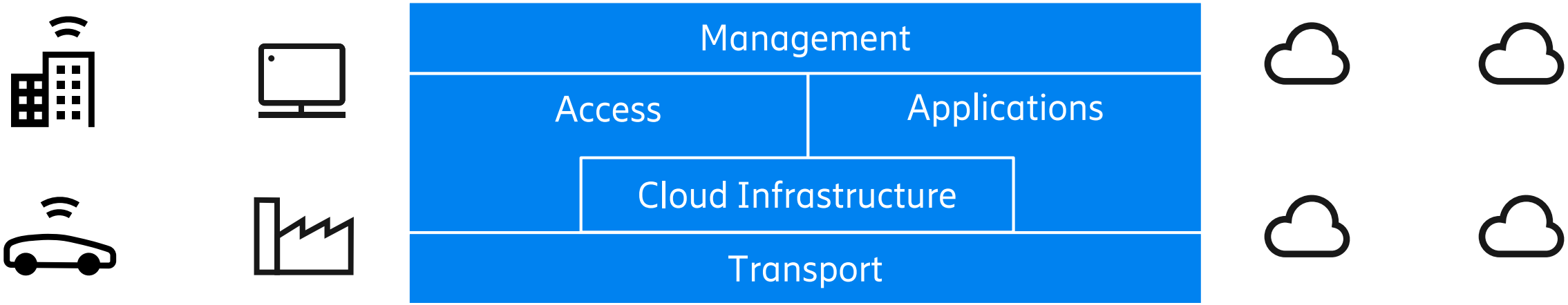
11 billion
(today: 10 bn)
Mobile phones,
pc/laptop/tablet

18 billion
(today: <6 bn)
Smart industrial &
consumer devices

Source: Ericsson Mobility Report



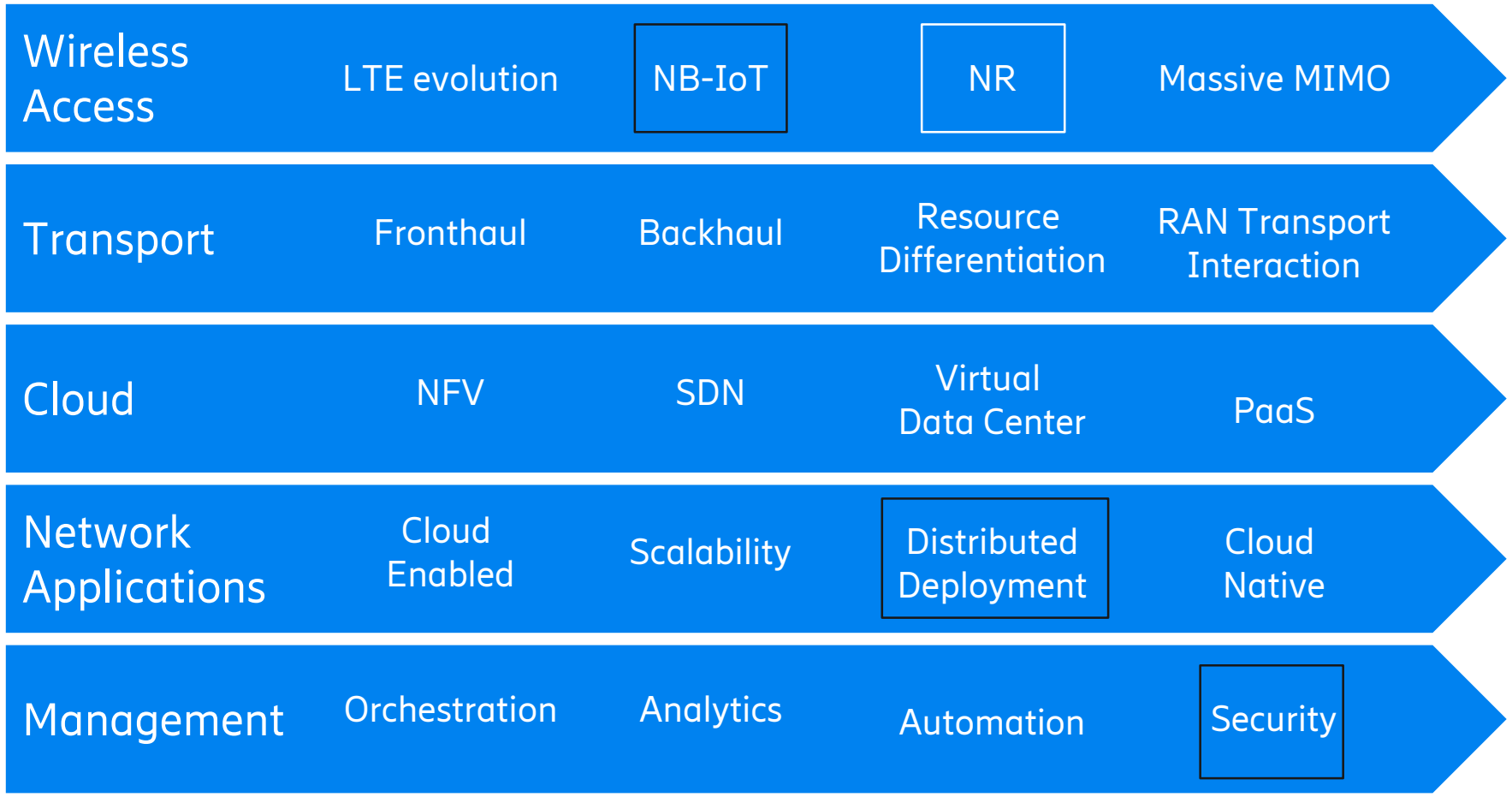
One common network platform



Flexibility, Time to Market,
Total cost of Ownership

20 Gbps	1000x	~1 ms	1M/km^2	Cost	10+	+20 dB
End-user data rates	Mobile data volumes	Lower latency	More devices	Device cost reduction	Years battery life	Better coverage

5G main components and their evolution



5G

Outline

The Background of the “G”

Massive Machine Type Communication, NB-IoT

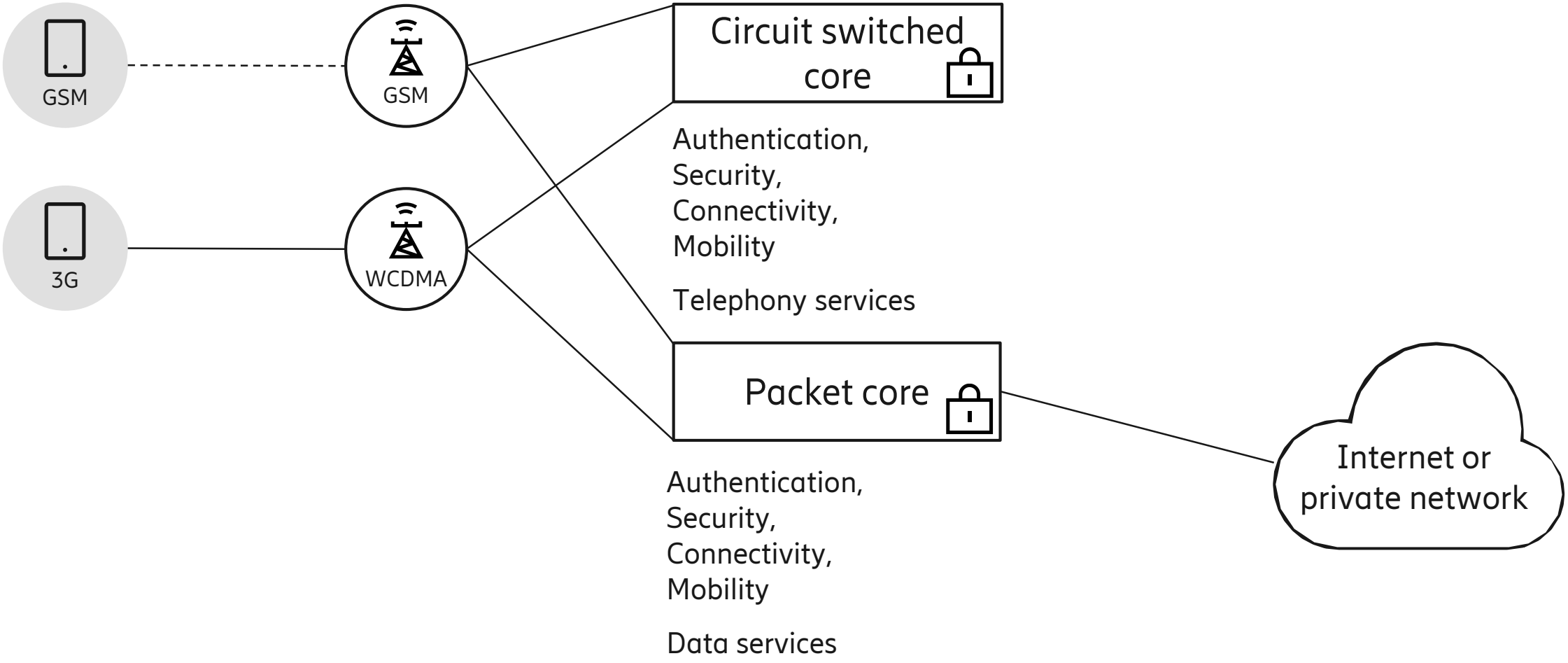
Device Management, Industry 4.0 Plug and Produce Field Device

Distributed Deployment, Distributed Cloud and Edge Computing

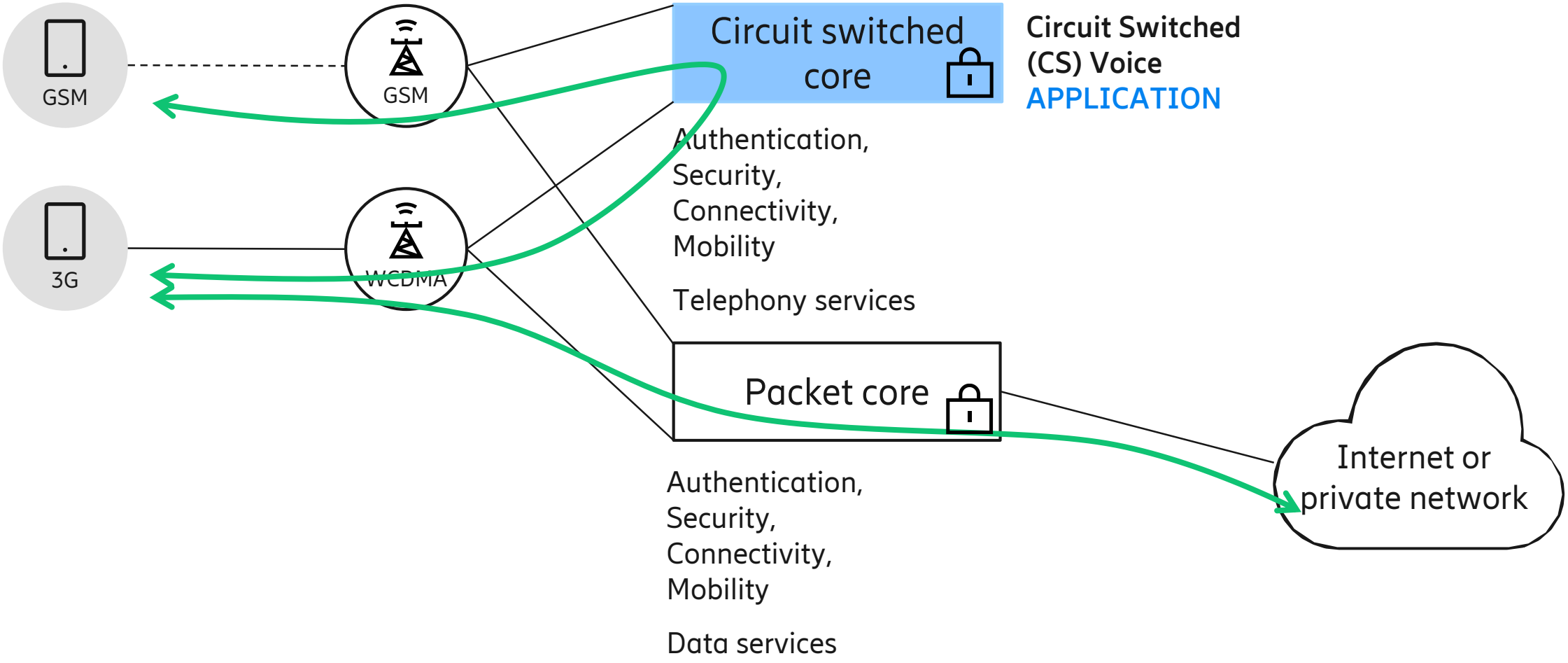
The Background of the "G"

Mobile Telecommunication Networks

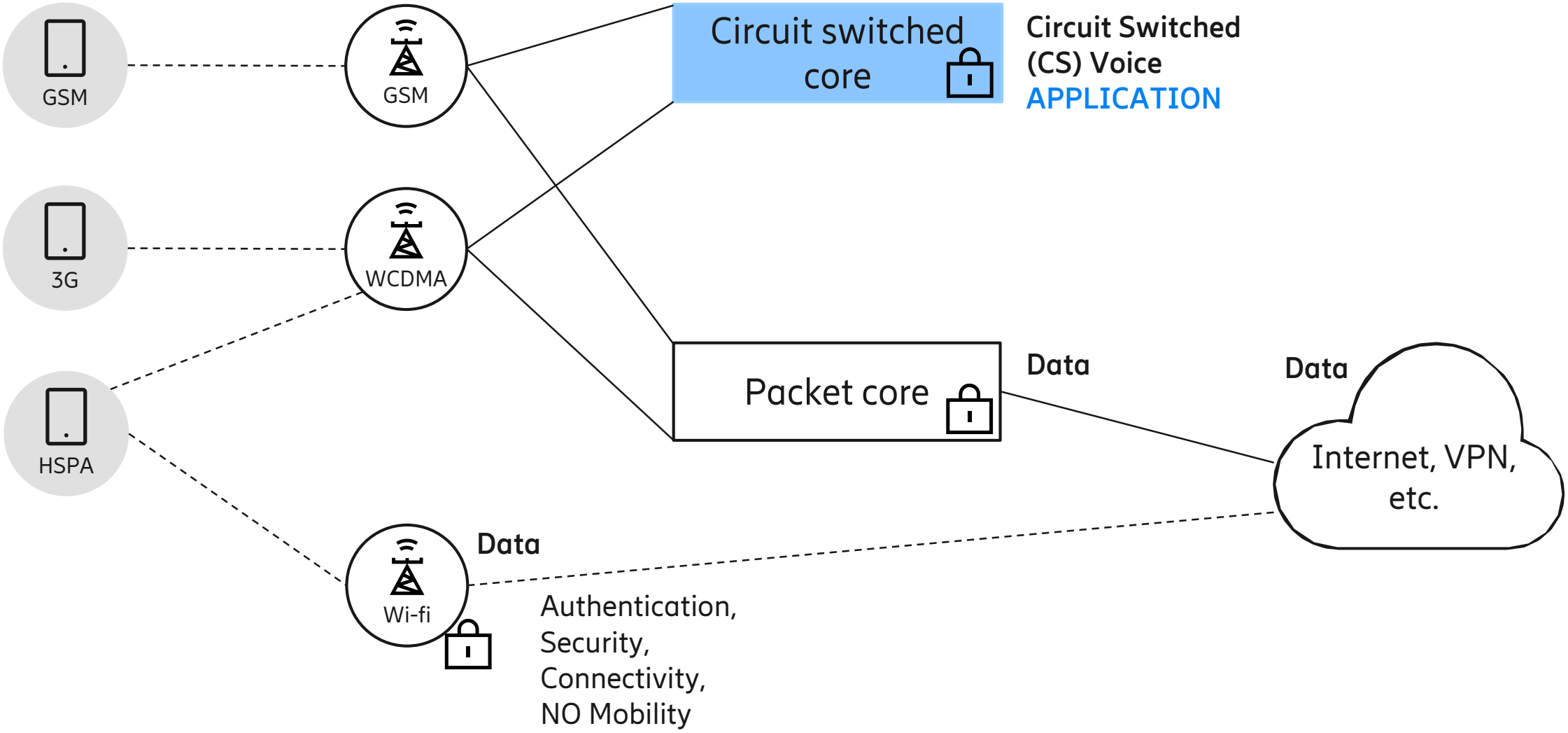
2G and 3G origins



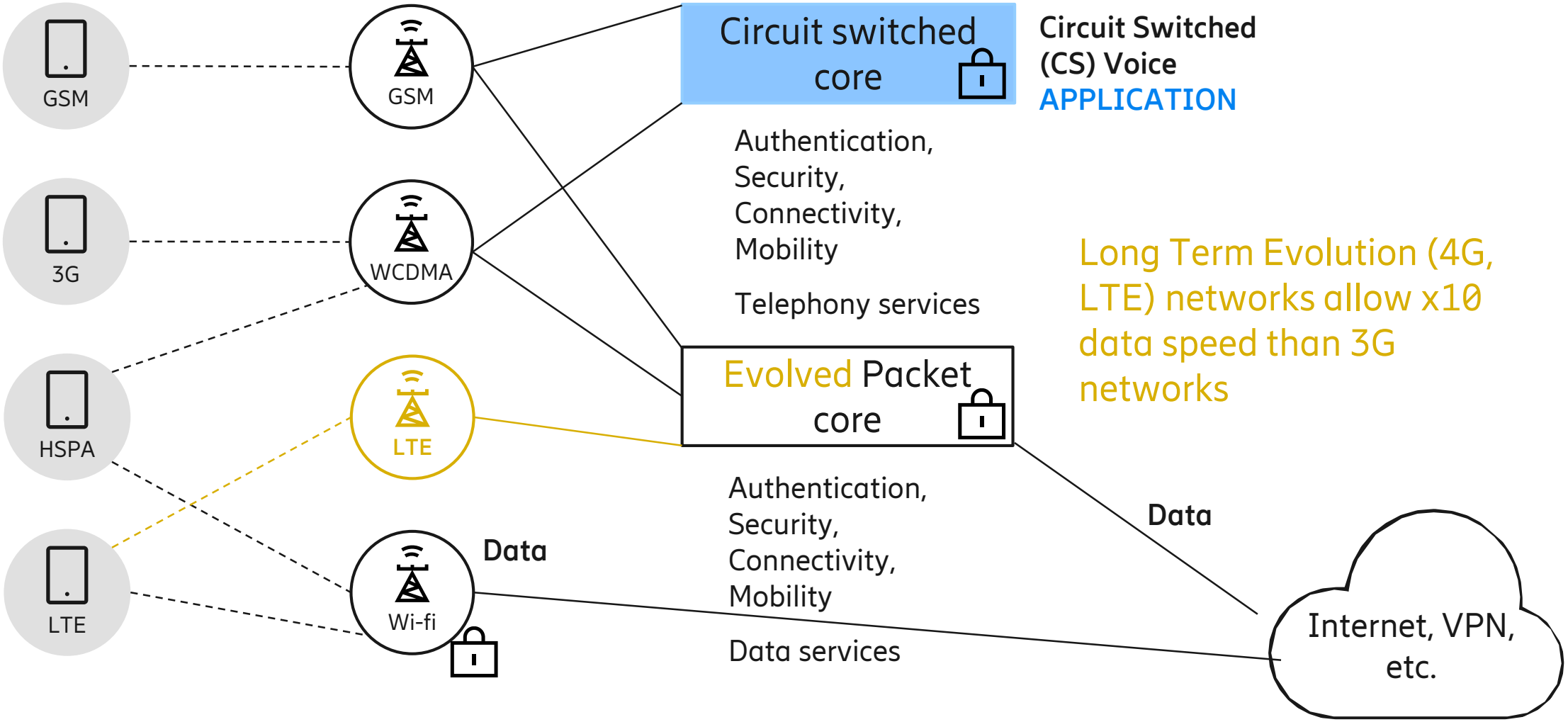
2G and 3G origins



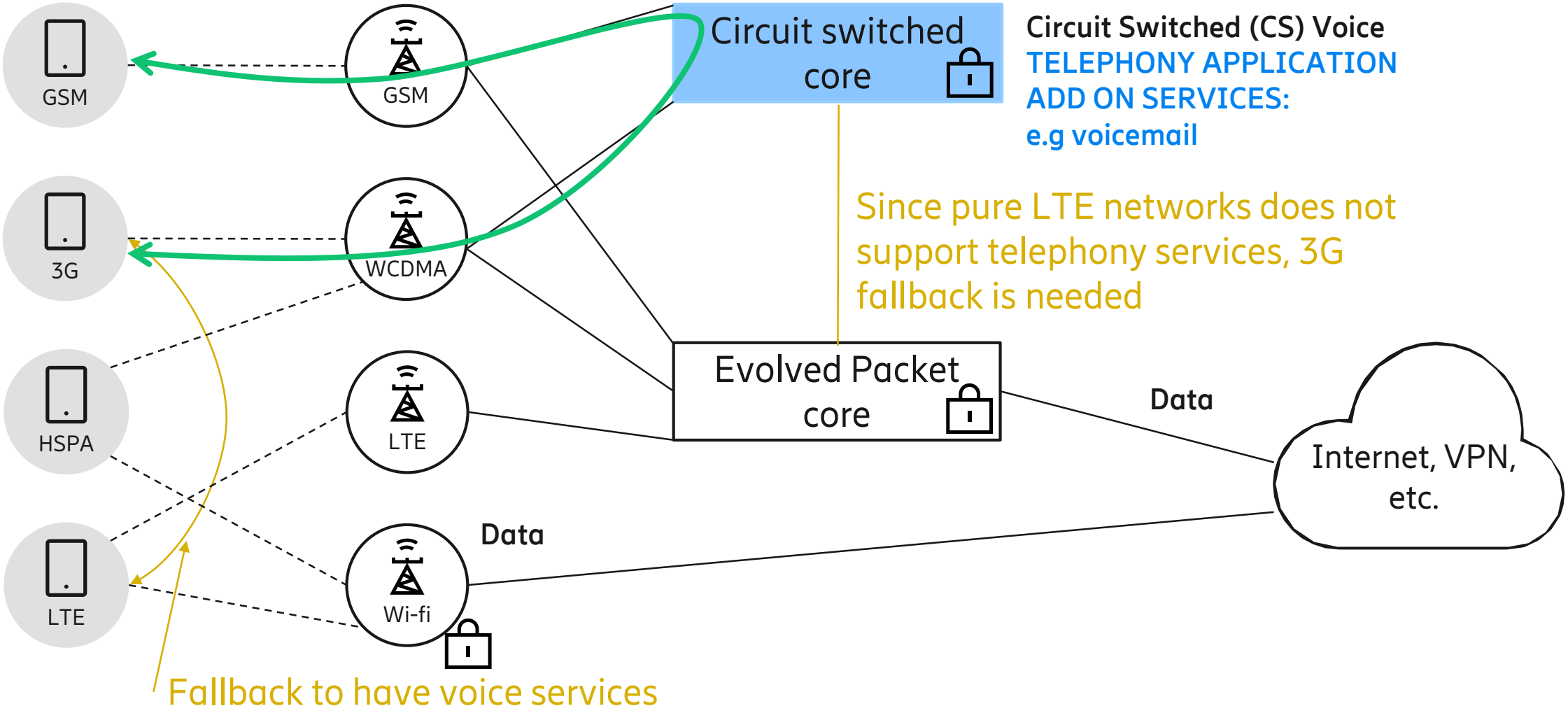
3G HSPA (High Speed Packet Access)



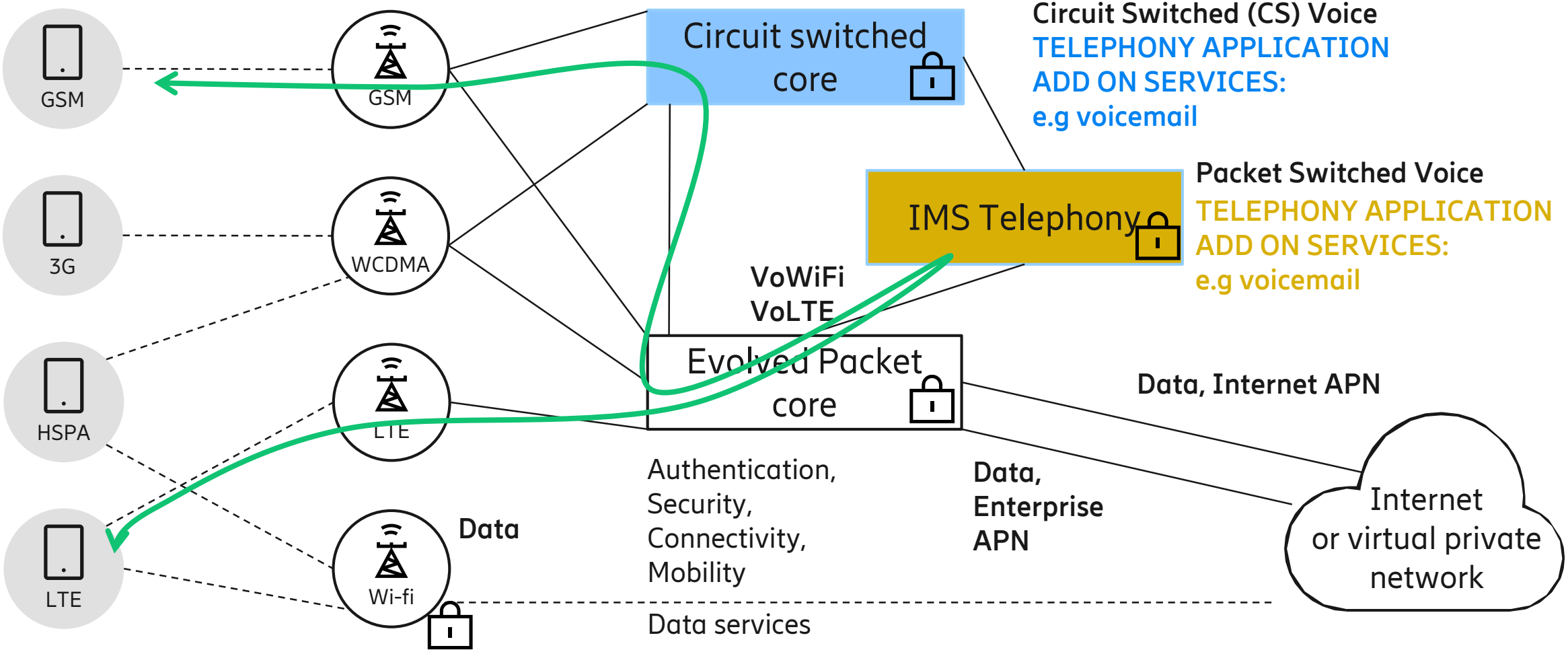
4G, Long Term Evolution (LTE)



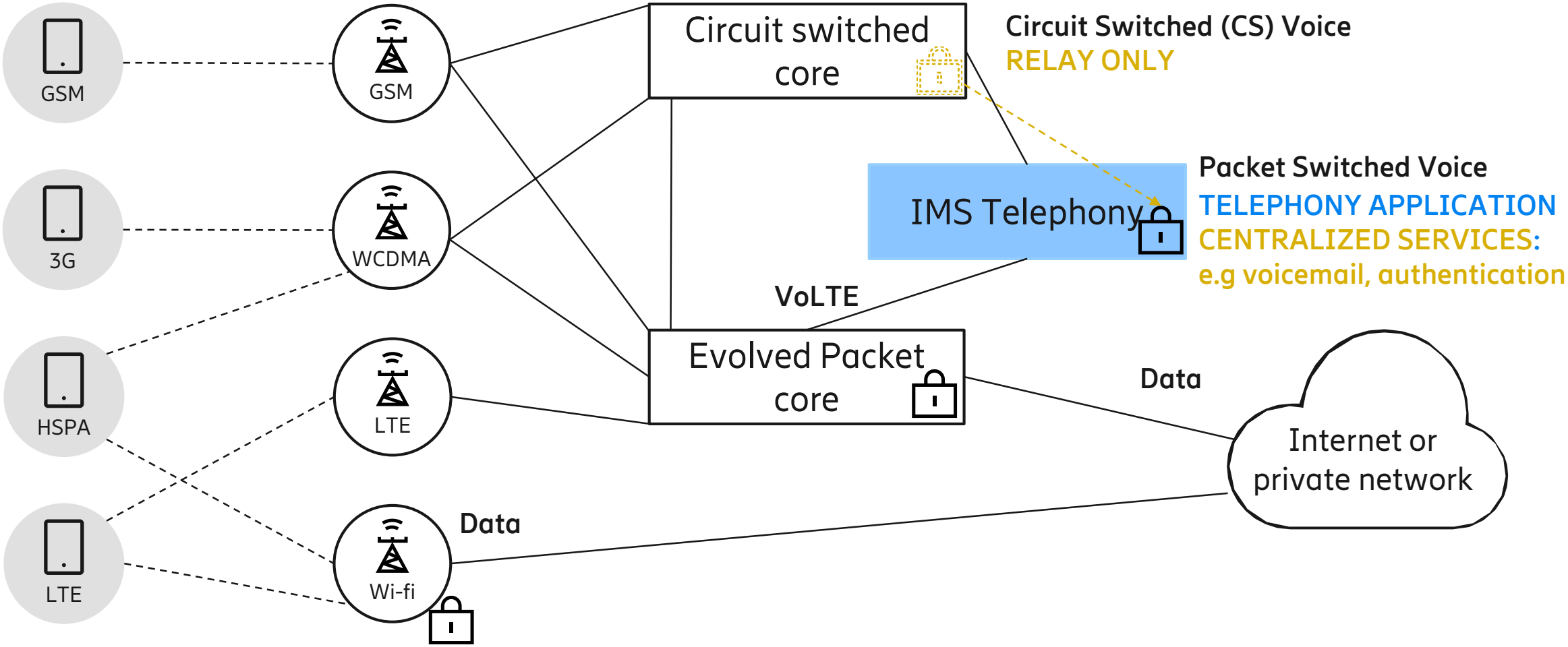
Circuit switched fallback: LTE Data, CS voice



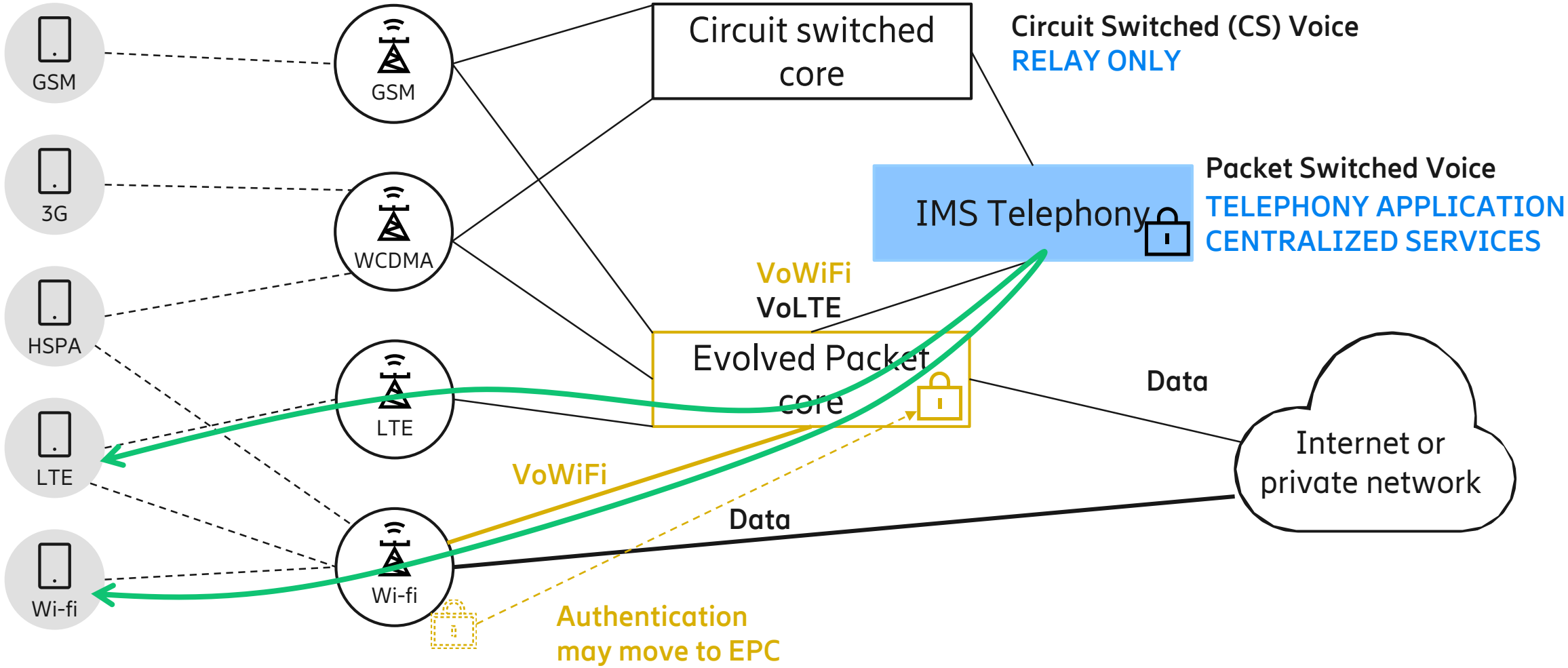
Voice over LTE with
IP Multimedia Subsystem (IMS)



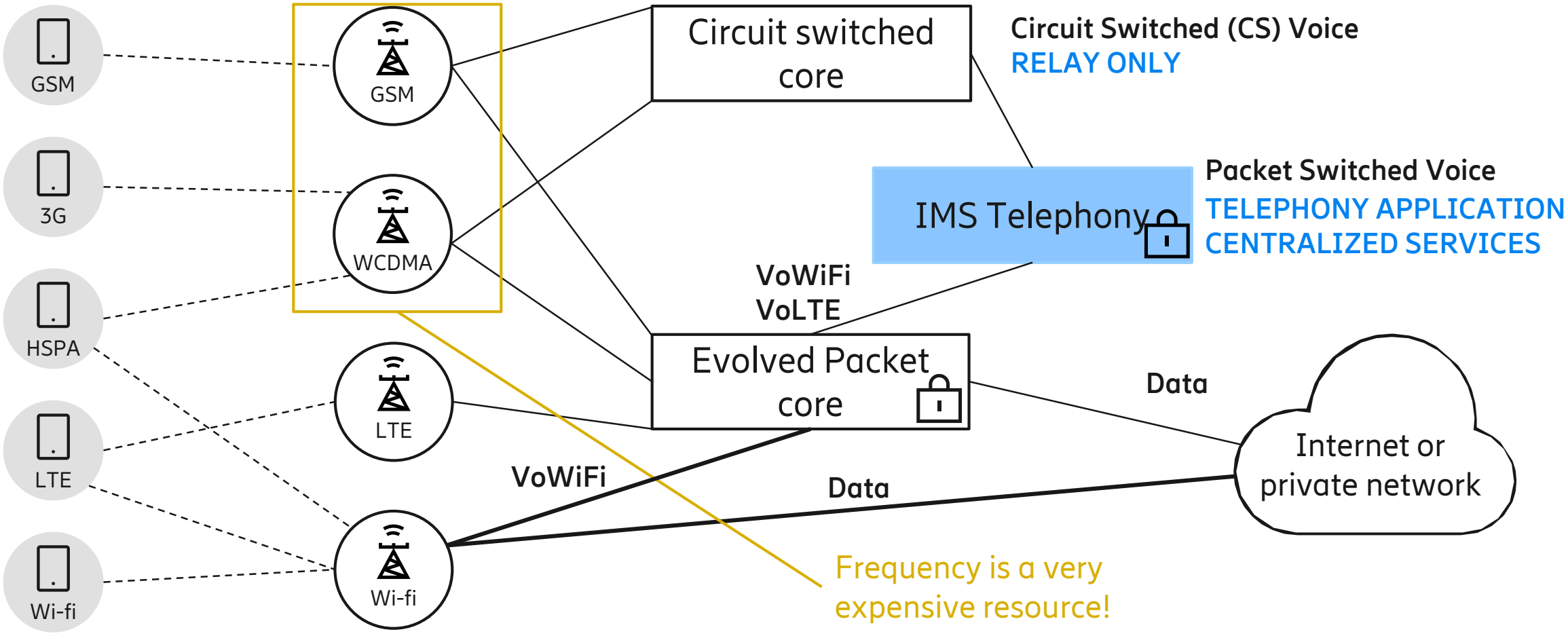
IMS centralized services



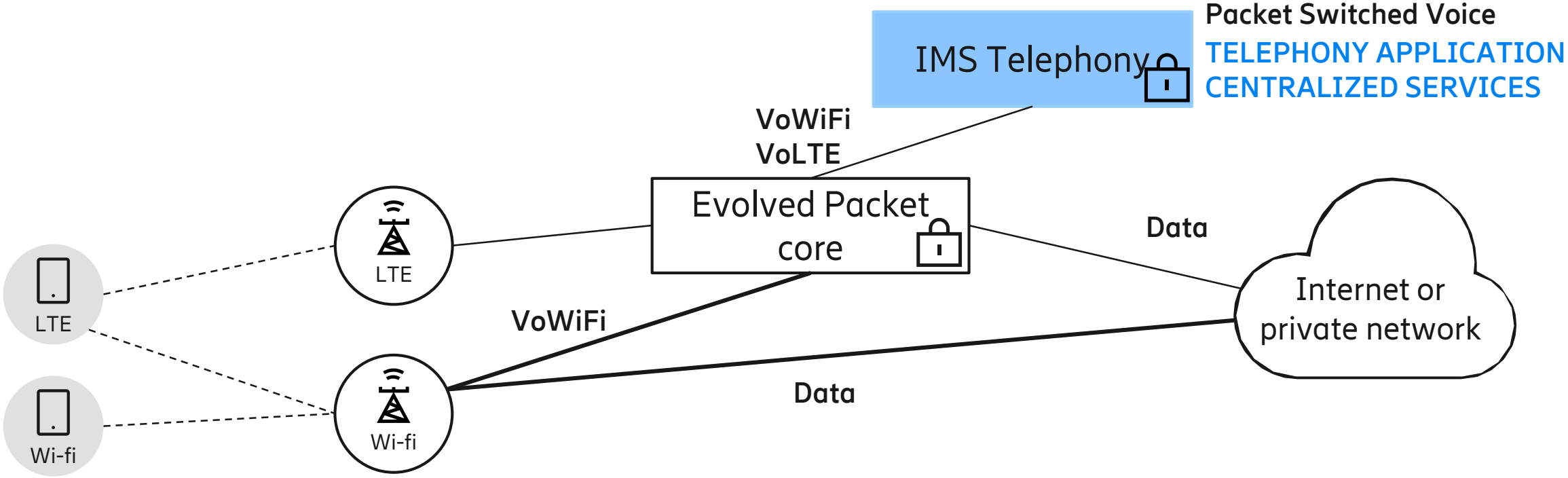
Voice over LTE, Voice over WiFi



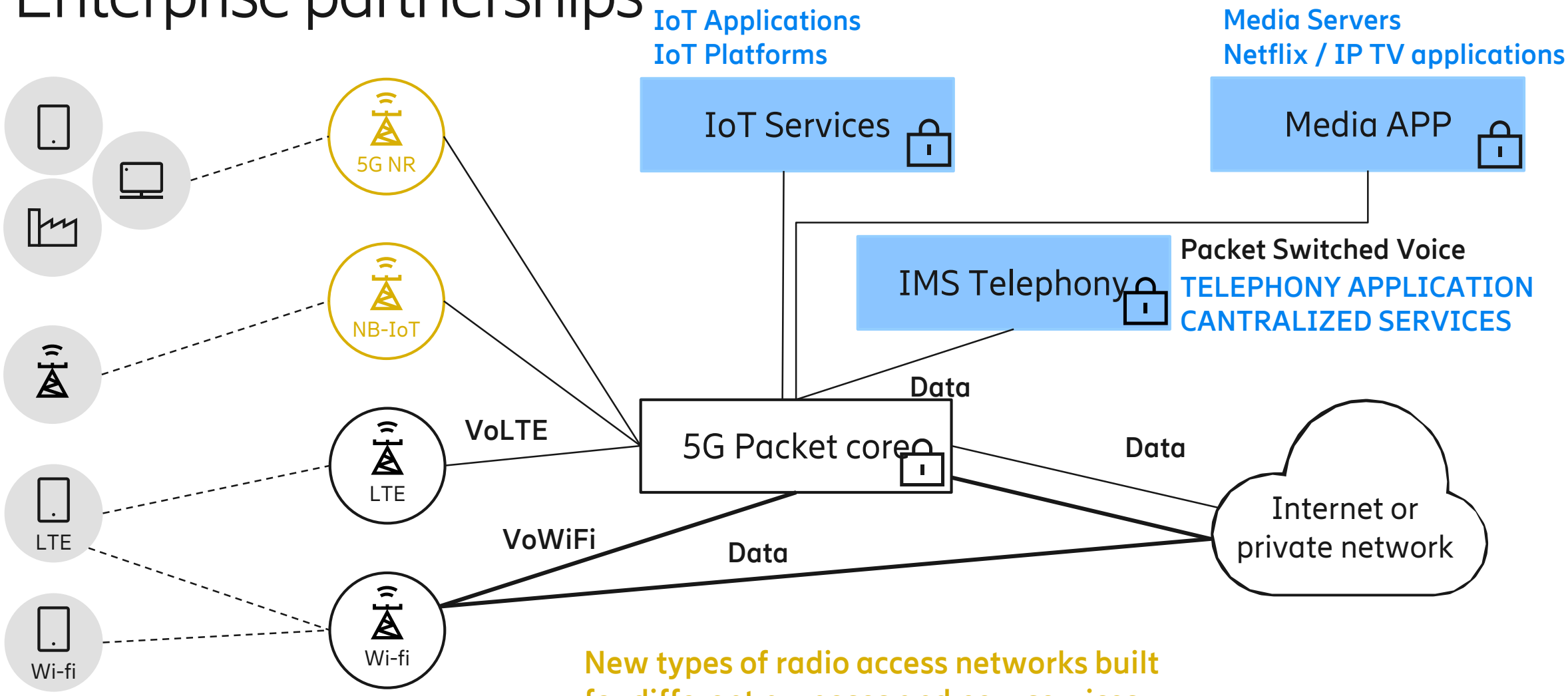
VoLTE and VoWiFi: why keep 2G, 3G?



Pure 4G, LTE telephony networks with wi-fi

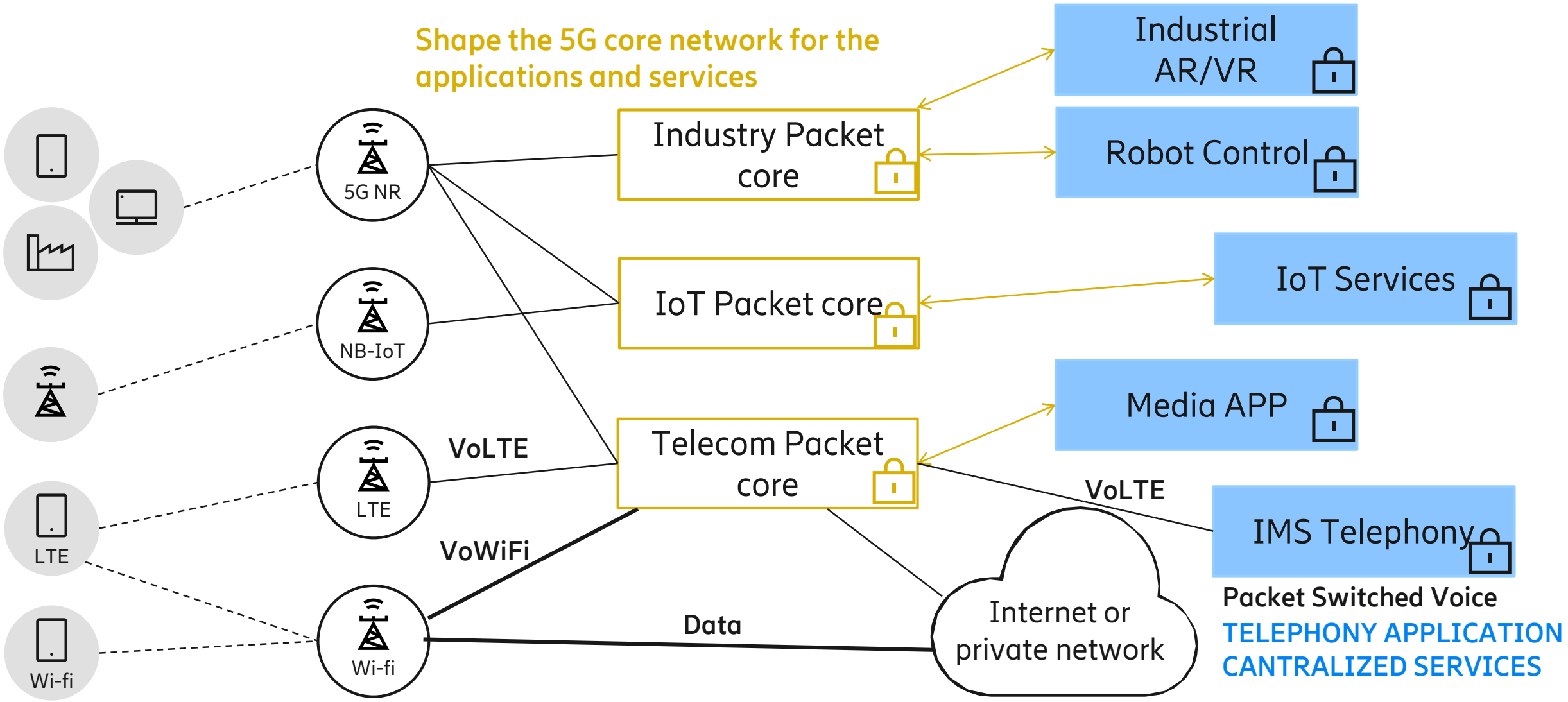


5G networks are built on Enterprise partnerships



New types of radio access networks built for different purposes and new services

5G network slicing



Example of Network slice types

- Low cost
- Low energy
- Massive numbers

- Wide area coverage
- Internet access
- Operator services

- High availability
- High reliability
- Low latency

- Very high availability
- Very high reliability
- Very low latency

Outline

The Background of the “G”

Massive Machine Type Communication, NB-IoT

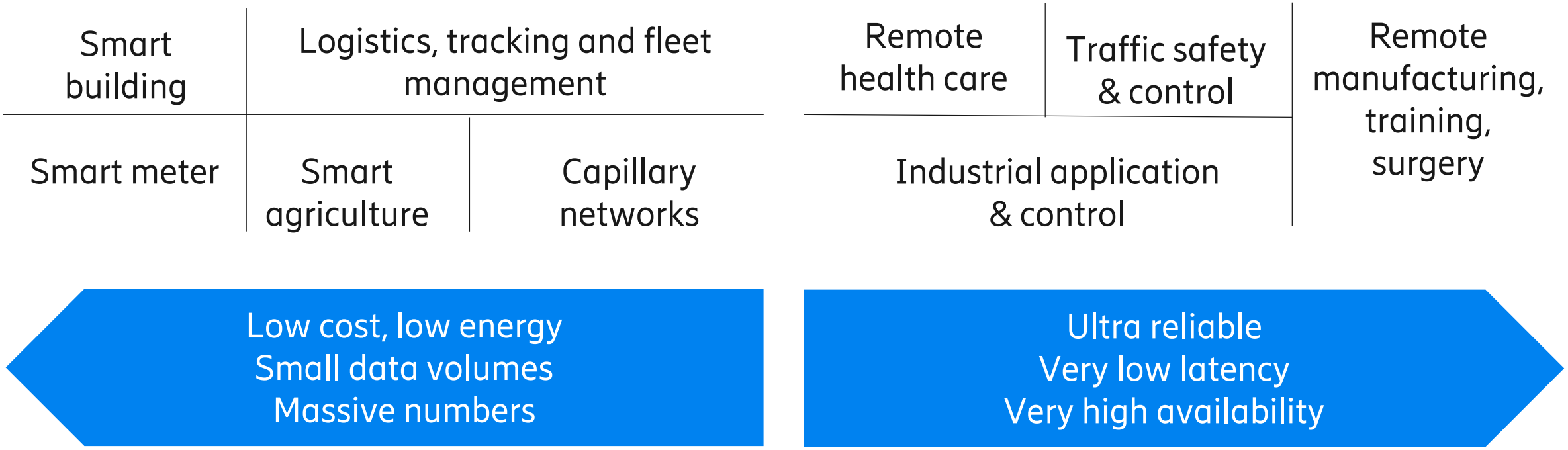
Device Management, Industry 4.0 Plug and Produce Field Device

Distributed Deployment, Distributed Cloud and Edge Computing

Massive Machine type communication

It’s a mobile network,
not for smartphones
but for IoT devices

IoT: Wide Range of Requirements

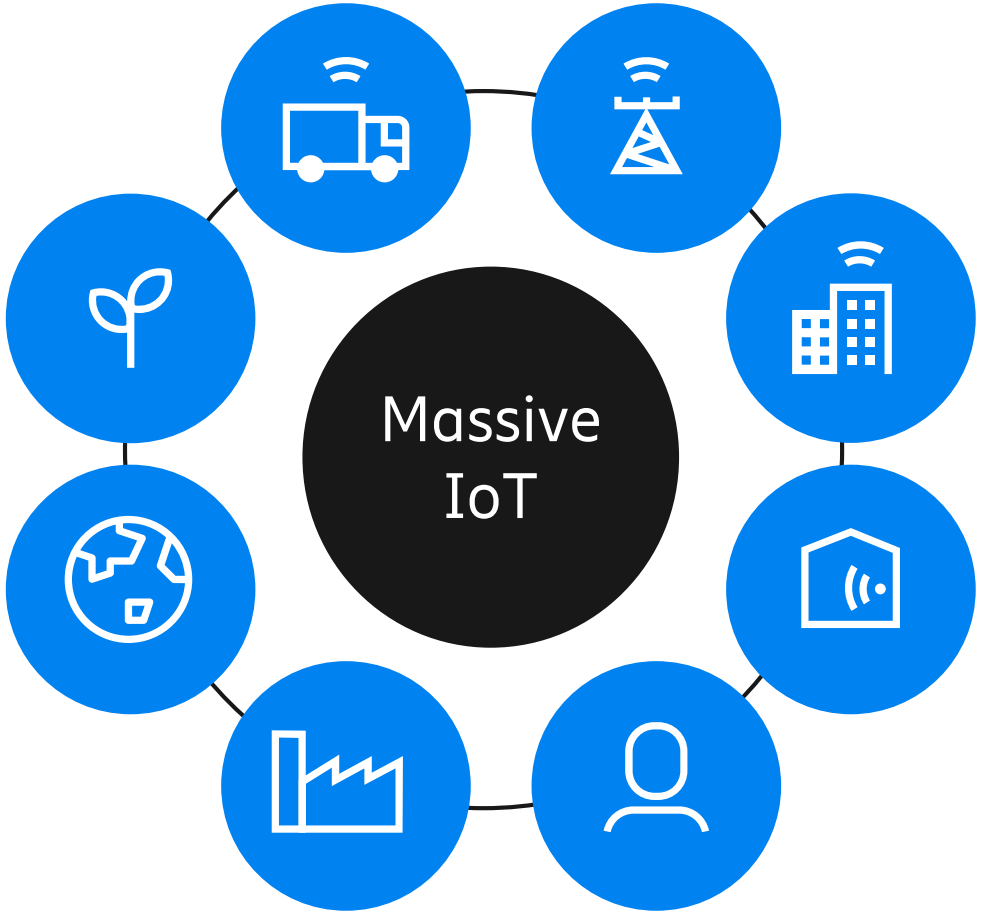


Transport & Logistics
Fleet Management
Goods tracking

Agriculture
Climate-Agriculture monitoring
Live stock tracking

Environment
Flood monitoring & alert
Environmental monitoring (Water, air, noise, etc)

Industrial
Process monitoring
& Control
Maintenance monitoring



Utilities
Smart metering
Smart grid management

Smart cities
Smart parking
Smart bicycles
Waste management
City lighting

Smart buildings
Smoke detectors
Alarm systems
Home automation

Consumers
Wearables
Kids/Elderly tracker
Medical monitoring

Connected park

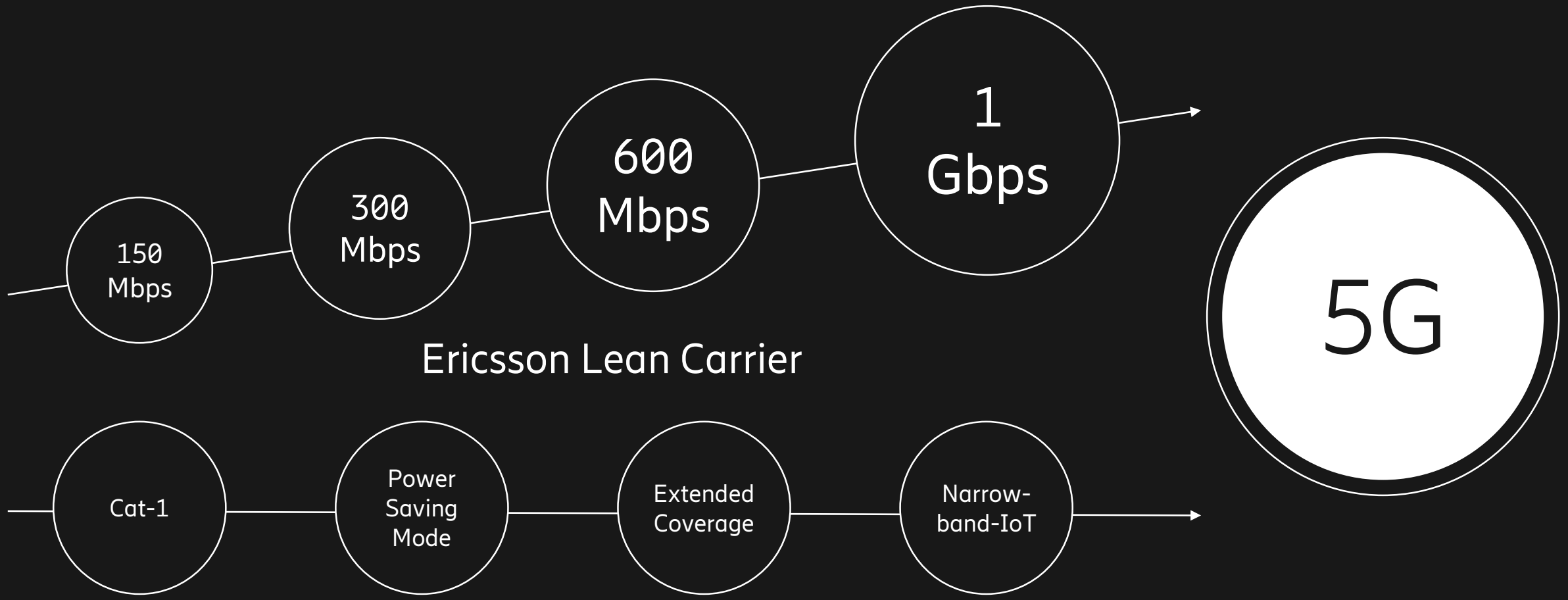
Connected park services:

- From guessing to knowing, measure the health of the park
- An intelligent maintenance system, an AR enabled worker
- Vibration reports on tools
- Remote operation
- Customer services developed on popular common Platforms

Requirements:

- Totally different traffic model (low and high bw, massive number of devices, rare communication)
- Cheap device is required, low Operator ARPU
- Low power devices are required
- Heavily customized application
- Security?, Positioning?, Zero touch management?, etc.

Ericsson paving the way to 5G



3GPP access technologies

	Bandwidth	Coverage	Battery life	Throughput (peak)	Security	Mobility	Deployment
Cat-M1	1.4MHz	160dB (+15dB)	10+ Year	0.8/1 Mbps full duplex	✓	Connected & idle mode mobility	SW
NB-IoT	200kHz	164dB (+20dB)	10+ Year	227/250kbps multi-tone UL	✓	Idle mode mobility	SW
EC-GSM-IoT	600kHz	164dB (+20dB)	10+ Year	473/473k bps	✓	Idle mode mobility	SW

Outline

The Background of the “G”

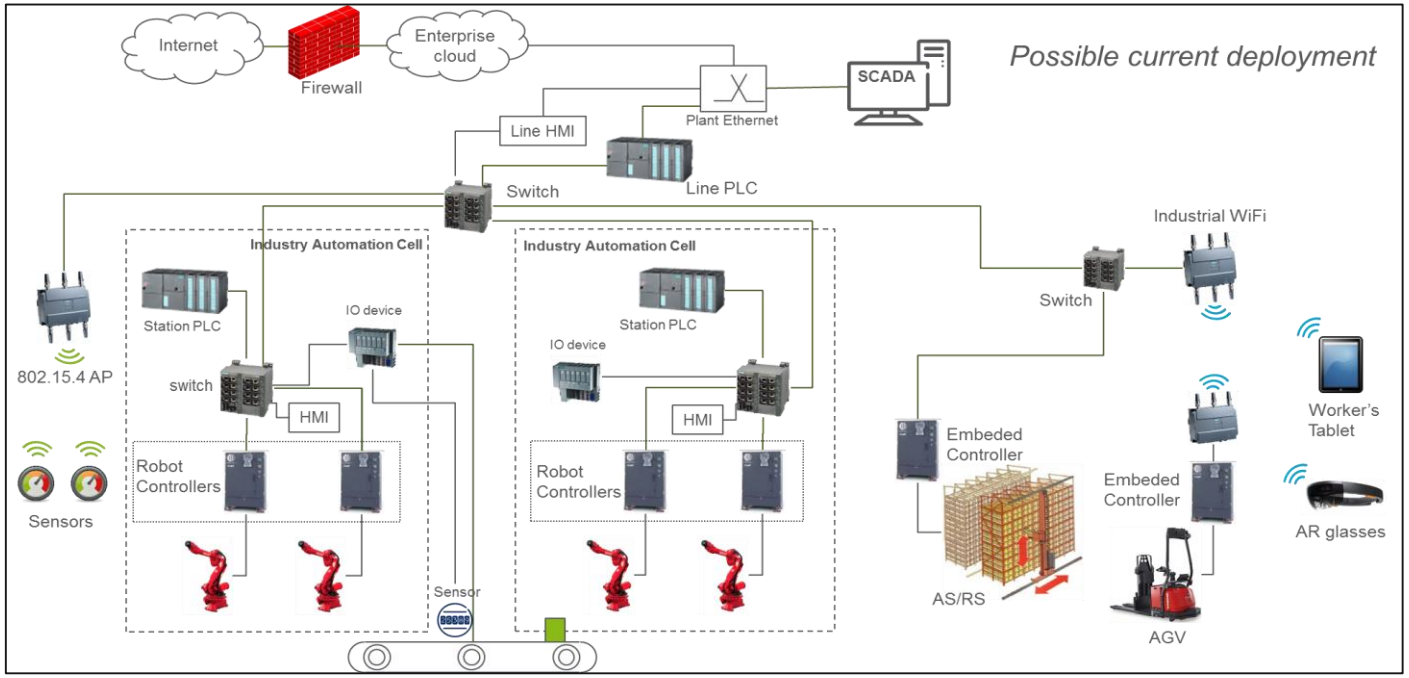
Massive Machine Type Communication, NB-IoT

Device Management, Industry 4.0 Plug and Produce Field Device

Distributed Deployment, Distributed Cloud and Edge Computing

Example: Industry automation

Local area Enterprise → demanding C-MTC traffic, NB-IoT sensors, smart worker with AR/VR



Diverse use cases with diverse reqs.

eMBB

M-MTC

C-MTC

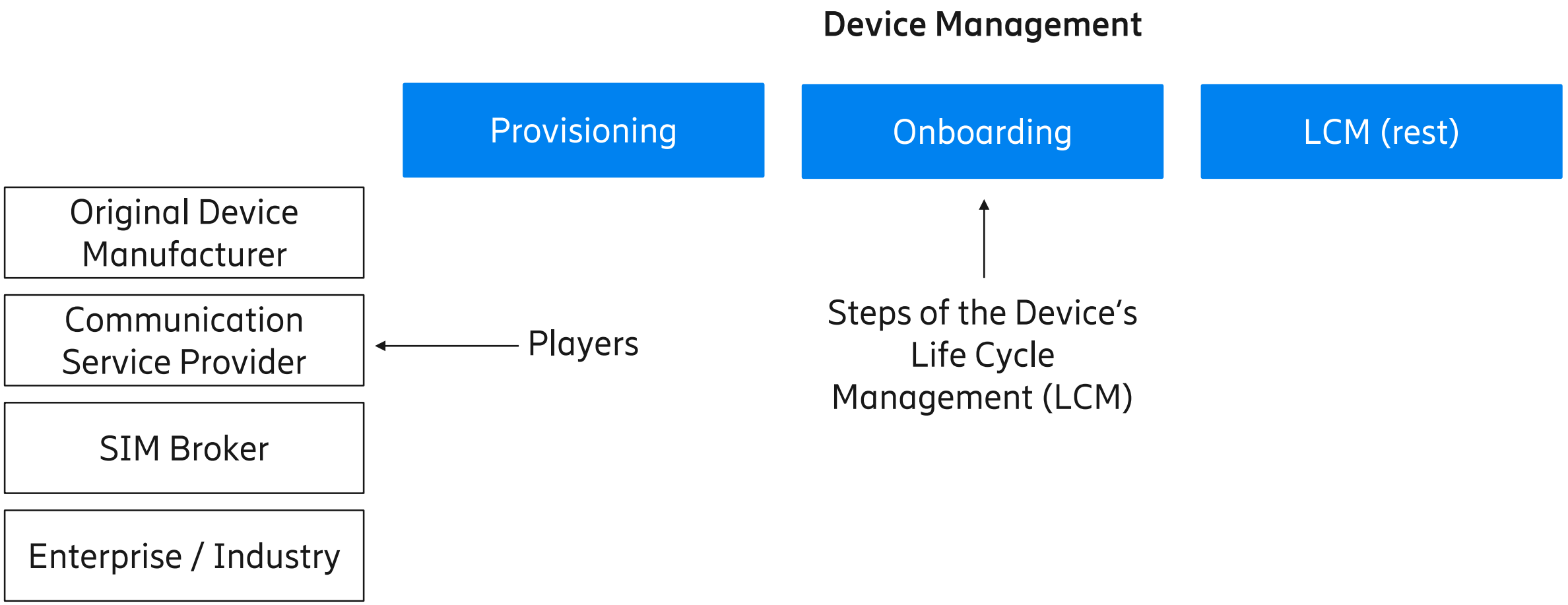
Sensors and remote analytics

vPLC de-wiring

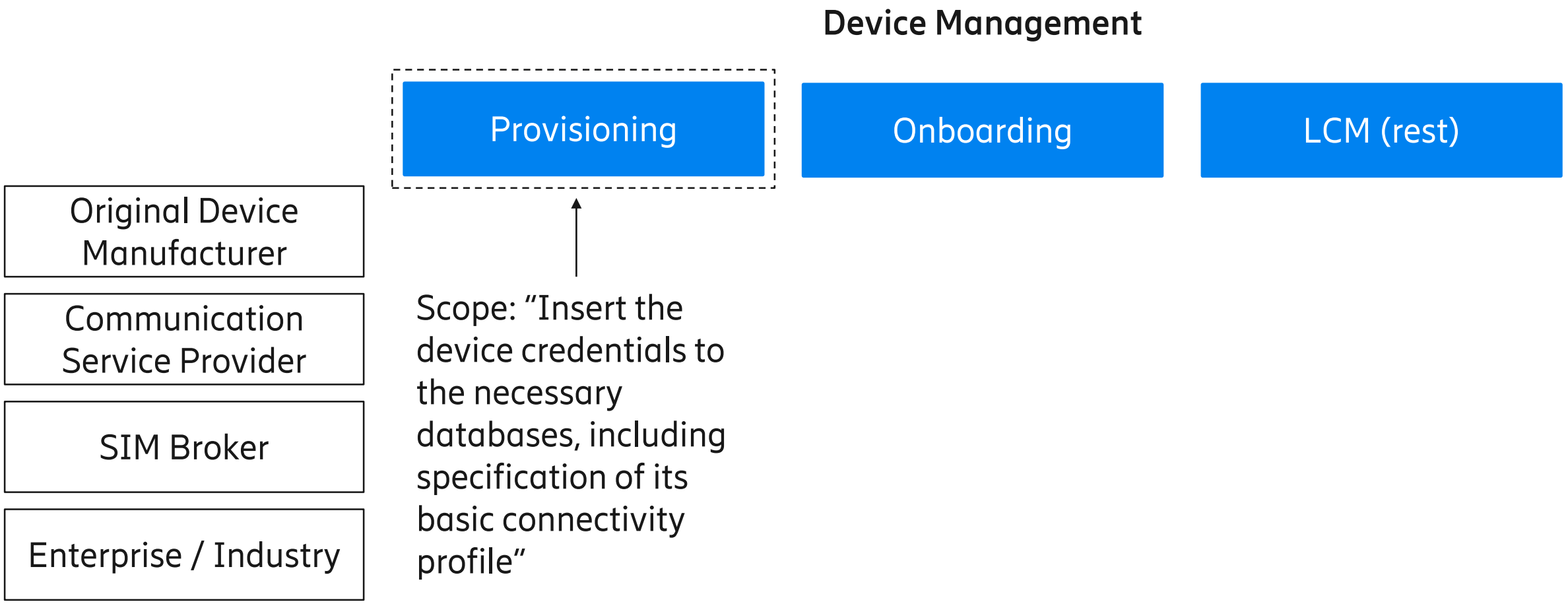
Warehousing

Smart Worker

Device management overview



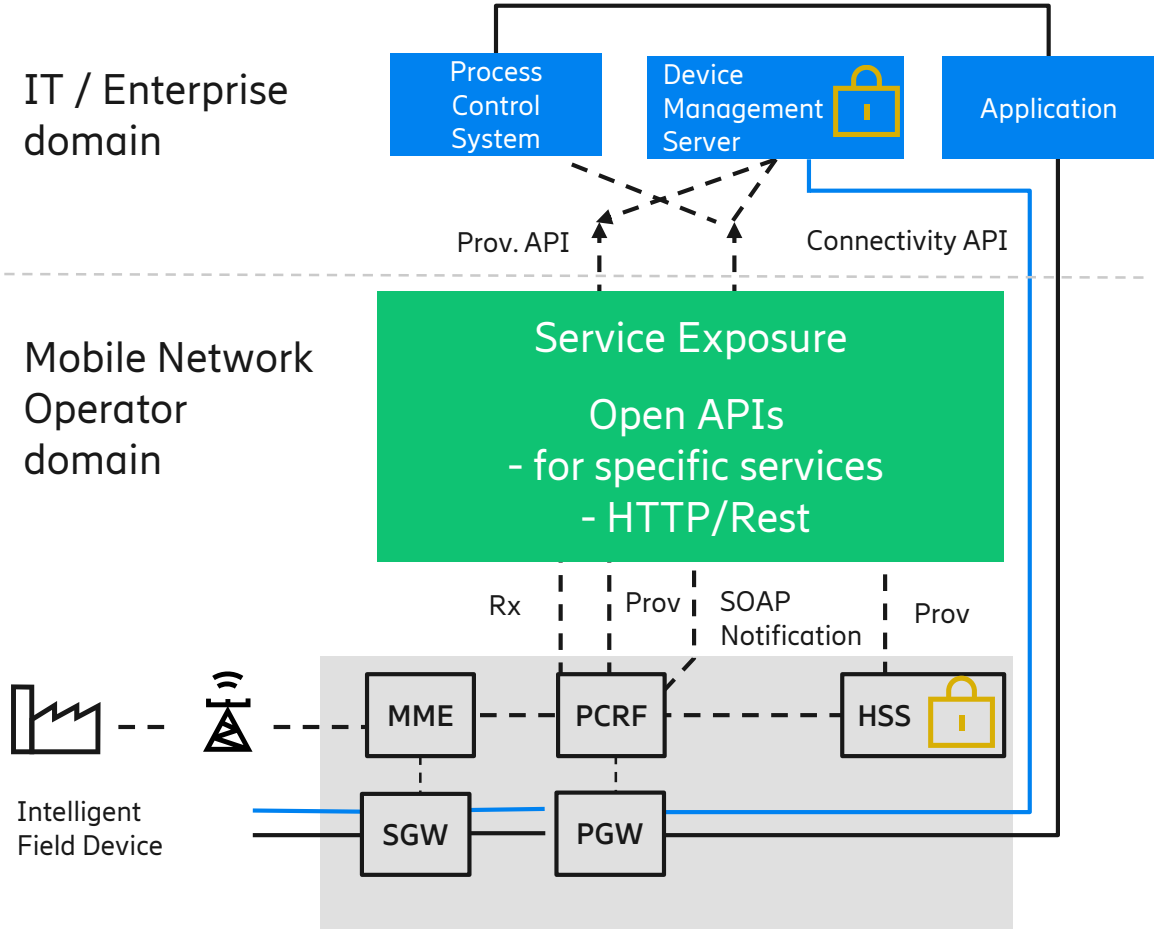
Device management overview



High level provisioning

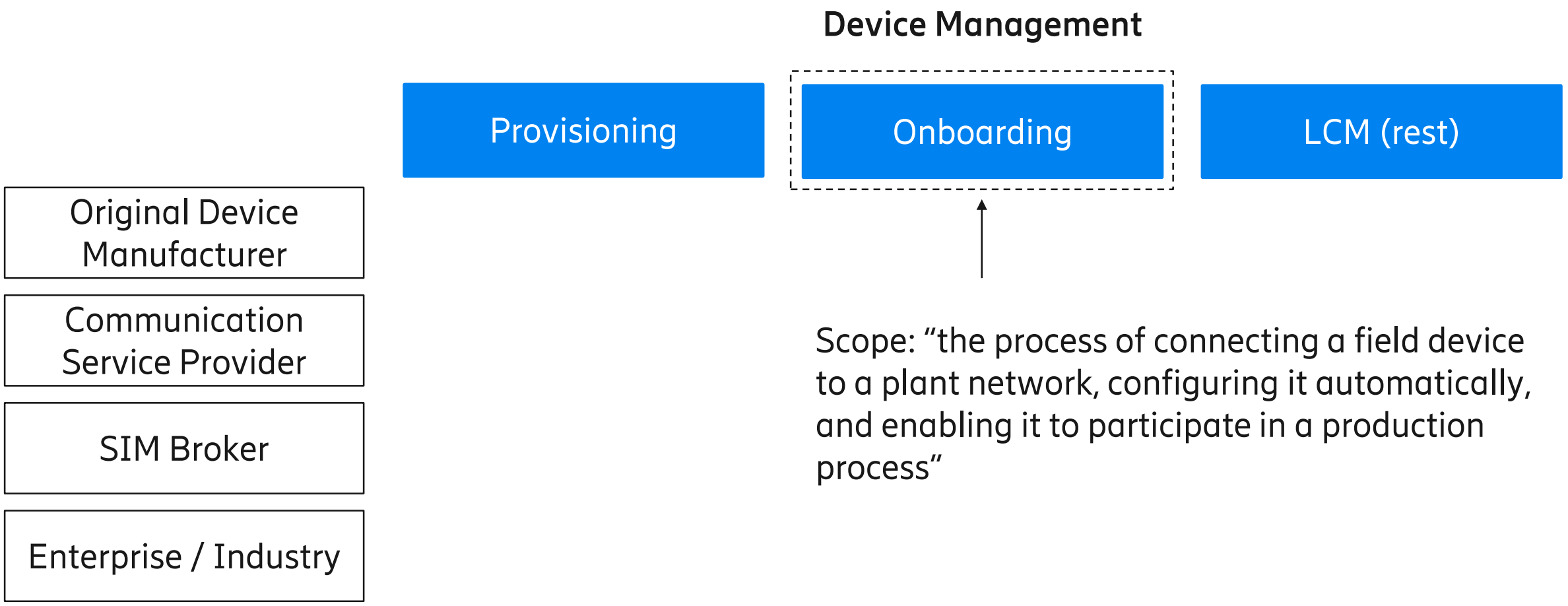
Device Provisioning

- Telecom Provisioning: the step when you create a SIM card and store the corresponding authentication profile in the Mobile Operator's user DB:
  - 2G/3G: HLR → SMS based IoT Devices
  - 4G/NB-IoT/5G: HSS → Most of the NB-IoT devices will fall here, currently adopting
  - 5G: Unified Data Management (UDM) function
- IT Provisioning: the step when you store authentication credentials of the system on the device and in the IT application authentication database



Device provisioning (example)

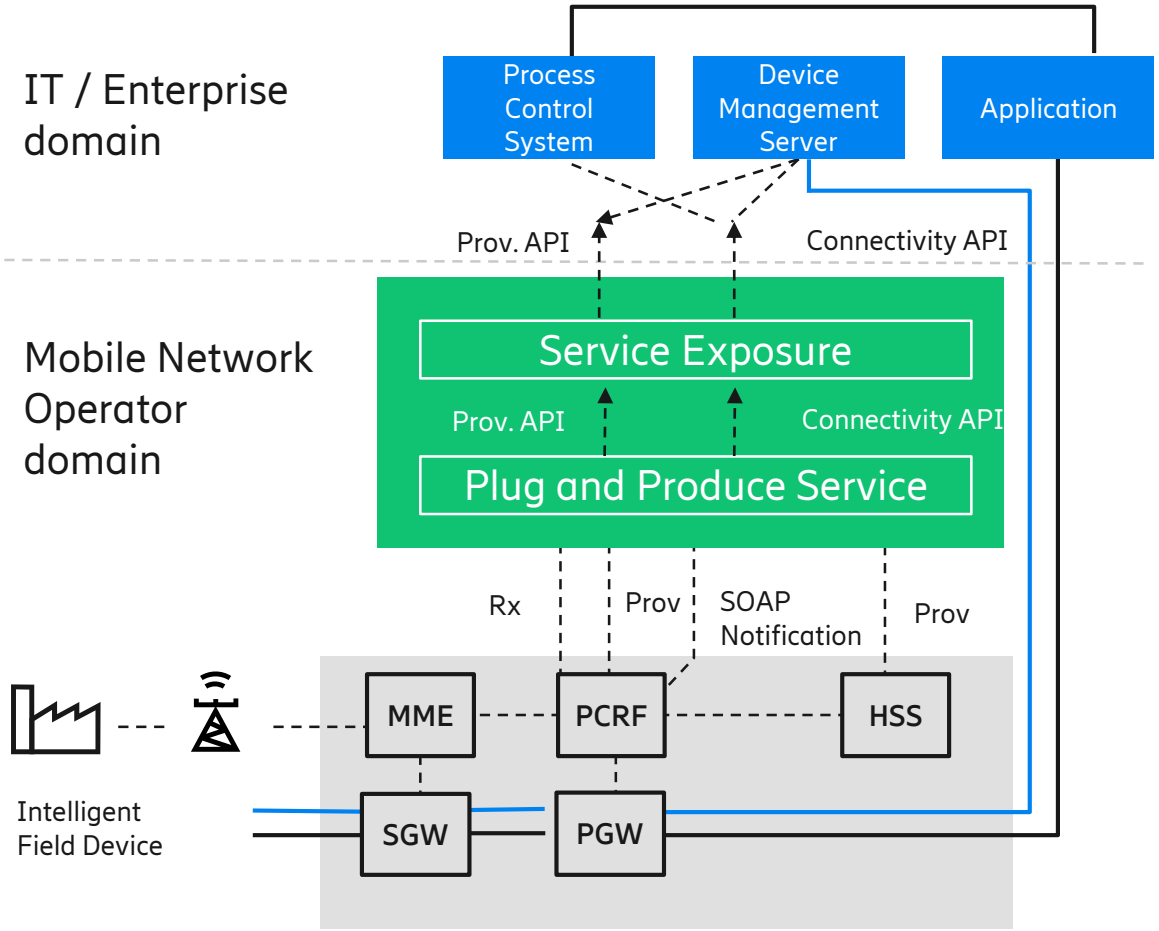
Device management overview



Plug and Produce for adaptable Factory

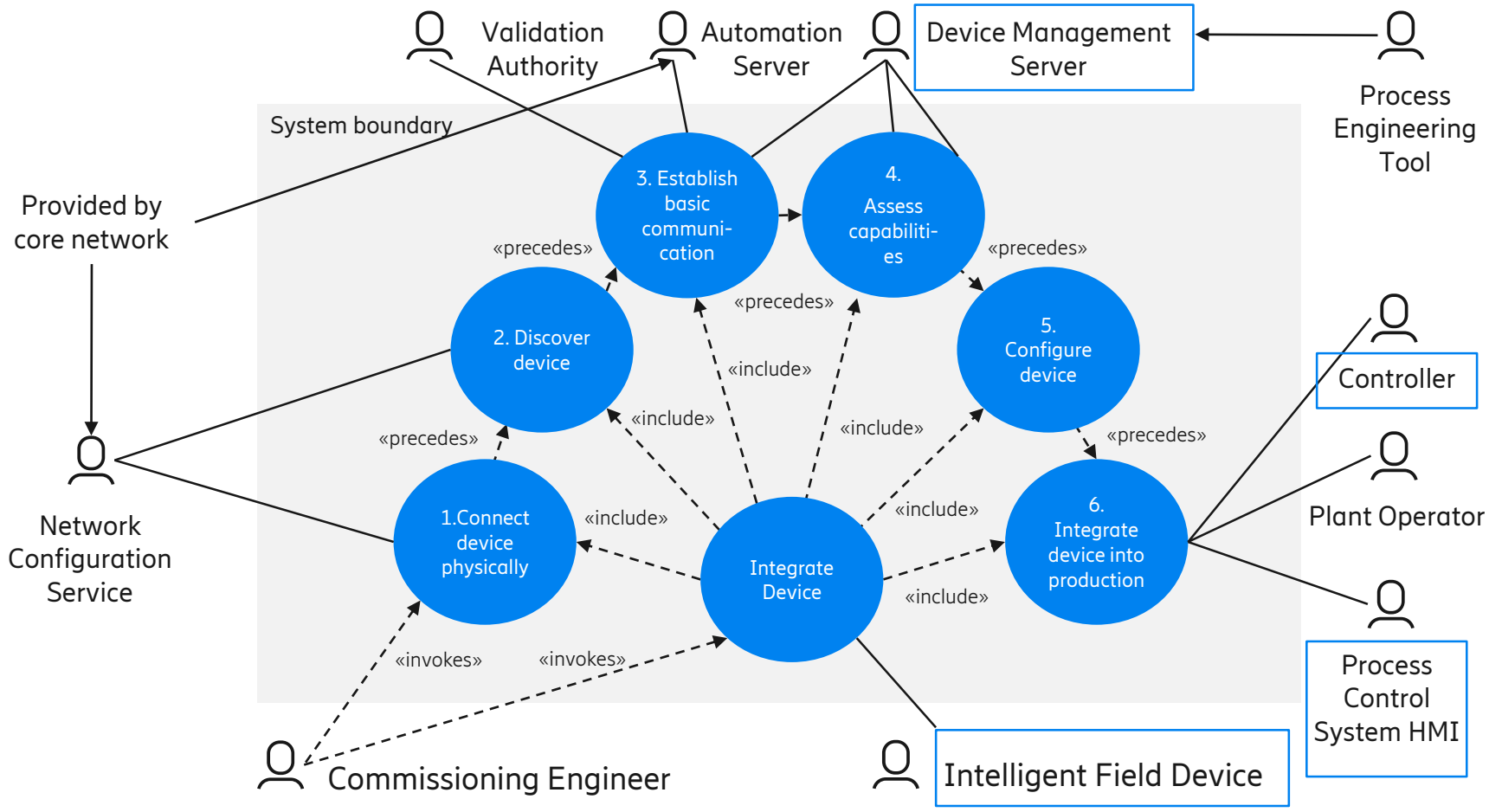
Plug and Produce for Field Devices

- Use case defined by the Industry 4.0
- Similar to the computer "plug-and-play", the manufacturing Field Devices should have "plug-and-produce" capabilities for future production lines.
  - New field devices can be integrated into production lines with minimal or no manual overhead
- Alternative solutions based on industrial standards IEC 62541 (OPC UA) and IEC 62769 (FDI)
- 3GPP rel16 SA1 S1-180243 proposes requirements on 3GPP networks



Use case Actors and steps
as Defined by Industry 4.0

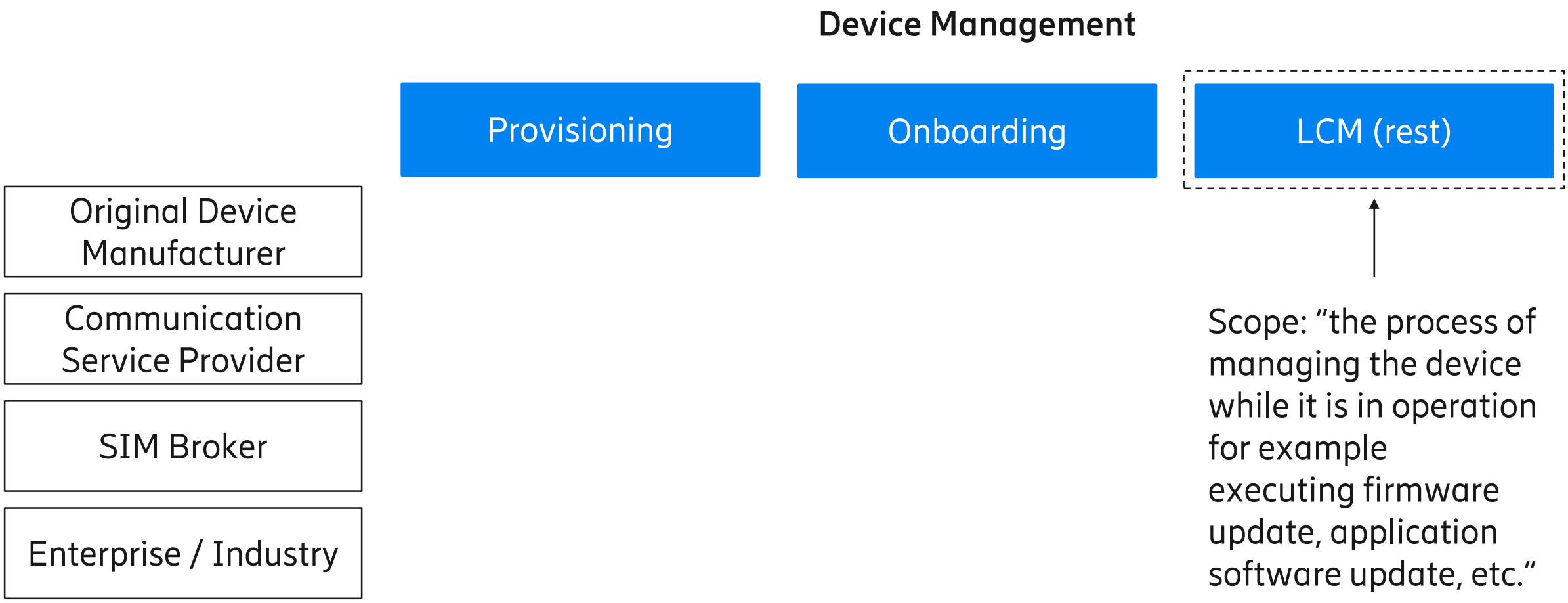
Problems:
- not at all "easy"...
- even 5G Core APIs require Telecommunication competence
- no proper API,
- no proper 5GC (EPC) methods



Source: Industrie 4.0 Plug-and-Produce for Adaptable Factories.
http://www.plattform-i40.de/I40/Redaktion/EN/Downloads/Publikation/Industrie-40-%20Plug-and-Produce.pdf?__blob=publicationFile&v=7

Device onboarding (Example)

Device management overview



Outline

The Background of the “G”

Massive Machine Type Communication, NB-IoT

Device Management, Industry 4.0 Plug and Produce Field Device

Distributed Deployment, Distributed Cloud and Edge Computing

Distributed Cloud

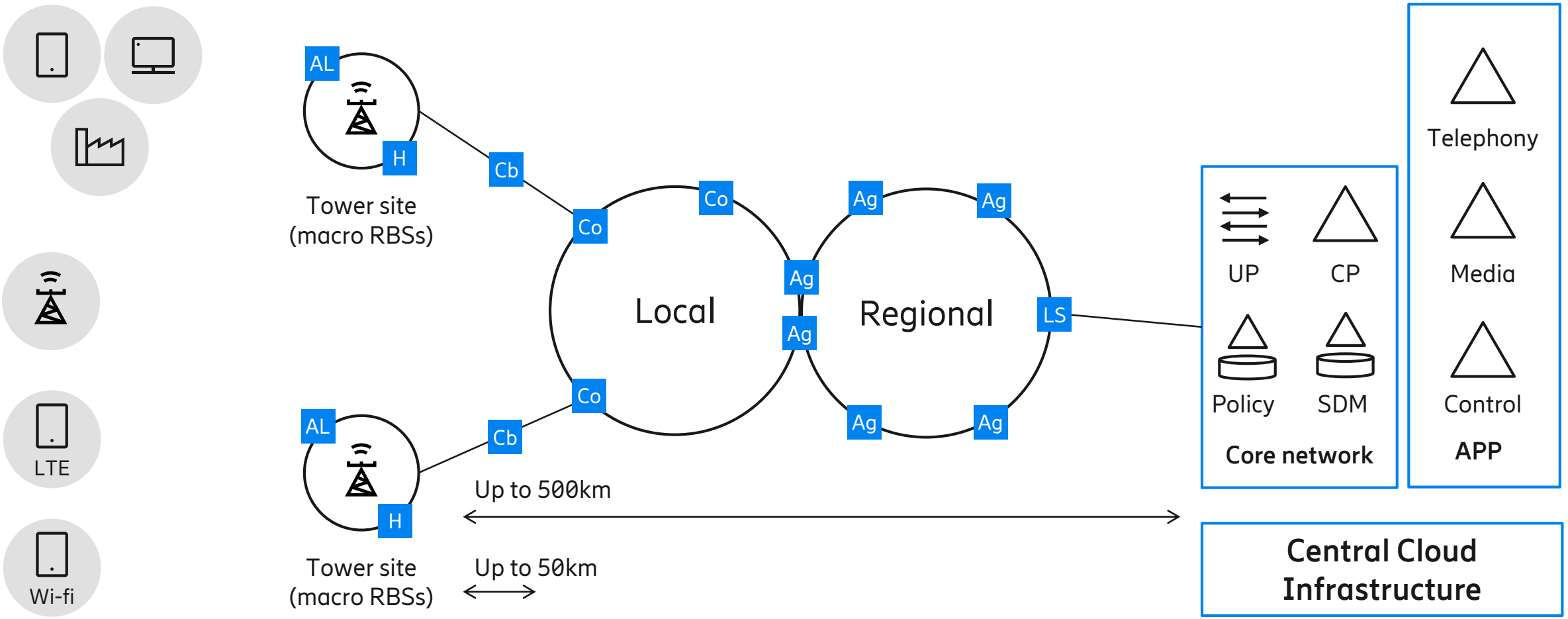
The cloud infrastructure for 5G

— Low latency communication is only feasible if the application part runs close to the mobile device

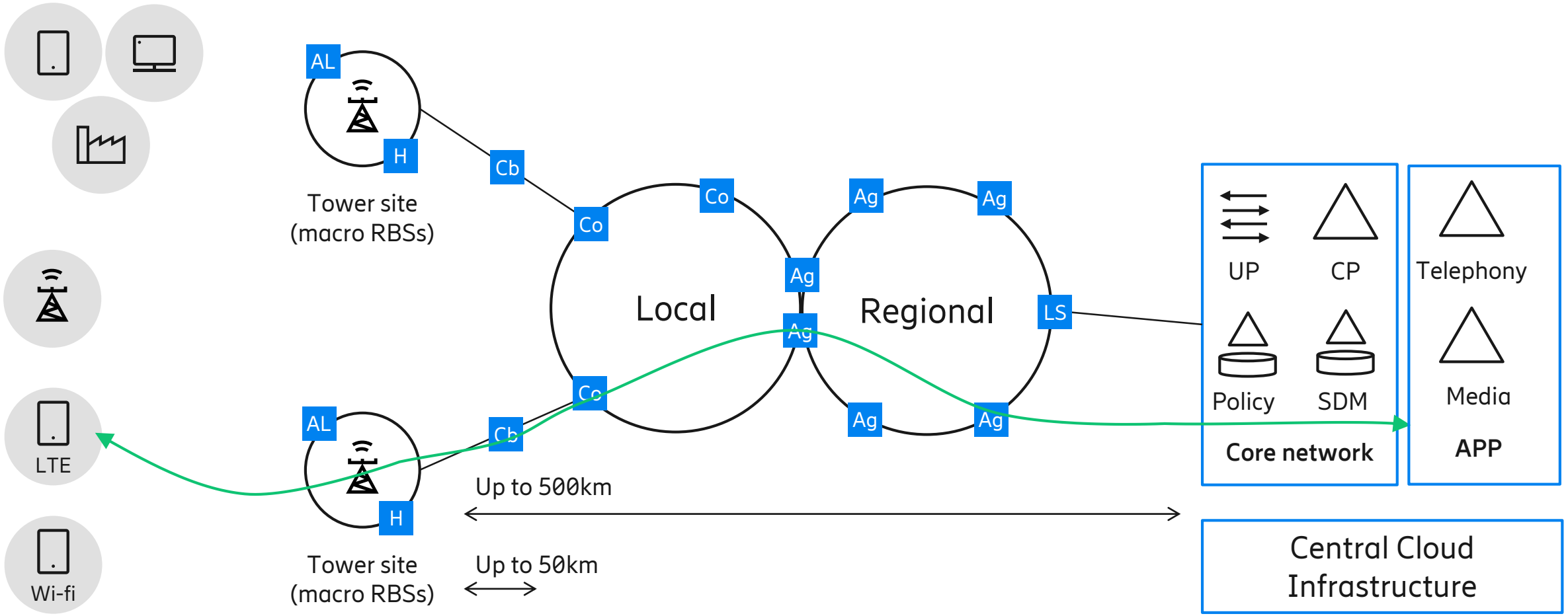
— Distributed cloud is the enabler to place your application to the right location to achieve low latency and optimize on bandwidth

Any guess on what is this?

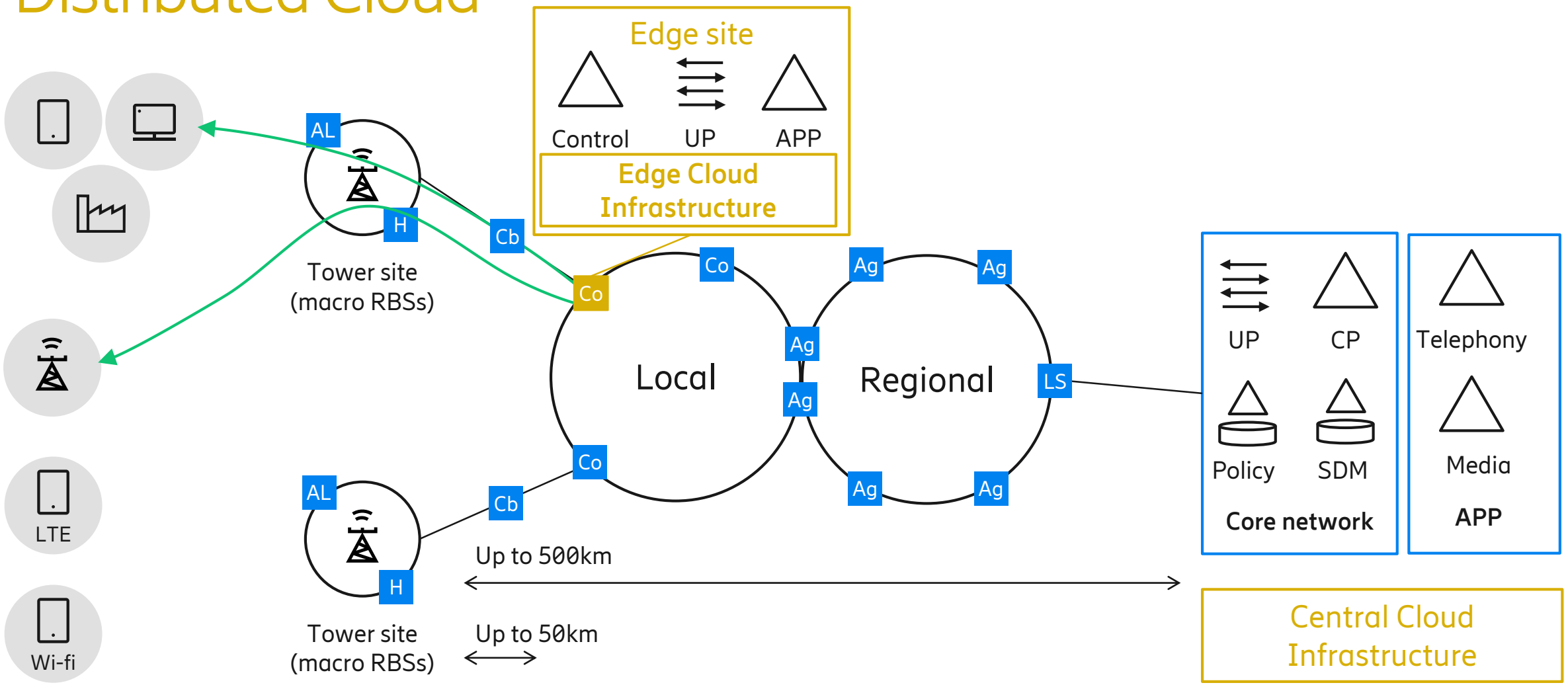
Network topology



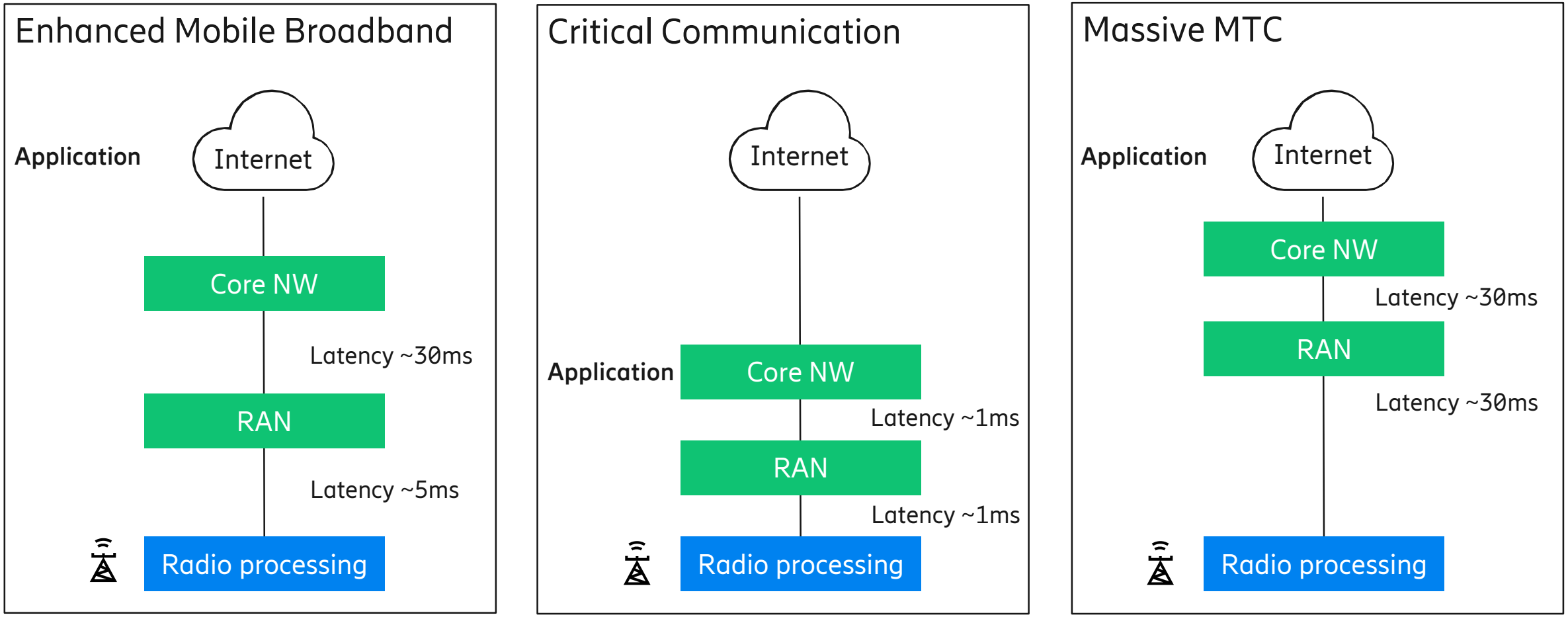
Network topology



Distributed Infrastructure
Distributed Cloud



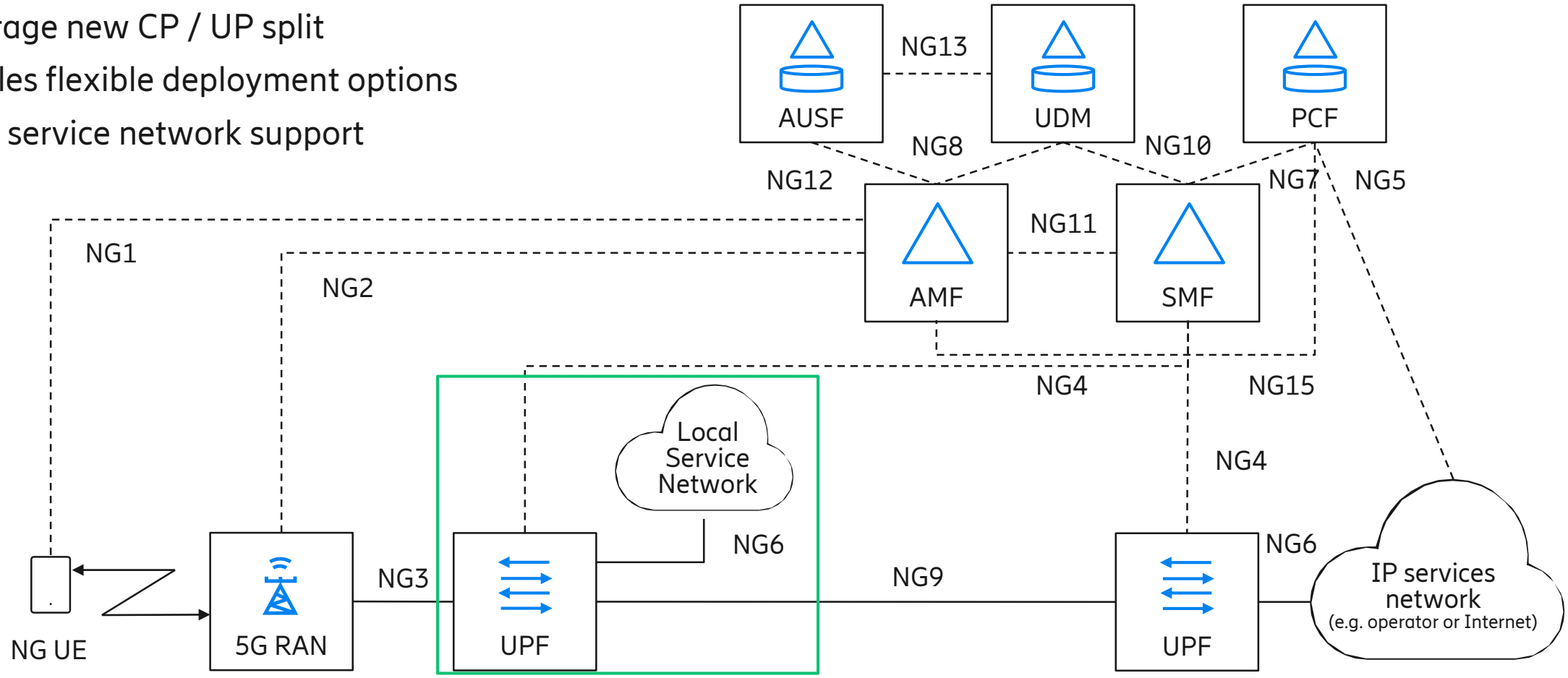
Distributed Cloud infrastructure



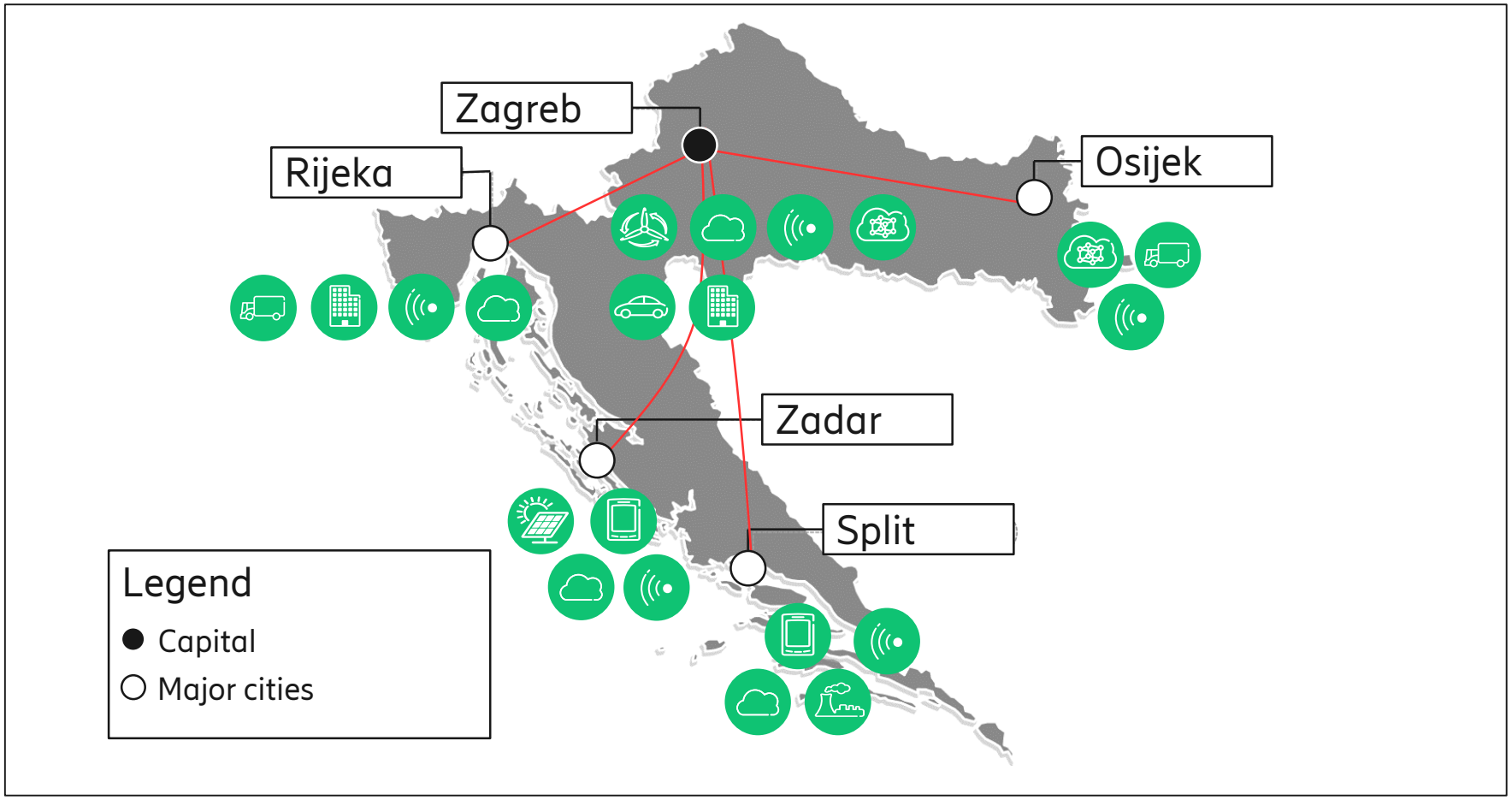
5G Core architecture Overview

Distributed User Plane Function

- Leverage new CP / UP split
- Enables flexible deployment options
- Local service network support

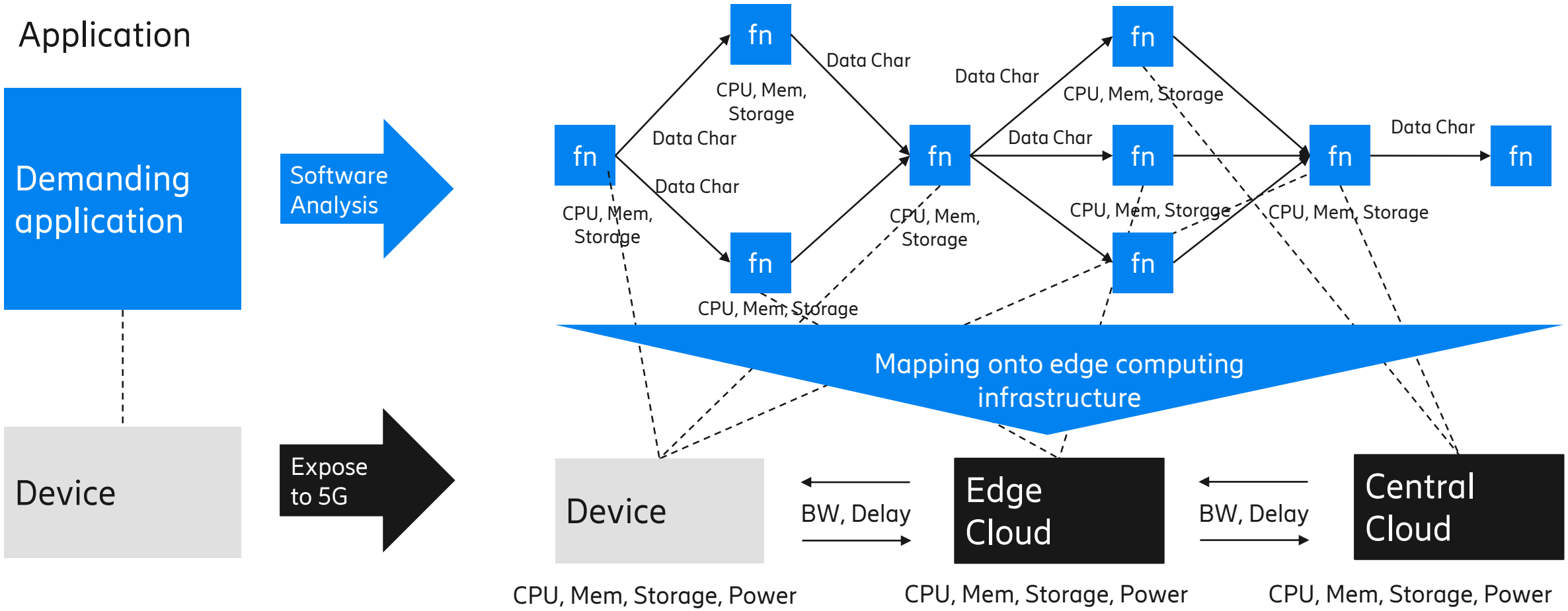


Geographical distribution



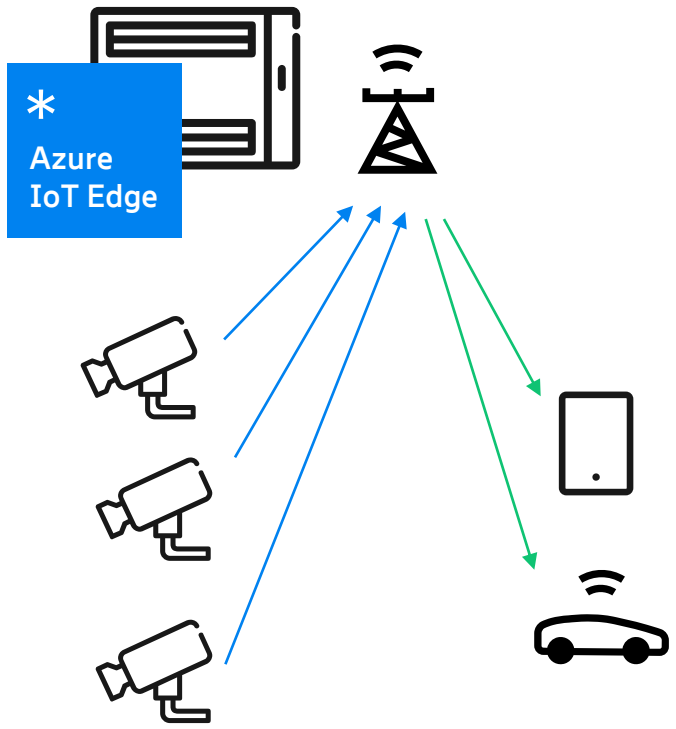
Demanding applications require edge computing

Mapping application components between Device, edge and central Cloud

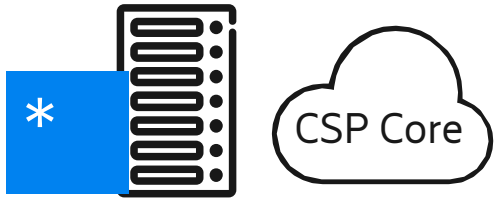


Reference use case
Machine Vision

Edge Site



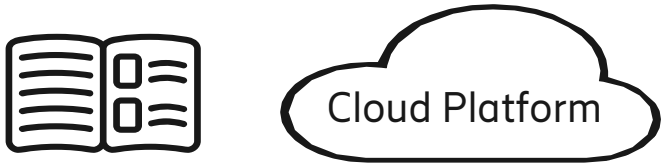
Orchestration & Exposure

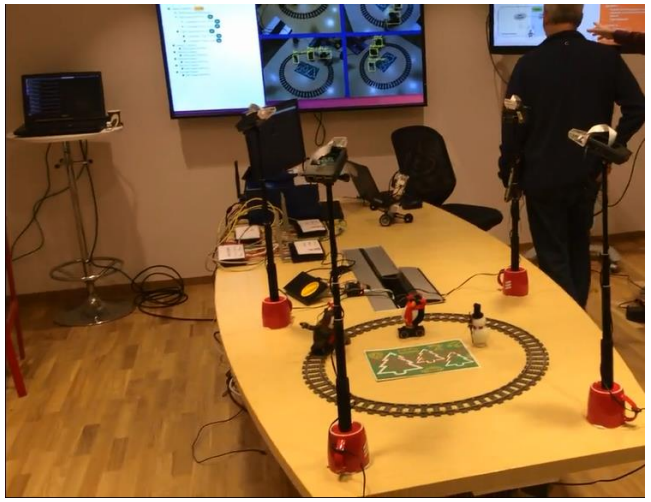


Machine Vision & Augmented Reality with Edge support

- Multiple cameras are streaming videos from different angles about the scene to the edge. On the edge machine intelligence is able to detect objects and determine their positions in real-time.
- Other set of clients can access RT location data and use it for AR and machine control cases.

API Marketplace





Key Takeaways

— The evolution of networks is motivated by new services and cost reduction

— Network exposure, programmability, simplification, “easy” user interface

— Network slicing, parts of the network are purpose optimized

— 3GPP security is a key asset, ongoing discussions about device life cycle management solutions

— Distributed Cloud infrastructure is the infrastructure for low latency communications

References

- TR 23.799 Study on Architecture for Next Generation System
- TR 28.801 Study on management and orchestration of network slicing for next generation network.
- TS 23.501 System Architecture for the 5G System
- TS 23.502 Procedures for the 5G System