Towards 5G-enabled services:

Technology validation and application perspectives

KONSTANTINOS V. KATSAROS, Ph.D.

Senior Research Engineer

MOBILE & CONNECTED WORLD CONFERENCE

JUNE 6TH 2019, ATHENS

At a Glance

19 countries with local presence

1,722 employees worldwide

67% International activities

A global telecommunication systems and solutions vendor with extensive know-how and a proven track record.

40 years of experience

70 countries we export to

3 R&D centers

Core Offerings

Wireless Access & Transmission

Intracom Telecom products employ the most advanced field-proven technologies achieving and exceeding the level of performance required by the modern applications for wireless access and backhaul.

Telco Software Solutions

Intracom Telecom has been building and enriching a wide portfolio of advanced telco software solutions, enabling Operators to generate new revenues and boost their Customers' Experience.

ICT Services & Smart City Solutions

Intracom Telecom strategically focuses on the delivery and operation of top-notch services for converged networking and cloud computing solutions. The company also offers a range or Smart City solutions.

Energy Solutions

Intracom Telecom designs, installs and commissions energy-related systems, providing Smart Grids and Energy Management solutions.

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Performance

Customization

Sharing

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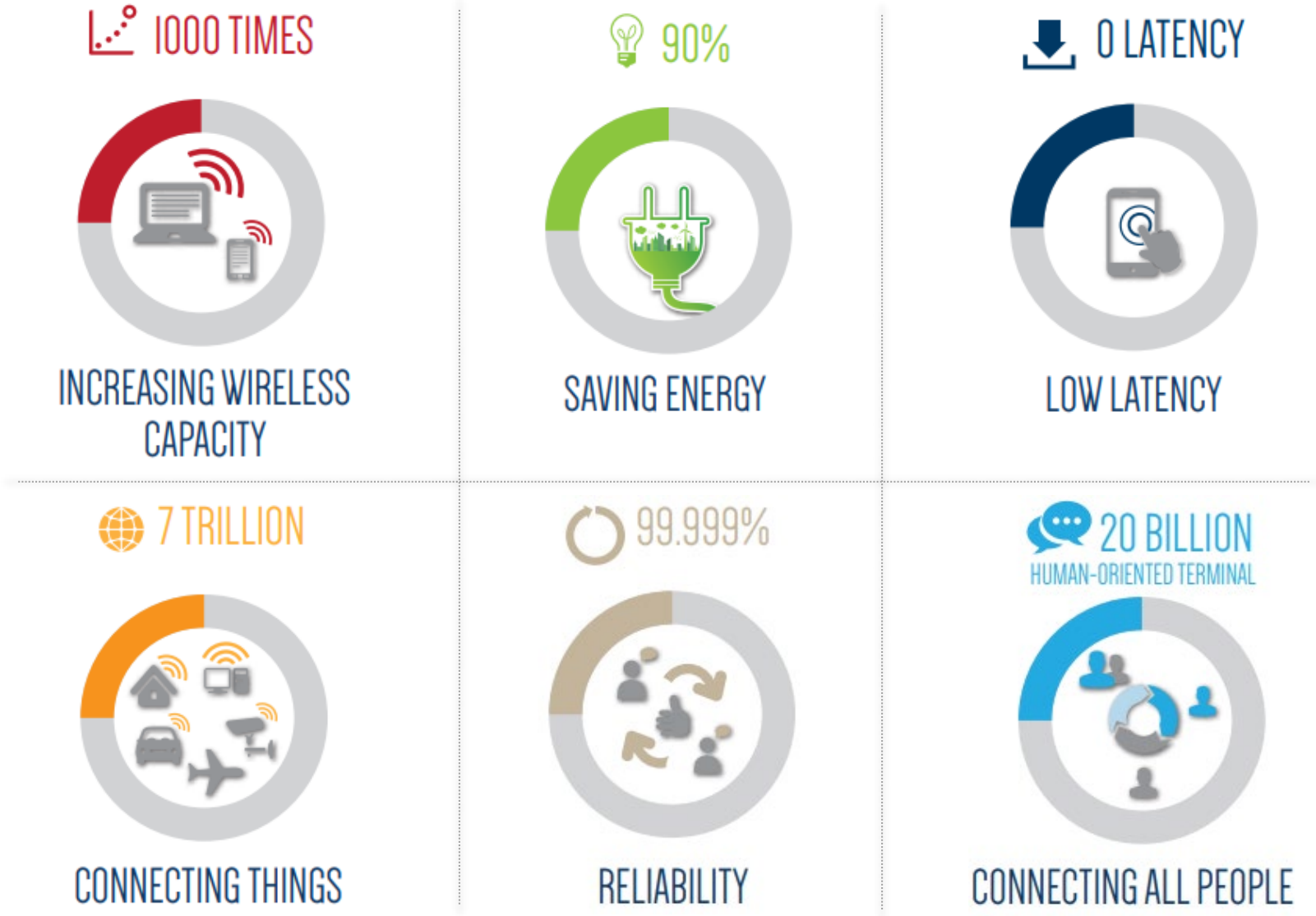
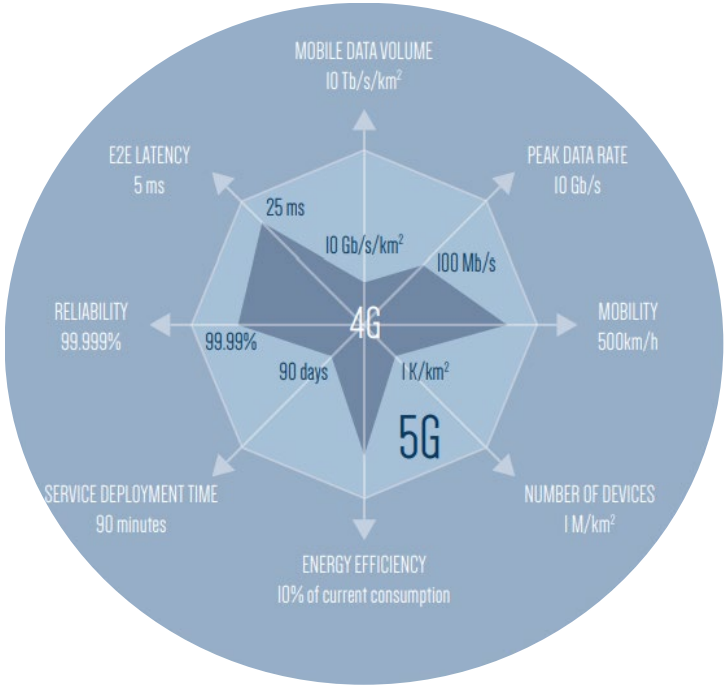
5G Key Performance Indicators (KPIs)





Source: 5G-PPP

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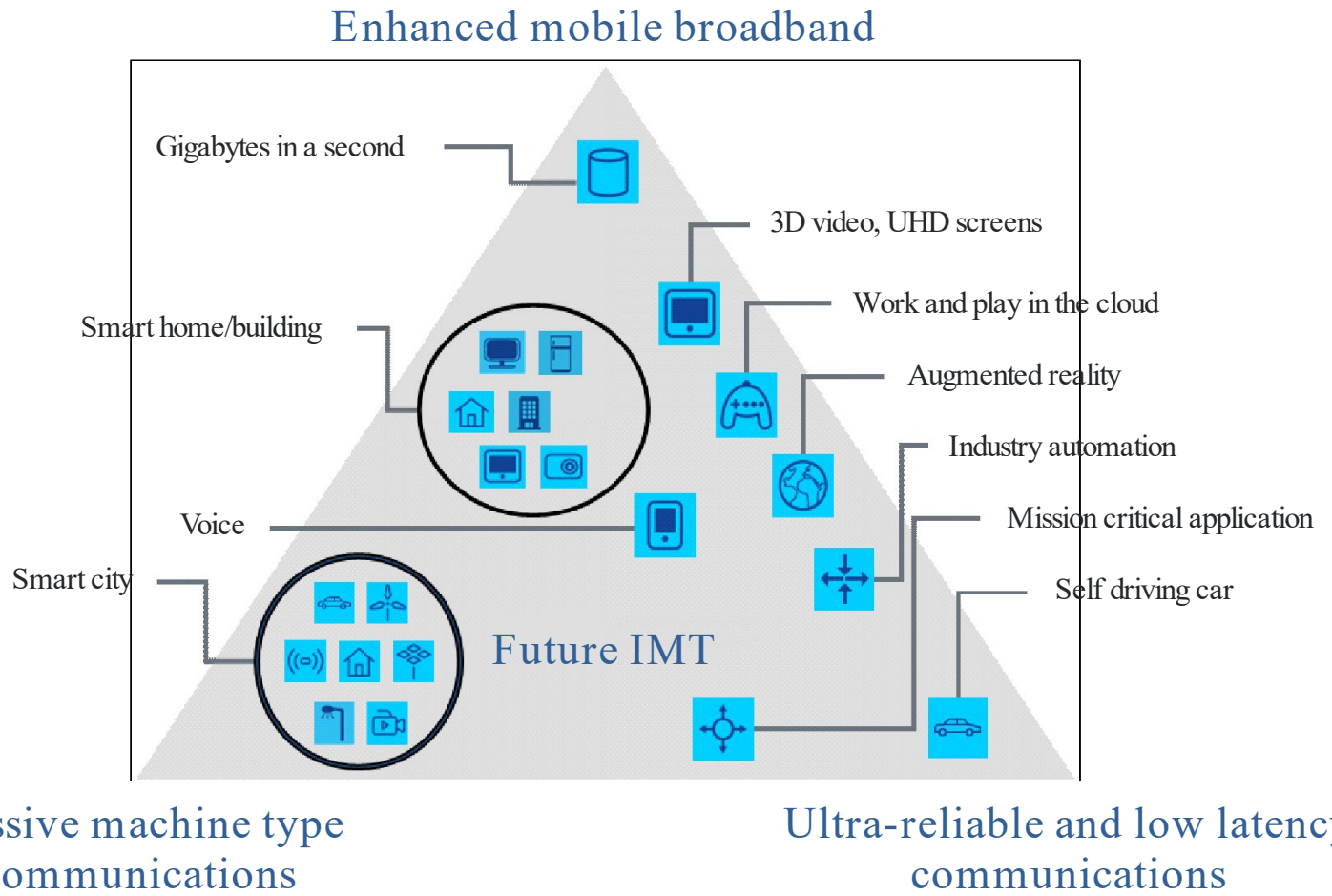
5G Usage Scenarios



Source: ITU-R IMT 2020

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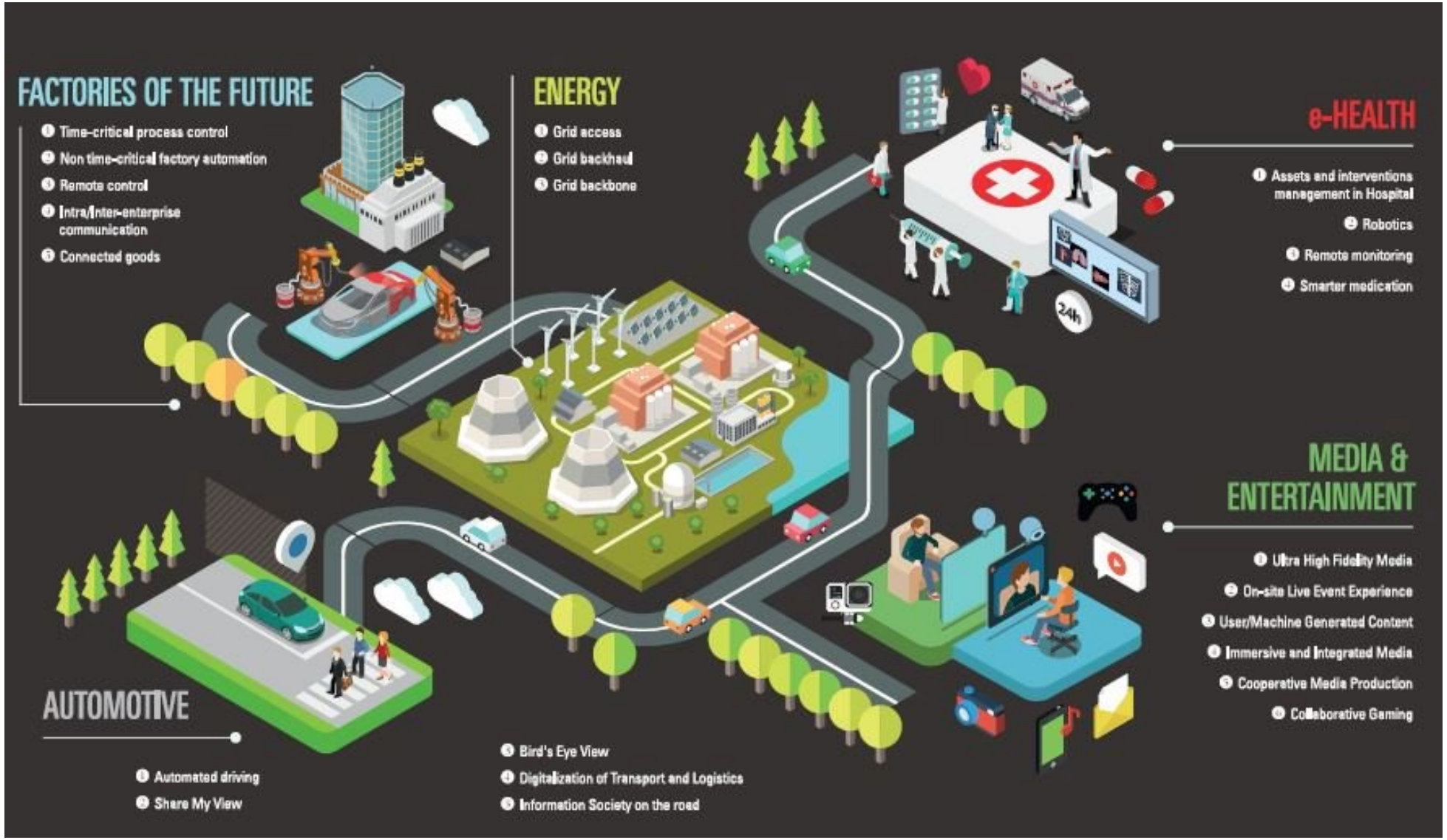
5G Verticals



Source: 5G-PPP

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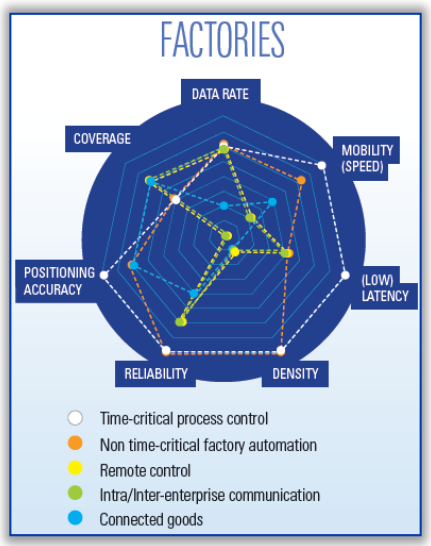
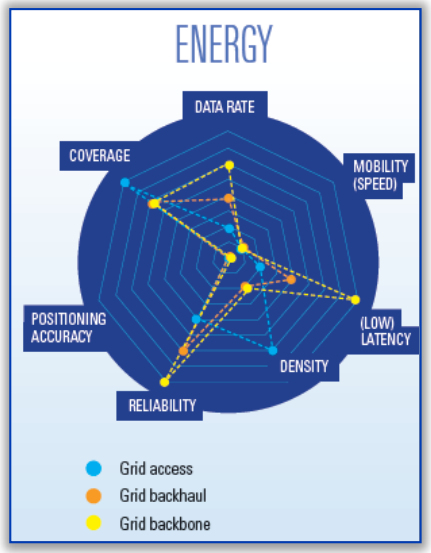
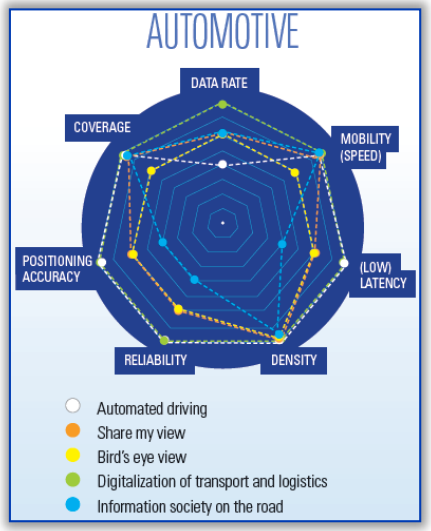
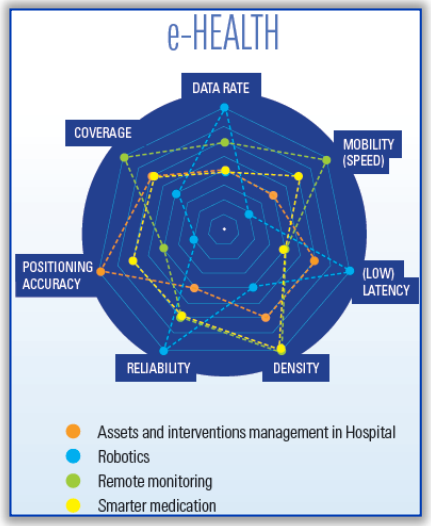
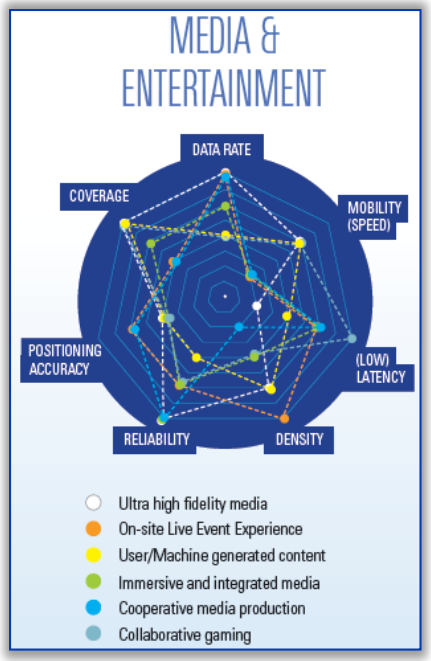
5G Vertical KPIs











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Towards 5G-empowered Verticals

Infrastructure support

- Wireless backhauling
- MEC orchestration
- Edge SaaS/PaaS/BaaS/FaaS

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omniBAS-OSDR
WiBAS OSDR
STREETNODE

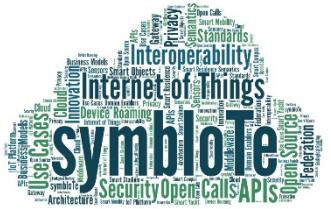
Enhanced Video Streaming Services

- High resolution and/or VR/360 video streaming
- User Generated Content / Personalization / multi-party streaming / social networking
- AR and Video Analytics application support: streaming / MEC infrastructure

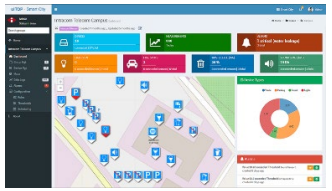
fs|cdn Content Distribution Network

IoT / mMTC support

- IoT Platform interoperability - symbIoTe
- IoT Infrastructure sharing – IoT Slicing
- Unified IoT Orchestration platform (uiTOP)



H2020 symbIoTe


uiTOP

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Towards 5G-empowered Verticals

Enhanced Video Streaming Services

- High resolution and/or VR/360 video streaming
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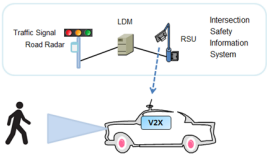
Multiple Vertical Domains

- **Media & Entertainment**
  Large event coverage (sports, festivals, *etc.*)
- **PPDR**
  First responders video sharing, drone-based surveillance / coordination crowd-management, etc.
- **eHealth**
  Ambulance support / remote expert guidance, *etc.*
- **Automotive**
  See-through overtaking infotainment, *etc.*
- **Smart X-culture**
  Precision agriculture/fish farming, field monitoring



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Towards Vertical Trials
Massive UHQ / 360⁰ Live Video Distribution

- **Multi-source**, **multi-viewer** support
  - ✓ MEC-based Pub/sub, Adaptive HTTP Streaming
- Live + 4K/8K + 360⁰
  - ✓ eMBB (up to 1Gbps)
  - ✓ URLLC: *motion-to-photon* latency (5-17ms)

Applications

- Massive event coverage (Media & Entertainment)
- Infotainment (Media & Entertainment / Automotive)
- Situational awareness (PPDR, Infrastructure monitoring)

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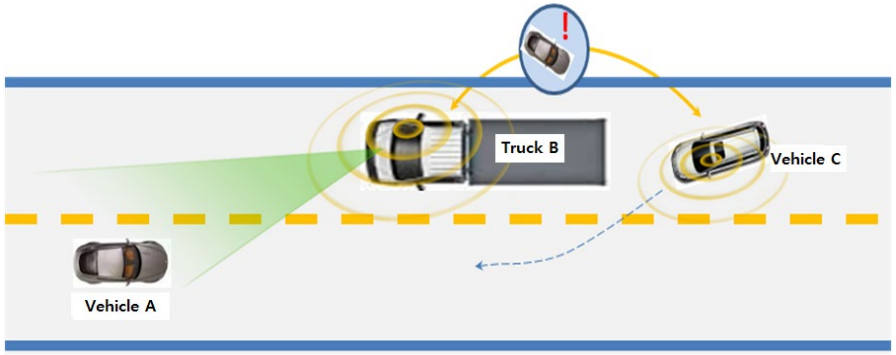
Collective perception of environment

- Real-time exchange of vehicle sensor information
  - **Perception beyond local sensor range**

    e.g., behind crests, curves or objects
  - Raw data: liability in case of accidents, distributed verification of sensor data, etc.



Assisted overtaking

Applications

- Automated forward collision avoidance, overtaking and lane changing

High-bandwidth	1 Gbps/UE (peak)
Low latency	3-10 ms
Message reliability	99.999%
Connection density	3-4K cars per Km^2

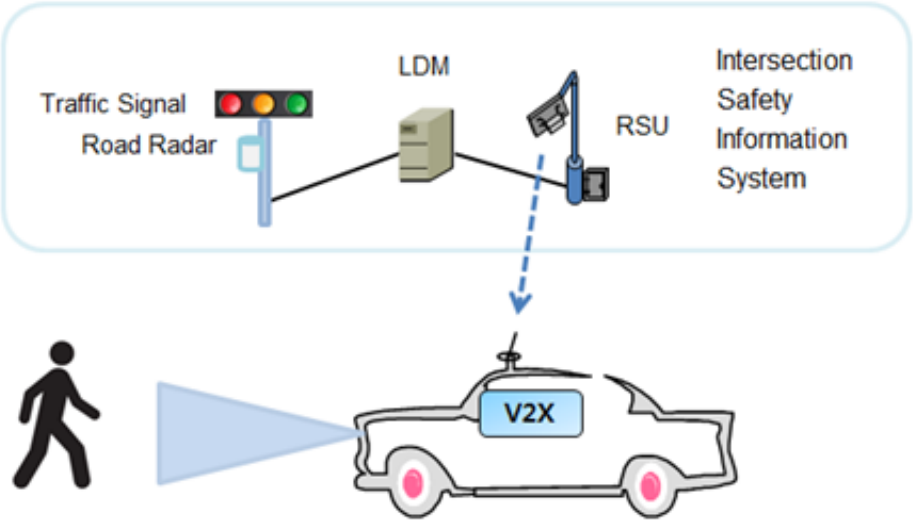
konkat@intracom-telecom.com

Towards Vertical Trials
Cooperative Connected and Automated Mobility

Automotive: sensor and state map sharing (SSMS)

- Enhancing **Local Dynamic Maps** with:
  - Higher **spatio-temporal fidelity**
  - Higher **reliability**
- **MEC** support for:
  - Localized, low-latency processing
  - Network traffic savings

✓ MEC, eMBB, URLLC



Intersection safety information provisioning for urban driving

Applications

➢ Platooning, Intersection safety

High-bandwidth	25-50Mbps/UE
Low latency	10 ms
Message reliability	90%-99.99%
Connection density	3-4K cars per Km^2

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Towards Vertical Trials
Precision Agriculture

- **Precision Spraying**: Spraying decision per plant – Space out , Weed eradication
  - Real-time Video analytics and spraying decision/actuation - CPS
  - ✓ MEC, eMBB, URLLC
- **Remote Disease Diagnosis**
  - Real-time Video analytics – diagnosis – AR interface
  - ✓ MEC, eMBB, URLLC
- **Drone Based Monitoring**
  - Mission-planning & remote control
  - Rich video feed & comparison against Satellite
  - ✓ MEC, eMBB, URLLC

konkat@intracom-telecom.com

How do we get there…?

Key 5G Technologies

- **5G-New Radio (NR) & 5G Core**
  - 3GPP
- **Network Function Virtualization (NFV)**
  - ETSI NFV
- **Software Defined Networking (SDN)**
  - Open Networking Foundation
- **Management and Orchestration (MANO)**
  - ETSI NFV MANO / ZTM / OSM
- **Multi-access Edge Computing (MEC)**
  - ETSI MEC, LF Edge, etc.

5G-NR & 5G Core

5G-New Radio

- Non-Standalone mode: 4G control plane
- Standalone mode: 5G control plane

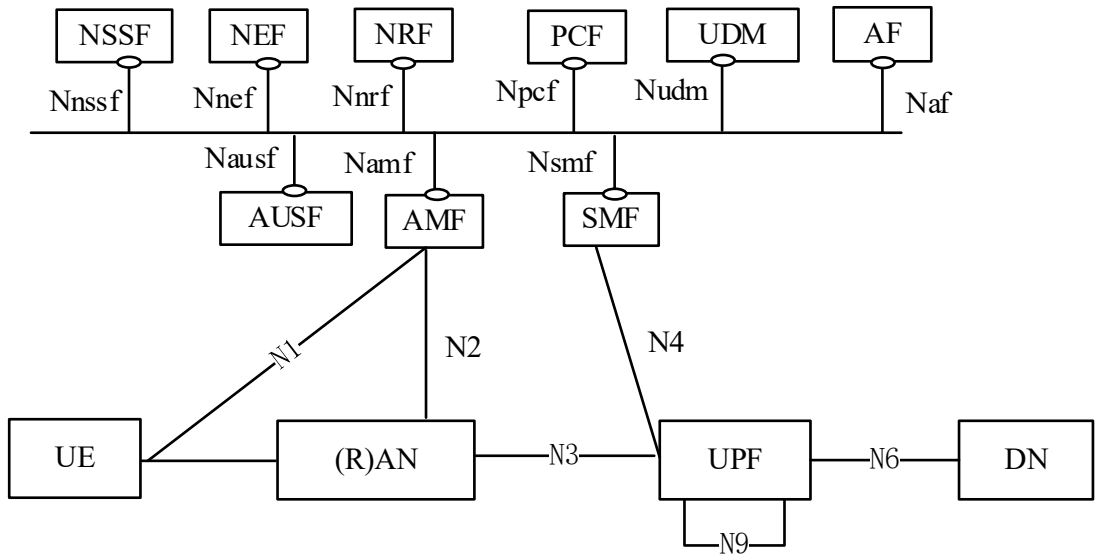
Frequency range designation	Corresponding frequency range
FR1	410 MHz – 7125 MHz
FR2	24250 MHz – 52600 MHz

3GPP 38 Specification Series
[Available at: https://www.3gpp.org/DynaReport/38-series.htm]

5G-Core

- Service-based architecture
- Control and Use Plane Separation (CUPS)
- Modular function design
- Enabling use of NFV/SDN

3GPP TS 23.501, TS 23.502, TS 23.503, TS 23.507
[Available at: https://www.3gpp.org/DynaReport/23-series.htm]



Source: 3GPP TS 23.501 V15.2.0 (2018-06)

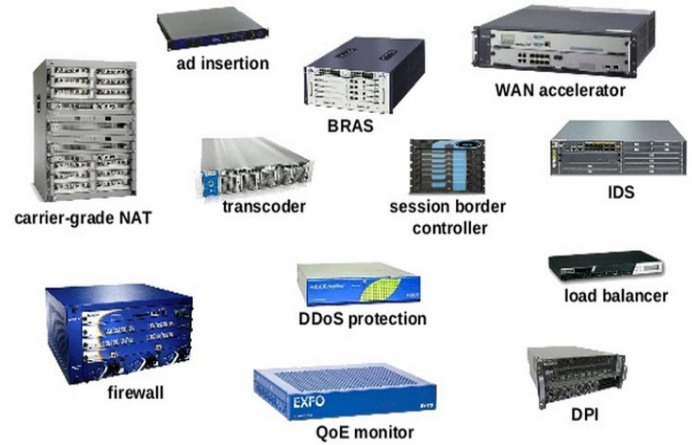
5G System architecture (5G Core)

Network Functions Virtualization (NFV)

Motivation

Large and increasing variety of **proprietary hardware**

- **High OPEX/ CAPEX**
- **Increased Time to Market** for new services



Concept

- Leverage standard IT **virtualization** technology on top of **COTS hardware**
- Consolidate functionality in (micro-)Data Centers throughout the network (or even user premises)

Benefits

- Lower OPEX/CAPEX
  - Infrastructure sharing
  - **Elasticity**
- **Openness** & Rapid innovation
- **Network Service Orchestration**

konkat@intracom-telecom.com

Mobile/Multi-access Edge Computing

Concept

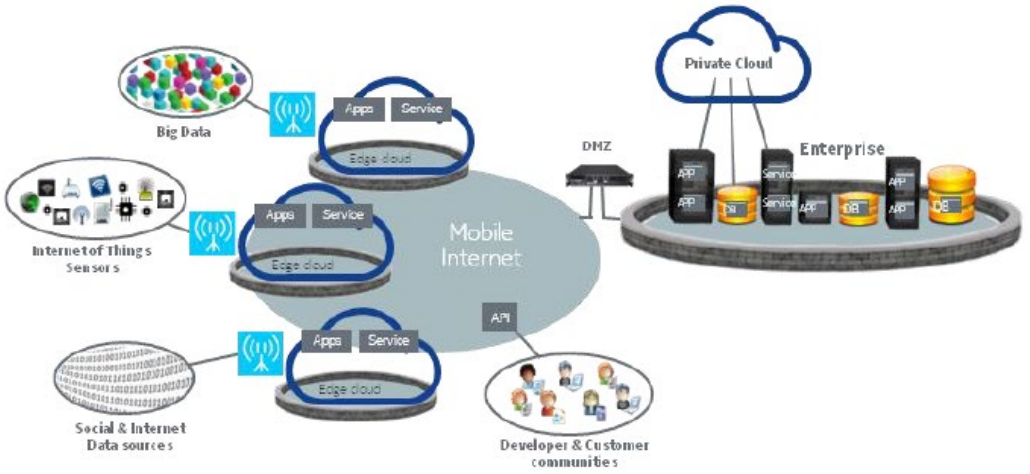
- Enable cloud computing capabilities at the edge of the (cellular) network
- Service/application oriented (as opposed to NFV…)
- Close integration with Radio Access Network (RAN)

Benefits

- Service optimization
  - Adaptation to (wireless) network conditions, location, *etc.*
- Reduced latency

Example application domains

- C-ITS / CCAM
- Augmented Reality
- Video Analytics
- IoT
- Content distribution
- …



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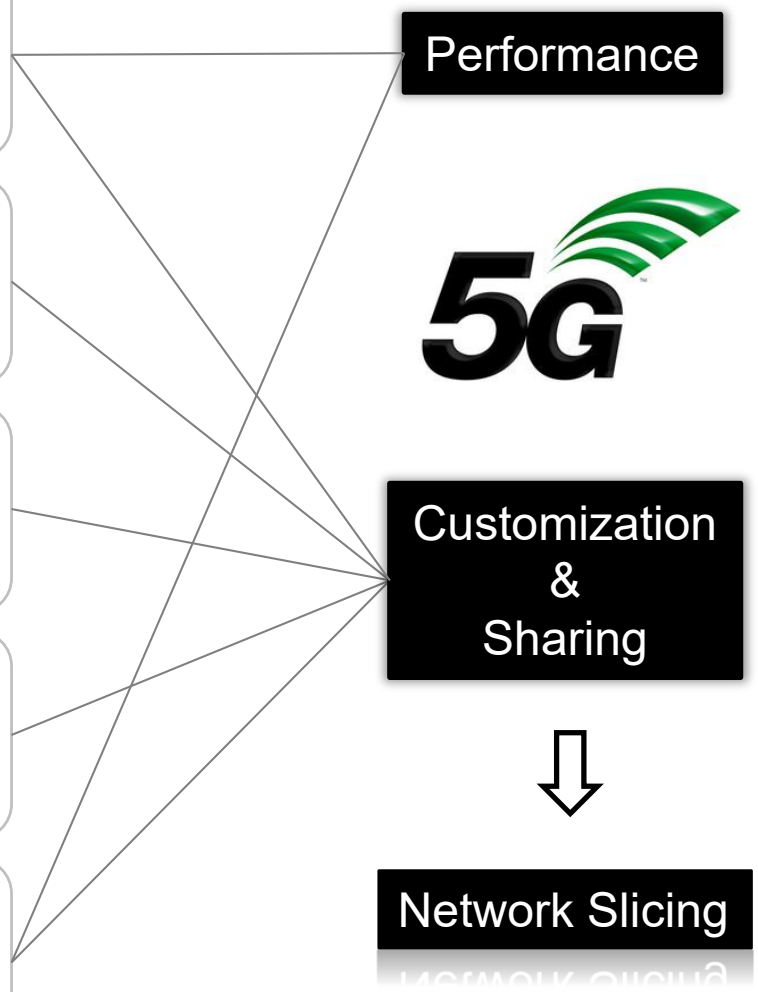

… and how close are we?

5G Related Products & Services

Wireless Front-/Back-haul

- 1–10 Gbps
- PtP / PtMP
- SDR & SDN-enabled
- Ethernet / CPRI for Backhaul / Fronthaul
- ✓ *Multiple deployments around the globe*

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WiBAS OSDR
STREETNODE

NFV Accelerator Platform

- Performance & Energy aware placement
  - ✓ 14-30% Power ✓ 30-60% Data Rate
- Non-disruptive tenant collocation
- Adaptive SLA-guided NS optimization
- Automated HW / SW & workload profiling

NFV-ready Virtualized Wi-Fi

- Multi-access Edge Computing
- End-to-end Slicing & Multi-tenancy
- Accelerated Service Deployment
- SFC support ► Rich VNF Library
- ✓ *Completed pilot tests for MGTS (CIS)*

Rich Media Distribution

- Live TV / VoD / multi-play services
- Full-fledged: encryption, transcoding, distribution & reception of content –Virtualized components
- Web, Smart TV/Phone, Tablet Interfaces
- ✓ *Multiple deployments e.g., USA*

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konkat@intracom-telecom.com

5G Research Activities

Network & Service Management

- MEC orchestration
- IoT Slicing
- Rich Media Distribution
- Softwarization of WindPark Networks
- Cross-domain Slicing & KPI monitoring
- Optimized cross-slice communication

Advanced Wireless Network Infrastructure

- SDN / SDR Wireless Backhaul
- Transport Network Slicing
- RoF-based Fronthaul
- mmWave Beamforming
- Terahertz Communications

H2020 / 5G PPP Projects

VIRTUWIND, CHARISMA, SpeedFG

Phase 1

5G blue SPACE, TERRANOVA

Phase 2 / B5G

5G-VINNI

Phase 3, Part I

5G-VICTORI, 5G HEART

Phase 3, Part II

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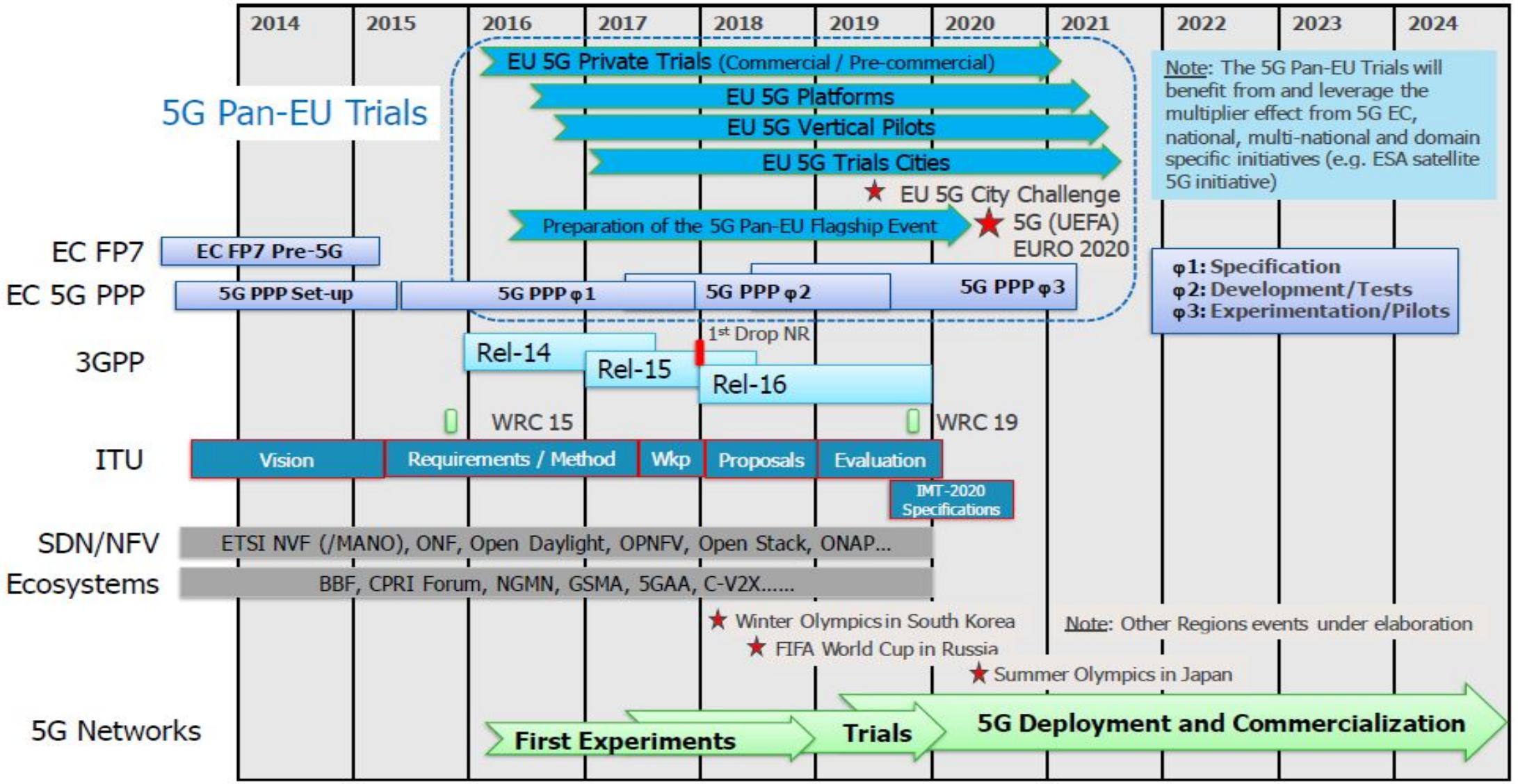
5G PPP Roadmap



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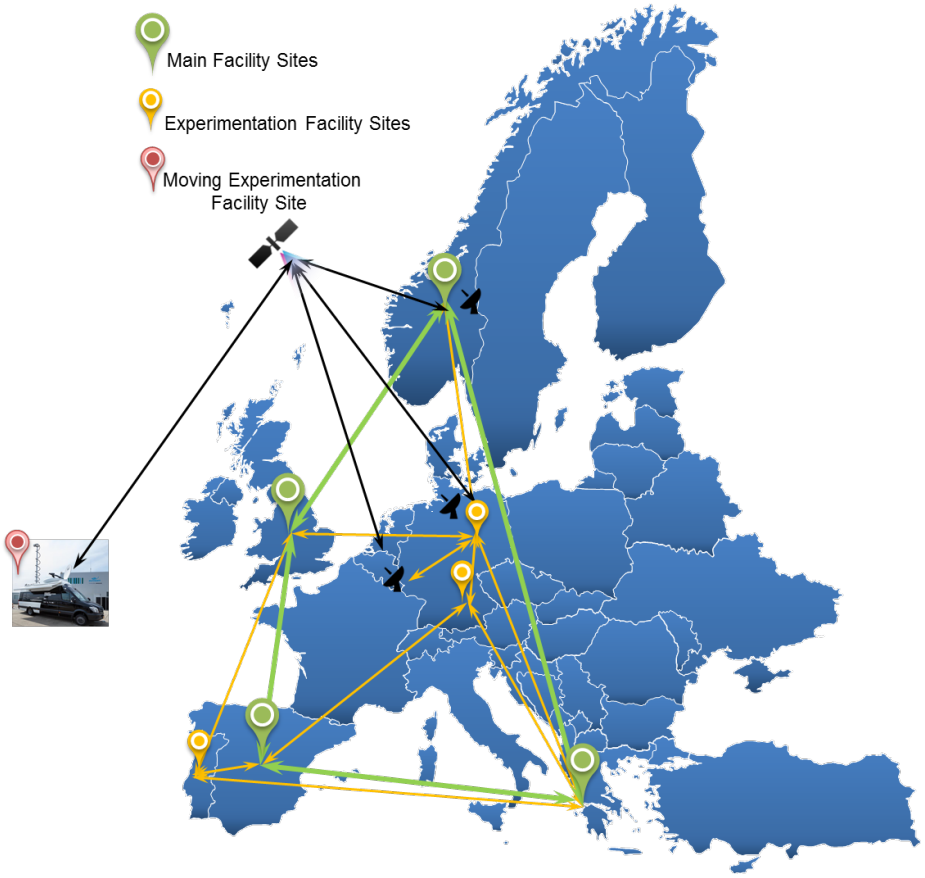
5G PPP Phase 3 Part.I: 5G-VINNI

5G VERTICALS INNOVATION INFRASTRUCTURE

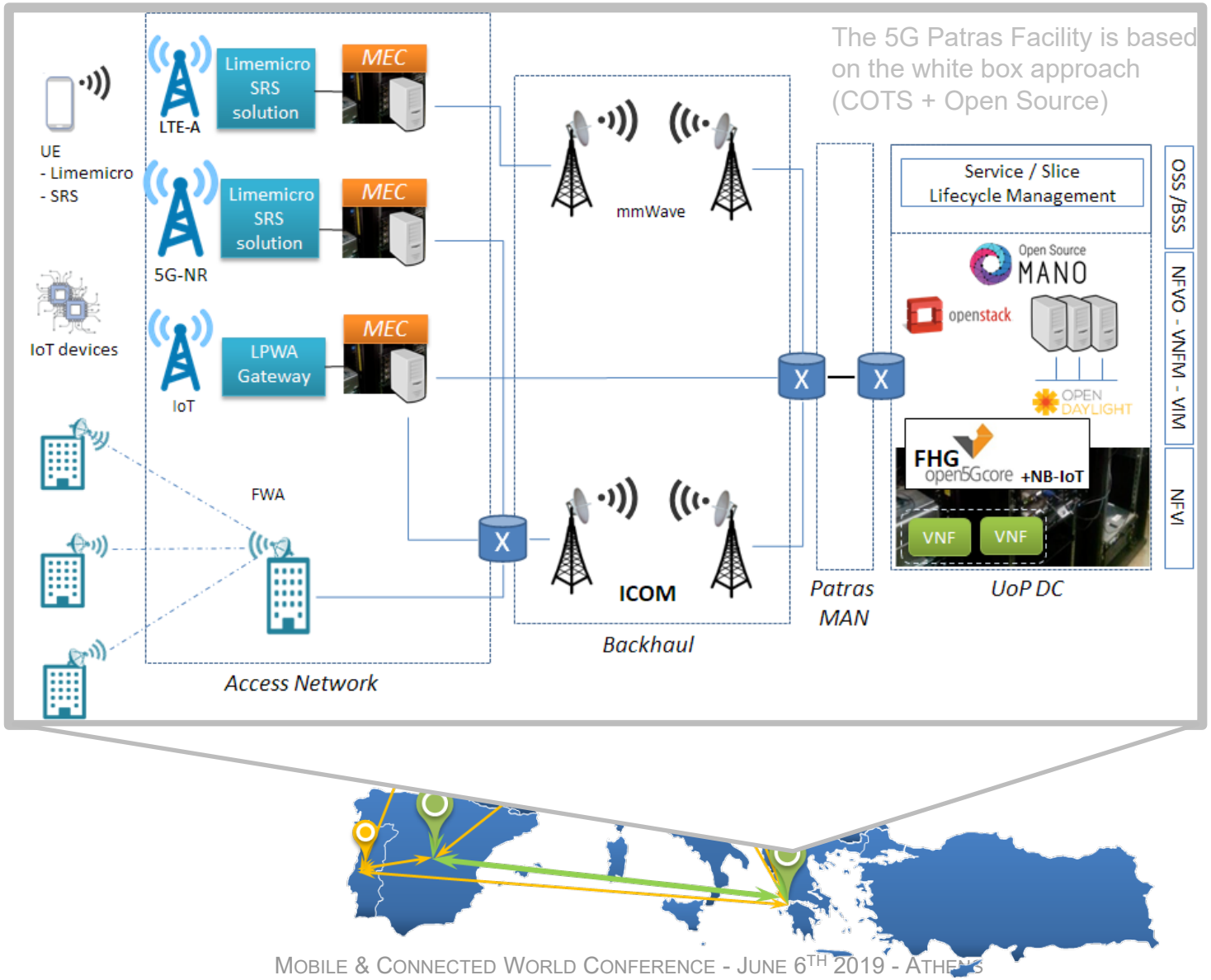
- **Main Facility sites**: E2E 5G-VINNI facility that offers services to ICT-18-19-22 projects with well-defined Service Level Agreements.
  - Norway (Oslo, Kongsberg)
  - UK (Martlesham)
  - Spain (Madrid)
  - Greece (Patras)



Start date: 01/07/2018, End date: 30/06/2021

Overall Budget: €19,997,733

5G PPP Phase 3 Part.I: 5G-VINNI



Patras/Greece Facility Site

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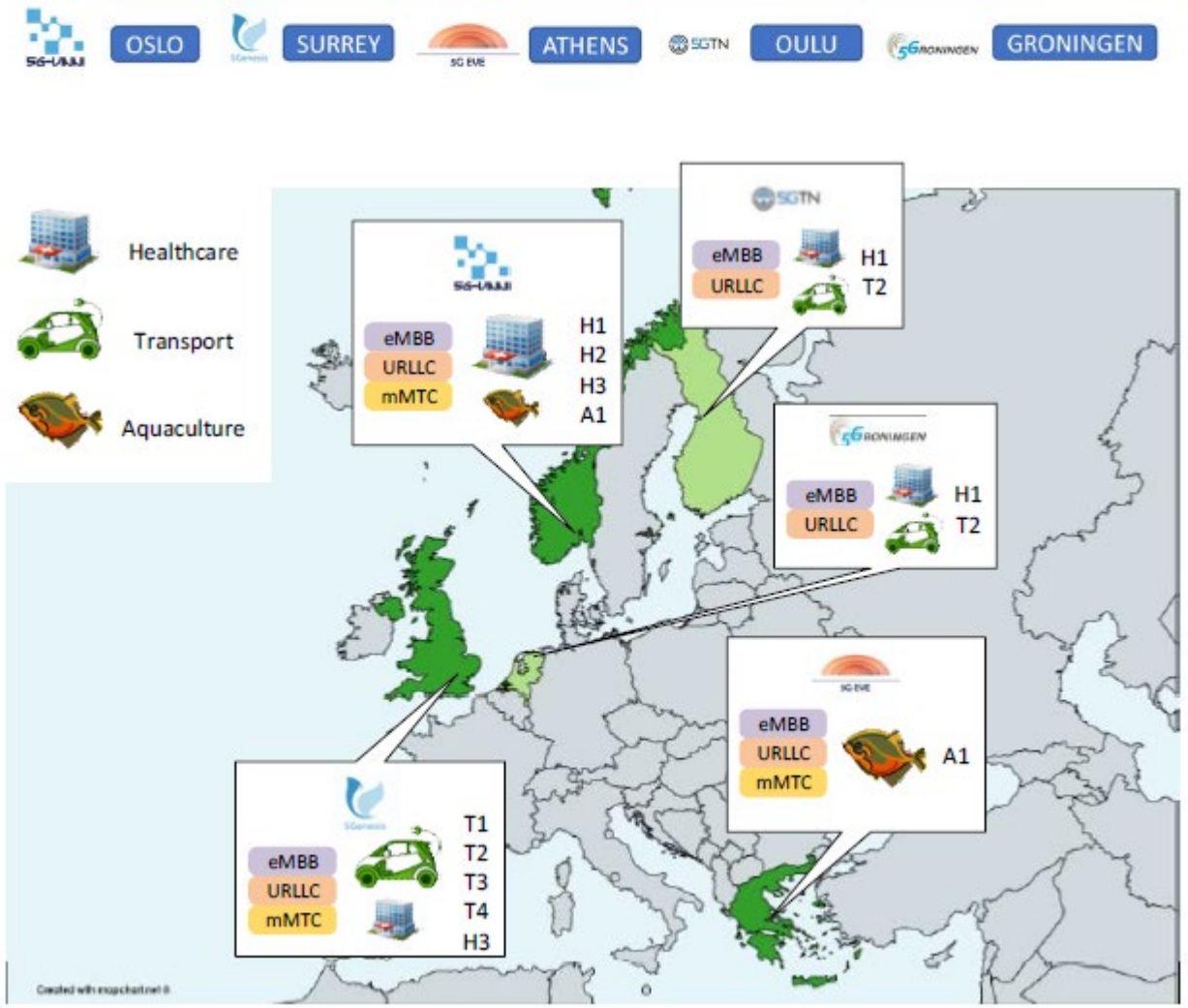
5G PPP Phase 3 Part.II: 5G-HEART

5G HEART

5G HEALTH AQUACULTURE AND TRANSPORT VALIDATION TRIALS



Starting: 01/06/2019, Ending: 31/05/2022

Overall Budget: €14,322,073

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5G PPP Phase 3 Part.II: 5G-VICTORI

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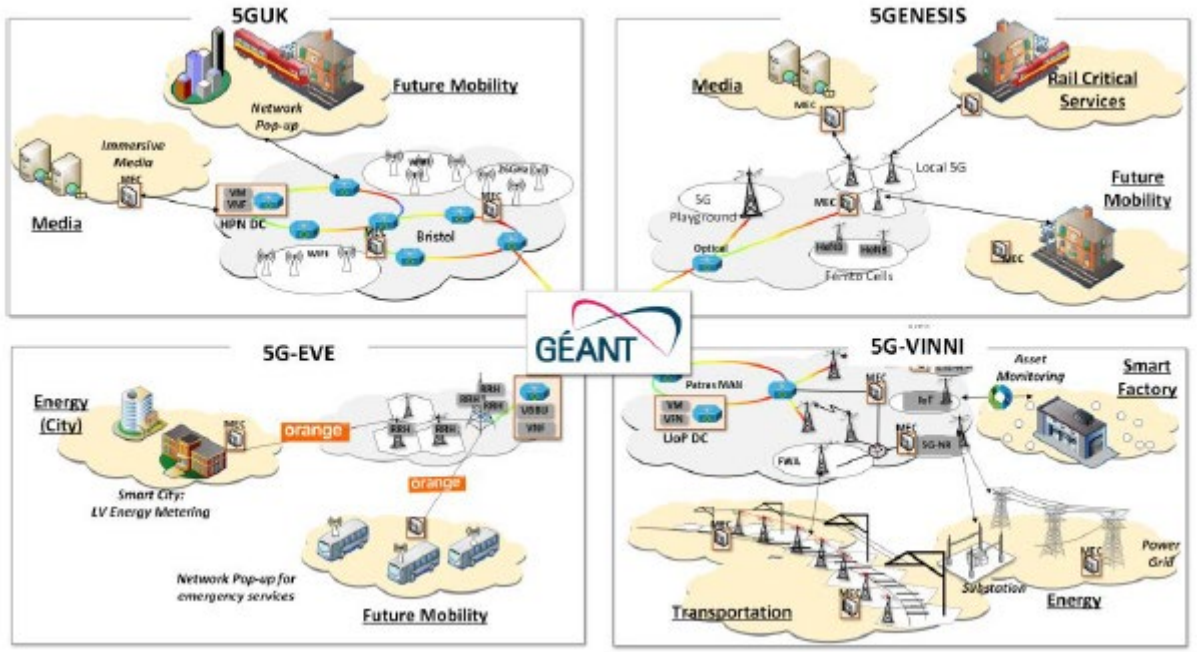
5G-VICTORI

*VERTICAL DEMOS OVER COMMON LARGE SCALE FIELD TRIALS FOR **RAIL, ENERGY** AND **MEDIA** INDUSTRIES*



Starting: 01/06/2019, Ending: 31/05/2022

Overall Budget: €13,499,491

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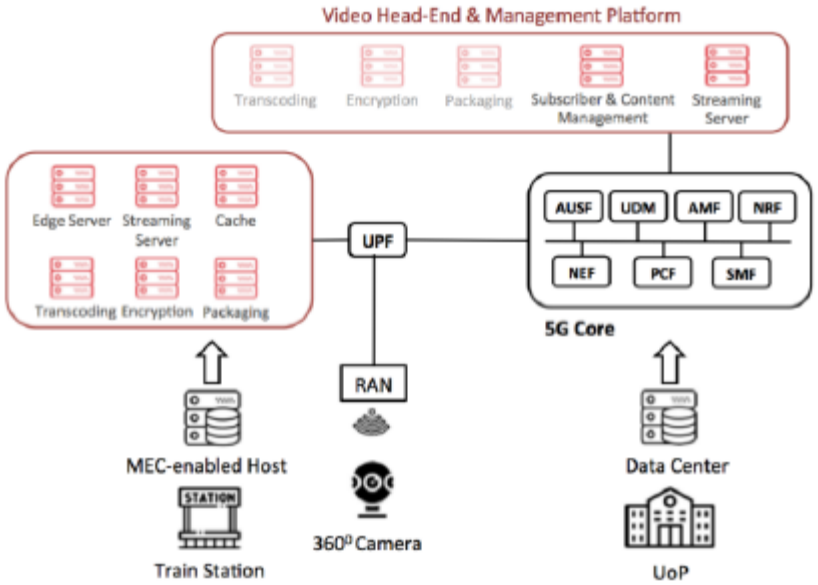
5G PPP Phase 3 Part.II: 5G-VICTORI

Media: CDN services in dense, static and mobile environments



MEC-based example vertical deployment

(5G-VINNI) Patras Facility Extension

- Infotainment and video-surveillance applications

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…we are getting there!

thank you

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