ICT-42-2020
5G Core Technology Innovations

FUDGE-5G

FUlly DisinteGrated private nEtworks for 5G verticals

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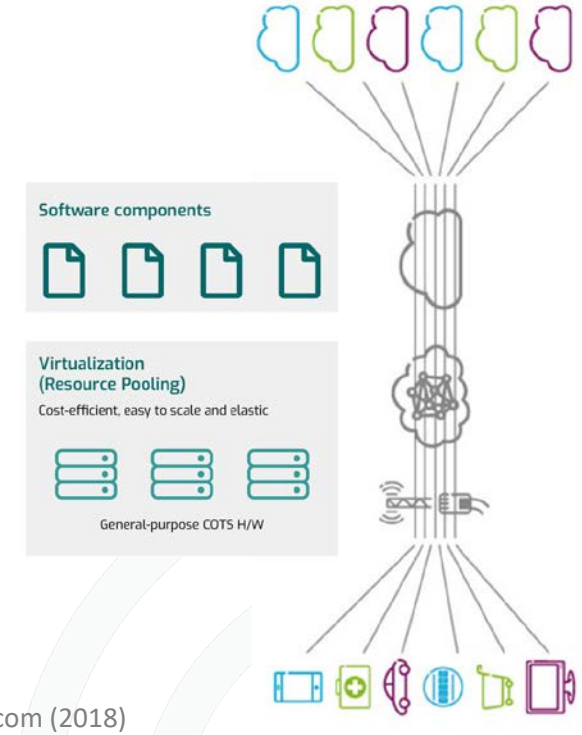
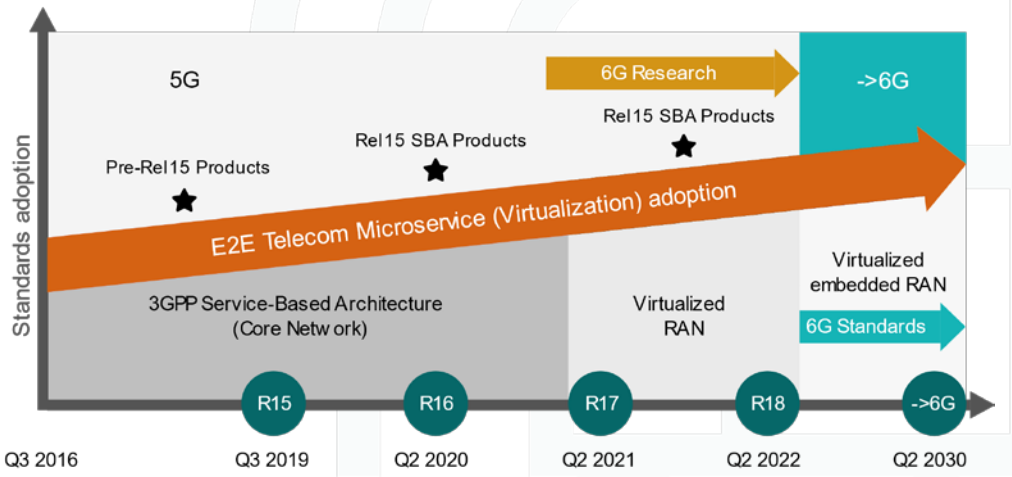
Motivation

- **5G** is **much more** than the **New Radio (NR)** physical layer
- To realize the **full potential** of 5G, the **Next Generation Core Network (5GC)** is required
  - Network Functions **(NFs)**, Service-Based Architecture **(SBA),** Orchestrators and Lifecycle Management
- 5G needs to accommodate a plethora of different vertical use cases under one common transport network
  - Only possible with **virtualization** and **cloud-native** solutions
- The emerging market of **5G private networks**, **Non-Public Networks (NPN)**, requires **customized solutions**



Source: SNS telecom (2018)



Project Fact Sheet

- **Project type:** H2020 Innovation Action (IA)
- **Budget: 6.1 M€** (total budget), 4.6 M€ (funding)
- **Consortium:** 12 partners with important vendors in the 5G ecosystem and 6 high-tech SMEs (10 countries)
  - Project coordination: UPV (Spain)
  - Technical coordination: Telenor Research (Norway)
- **Project duration:** 30 months (September 2020 – February 2023)

Source
https://cordis.europa.eu/project/id/957242

- **Main 5G Components:** virtualized 5GC solutions and service orchestrators
  - TRL 7 (*system prototype demonstration in operational environment*)
- **Vertical use cases:** 5 use cases that will be trialed in the **5G-VINNI** infrastructure managed by **Telenor Research** in Norway with prominent stakeholders as vertical end users
  - **Media** Showroom with Remote Production
  - Public Protection and Disaster Relief (**PPDR**)
  - **Industry 4.0** network
  - **5G Virtual Office**
  - **Interconnected NPNs**

Consortium

x12 Partners, x10 Countries

High-Tech SMEs (x6)

- ATHONET
- Cumucore
- ONE2MANY
- UBITECH
- OneSource
- FIVECOMM

Technology Vendors (x3)

- THALES
- InterDigital
- HUAWEI

Mobile Operator (x1)

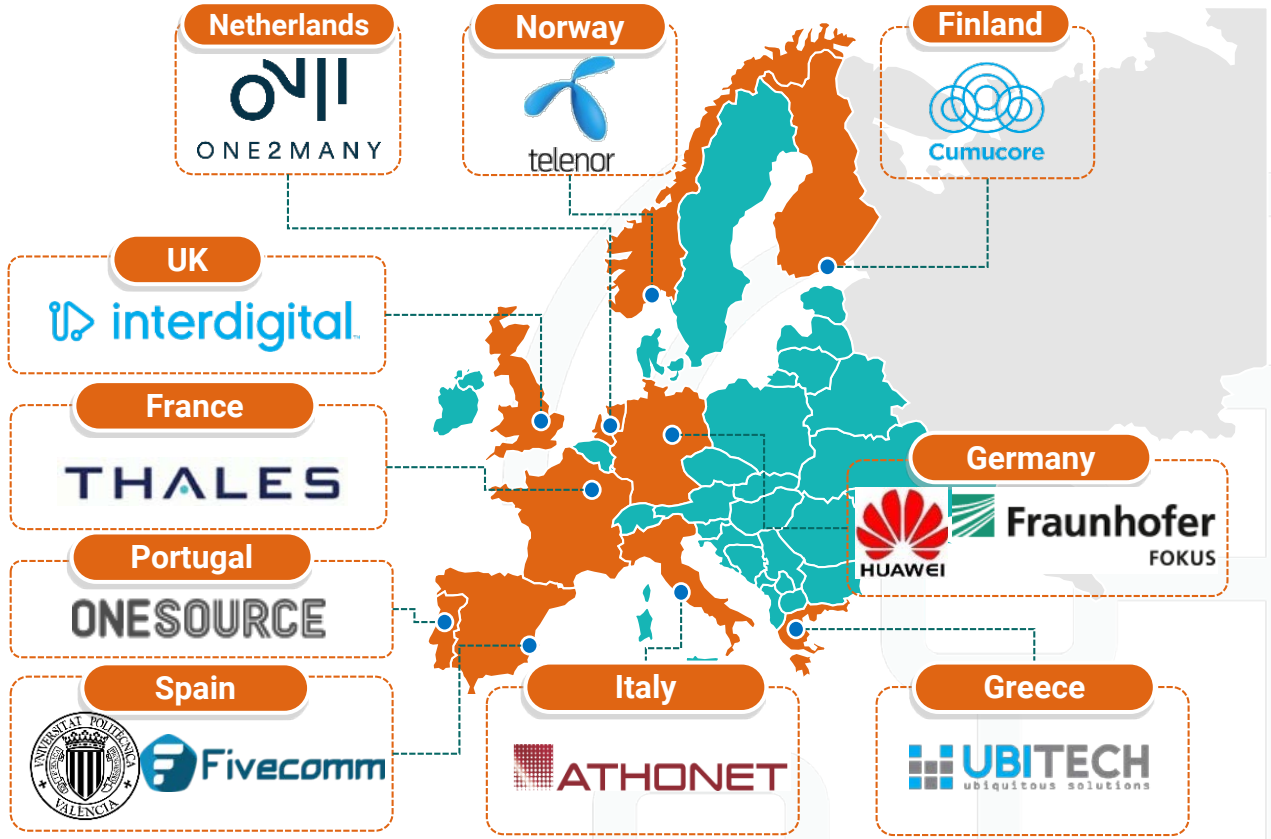
- Telenor

Research Institute (x1)

- Fraunhofer FOKUS

Public University (x1)

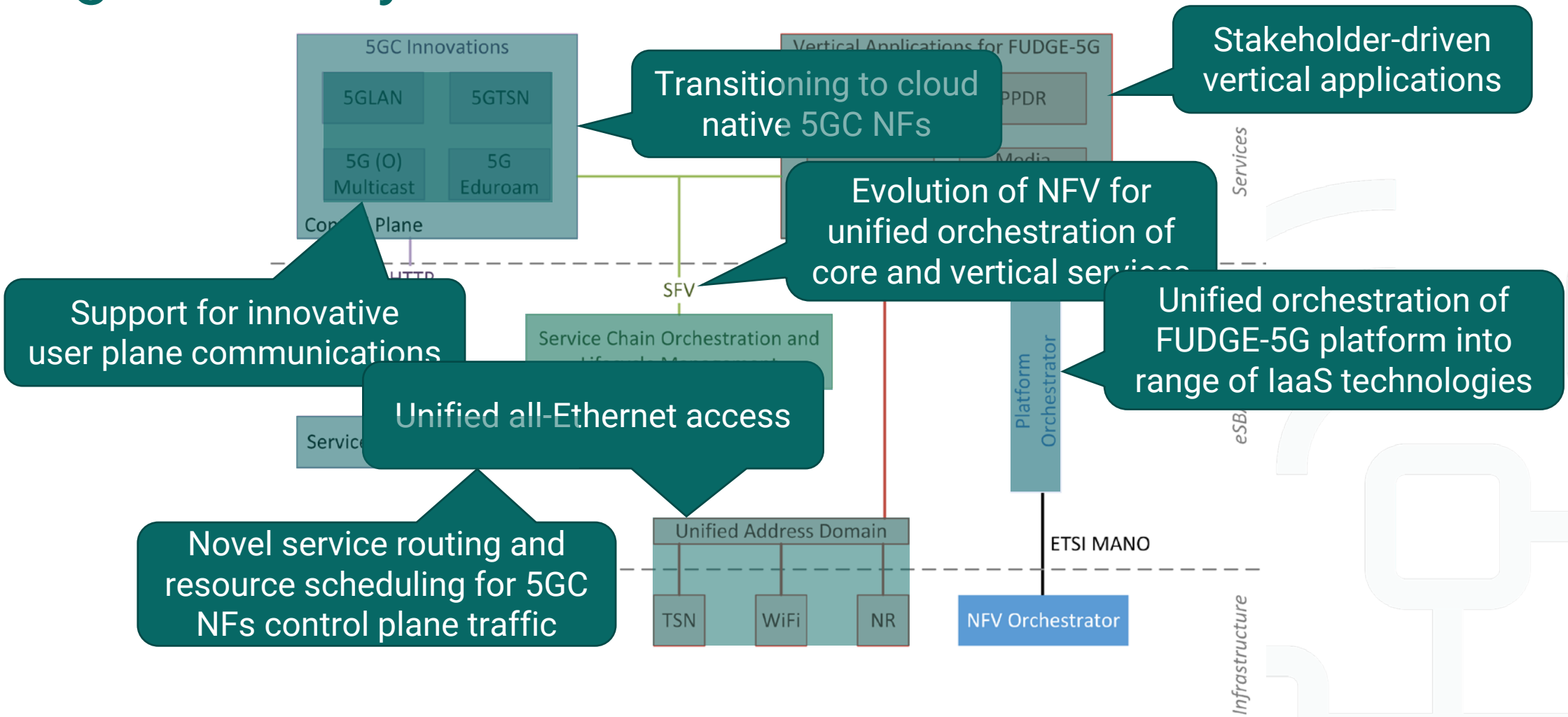
- Universitat Politecnica de Valencia



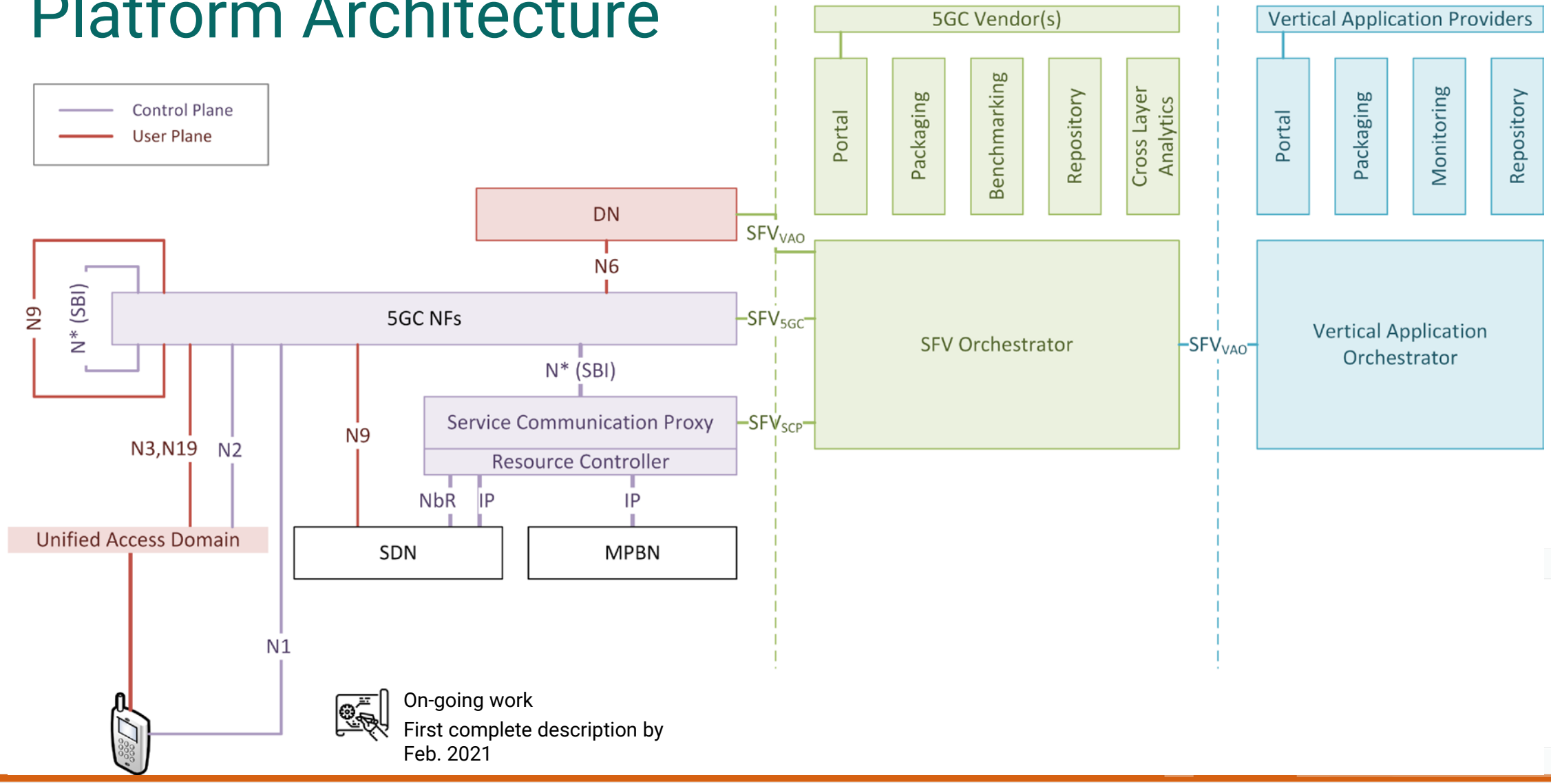
FUDGE-5G Main Innovations

- **Unified Service Based Architecture for 5G non-public networks**
  - SBA for the user data plane, in addition to the control plane
- **5GC NFs as micro-services**
  - New cloud-native 5G NFs to be deployed anywhere (edge, on-premises and cloud)
- **LAN-Native Support in 5G networks**
  - Unified access across fixed LAN, WiFi and 5G (“all Ethernet” access), including 5G-Multicast
- **Interconnecting Non-Public 5G Networks**
  - Not supported by current 3GPP specifications
- **Integration between Public and Non-Public 5G Networks**
  - 5G-VINNI as public network and FUDGE-5G as non-public network
- **5G-TSN (Time Sensitive Networking)**
  - Time synchronization on top of 5GLAN
- **5GC deployments on Public/Private Clouds, hybrid, etc.**
- **Multi-vendor 5GC deployments**
- **Subscription concealed identifier (SUCI)**

High Level System Overview



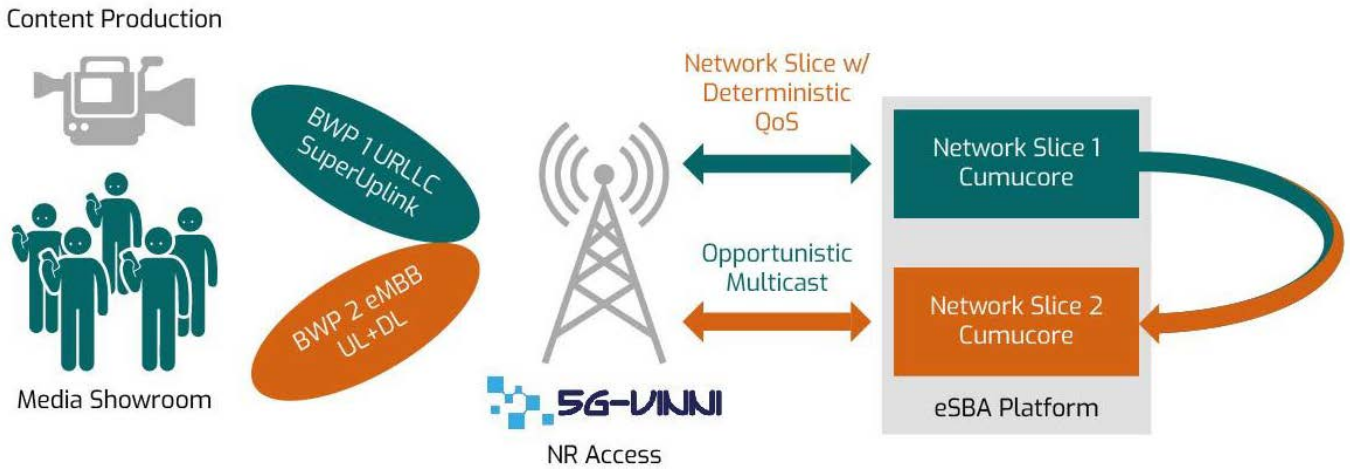
Platform Architecture



On-going work

First complete description by Feb. 2021

Media Use Case



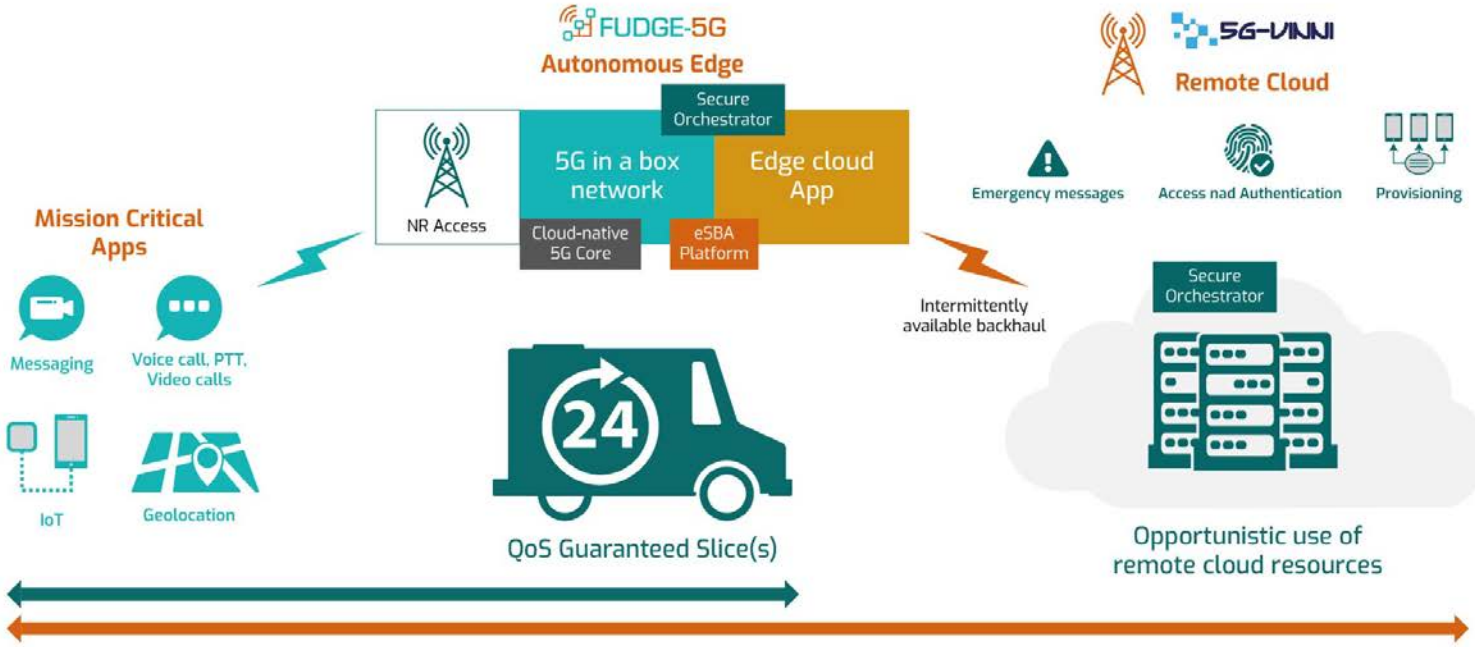
Stakeholder: NRK

Partners: interdigital. ATHONET telenor group Cumucore Fivecomm

- **NPN showcasing flexibility to concurrently serve diverse multimedia scenarios**
  - Leveraging **Network Slicing** to ensure the correct QoS across services
  - **RAN sharing with PLMN** and interoperable core parameter customization for different network slices
- **Main Innovations:**
  - **Interoperability** testing between hybrid cloud/premises deployment
  - **System Slicing** in FUDGE-5G Platform: UL-focused slice for **Content Production**, DL-focused slice for **Media Showroom**.
  - **Opportunistic Multicast** based on Name-based Routing
  - **Uplink enhancement techniques** to ensure the QoS in Remote Production

PPDR Use Case

- **Non-public 5G network for first responders and protection forces**
  - Work even when other infrastructure fails (earthquake, tsunami, etc..)
  - **Easy to deploy and configure 5G network**
  - **Completely standalone or backhauled to a remote cloud**



- **Main Innovations**
  - **Mobile autonomous edge** provides all-in-one 5G services in a mobile platform
  - **End-to-end orchestration** enforces services from the radio up to the cloud
  - **Opportunistic use of intermittent backhaul links** improves processing power with the help of a remote cloud.
  - Demonstrate the coexistence of PPDR-specific **NPN** and non-critical **PLMNs**
  - **SUCI** protects against IMSI catching techniques

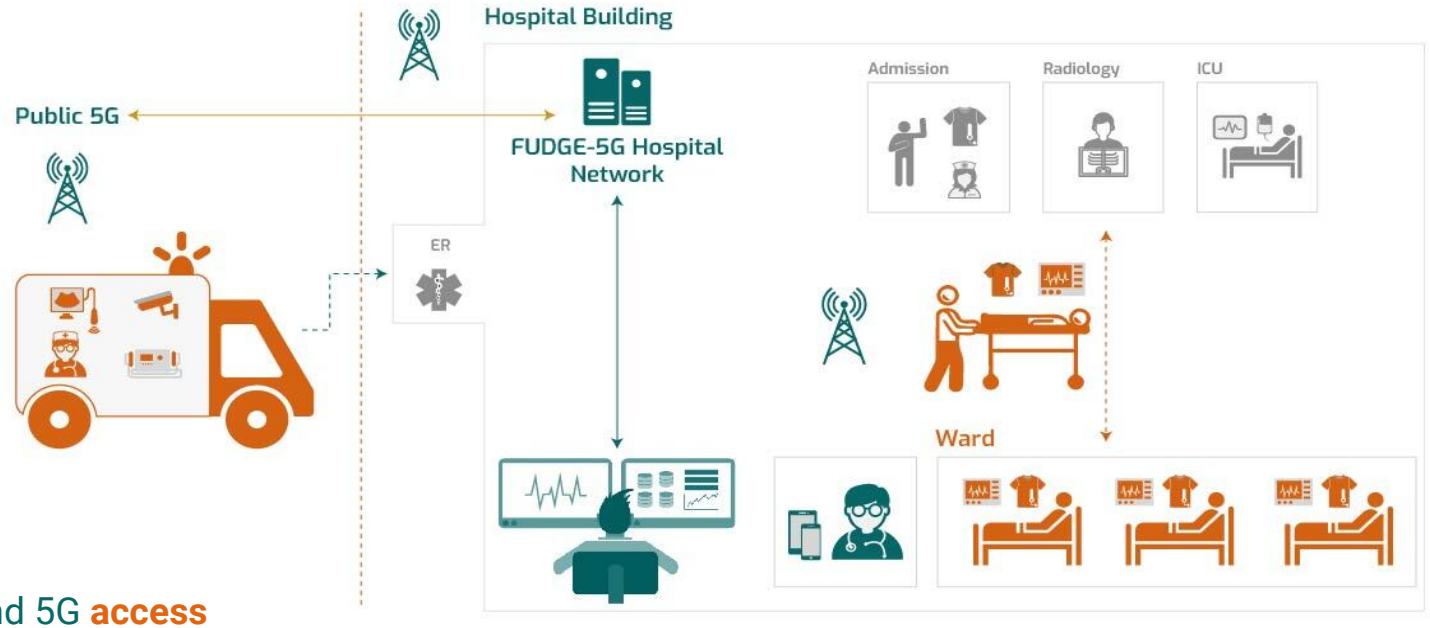
Stakeholder: Norwegian Defense Material Agency

Partners: ATHONET, telenor group, Fivecomm, interdigital, ONESOURCE, ONE2MANY, THALES, UBITECH

FUDGE-5G

5G Virtual Office Use Case

- **Non-public 5G network with PNI and SNPN deployment:**
  - PNI-NPN provides **continuous coverage** in outdoor areas, exposing internal Hospital services and devices
  - Hospital SNPN indoor coverage features **isolation for privileged devices and sensitive data**, guaranteed QoS for devices, and remote operation of medical devices in real time



- **Main Innovations**
  - 5GLAN environment providing an **unified** Ethernet, Wi-Fi and 5G **access**
  - **End-to-end Network Slicing** with focus on security and speed tolerance
  - **Vertical Application Orchestration** enabling and improving consistent QoS for apps and devices
  - **Multicast Communications** to push notifications and send alerts to specific user groups

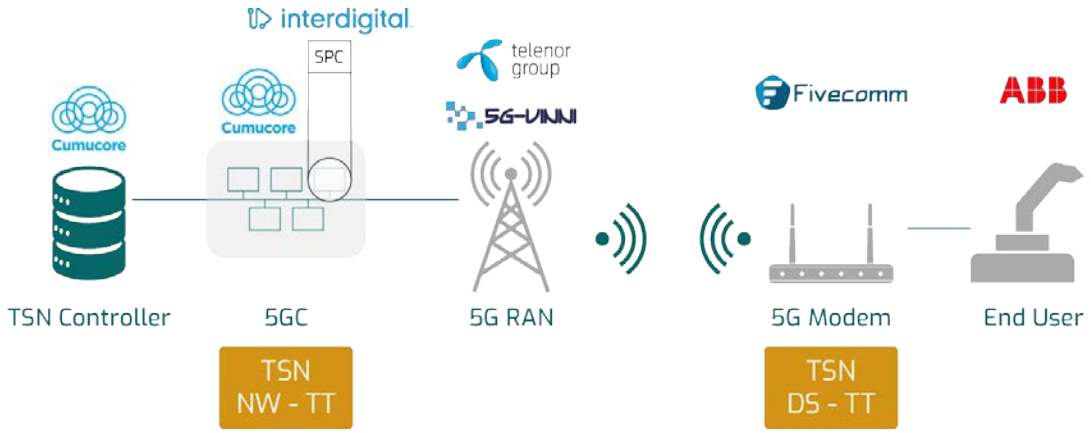
Stakeholder: Oslo University Hospital

Partners: ONESOURCE Consultoria Informática Lda., Fraunhofer FOKUS, telenor group, THALES, UBITECH ubiquitous solutions

Industry 4.0 Use Case

- **NPNs will be used in an industrial facility to showcase time sensitive and ultrareliable applications using 5G.**
  - Public Networks cannot meet all the requirements of an industry (usually poor coverage).
  - NPNs are dedicated to the needs of a vertical industry, instead of having to satisfy the requirements of the public.

High-level topology:



- **Benefits of NPN usage:**
  - Strong level of **security**
  - **Time critical** applicability
- **Main innovations:**
  - 5G Time Sensitive Networking (**5G-TSN**)
  - 5G Local Area Networks **(5GLAN)**
- **Test cases:**
  - Remote monitoring as a service
  - Remote control as a service with real-time feedback
  - 5G adaptability in industrial environments
  - Process control over 5G

Stakeholder:

ABB

- **Location:** Oslo (ABB industry facility)

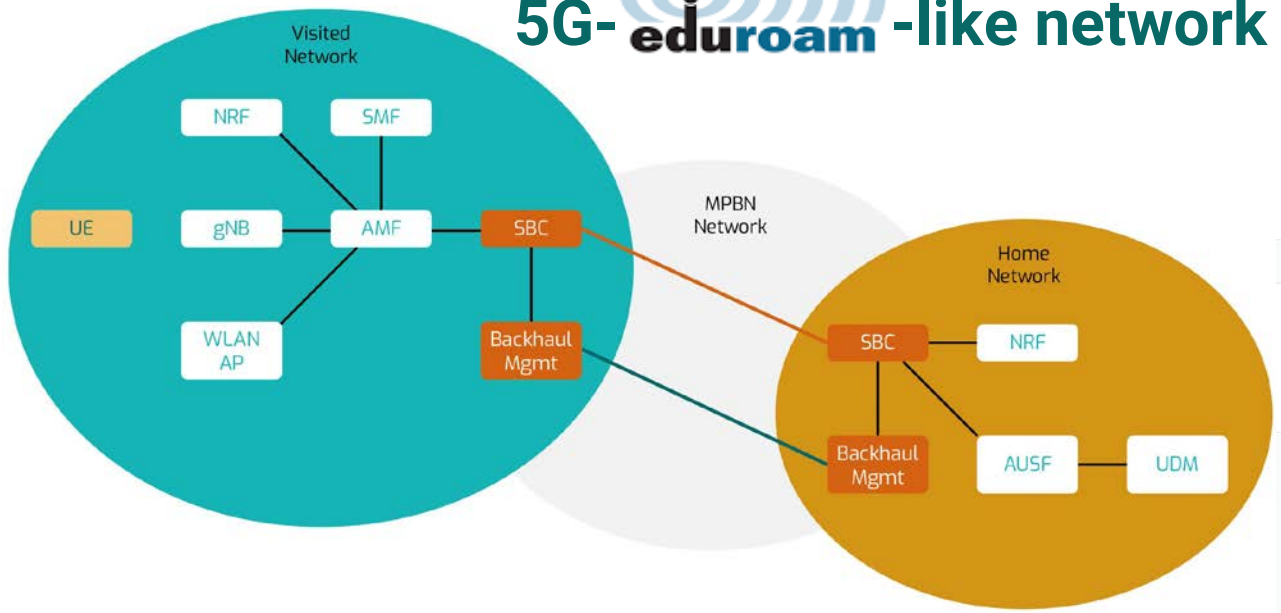
Partners:

Fivecomm interdigital telenor group Cumucore

Interconnected NPNs Use Case

- **To demonstrate the capabilities of the FUDGE-5G platform to support seamless connectivity of devices across multiple own administrated domains**
- **Non-Public Network:**
  - Highlighting **secured 5G connectivity** for users within a campus network
  - Standalone networks supporting **seamless connectivity to thousands of devices** and isolating capabilities in the home networks
- **Interoperability** testing connectivity between **5G Core deployed in three locations:**
  - Berlin (FOKUS), Norway (Telenor), Valencia (UPV)
- **Main Innovations:**
  - **Distributed Localized Network:** Developing an end-to-end structure enabling multi-administrated local networks which will facilitate a loose roaming infrastructure without requiring special peering or backhaul (should work with any type of best effort backhaul)
  - **Distributed Authentication Framework**: Authentication and Authorization of devices in home network and also while roaming into other local EDUROAM networks

5G- eduroam -like network



Stakeholder: telenor group

Partners: Fraunhofer FOKUS, interdigital., telenor group, ONESOURCE Consultoria Informática Lda., Universitat Politècnica de València

Thanks for your attention!

Any questions?

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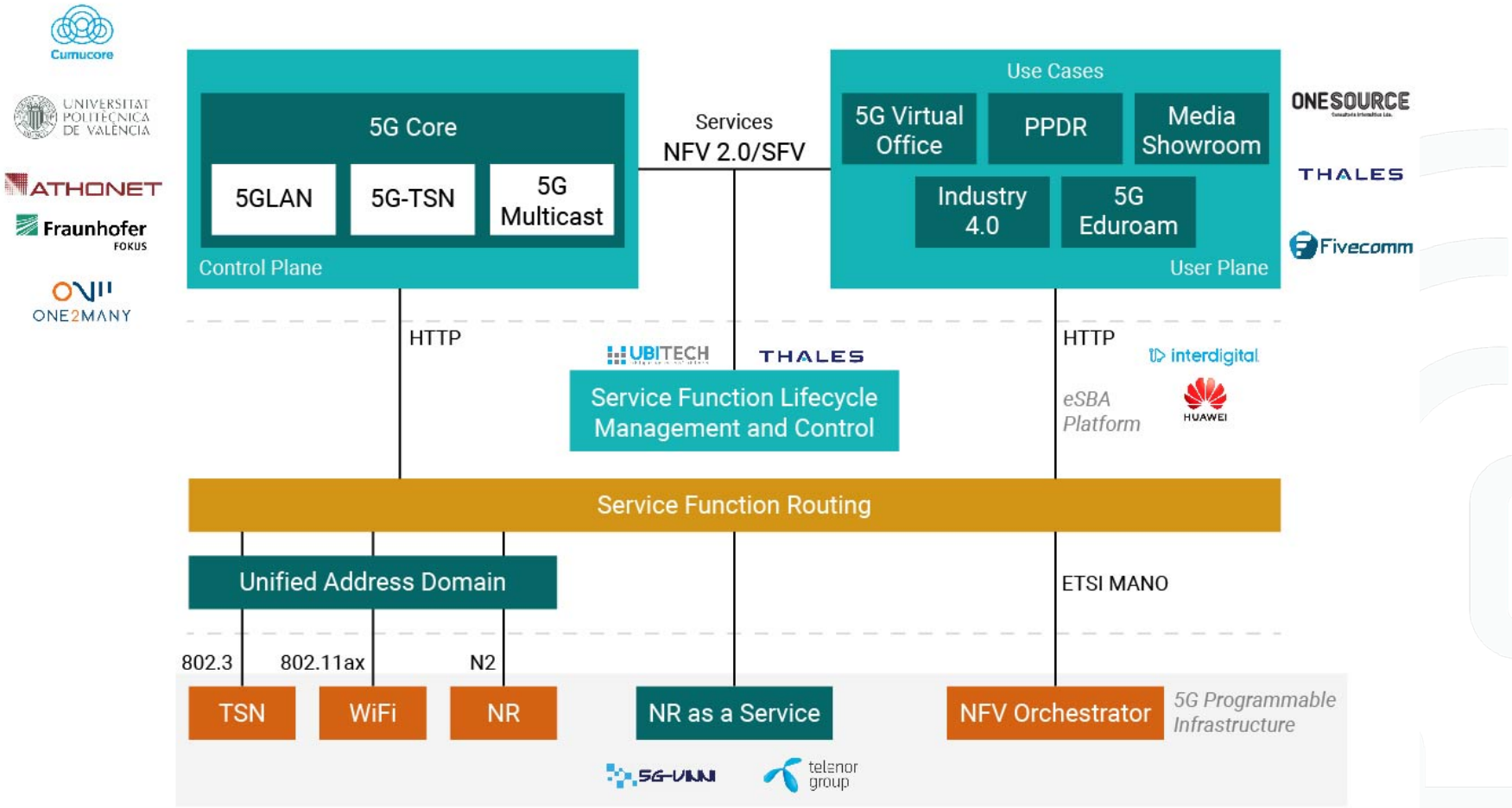
5G Components Catalogue
and initial High-Level Architecture



Platform Architecture