RARE/FreeRTR Use Case: Open-Source Implementation of 5G User Plane Function (UPF)

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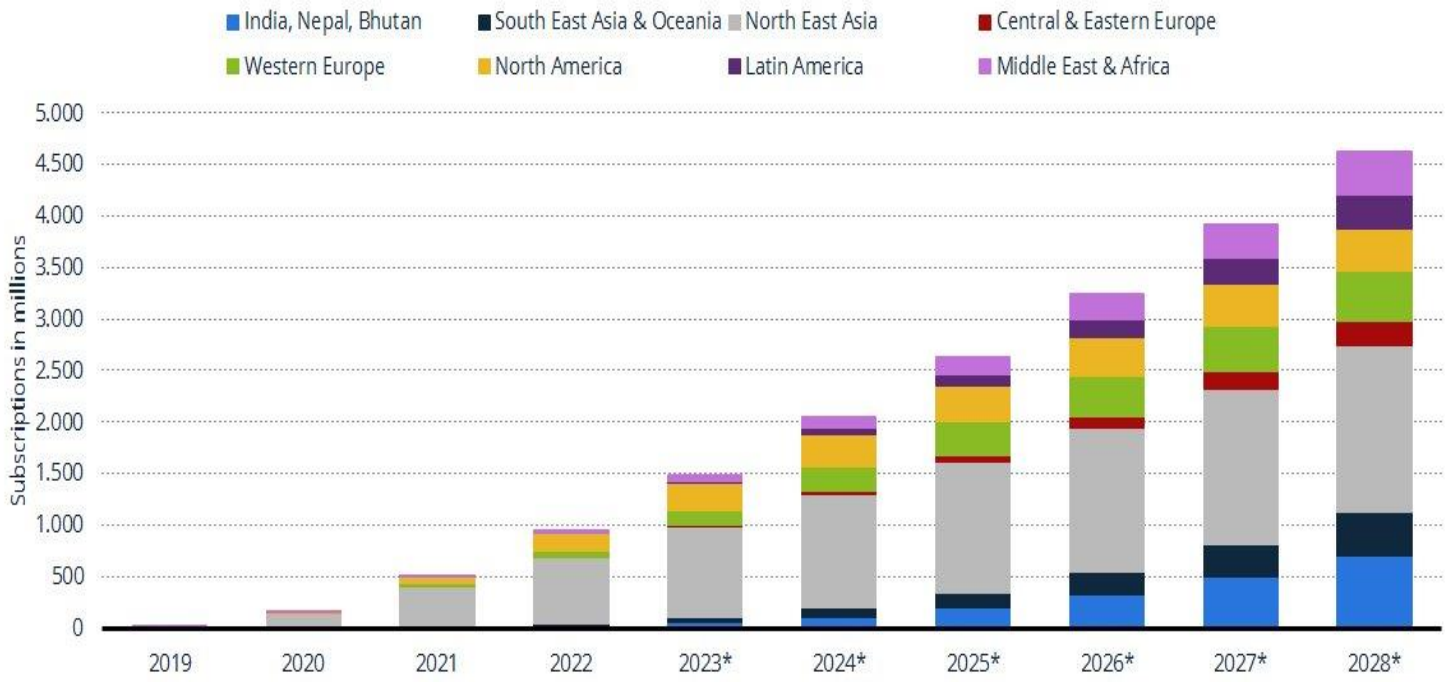
GN5-1

Agenda

- 5G
- RARE router
- UPF implementation
- Scenario under consideration
- Conclusions

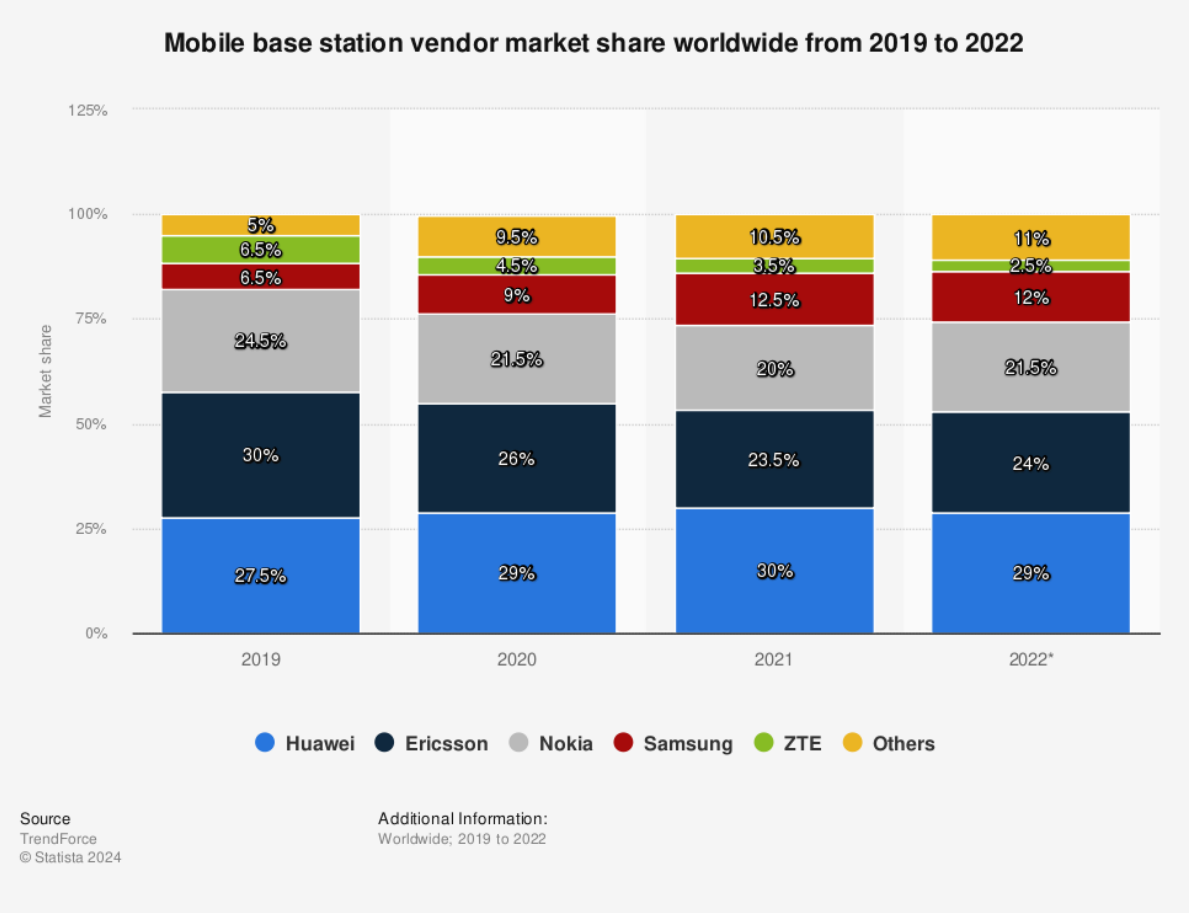
5G: vision

- Mobile broadband is the fundamental technology for interconnecting communities and individuals
- 5G will continue growing with more that 4.4 billion subscribers predicted by 2027*
- The impact of mMTC



5G: vision

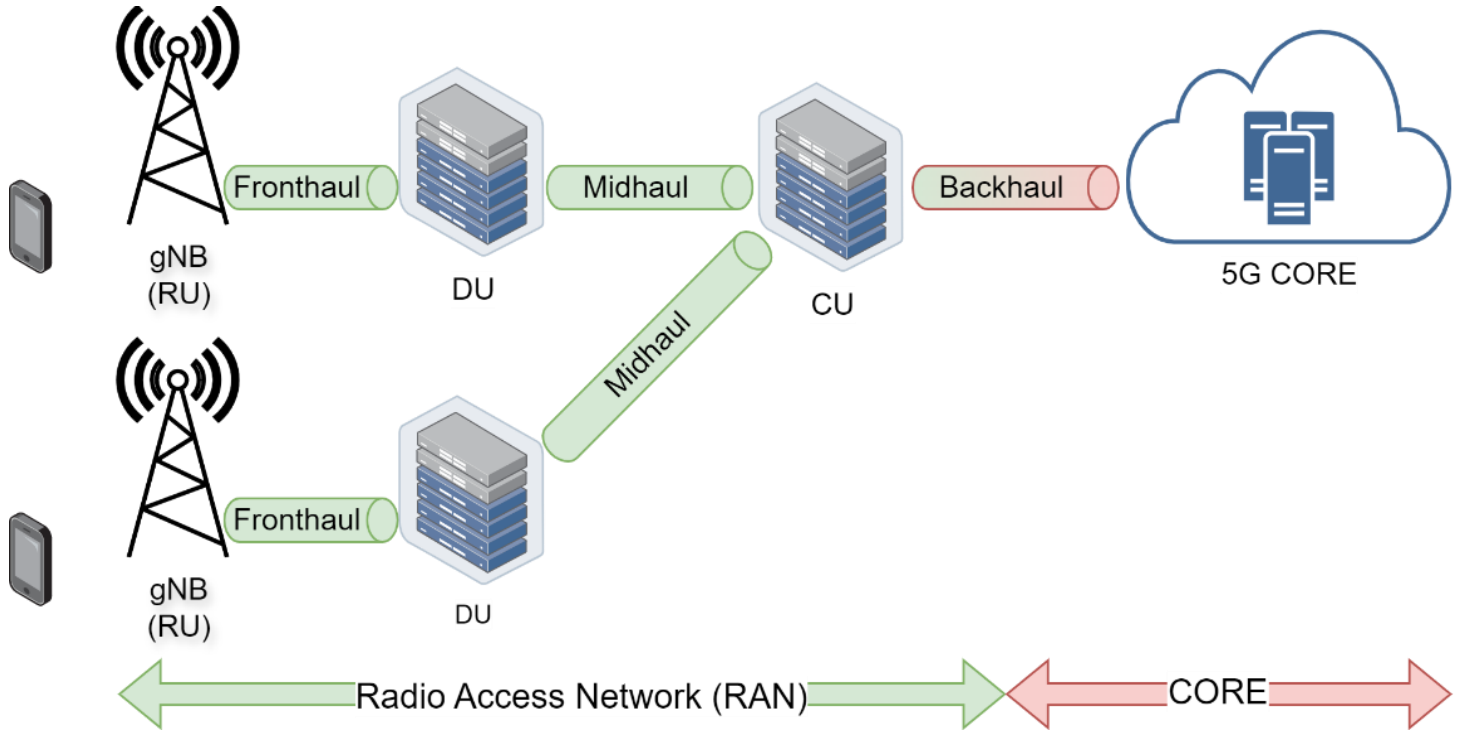
- Five tier one vendors
  - High CAPEX/OPEX
- The market share is growing for "Other" vendors
  - Open-source solutions
  - Startups
  - More customizable and affordable products



5G: architecture

Radio Access Network

- Base station (gNB)
- Function split (DU-CU)
- Fronthaul/Midhaul links

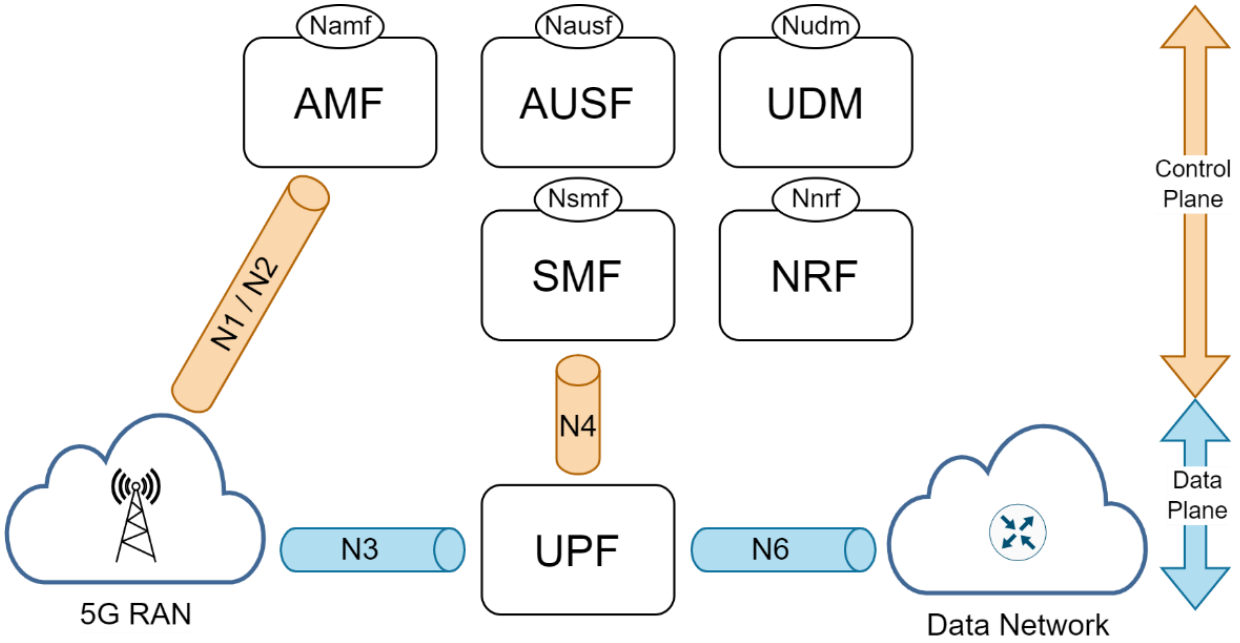


5G: architecture

5G core

- Service Based Architecture (SBA) framework
- A set of interconnected Network Functions (NFs) to provide:
  - the control plane functionality
  - common data repositories
- NFs
  - Self-contained, independent and reusable
  - Expose services through well-defined interfaces: REST, QUIC

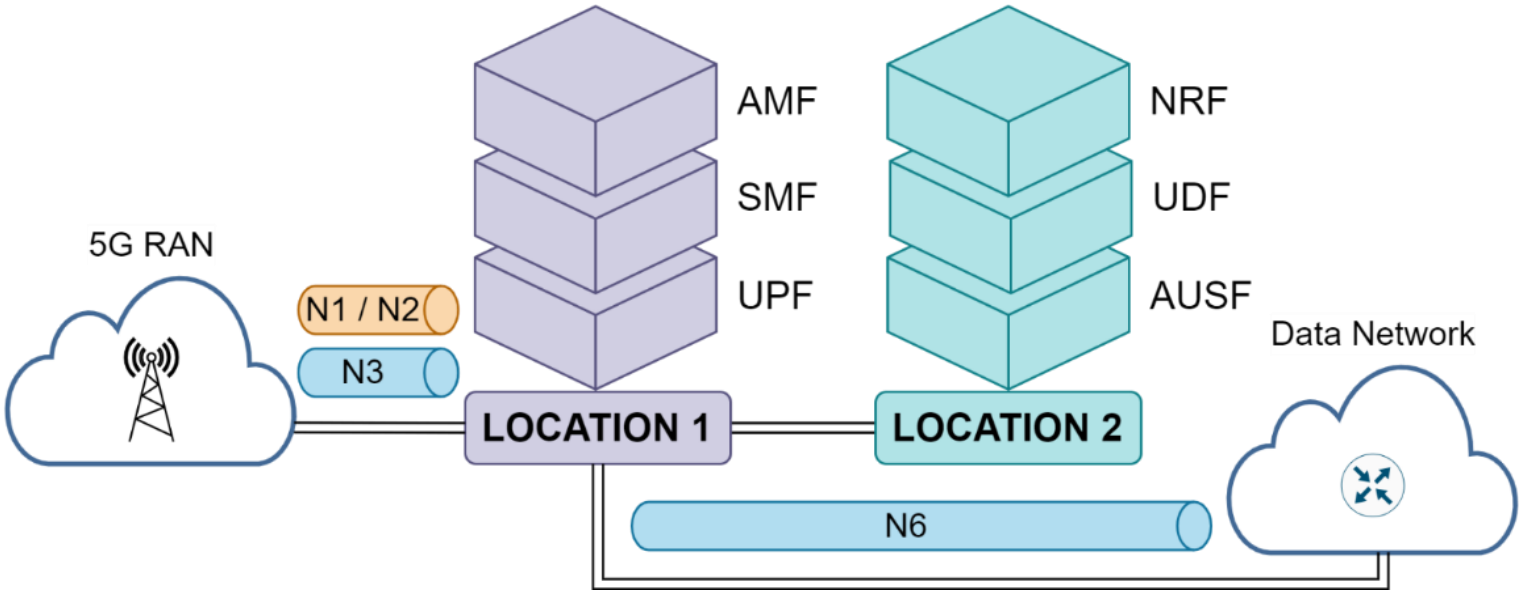
Standard 5G Core deployment



5G: deployment

Example of 5G deployments

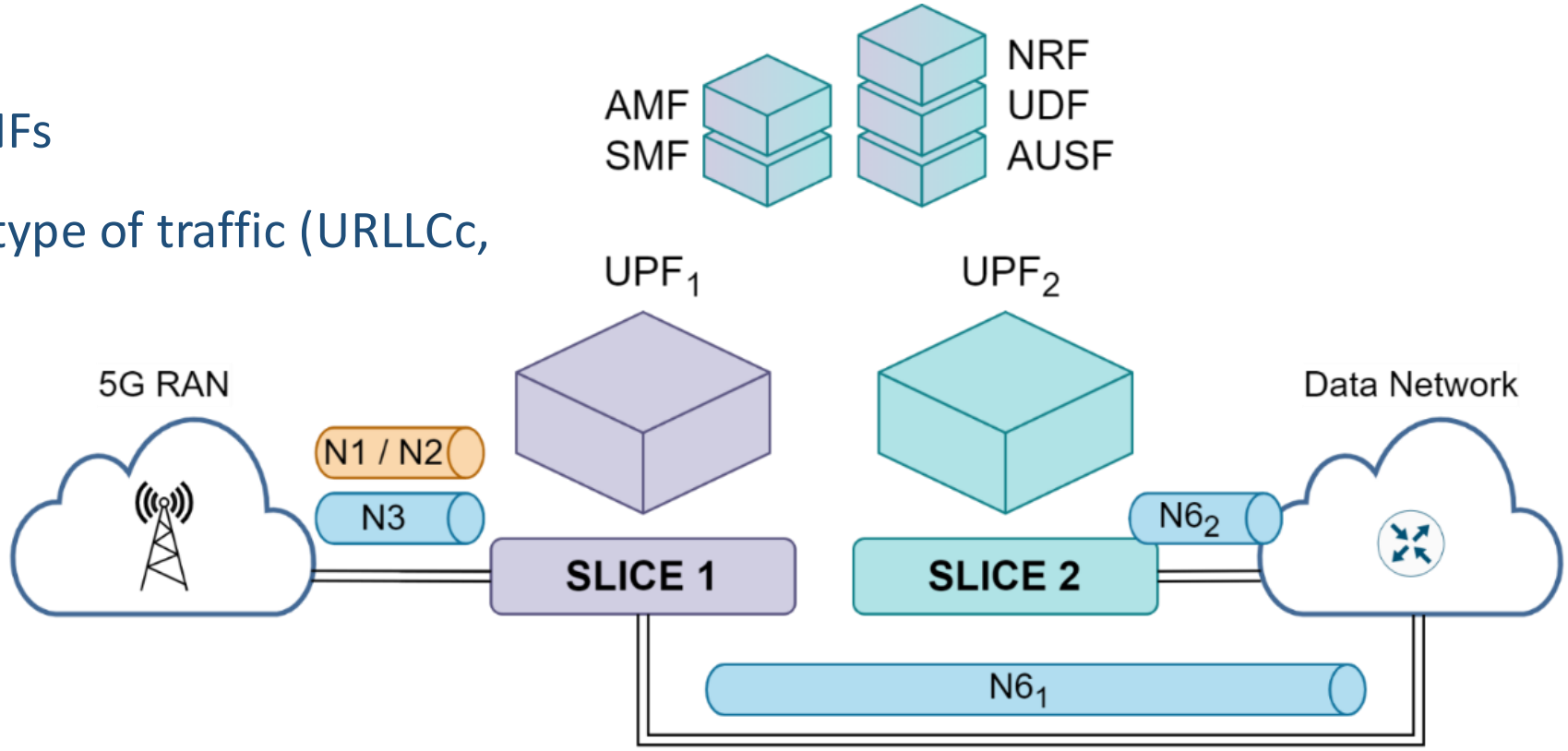
- 5G containerization
  - NFs at different locations
  - Not all the configurations are possible



5G: deployment

Example of 5G deployments

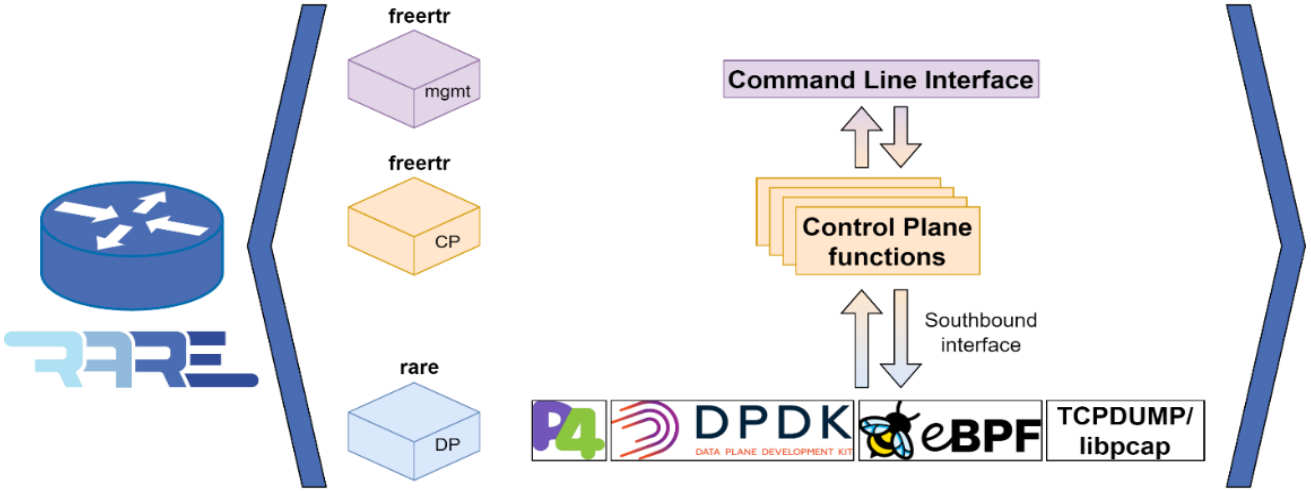
- 5G slicing
  - Duplication of NFs
  - Each slice for a type of traffic (URLLCc, eMBB, mMTC)



RARE router

Router for Academia, Research & Education (RARE)

- Production ready routing and switching functionalities
- **GEANT 5th programme**
- Control and data plane separation
  - Control plane: ***freertr***
  - Data plane: ***rare***
    - Programmable data plane
    - P4, DPDK, XDP, libpcap



RARE router

- Functionality
- Routing & forwarding
  - IP, LLDP, VLAN, MPLS, BGP, OSPF, BFD
- Tunneling
  - GRE, L2TP, VXLAN, GTPv1, IPsec, MACsec, wireguard, openvpn
- Management
  - Telnet, SSH
- Performance
- Tested at **100 Gbps** (Tofino ASIC)
- Tested at **400 Gbps** (Tofino2 ASIC)

UPF implementation in RARE

Target

- Provide a standalone UPF

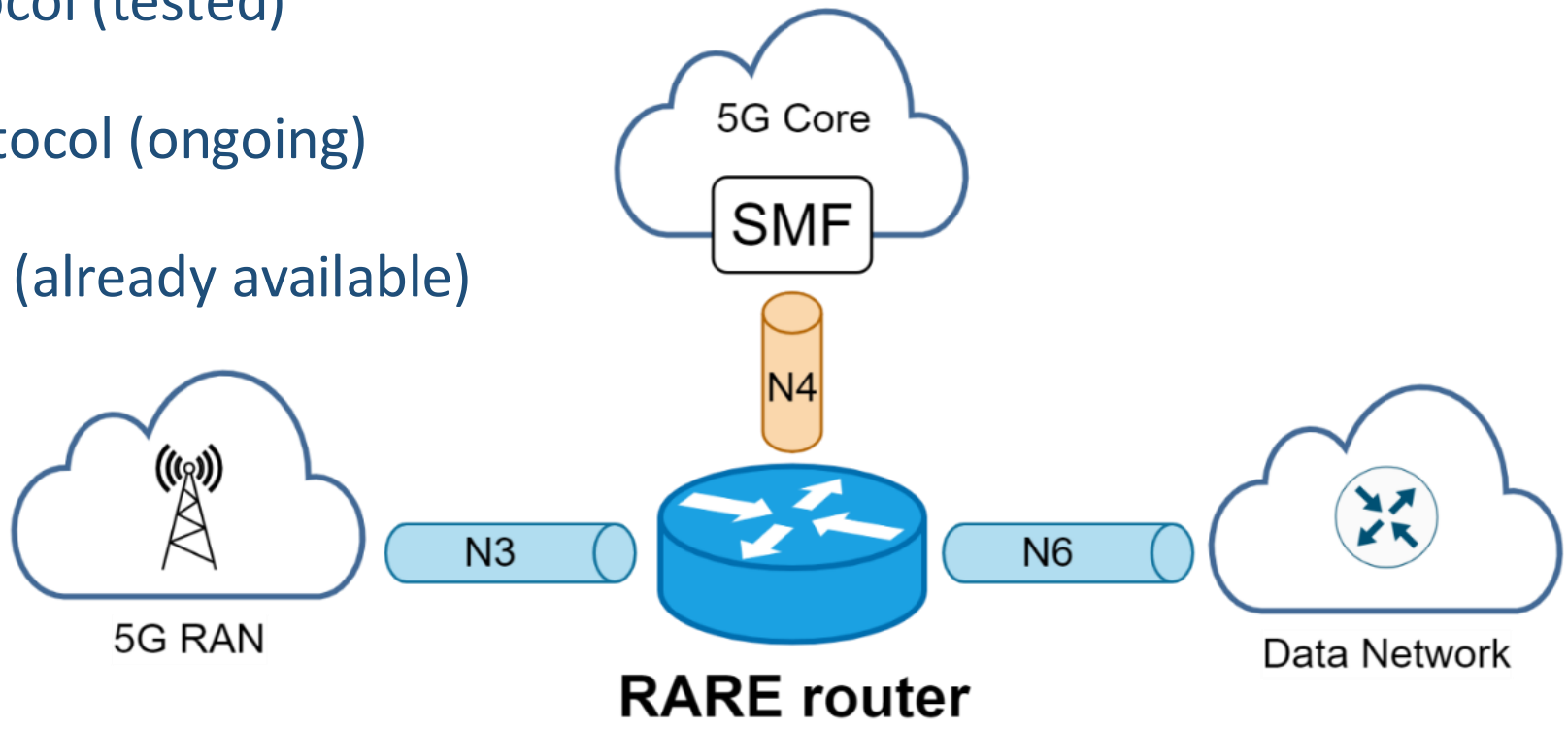
Motivation

- Affordable UPF solution
- Enhance the performance between the RAN and the Data Network (DN)
  - More users
  - Higher data rate
  - Lower delay/jitter

UPF implementation in RARE

Implementation

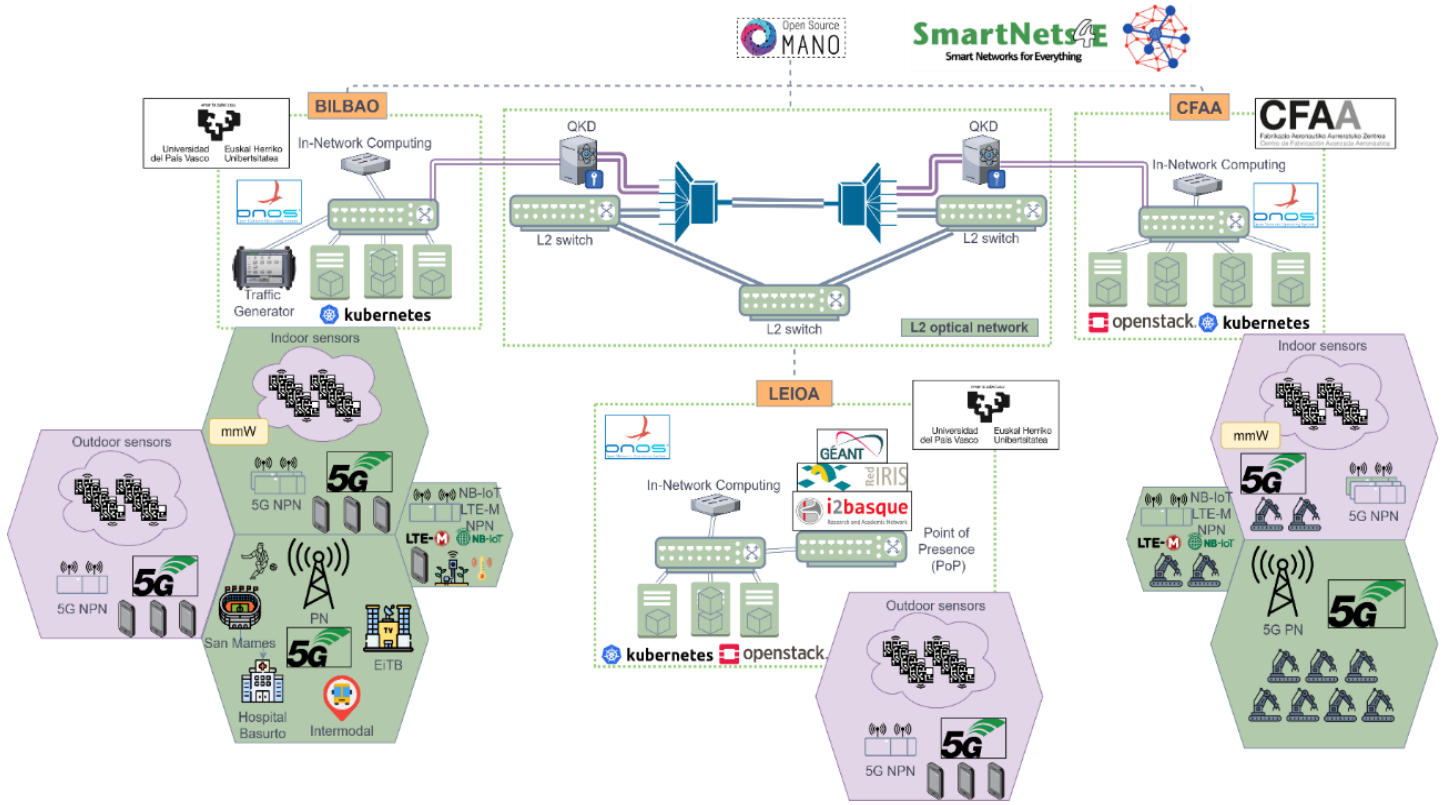
- **N4** interface: **PFCP** protocol (tested)
- **N3** interface: **GTPv2** protocol (ongoing)
- **N6** interface: **IP** protocol (already available)



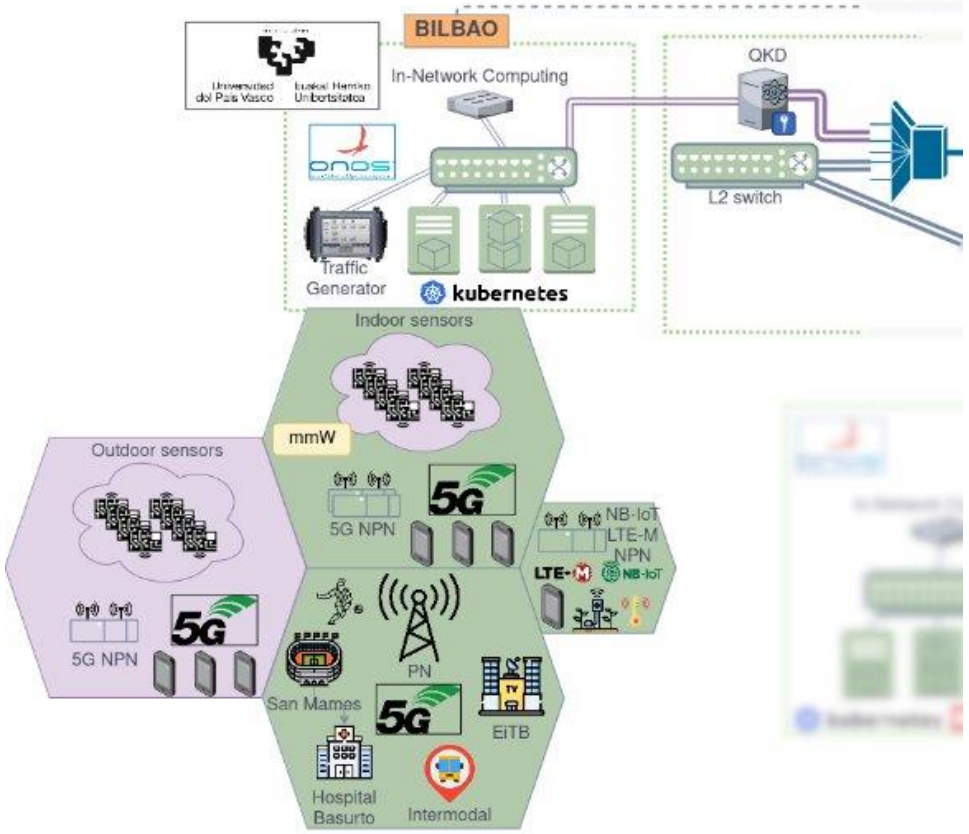
Scenario under consideration

Smart Networks for Everything (**SmartNets4E**[1])

- An infrastructure for network research
- Three nodes interconnected at 10/100G
- Research resources for 5G/6G in different verticals
  - Advanced manufacturing (CFAA node)
  - Health, education, transportation and mobility (BILBAO node)
- Integrated into the ESFRI SLICES-RI
- Collocated with GEANT's PoP (LEIOA node)



Scenario under consideration



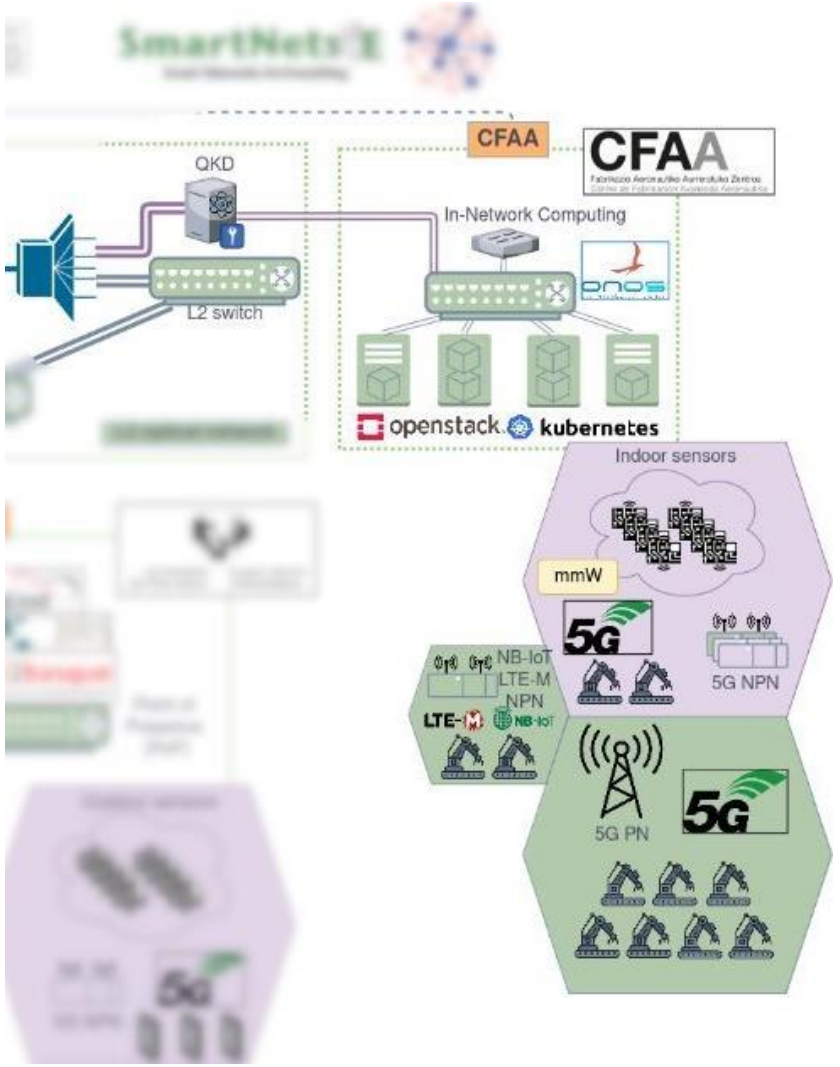
SmartNets4E: **BILBAO** location

- Computing nodes
- Commercial and experimental 5G NPN
- Quantum Key Distribution (QKD) equipment
  - Secure communication between CFAA and BILBAO
- Network analysis and testing equipment:
  - Traffic generator
  - Impairment generator
- Experimental P4 network

Scenario under consideration

SmartNets4E: **CFAA location**

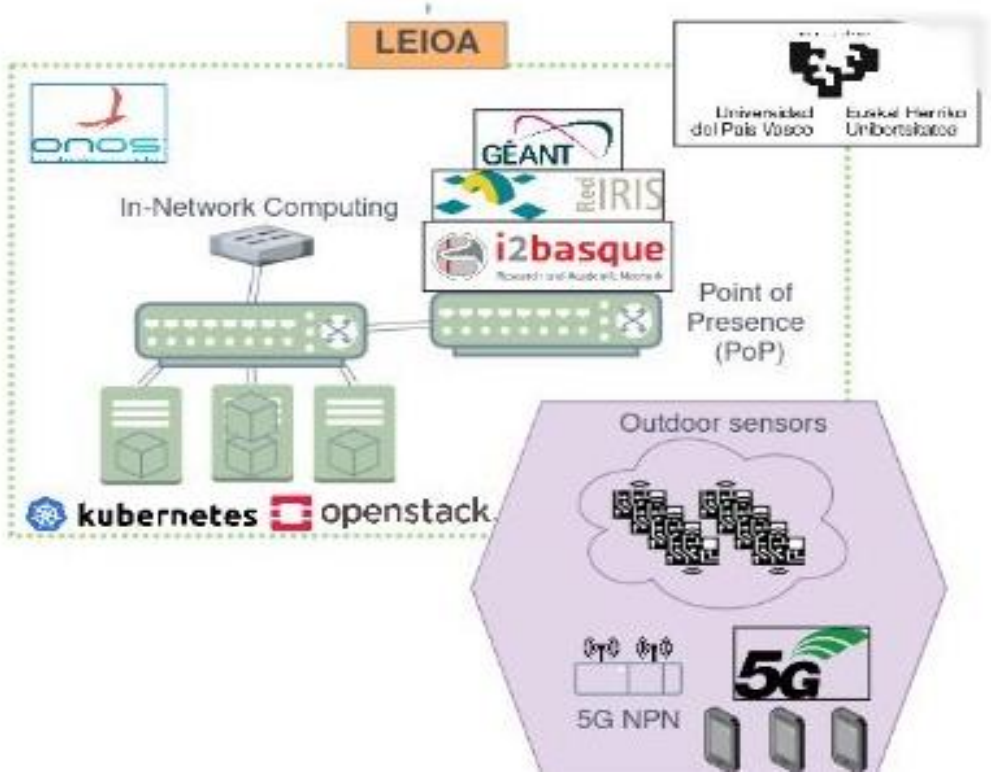
- Advanced manufacturing R&D
- Indoor commercial 5G NPN (mmWave)
- Experimental 5G NPN
  - LTE-M and NB-IoT support
- IIoT sensor network
- Quantum Key Distribution (QKD) equipment
  - Secure communication between CFAA and BILBAO



Scenario under consideration

SmartNets4E: **LEIOA location**

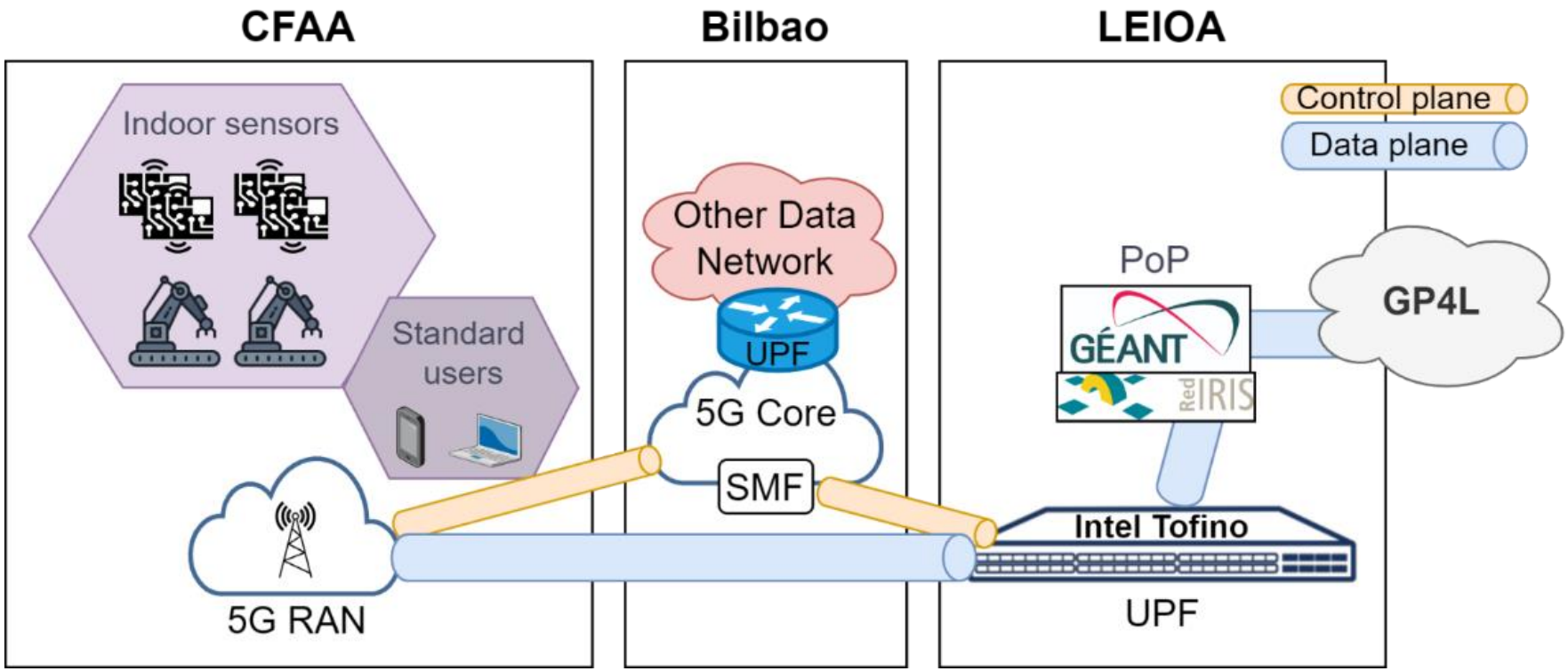
- Interconnection site
  - GEANT PoP
  - RedIRIS PoP
- Computing nodes
- Outdoor commercial 5G NPN
  - Campus network



Use case

The role of RARE-UPF

- The scenario in our research infrastructure



Use case

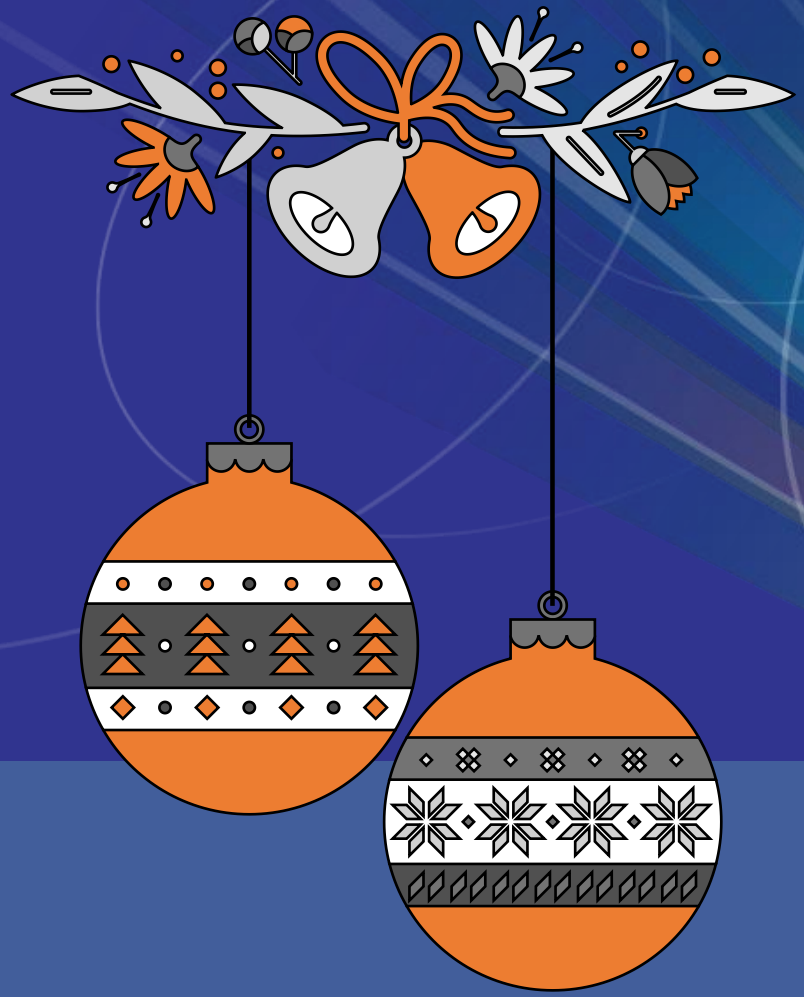
Video:

- SmartNets4E : the 3 locations of the experimentation facility
- 5G and RARE infrastructure
- PFCP implementation in RARE

Use case

Conclusions	High-performance user plane for 5G core network
	Multi-UPF scenario
Next steps	Performance tests
	Implementation of other 5G entities: SMF, N3IWF, etc.
	Remote access and management tools

Thank You



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