5G-HEART Newsletter

28th May 2021
Issue No.5

5G HEART
5G Health, Aquaculture and Transport Validation Trials

Project website: https://5gheart.org/

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"5G-HEART aims to perform vertical validation trials on top of five 5G testbed facilities: 5G-VINNI, 5GENESIS, 5G-EVE, 5GRONINGEN and 5GTN".

5G-HEART Network Architecture

The 5G-HEART project aims to perform vertical validation trials on top of three ICT-17 facilities (5G-VINNI, 5GENESIS, and 5G-EVE) and two national 5G testbed platforms (5GRONINGEN and 5GTN) with use cases for three vertical domains: health-care, transport and aquaculture.

For each selected use case [1] the user requirements are analysed and converted into network-specific KPIs that the underlying network infrastructure is expected to support. Specifically, five existing testbed facilities with network-slicing capability are available to 5G-HEART.

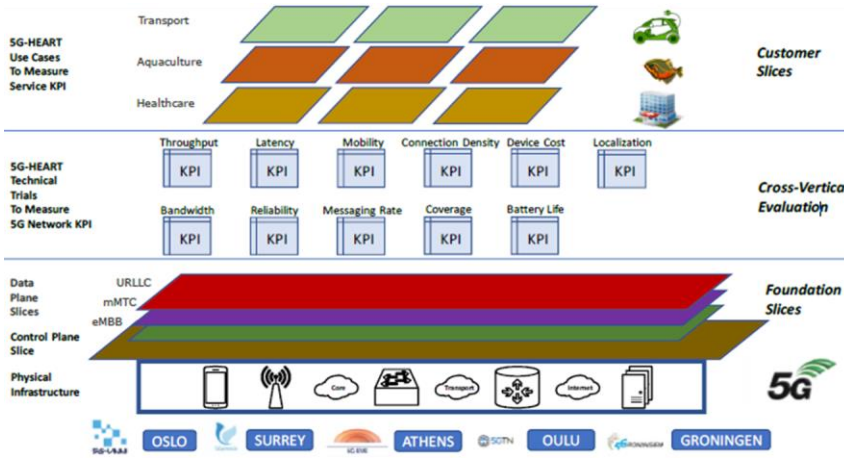

Figure 1. 5G-HEART main elements and overall approach.

2. 5G-VINNI Testbed

The 5G-VINNI facility is used to support the 5G-HEART use cases implemented in Norway, mainly consisting of Aquaculture and Healthcare. 5G-VINNI is composed by three main domains: Radio, Transport and Datacentre. New Radio (NG-RAN) from Huawei and Ericsson are used, based on antennas for mid-band (3600 MHz) and high-band (24.5-27.25 GHz). The transport network is an optical fibre MPLS network with presence across all Norway. The Datacentre domain is composed by the "central-site" in Oslo, allocating the main CORE functions and respective slices, and the "edge-sties", where subsets of the CORE and 3rd party VNFs can be allocated. As presented in Figure 2, today 5G-VINNI has 3 slices in Non-StandAlone (NSA) covering the eMBB, mMTC, and URLLC 3GPP slices, and the two SA slices are today implemented with eMBB and mMTC features, but either any of those may be reconfigured to uRLLC type, or a new (3rd) SA Slice instance can be deployed when needed. Finally, Autonomous Edge settings have been successfully tested and operated and new ones can be deployed on demand depending on the use case need. The use-cases/scenarios served by 5G-VINNI are shown in Table 1.

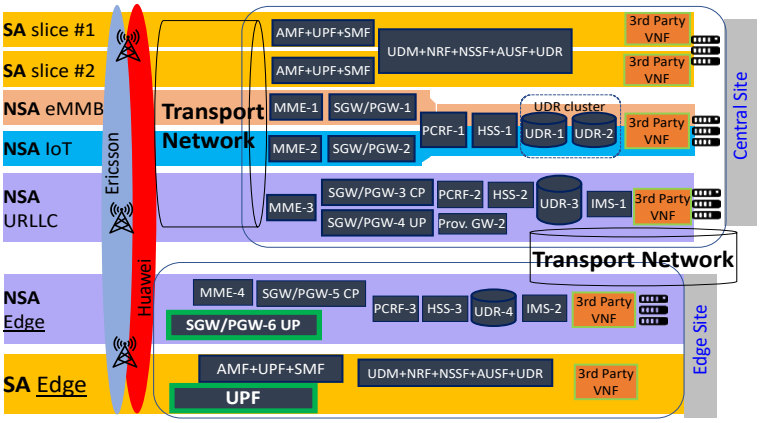

Figure 2. Network slicing for 5G-VINNI services.

Table 1: List of subcases/scenarios of verticals served by 5G-VINNI

Vertical	Subcases/Scenarios		Service Type	Notes
Health -care	H1B	AR/VR enabled remote ultrasound	eMBB /uRLLC	
	H1B	Robotic-assisted ultrasound examination	eMBB / uRLLC	
	H1D	Critical health event	uRLLC	
	H2A	Automatic pill camera anomaly detection	eMBB / uRLLC	
	H3A	Vital-sign patch prototype	mMTC	
Aqua-culture	A1S1	Sensory data monitoring	mMTC	
	A1S2	Camera data monitoring	eMBB	
	A1S4	Edge and cloud-based computing	eMBB /mMTC	Mobile Edge
	A1S5	Cable-free communication on site	eMBB / mMTC	Mobile Edge

3. 5GENESIS Testbed

Among the different platforms in the 5GENESIS project, the Surrey Platform [2], hosted at the University of Surrey in UK, is exploited in 5G-HEART. The Surrey Platform is a multi-RAT environment, supporting both 3GPP and non-3GPP networks. Commercial-of-the-shelf (COTS) 5G NR solutions are integrated as part of a large flexible 5G network infrastructure that allows support for a wide range of 5G use-cases empowered by network slicing within the scope of 5GENESIS. The Surrey Platform 5G core, developed in-house, is fully compliant to the 3GPP Rel.15 standards for the core network functionality with Rel.16 compliance (SA-mode) expected by Q4-2021. The Surrey Platform RAN also supports Narrow Band IoT, as well as WiFi (802.11ac), integrated using the Non-3GPP Interworking Function (N3IWF), and LoRa Wide Area Network.

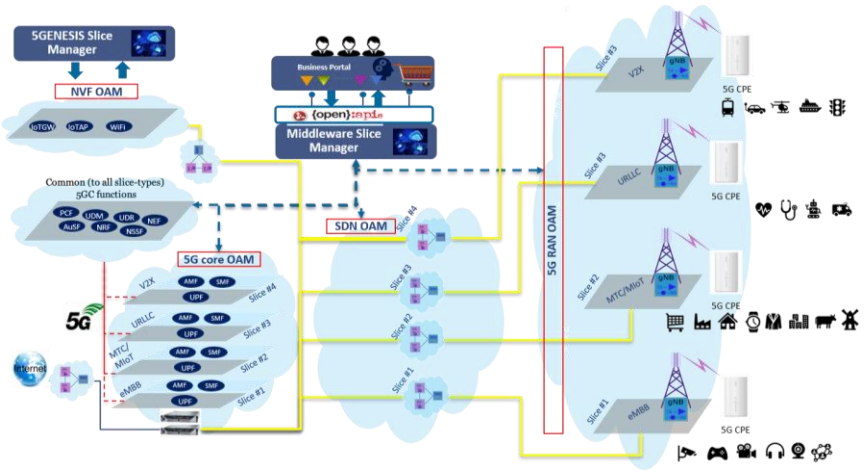

Figure 3. Network slicing for different services in 5GENESIS.

Figure 3 shows the virtualisation, local orchestration configuration and end-to-end orchestration supported by 5GENESIS. The architecture is modular by design, as it follows principles of local control of each radio technology network by its provider as a separate administrative domain. It also provides access to the capabilities of each vendor product technology, by means of standard APIs.

Table 2: List of subcases/scenarios supported by 5GENESIS platform

Vertical	Subcases/Scenarios	Service Type
Trans-port	T1S1/T1S2: High bandwidth in-vehicle situational awareness & see-through for platooning	eMBB/uRLLC
	T2S3: Quality of service (QoS) for advanced driving	uRLLC
	T3S1: Tele-operated support (TeSo)	eMBB/uRLLC
	T4S3: Smart traffic corridors	mMTC
	T4S4: Location based advertising	mMTC
	T4S5: End-to-end (E2E) slicing- Generic functionality applicable to all scenarios	-
	T4S6: Vehicle sourced high-definition (HD) mapping	mMTC
	T4S7: Environmental services	mMTC

4. 5G-EVE Testbed

The 5G-EVE testbed, which is used in 5G-HEART project, is located in OTE premises, in northern Athens. It is for the Aquaculture trials that will take place in Greece. The Greek site where the testbed will be used is presented in Figure 4. It is based on the Non-Standalone (NSA) architecture which combines the re-use of the 4G hardware with the advantages of the 5G network. For the core network, the EPC-in-a-box approach is used, which is built on Ericsson Cloud Execution Environment. For 5G-HEART network monitoring, 5G-EVE will be extended with the use of probes.

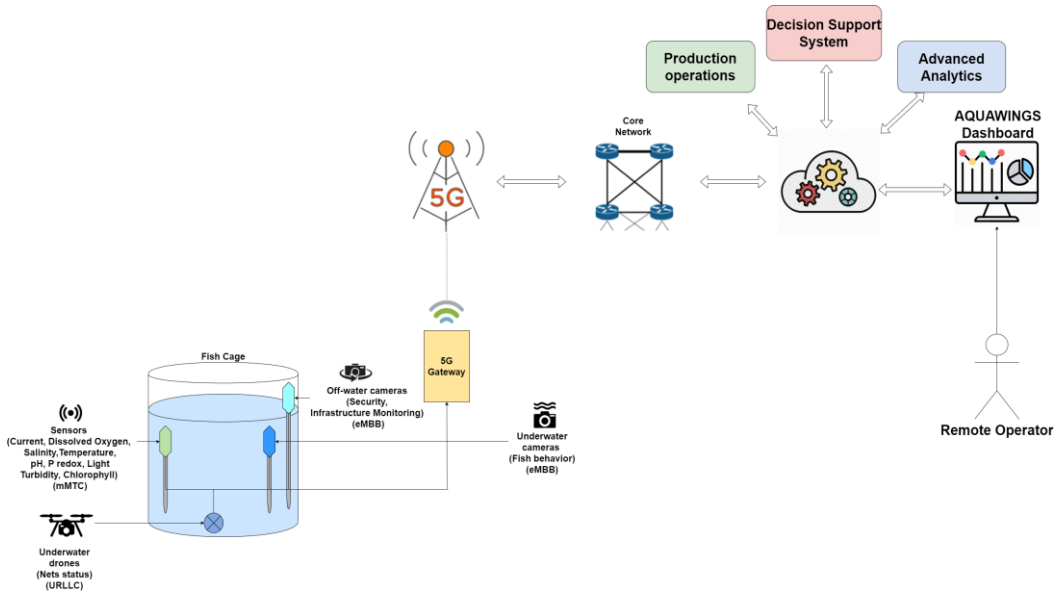

Figure 4. Greek site for aquaculture trials.

At the first stage of the implementation, the 5G-EVE testbed consists of one slice based on the uRLLC service. As presented in Table 3, the 5G-EVE testbed will support eMBB and mMTC services as well. Therefore, in order to support all the required services, an APN differentiation slicing mechanism will be used. This mechanism is based on the partitioning of the vPGW resources that will be allocated to a 3rd party application, which could be a MBB or MTC type of application. Finally, for management and orchestration, ETSI-hosted OSM is used in 5G-EVE testbed, since it offers a highly mature framework, production readiness and ease of initiation.

Table 3: List of subcases/scenarios of verticals served by 5G-EVE

Vertical	Subcases/Scenarios	Service Type
Healthcare	H1E: Aquaculture remote health monitoring	eMBB /uRLLC / mMTC
Aquaculture	A1S1: Sensory data monitoring	mMTC
	A1S2: Camera data monitoring	eMBB
	A1S3: Automation and actuation functionalities	eMBB / uRLLC

5. 5GRONINGEN Testbed

The 5Groningen testbed is spread out over four different locations, all of which are used in 5G-HEART. The four locations are divided in two pairs of edge location and central location, and both pairs are linked together through a shared central database in one of the central locations. The connectivity between the locations is enabled through the use of secure VPN connections. The central locations are in Hague (including the central database) and in Groningen, while the edge locations are in Hoogezand and Helmond. Both edge locations are equipped with 5G NSA and SA capable of radio access networks and servers capable of hosting diverse applications and 5G network functions (such as a UPF), enabling edge computing.

The core networks used are orchestrated to ease the configuration and deployment of the chosen core networks (EPC for 5G NSA and 5GC for 5G SA). The EPC cores are orchestrated using OpenSource MANO (OSM) and Juju charms on top of an OpenStack infrastructure. Each function in the EPC core is deployed as a virtual machine (VM). The 5GC cores are orchestrated using Kubernetes, where the Kubernetes nodes are also VMs. In the 5GC cores, all the network functions are deployed as Docker containers.

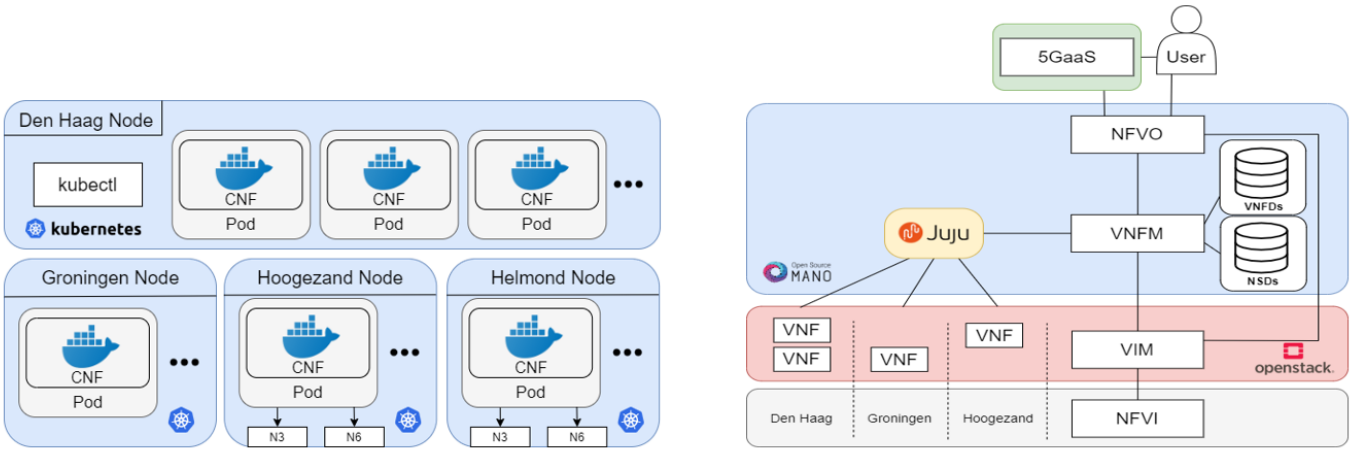

Figure 5. Orchestration setups for 5GC (left) and EPC (right) core networks.

In both cases (5G NSA or 5G SA) we are able to use slicing. In 5G NSA, we use the DECOR functionality, where a UE can connect to a dedicated core network which can be composed of one or more network services (NS). In 5G SA, slicing is done as specified by 3GPP and the slices are chosen based on the NSSAI. In its current form, all the slices share the same network functions except the SMF and the UPF, which are unique for each slice. UEs can connect to several slices simultaneously while using the same AMF.

Use-cases/scenarios served by 5GRONINGEN are shown in Table 4. T2S1/T2S2 and H1C are combined use cases. For H1C, multiple types of devices connect to a single eMBB slice and for TS21/T2S2, the on-board unit of the vehicle connects to a URLLC slice using MEC (edge computing).

Table 4: List of subcases/scenarios of verticals served by 5GRONINGEN

Vertical	Subcases/Scenarios	Service Type
Transport	T2S1/T2S2: Smart junctions and network assisted & cooperative collision avoidance (CoCa)	uRLLC
Healthcare	H1C: Smart ambulance streaming video and patient vitals to control centre	eMBB

6. 5GTN Testbed

5G Test Network (5GTN), operated by VTT in Oulu, Finland, enables the testing of the performance of new communication technologies and services in a realistic network environment. The network is a 5G technology and service development platform including a continuously evolving Radio Access Network (RAN) and a cloud-based core network. The RAN part contains both 4G and 5G technologies for flexible utilisation in variety of vertical industry use cases. The core network part is fully virtualised, supporting distribution of network functionalities both in control plane and user plane. Multi-access Edge Computing (MEC) and evolved Multimedia Broadcast Multicast Service (eMBMS) functionalities are also available. The architecture has integrated testing and network management frameworks implemented, enabling new functionalities in these domains to be built on top of the existing platform or as parallel implementations complementing the existing functionality.

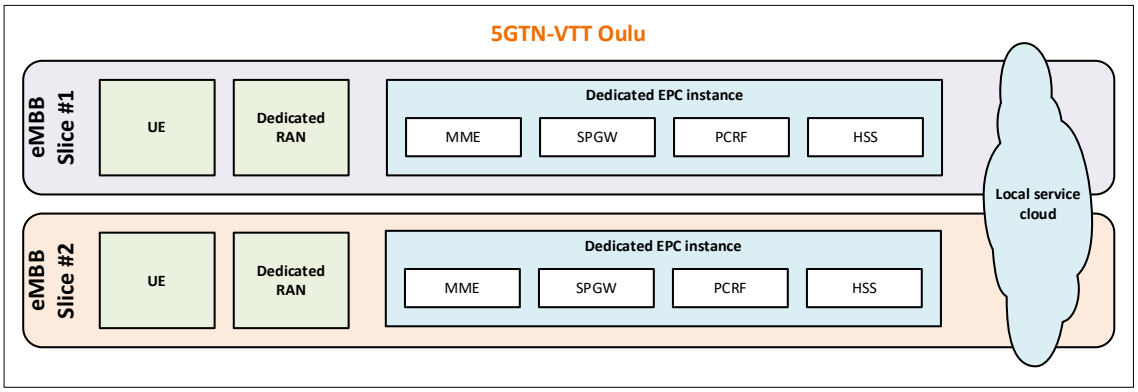

Figure 6. Network slicing for different services in 5GTN.

In its current state, VTT's 5GTN test facility supports rudimentary slicing through assignment of dedicated RAN and core network instances to different 5G Non-Standalone (NSA) slices as shown in Figure 6. The test facility can only provide eMBB slices, but the ongoing move to Standalone (SA) 5G deployment will enhance the network function and resource allocation flexibility for isolated network slices as the different parts of the network infrastructure are upgraded and updated during the process. 5G SA and, with it, dynamic slicing support is scheduled to be introduced into the testbed during the second half of 2021 with partial support for uRLLC and mMTC slices. The trials hosted by the testbed as well as the service types required by them are listed in Table 5.

Table 5: List of subcases/scenarios of verticals served by 5GTN

Vertical	Subcases/scenarios	Service type
Healthcare	H1A: Educational surgery	eMBB
Transport	T2S4: Human tachograph	uRLLC
	T4S1: Vehicle prognostics	mMTC
	T4S2: Over-the-Air (OTA) updates	mMTC

7. Summary

In this newsletter, the network architectures of five testbed facilities which are utilized in the 5G-HEART project are introduced: 5G-VINNI, 5GENESIS, 5G-EVE, 5GRONINGEN, and 5GTN. While testbeds are utilized to serve multiple use cases of three verticals, network slicing methodology of each facility to show how the network can be configured to effectively support use cases of different QoS is also introduced.

Five testbed facilities are being implemented across multiple phases and implementation of different use cases is still a work in progress. For your information, detailed contents about what 5G-HEART is doing about network architecture design and slicing definitions are included in [3] which is restricted public access, but the final open version will be available in Nov. 2021. At this moment, for more in-depth reading on each testbed facility, please refer to reports [2], [4] and [5].

References

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