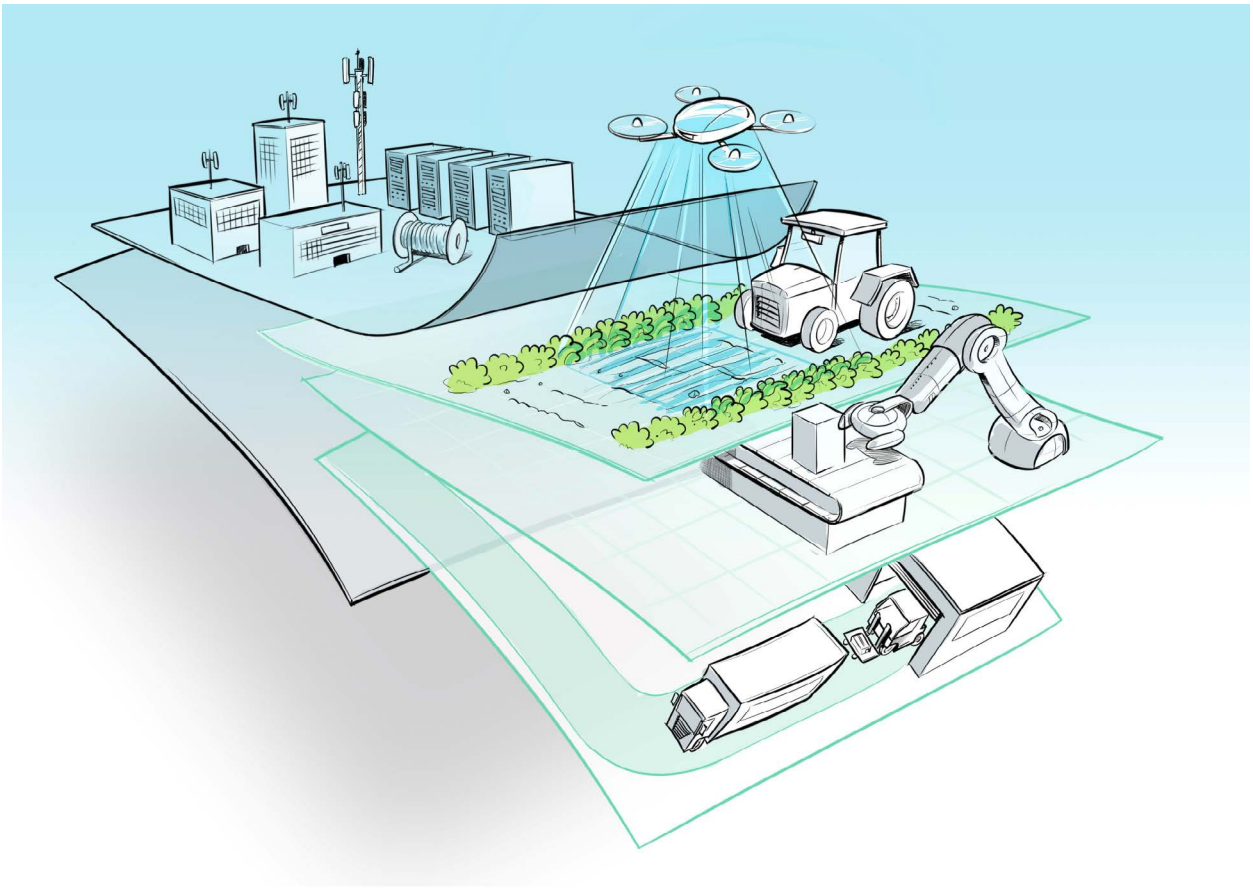
5G SERVICE PLATFORM (5GSP):
AN INNOVATIVE PLATFORM TO EXPOSE NEW 5G FEATURES AT INTERNET API LEVEL



TNO innovation for life

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ABSTRACT

The 5G Service Platform (5GSP) developed by TNO exposes some of the 5G features (like slicing and mobile edge computing) as an Internet API. This makes these 5G features easily accessible for 3rd party application developers, customers and operators in different application domains (known as verticals in 5G terminology). The motto of 5GSP is: “To maximise massive use of 5G capabilities in a variety of application areas (verticals) through automation and ‘labourless’ DIY mass customisation”. It is now exploited in the national 5Groningen field lab, and will be used for different use cases such as the ambulance use cases of the Horizon 2020 5G-HEART project. The aim is to get 5GSP adopted by telecom operators, to be used on top of their own 5G telecom infrastructure, as a means to monetise the 5G features.

1. INTRODUCTION

This article describes a Proof of Concept (PoC) service development and deployment platform called 5G Service Platform (5GSP), which enables telecom operators to provide 5G telecom services in a highly dynamic way, tailored to the specific needs of different application domains (verticals).

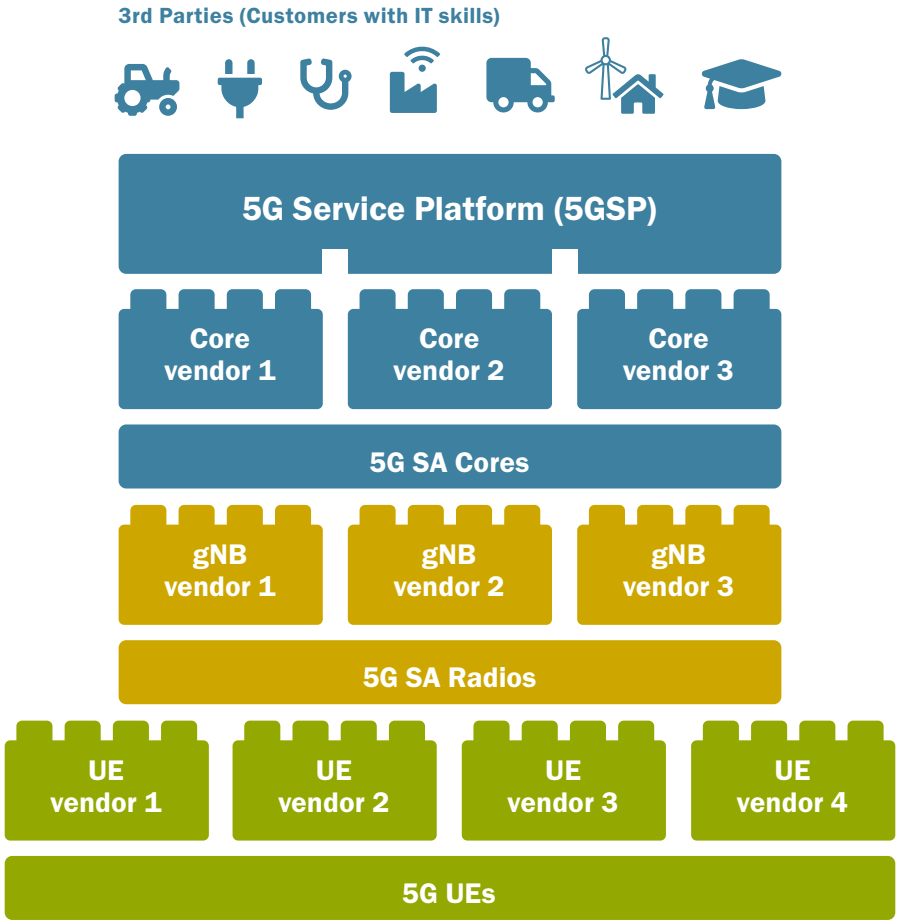

Figure 1: *5GSP can work on top of different 5G systems*

5GSP has been developed together with TNO's Hi-5 platform, our unique pre-standard 5G mobile testbed used for experiments in the core network, radio network integration, distributed management and virtualisation. However, 5GSP can also work with other 5G systems. The combined 5GSP and Hi-5 setup allows for experimentation, development and proof-of-concept building. The various core networks are linked to several access network modules and several commercial gNodeBs (Figure 1).[1]

5GSP aims to help operators offer high value added 5G services to their customers in a way that is familiar for the customers if they buy cloud-services from hyper scalers. The motto of 5GSP is: "to maximise massive use of 5G capabilities by a variety of application areas (verticals) through automation and 'labourless' DIY mass customisation."

The primary objective for the development of 5GSP was to provide engineers from the field of Information Technology (IT) access to specific 5G features, without requiring them to have an expert level understanding of the 5G technology involved. It exposes 5G features (like slicing and mobile edge computing) at Internet API level, making them thereby easily accessible for operators, 3rd party application developers and customers in different verticals.

The concept of 5GSP was born at the end of 2018 and developed in parallel with, and independently of, other initiatives to specify and/or develop 5G service development and deployment platforms (such as 3GPP SA6, GSMA GST and OPC and the H2020 5G-VINNI project). As far as the authors

1 https://www.tno.nl/en/about-tno/news/2020/6/tno-launches-fully-fledged-5g-test-network/

know, most of these other initiatives are at this moment in time still in a documentation phase, with no implementations yet available (with the exception of 5G-VINNI, which does have a PoC). The 5GSP work started with the development of a PoC, with a focus on a low entry barrier for developers and other end-users. Features were developed in an agile way, using separation of concerns as our design principle. Based on the Infrastructure as Code concept, we allow users to deploy a 5G virtual infrastructure based on their specification. 5GSP is focused on ease of use and is intent-based, whilst 5G-VINNI focuses more on slice definitions and slice deployments.

The rest of the article is structured as follows. 5GSP is described in Section 2, and a comparison with other relevant initiatives is given in Section 3. Section 4 illustrates a sample implementation using 5GSP. A concluding remark and way forward are provided in Section 5.

2. 5G SERVICE PLATFORM (5GSP)

5GSP provides an Application Programming Interface (API) and accompanying customer self-service User Interface (UI) for the specification, deployment and customisation of customer-specific 5G virtual infrastructures. Such virtual infrastructures are specified through a '5GSP-compose' file. The concept of 5GSP-compose[2] can be used to describe software services and their network/storage needs. A 5GSP-compose file is used to specify:

- Services, to be deployed in the telco cloud, at the edge or at other locations
- User equipment (UE), such as IoT devices or smartphones, that should be given access
- The network connections between UEs and services, as well as to the Internet
- Geographical areas/locations where services and slices may be used
- Desired performance characteristics of the 5G network

5GSP-template files are used for easy configurations of 5GSP-compose files. Template creators can define variables in the template, used to calculate values in the 5GSP-compose file.

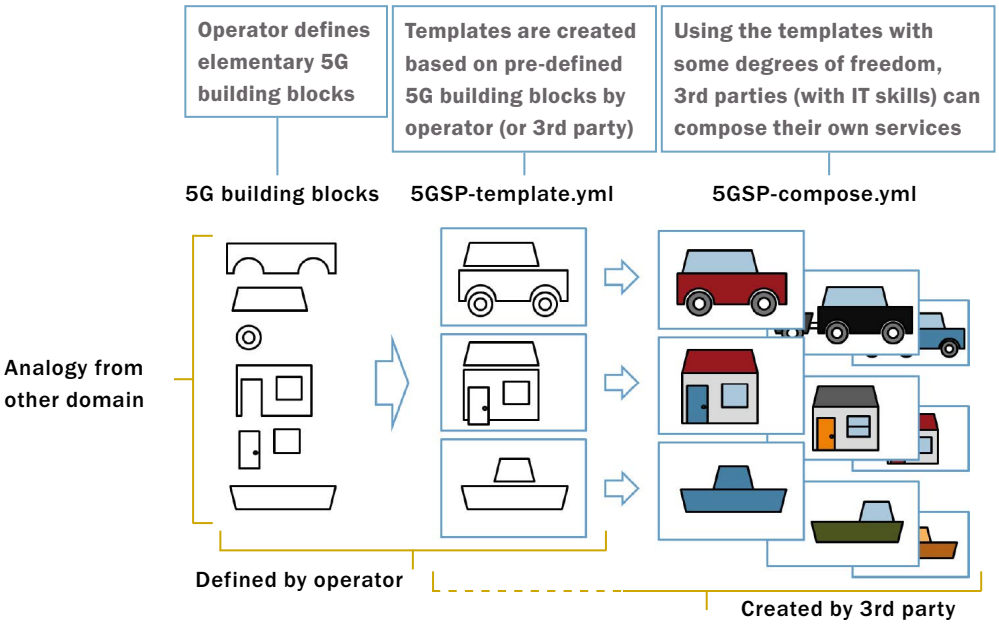

Figure 2: *5GSP template and compose files - from building blocks to a blueprint, and to a customised result*

2 The 5GSP-compose concept is similar to Docker-compose – https://docs.docker.com/compose/

To better illustrate the relationship between the 5GSP-compose and 5GSP-template files, we show an analogy in Figure 2. The operator defines several elementary building blocks, such as the ability to define (edge-)services. A 5GSP-template file is a description of how the building blocks could be put together as a virtual infrastructure to form a type of service (such as forwarding video in a certain area) as well as some template fields that need to be configured (such as the area and quality of the video). For example, the template can contain a variable for video quality with options for low, HD and 4K. Based on the selected option, a value for the bandwidth (data rate) of the mobile connection can be calculated. A filled-in template, compiled into a 5GSP-compose file, is then a specific configuration of a template (such as forwarding video with a required bandwidth of 30 Mbps, in the Groningen area).

5GSP uses an intent-based approach, where the intent of the customer (through the network characteristics specified in the 5GSP-compose file) is interpreted by 5GSP. The 5G virtual infrastructure is then configured to satisfy the intent. This can be achieved by deploying one or more custom slices, configuring the existing virtual infrastructure, deploying new services, etc.

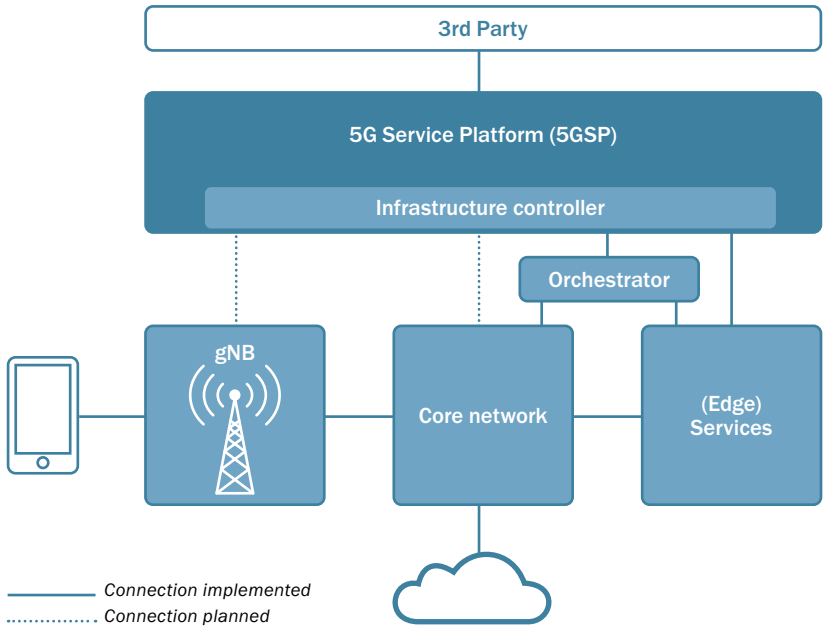

Figure 3: *5GSP relationships and connections with other parts of a 5G infrastructure*

5GSP connects to 3rd parties through the API and interacts with the orchestrator and the service hosting platform, as shown in Figure 3.

Different operators can use different 5G-cores and different (service) orchestrators.
The 5GSP-compose file is therefore interpreted by an adapter, called the infrastructure controller, that is specific for an orchestrator and core combination (such as Kubernetes+Open5GS or OSM+Open5Gcore).

3. COMPARISON WITH OTHER RELEVANT INITIATIVES

The 5G system is a complex network architecture defined and standardised by a large partnership of companies. The main standardisation group is 3GPP, which is divided into different working groups each with its respective focus. The 3GPP working group that is most relevant to service platforms and third party APIs is SA6 – Applications. Other organisations such as GSMA also align with 3GPP and add suggestions, implementation guides and extensions. Initiatives also exist besides these standardisation groups. In this section we discuss a number of relevant initiatives.

3GPP SA6

One of the goals of the 3GPP SA6 Working Group is to provide enablers for specific vertical applications – e.g. Automotive (V2X), Factory of the Future, Unmanned Aerial System (UAS) – as well as frameworks for interacting with a 5G core, such as Common API Framework[3] (CAPIF), Service Enabler Architecture Layer[4] (SEAL) and an architecture for enabling Edge Applications[5] (EDGEAPP). CAPIF is designed as a single platform for the discovery and invocation of core network functions. SEAL provides capabilities commonly required by verticals, such as Group Management, Configuration Management, Location Reporting, UE configuration, Identity Management, Key Management and Network Resource Management. EDGEAPP is a common edge computing API. SEAL and EDGEAPP both consist of provider-side and UE-side functionalities.

While 5GSP focuses on the control plane, 3GPP SA6 addresses both the control plane and the user plane. 3GPP SA6 also provides protocols specific to a number of verticals while 5GSP is more vertical-neutral. However, 5GSP adapters could make use of CAPIF, SEAL and EDGEAPP in the future, once vendors have implemented them and made them available as software components. This will lower the burden of implementation of adapters for each orchestrator/core combination.

GSMA GST

With Generic Network Slice Templates (GST) and NEtwork Slice Types (NEST)[6], the GSMA Networks Group aims to provide a common format for specifying network slice attributes. A GST defines which attributes can be described. A NEST is a configuration of those attributes, similar to our 5GSP-compose files described above, but only for the configuration of network slices. Attributes can describe the performance (e.g. maximum slice throughput), functions (e.g. NB-IoT support indicator), control and management (e.g. Session and Service Continuity mode), as well as scalability characteristics (e.g. maximum number of UEs) of a network slice. Some attributes specify KPIs that need to be maintained (such as throughput), while others give access to an API (e.g. user management).

The biggest difference from 5GSP is that the GSMA GST concept focuses only on the specification of network slices, while 5GSP also describes other parts of the end-to-end network: for example, what services to deploy (and where), the QoS requirements of the network between the service and the UE, and the QoS requirements between the service and the external internet. On the other hand, the GST supports more slice attributes.

OPERATOR PLATFORM CONCEPT

The GSMA Future Networks working group launched the Operator Platform Concept (OPC) work in January 2020. The goal of OPC is bringing together developers, operators, platform providers and the broader ecosystem to create global, interoperable Mobile Edge Computing (MEC) Services. OPC intends to cover features such as MEC service deployment, access from outside the home network (e.g. Wi-Fi, roaming), seamless transition of services between networks (i.e. from one operator to another), Network as a Service (with QoS), edge node sharing between networks, and later also network slicing.

3 https://www.3gpp.org/DynaReport/29222.htm
4 https://www.3gpp.org/dynareport/29549.htm
5 https://www.3gpp.org/DynaReport/23558.htm
6 https://www.gsma.com/newsroom/wp-content/uploads//NG.116-v5.0-7.pdf

In June 2021 GSMA released the Permanent Reference Document (PRD) "GSMA Operator Platform Telco Edge Requirements version 2021"[7]. Based on this document the industry is invited to define and develop the operator platform concept requirements and specifications. This means that it will take at least a couple of years before such an OPC-compliant platform is available for commercial use by telecom operators. We will closely monitor what is written in the PRD and what is developed by the industry and released by operators. As OPC matures, 5GSP could be extended to integrate with the different features of OPC.

5G-VINNI

5G-VINNI[8] is an European H2020 R&D project which spans several countries. 5G-VINNI aims to demonstrate a practical implementation of 5G infrastructure capable of supporting the key 5G KPIs and allow verticals to test and validate applications that require those KPIs.

The way in which 5G-VINNI allows industries to test specific applications has many similarities with the 5GSP approach. In both cases, an easy-to-use online platform is provided, where customers can submit templates or customize pre-existing ones. On top of that, each particular service is provisioned for a defined geographical scope and can work with a variety of different orchestrators.

5G-VINNI is more focused on creating a blueprint for the interconnection between the different platforms rather than on providing a single software platform. Unlike 5GSP, 5G-VINNI services are slices, based on NSTs (Network Slice Templates) and it does not use an intent-based approach. The use of NSTs limits the choice of orchestrators to those based on ETSI standards, so without further adjustment it is not possible to use common tools, such as Kubernetes, in the cloud world.

4. 5GSP IN PRACTICE

In one of the addressed use cases of the Horizon 2020 5G-HEART project, 5G is used for more effective remote assessment in ambulance services in collaboration with Ambulancezorg Groningen: a paramedic at the scene can ask a Chief Medical Officer (CMO) for advice remotely (see Figure 4). A description of the use cases is given in a 5G-HEART project deliverable[9], including some preliminary results.

Figure 4 *Use case example with a paramedic at the scene consulting a remote CMO via mobile communication*

7 https://www.gsma.com/futurenetworks/resources/gsma-operator-platform-telco-edge-requirements-2021/
8 https://www.5g-vinni.eu/
9 https://5gheart.org/wp-content/uploads/5G-HEART_D3.2.pdf

In a follow-up use case test, 5GSP is used to initiate 2 slices on a 5G Standalone (SA) core. The first slice is the default slice, which is used by the general public. The ambulance equipment uses this slice whilst waiting at the ambulance station for low priority communication such as equipment status updates. The second slice is used in emergency situations, e.g. when a paramedic wants to consult a CMO by transmitting a video stream and perhaps other data streams from devices such as electrocardiogram (ECG) equipment or ultrasound probes. For this use case we mimic the Ambulance Management System (AMS) with a demo front end (see Figure 5) that can communicate with the 5GSP API.

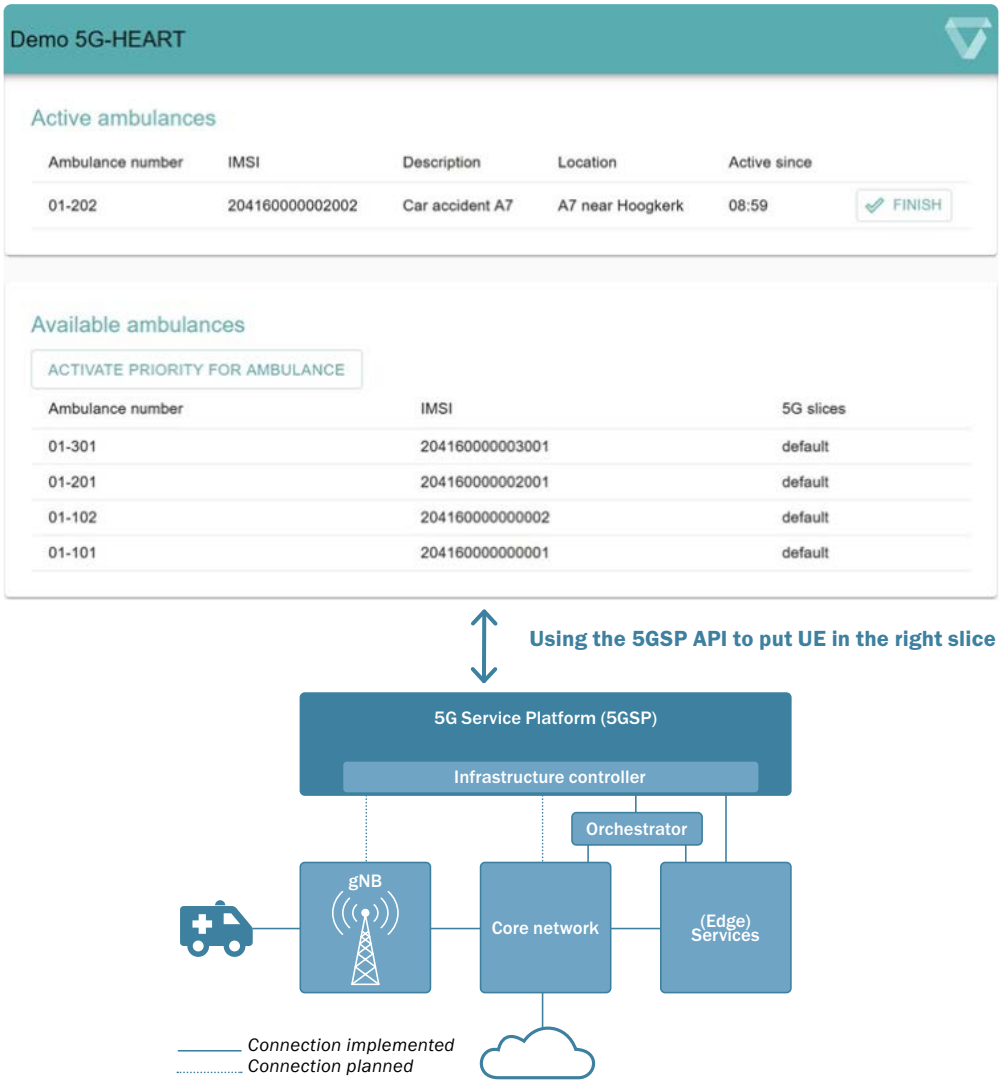

Figure 5: *Illustration of an Ambulance Management System (AMS) using 5GSP*

In the default situation, all ambulances are at the station on standby. As soon as there is an emergency, the ambulance dispatcher selects the ambulance to be sent to the scene, see Figure 6. When using our AMS, an instruction is sent to the 5GSP platform to move the UE from the default to the priority slice.

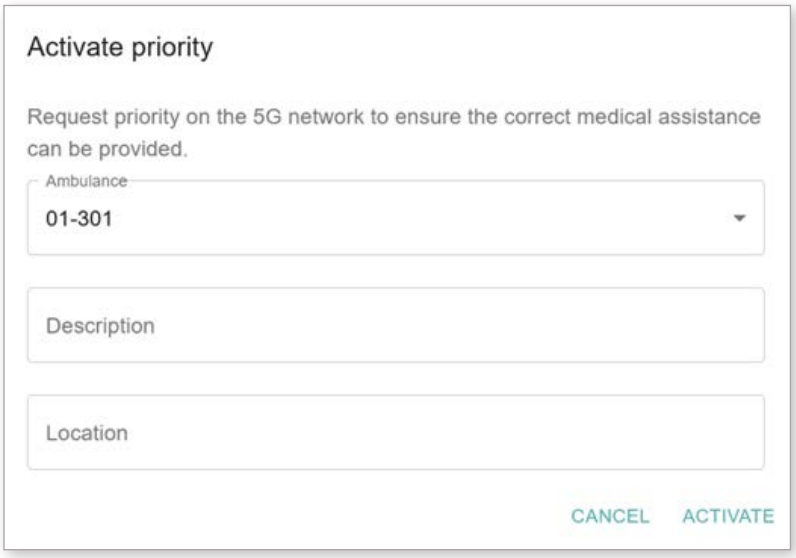

Figure 6: *Selecting an ambulance for the priority slice*

After a couple of seconds the UE is placed in the priority slice. As soon as the ambulance is reported back at the station by the AMS, the AMS will instruct 5GSP to move the UE back in the default slice.

5. CONCLUSION / WAY FORWARD

The previous sections briefly explained 5GSP, including how it relates to other initiatives, and a sample use case using 5GSP. 5GSP is now being further exploited in the national 5Groningen field lab, and will be used for different use cases including the 5G-HEART field trials.

The ultimate aim is for 5GSP to be adopted by telecom operators, on top of their own 5G telecom infrastructure, as a means to offer easy-to-understand and self-configurable service templates for 3rd parties. This would allow operators to monetise the possibilities offered by 5G and sell more/better infrastructure properties for a higher price. They can expand their business beyond telecommunication infrastructures, exploit their distinctiveness to gain a competitive edge over other infrastructure providers and maximise the use of advanced and value adding features with minimal effort. Furthermore, customers can benefit from the use of 5GSP as it enables them to develop new types of services over 5G which they can sell to their own clients. Customers can also deploy 5G services without in-depth knowledge of telecommunications technology, and improve their own processes and services through the use of 5G.

In the near future, 5GSP will be extended with the possibility to configure radio networks. Meanwhile, we will monitor the other initiatives mentioned in this paper. When implementations of these initiatives become available, we will extend 5GSP to support or make use of these implementations where appropriate.

ACKNOWLEDGEMENTS

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