5GINFIRE

Newsletter

No-2 2019

Final 5GINFIRE Workshop

At 10th FOCUS FUSECO Forum – Berlin, Germany – 7 November 2019

From 5GINFIRE Towards Large-Scale European Testbeds

After almost three years of operation, the 5GINFIRE project will present its achievements to the wide audience and discuss further opportunities and constrains for the large-scale 5G experimentation and testing. The 5GINFIRE established a first open 5G playground consisting of eight European testbeds and one Brazilian facility, enabling experimentation in various vertical industry domains in context of initial 5G based applications and services as well as 5G networking capabilities. The experiences gathered in 5GINFIRE through its experiments represent a valuable input for the large-scale testbeds which are currently being established by projects within the 5G PPP program in Horizon 2020.

Newsletter highlights:

Website: www.5ginfire.eu

Contact: contact@5GINFIRE.eu

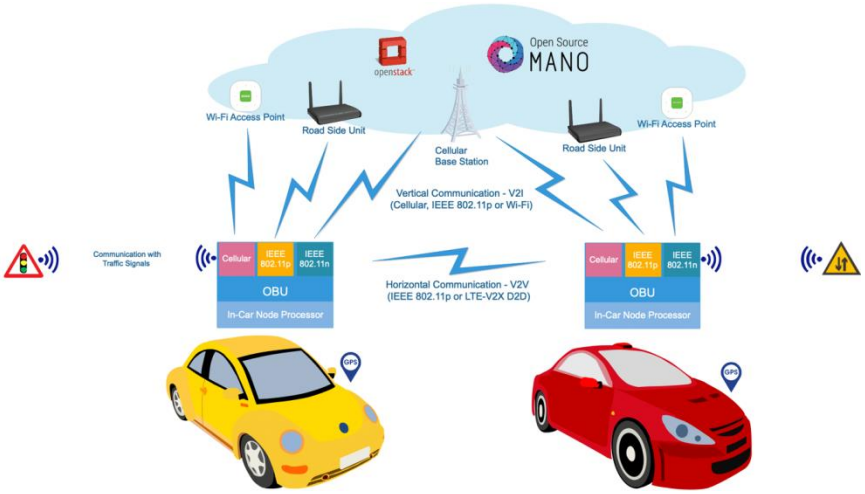
Twitter: 5GINFIRE

5G FOR AUTOMOTIVE INNOVATION

A city-scale 5G automotive testbed for open experimentation

Vehicular networks are seen as one of the key enablers for the always connected paradigm, providing useful communications among vehicles and between vehicles and the infrastructure. As a natural consequence, the design and implementation of Intelligent Transportation Services (ITS) applications has been a hot topic, and a proper evaluation of these applications must consider a realistic environment. Acknowledging that network simulators are getting more and more accurate when representing a real scenario, they are far from acceptable when in driving assistance and safety situations. In these cases, the evaluation environment should be as close as possible to the real scenario.

Figure 1: IT-AV AUTOMOTIVE ARCHITECTURE



An automotive testbed, deployed in the campus of the University of Aveiro, Portugal, and managed by Instituto de Telecomunicações – Aveiro, has been widely used for the evaluation of new services and applications for the vehicular vertical (Figure 1). The vehicular testbed consists of On-Board Units (OBUs), deployed in vehicles, and Roadside Units (RSUs). The OBUs are able to connect to each other via standard IEEE 802.11p/WAVE or LTE-V2X D2D links, and are able to connect to the RSUs through IEEE 802.11p/WAVE, IEEE 802.11n/WiFi and/or cellular links, in a multihomed communication. The cellular network is granted through a small cell C-RAN using Band 7 (2.6GHz) powered by an OpenAirInterface (OAI) Evolved Packet Core (EPC). Each OBU is equipped with an additional IEEE 802.11n/WiFi interface, to disseminate a WiFi connection to end-users, usually vehicle's occupants, to have connectivity to the Internet. Moreover, each vehicle has access to its information such as velocity, GPS and heading, and is also equipped with in-Car Node Processors that can be used to increase the computational power of the OBUs.

The testbed enables resource sharing, making use of softwarized networks, and replacing hardware network functions through software functions by the means of Network Function Virtualization (NFV) technologies. This way, network functions, as well as many other vertical-centric applications, are available in the Cloud, enabling flexibility, programmability and extensibility to the network.

IT-Av automotive testbed has been thoroughly explored, not only in the scope of research projects, as is the case of 5GINFIRE, but also for in-house research activities. The IT-Av automotive testbed, together with the remaining 5GINFIRE orchestration services, offers a complete playground for the development and assessment of new ITS applications and network mechanisms. Due to its integrated multi-communication solution and edge virtualization capabilities, the range of services to be explored is countless: road safety, smart and green transportation, location-dependent services, in-vehicle Internet access, and many more.

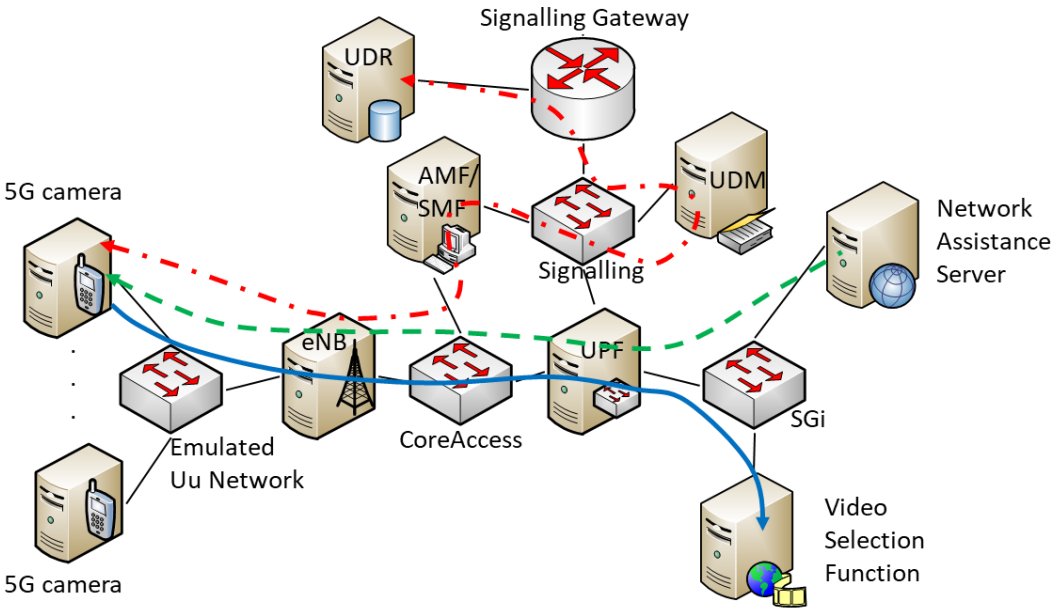
5G FOR MEDIA

Customizable 5G testbed for Media

Advanced media applications such as 6 Degrees of Freedom Virtual Reality (6DoF VR), Social eXtended Reality (XR) and ultra-high quality live streaming during events, are set to bring users' experiences to a completely new level. At the same time, these applications are known to be very demanding with respect to the resources they require: high bandwidth consumption, tight delay budget, extensive CPU/GPU usage or large memory footprint are common in the media world. Additionally, specific sectors of the media industry require a "managed" type of services, which can offer service guarantees. Last but not least, the applications and services need to be thoroughly tested and monitored which – due to 'continuous delivery' model of modern services – is not a one-time effort either.

Figure 2: 5G MEDIA TESTBED AT TNO

Example of a 5G slice with a service to collect video streams from 5G-enabled cameras



In order to address these demands and challenges, both infrastructure programmability and application programmability need to be exploited. **In our vision, 5G networks should provide "app-aware slices" where both infrastructure and applications can be re-configured in run time in an orchestrated way.** Coordination of these actions requires an orchestrator which is aware of application and infrastructure capabilities, statuses and requirements. While very powerful and beneficial, such orchestration approach may pose challenges to the specific verticals service providers who are experts in their domains but may lack expertise in 5G/softwarized infrastructures.

For this purpose, a customizable 5G testbed (field lab), which is capable of providing "app-aware" slices, has been established at TNO in Netherlands (Figure 2)**.** There are several benefits for media vertical service providers when using this 5G testbed: first of all, the orchestrated cloud and 5G infrastructure (based on open source and open APIs) is readily available, allowing media vertical service providers to focus on their services and use cases. Furthermore, the team behind the 5G testbed consists of both 5G/cloud experts as well as media specialists and has a track record of working together on unleashing the power of programmable infrastructures for the benefit of the media industry. Moreover, automated, rigorous and reproducible integration tests can be programmed using extensible, open source based testing engines.

SECURITY IN 5G

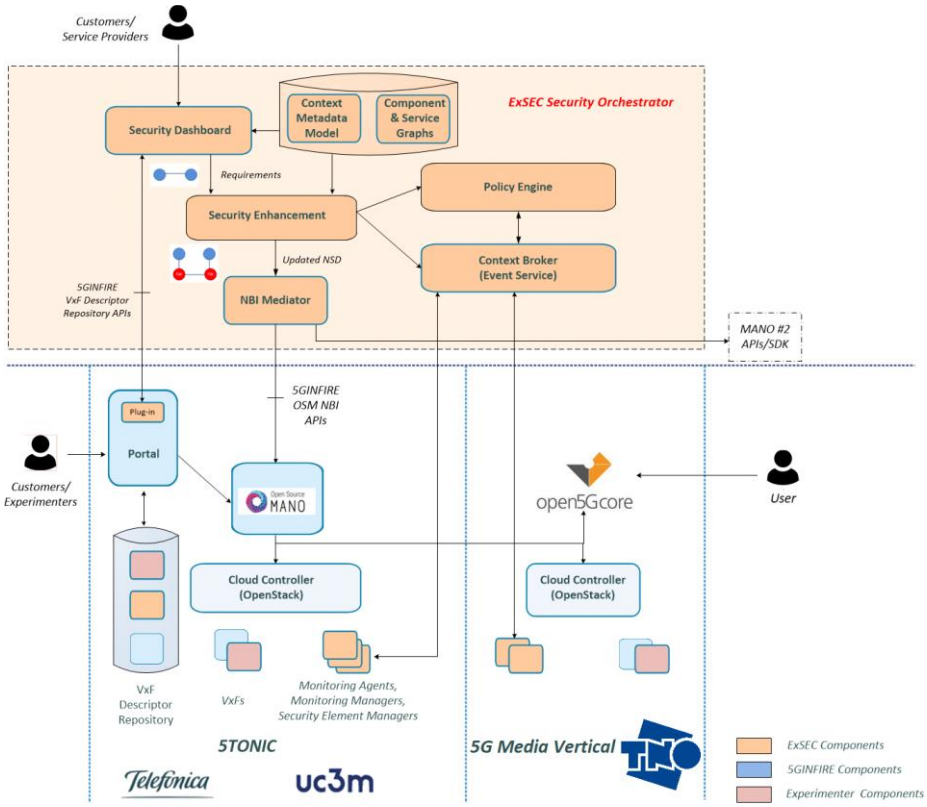
Test Beds for 5G Security and Cybersecurity Innovation

5G system implementations are based on virtual functions (network, application, MANO) and microservices deployed on distributed / federated virtualized infrastructures. This new execution environment combined with a cloud service-delivery model raises new security concerns and introduces new security problems like e.g. multi-admin isolation, user / tenant Identity and Access Management (IAM), secure boot / crash, secure hypervisor / enclaves, etc.. In addition to this technology-centric dimension, a user-centric dimension is addressed increasingly by regulators, law enforcement agencies and service providers, driven by user- and industry-specific privacy concerns.

Initially, 5GINFIRE offered an open experimentation environment for DevOps from the area of 5G networks and from a number of vertical application domains such as automotive, media, healthcare, etc., however without taking into account the following security constrains:

- The testbeds did not provide enough protection of the experiments and of the testbed-provider resources against malicious attacks, except for a basic access control over VPN and a basic communication-integrity protection by means of TLS.
- The experimenters were not able to evaluate the security posture of their new VxF and services, nor the compliance to applicable security and privacy standards and regulations.
- There was no support for DevOps from the security ecosystem, which needs an open experimentation environment for experimenting with security & privacy services and their governance, in order to speed innovation in the cybersecurity space.

Figure 3: EXSEC DEPLOYMENT ON THE 5G MEDIA TESTBED IN 5GINFIRE



A first step to solve these issues in future 5G networks has been undertaken by ExSEC experiment (Externalized Security Assurance as a Service for Hosted Virtualized Infrastructures) run on the top of the 5GINFIRE infrastructure (Figure 3)**, providing a solution for protecting deployed experiments and later on 5G services and applications.**

WHAT ARE THE 5G VERTICALS NEEDS IN PERFORMING EXPERIMENTS?

7th OSM Hackfest – Patras, Greece – 9 – 13 September 2019

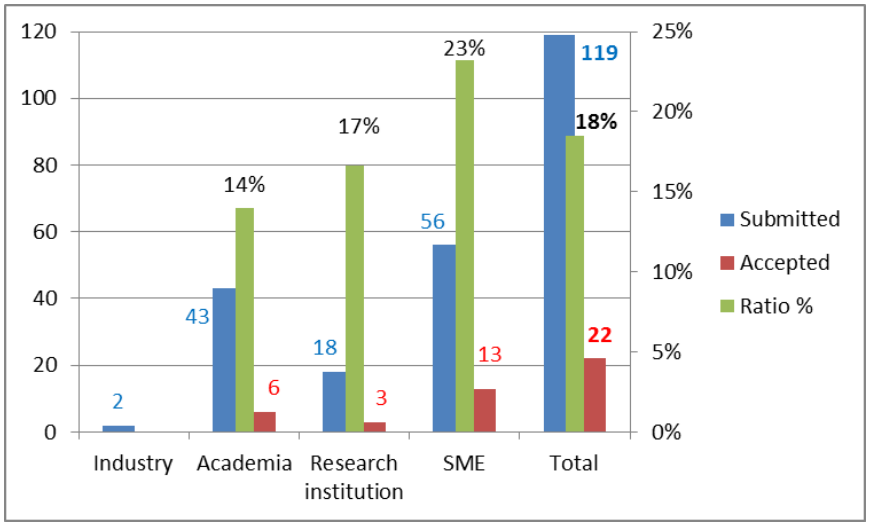
5GINFIRE supported the 7th OSM Hackfest and organized a dedicated workshop as a part of the event on 11th September. As one of the most successful OSM Hackfest organized, about 80 participants attended this specialized event thanks the University of Patras providing complex technical infrastructure and expertise. This was usefully organized as OSM is key part of the 5GINFIRE infrastructure and the project looks for active interaction with the community. In cooperation with the OSM community, the 5GINFIRE project organized a full dedicated half day workshop on discussing 5G testbeds offers to Verticals and highlighting the OSM importance. After a keynote from Christos Tranoris, University of Patras, presenting the potential of 5GINFIRE tests infrastructure, Juan Rodriguez Martinez from Telefonica reminded on the importance of "how OSM can accelerate 5G Vertical services". Benoit Orihuela from EGM presented the cooperation between the 5GTango and 5GINFIRE projects in providing Validation & Verification (V&V) services. Finally, the 5GINFIRE project organized the presentations of view points in three verticals: the automotive, the media and the security domains (see above). At the end, a networking event was chaired by Mona Hrapkowicz from Intel and OSM MARCOM Chair and confirmed great interested by the audience on the interaction between the various technologies such NFVs, OSM, the interest of organizing experiments and the needs coming the vertical industries. This conclusion paves the way of the 5GINFIRE exploitation activities towards the verticals.

OPEN CALLS AND EXPERIMENTS – OVERVIEW

The 5GINFIRE Open Calls

During its life time, the 5GINFIRE project organized four competitive open calls with an overall budget of almost 2,500,000€, looking for new infrastructures to enlarge the 5GINFIRE experimental infrastructure, new and additional functionalities to improve and enhance the 5GINFIRE experimental framework, and experiments to test innovative solutions on the top of the 5GINFIRE. The most part of the contributions (157 proposals in total) was received from SMEs, followed by Academia, and Research Institutions (Figure 5). This trend can be also observed for the 30 accepted proposals, where half of them are from SMEs.

Figure 4: OPEN CALL STATISTICS FOR EXPERIMENTS



Altogether 119 proposals for experiments have been submitted and 22 of them accepted (Figure 4), resulting with an overall success rate of 18%. The highest number of proposals has been received and accepted from SMEs.

Figure 5: OVERALL 5GINFIRE SUBMISSIONS VS ACCEPTED PROPOSALS

Experiment Areas and Domains

The main application areas addressed by the experiments were in areas of Cooperative Intelligent Transportation and various media related applications (multi-media streaming, real-time a/c surveillance, emergency services, etc.). Further experiments were focusing on optimizing various 5G capabilities (latency, slicing, security, energy efficiency, etc.) and some specific applications, such as IoT enabled application for tourism and accessibility solutions.

Thus, the main individual domain addressed by the 5GINFIRE experimenters was the 5G networking capabilities (40% of experiments), whereas majority of experiments addressed various industry vertical sectors, mainly Automotive and Smart Cities (Note that testbeds / experimental infrastructures enabling experimentation in other vertical domains joined the 5GINFIRE later during the project life time).

THE EXPERIMENTAL INFRASTRUCTURE

The 5GINFIRE project established its framework at an early stage, to enable a variety of external experiments. The initial 5GINFIRE experimental infrastructure included an automotive and a smart city testbed as well as 5TONIC facility, which was extended through competitive open calls to eight 5GINFIRE testbeds enabling remote implementation of experiments, by using the 5GINFIRE experimenter portal, and addressing various vertical sectors and 5G oriented networking experimentation (Figure 6). In addition, the 5GINFIRE has links with testbeds in Brazil through connection with the Federal University of Uberlândia.

5TONIC laboratory hosts the 5GINFIRE orchestration service and the NFV infrastructure as well as is serves to evaluate and demonstrate the capabilities and interoperation of pre-commercial 5G equipment and devices, services, and applications. This multipurpose environment of multiple racks can be flexibly interconnected according to any experimentation requirements. In particular, secure external access may be provided, allowing remote solutions to support management, control, and data operations.

IT-Aveiro Automotive Environment consists of On-Board Units (OBU) in the vehicles and roadside units connected to the Internet, where each OBU has multiple wireless interfaces, enabling communications with other vehicles and the entire testbed infrastructure. The OBUs have access to the vehicular information such as velocity, position, and heading as well as information about the surroundings.

University of Bristol 5G testbed is a multisite network connected through a 10km fibre with several active switching nodes, including the core network and an extra edge computing node. Access points using various technologies are located in the city center. The available radio access technologies deliver high bandwidth, high-bitrate, and high-reliability connections, where availability of LTE-Advanced and future installations of 5G access points are of particular importance.

e-Health experimental infrastructure located in Poznan Supercomputing and Networking Center consists of cutting-edge equipment enabling implementation and testing of e-Health cloud applications, products, or services. The infrastructure makes accessible to experimenters e-Health devices from three functional groups: the operating room, the physiological sensors, and the patient wellbeing sensors.

5G Media testbed enables execution of media use cases beyond current state of the art, looking at two target areas; 6-degrees-of-freedom (6DoF) VR streaming and professional video production (uplink streaming) for live TV. The testbed provides hardware components, such as data plane acceleration modules, encoding/decoding modules, GPUs, etc., to meet necessary requirements, in terms of bandwidth and latency, to the target classes of future media applications.

PPDR ONE is a 5G enabled telco-grade development, testing, and verification facility for outdoor and indoor experimentation on network architectures and services for **Public Protection and Disaster Relief**. PPDR ONE is representing an all-in-one facility which includes SDR-based radio and core mobile system, cloud backend infrastructure, etc. A portable compact PPDR ONE node is ready to be shipped and deployed anywhere in the EU, covering both indoor scenarios and field operation.

NITOS testbed is one of the largest single-site open experimental facilities in Europe, allowing users to take advantage of highly programmable equipment supporting a variety of wireless technologies, such as IEEE 802.11 compatible equipment, LTE, WIMAX, SDR 5G, etc., which are all interconnected via OpenFlow switches and a cloud computing testbed. The equipment is distributed across three different testbed locations in the city of Volos and can be combined with each other as required.

WINS-5G testbed provides a radio slicing and virtualization tool called Hypervisor for Software Defined Radios (HyDRA), developed to support experimentation monitoring in wireless, packet, and optical networks. HyDRA as a VNF is available in other 5GINFIRE testbeds equipped with Universal Software Radio Peripherals (USRPs) N210s, offering an opportunity to test and evaluate advanced 5G use case scenarios with massive communications needs and ultra-low latency requirements.

5GINFIRE

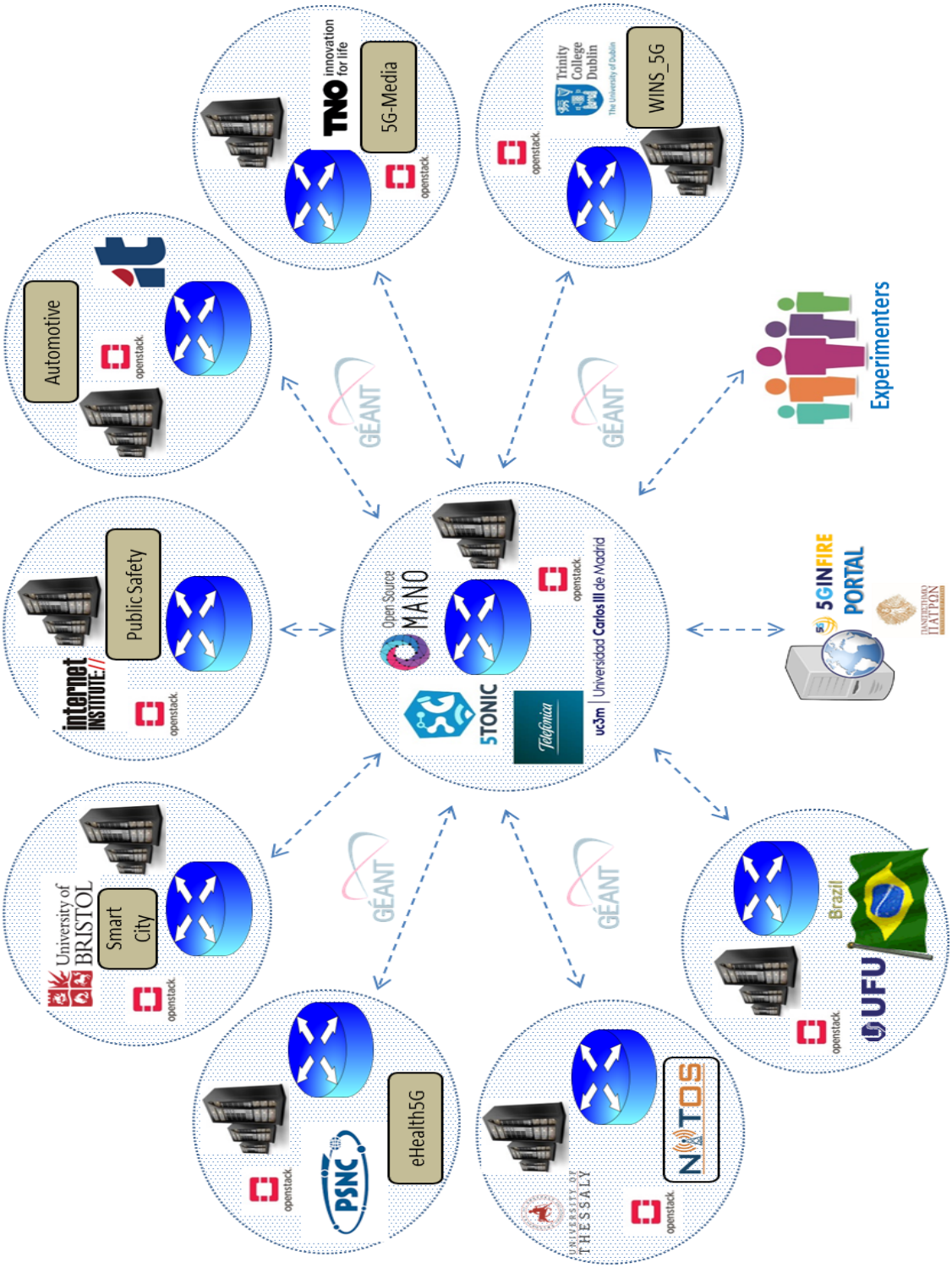


Figure 6: 5GINFIRE EXPERIMENTAL INFRASTRUCTURE

Website: www.5ginfire.eu

Contact: contact@5GINFIRE.eu

Twitter: 5GINFIRE