5G-VINNI: The 5G Verticals Innovation Infrastructure initiative

The 5G Verticals Innovation Infrastructure initiative, or 5G-VINNI, is a conglomerate of 23 partners, including telcos such as BT, Telefónica, Altice, Cisco, Ericsson, Huawei and Nokia, as well as academics from across Europe. The €20 million project will be coordinated by Telenor Group, the international telecom operator headquartered in Norway.

The project, scheduled to run for three years, will leverage the latest 5G technologies, including results from previous 5G PPP [1] phases, and employs advanced network virtualization, slicing, radio and core technologies. In addition, a rigorous automated testing campaign will be employed to validate 5G under various combinations of technologies and network loads. The project will use the likes of advanced network virtualisation, slicing, radio and core technologies. Participants will hold automated tests to see how 5G performs using various combinations of technologies and under different kinds of requirements. Open APIs will be used to ensure participants have easy access to the trials.

5G-VINNI will be run at four main sites located in Norway, UK, Spain and Greece. In addition, experimental sites will be established in Germany and Portugal. Open APIs will be provided to ensure easy access to the 5G-VINNI facility.

The 5G-VINNI objectives are:

1. Design an advanced and accessible 5G end-to-end facility.
2. Build several interworking sites of the 5G-VINNI end-to-end facility.
3. Provide user friendly zero-touch orchestration, operations and management systems for the 5G-VINNI facility.
4. Validate the 5G KPIs and support the execution of E2E trial of vertical use cases to prove the 5G-VINNI capabilities.
5. Develop a viable business and ecosystem model to support the life of the 5G-VINNI facility during and beyond the span of the project.
6. Demonstrate the value of 5G solutions to the 5G community particularly to relevant standards and open source communities with a view to securing widespread adoption of these solutions.

Members of 5G-VINNI are: Telenor Group (Telenor Research, Telenor Norway and Telenor Satellite), British Telecom (UK), Telefonica (Spain), SES (Lux), Huawei (Norway and Germany), Ericsson (Norway), Nokia (Norway), Samsung (UK), Intracom (Greece), Keysight (Denmark), Cisco (Norway), Alticelabs (Portugal), Engineering (Italy), AUEB (Greece), UC2M (Spain), Simula (Norway), Uni.Patras (Greece), Fraunhofer FOKUS (Germany), EANTC (Germany), Limemicro (UK), SRS (IR), and Eurescom (Germany).

About University of Patras, NAM Group in 5G

The 5G-VINNI facility in Patras/Greece will be an exemplary Open Source 5G-IoT facility. This means that most of the installed components will be offered as Open Source but there will be also dedicated components and services to support 5G-IoT scenarios. Numerous partners will deploy their technologies in the Patras/Greece facility, thus creating a unique 5G playground for KPI validation and support on future verticals.

The 5G-VINNI facility in Greece will be part of the Patras Platform for Experimentation lab (http://nam.ece.upatras.gr/ppe/ [2]). City of Patras has been recently selected by the Greek Ministry of Digital Policy, Telecommunications and Media, as one of the first two 5G pilot cities in Greece. Under this plan, 5G infrastructure will be deployed across the city to facilitate 5G trials and validate the effectiveness of the proposed architecture.

In Greece facility site the following tasks will be performed:
• Providing 5G standard-conformant components and Core Network infrastructure as extension of the FhG Open5GCore toolkit
• Provide ICOM's mmWave backhaul to link the access to the core network, and Fixed Wireless Access to provide broadband services to the facility
• Integration of FhG Open5GCore with Limemicro SDR platform and the SRS UE and g/eNB
• Enabling the E2E deployment of multiple customized-slices over the whole network - access, transport and core. This will further include the slicing of the IoT devices at the edge of the network.
• Supporting MEC orchestration and mobility management features for the support of interactive mobile streaming edge services.

The Patras 5G testbed will focus on the validation of a series of KPIs, related to developed/deployed features and the selected use cases. On the generic NFV/MEC front and with respect to the available MANO features, validation will focus on the Latency, Energy, Throughput, Service Deployment Time KPIs. Related to the employed use cases, activities will also focus on Reliability (Service Continuity), Latency (Interactivity), Energy Efficiency and Throughput KPIs. Additional, qualitative/quantitative assessment activities will focus on validating resource and traffic isolation.

The set of use cases which will challenge the 5G-VINNI KPIs and will be targeted by the test plans are as follows:

• Information society on the road (eMBB)
• Collaborative gaming AR/VR (URLLC and eMBB)
• Ultra-high fidelity media AR/VR (URLLS and eMBB)
• Intelligent navigation (URLLC and eMBB)

Architecture and Components of the Facility Site

Access Network, MEC devices and UE

In Patras/Greece facility there will be 2-3 base stations together with MEC devices at the Patras campus and at the City of Patras placed at properly selected places to facilitate the execution of
test plans together with around 6 UEs. UoP together with ICOM will implement and integrate any standardized APIs and services to provide MEC functionality, including the virtualization of edge IoT devices, i.e., IoT Slicing, as a VIM component. LimeMicro's hardware will be used for both handset and base station, and proposing to use a typical LTE frequency that is available at the location of the Patras/Greece facility (e.g. in band 8 or 20). LimeMicro specialises in field programmable RF (FPRF) transceivers and open source LimeSDR, LimeNET platforms for the next generation of wireless broadband systems. These products offer an unprecedented level of configurability and will be used in the Patras/Greece to create wireless communication networking equipment using commodity hardwares, i.e., x86-based machines that can be programmable and reconfigured to run on any wireless communications frequency and mobile standards from 2G to 5G networks of the future.

SRS will integrate its software suite into the LimeMicro SDR hardware platform as well as interworking with the Fraunhofer open5GCore will be assured. SRS intends to develop a set of selected 5G NR features for srsLTE that will be available for KPI validation within the project. SRS will extend their code base for both UE and (g/e)NB to support the 5G NR scalable numerology for configurable subcarrier spacings, integrate the new channel coding, and higher order modulation types supported by 5G. This work will serve as a proof-of-concept and feasibility study of a SDR-based 5G NR implementation. We are intending to adopt the non-standalone (NSA) mode for 5G NR in which a NR gNB will provide user-plane traffic services for a NR-capable UE to a master 4G eNB.

**Backhaul**

ICOM will provide to the Greek facility state-of-the-art mmWave backhaul and Fixed Wireless Access (FWA) solutions. The UltraLink™-GX80 all-outdoor mmWave PtP Ethernet radio at 70/80 GHz (E-Band), that provides a 10 Gbps backhaul capacity, will be used to interconnect the g/eNBs with the core network and the data centre at the UoP premises. Further, ICOM's FWA solutions will be used to public organisations' sites (e.g. University Campus, City Hall, etc.) in the city. The WiBAS™ OSDR PtMP all-outdoor radio, as it has been enhanced to provide >1.5 Gbps aggregate sector capacity and <1 ms latency through the phase 1 project SPEED-5G, will be used. Within the project ICOM will add support for SDN-based network slicing to the wireless backhaul and FWA network segments.

**Cloud/MANO services**

Currently, the Patras/Greece facility is equipped with a cloud platform offered by the University of Patras, able to host core network components, as well as NFV and MEC deployments. The cloud platform offer a total computing power of 112 CPUs and 236 Gigabytes of RAM and 10 TB of storage. On top of our cloud hardware, a rich set of state-of-the-art SW tools is already available, which comprises our platform for experimentation called Cloudville13. These include OpenStack as the cloud operating system, while OSM and OpenBaton are also available to allow NSD/VNF deployments. Prometheus alongside with Grafana are installed for monitoring purposes. At the same time, Elastic search and Kibana are installed and being used to collect and visualize data extracted from IoT devices and sensors.

**Core 5G /IoT services**

In Cloudville, apart from Service Slice life-cycle management services and OSM, the FhHG Open5G Core will be installed. The Fraunhofer Open5GCore implementation is a 5G oriented implementation of the core network (currently 3GPP Release 14 and 15). The Open5GCore enables the connectivity service as requested within the 5G networks. To support NB-IoT, the Patras/Greece facility will host the Open5GCore NB-IoT extension, which is the first implementation of the essential 3GPP NB-IoT features (Release 13 - TS 23.682) enabling the demonstration of low energy IoT communication. It addresses the current stringent needs of the 5G use cases to provide low power, low cost efficient communication for a massive number of devices.
MEC

The Patras/Greece facility will provide support for Mobile/Multi-access Edge Computing on two fronts:
(i) IoT Slicing: A Virtualized Infrastructure Management (VIM) (sub-)component will be designed, implemented and integrated within the overall MANO architecture, to enable the virtualization of the available edge IoT resources (sensors/actuators) for access within individual network slices.
(ii) Mobile streaming applications support: The facility will support MANO mechanisms for the realization of high throughput, low latency, mobile types of applications (e.g., gaming, AR/VR) and corresponding test cases. Such mechanisms will include DNS and traffic flow management (on Mp1 ETSI MEC interface) for baseline service orchestration, as well as mobility support mechanisms i.e., mobility management events such as application context transfer, user redirection network/application level), and a subset of the Location Service (ETSI GS MEC 013) for triggering mobility management events.

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