PPDR One Facility Overview

Public Protection and Disaster Relief facility for Outdoor and iNdoor 5G Experiments (PPDR ONE) is an extension of the 5GINFIRE ecosystem with a 5G enabled telco-grade development, testing and verification facility for experimentation with 5G network architectures and services for Public Protection and Disaster Relief (PPDR). With PPDR ONE, 5GINFIRE covers the public safety sector and incorporate capabilities to conduct laboratory and field 5G experiments designed for the needs of emergency response, disaster relief, and critical infrastructure protection.
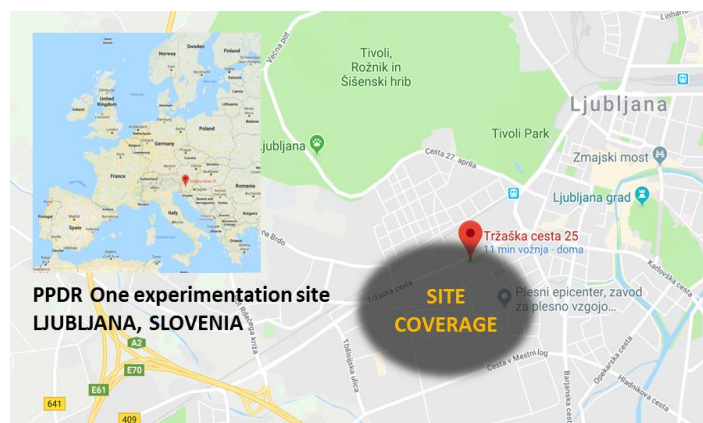

Figure 1: PPDR ONE facility location at INTERNET INSTITUTE premises in Ljubljana with indoor and outdoor coverage (prediction on n28/B28 band).

Located at INTERNET INSTITUTE premises in Ljubljana, Slovenia, the facility incorporates indoor and outdoor experimentation sites as well as a compact portable node for field experiments, ready to be shipped to any location in the EU. PPDR ONE represents an all-in-one experimentation facility that delivers all components of a virtualised 5G-enabled PPDR environment – SDR-based radio and core mobile system with flexible configuration options powered by NFV, cloud backend infrastructure, a set of reference PPDR services and apps, a PPDR IoT kit, industrial and ruggedized end user devices as well as a test and validation toolkit.

Architecture

PPDR ONE delivers a dedicated 5G enabled telco-grade development, testing and verification facility for experimentation with PPDR-specific 5G network architectures and services. The PPDR ONE facility is aligned with the 5GINFIRE reference model architecture and integrated into the experimentation ecosystem with the support for 5GINFIRE experimentation workflow.
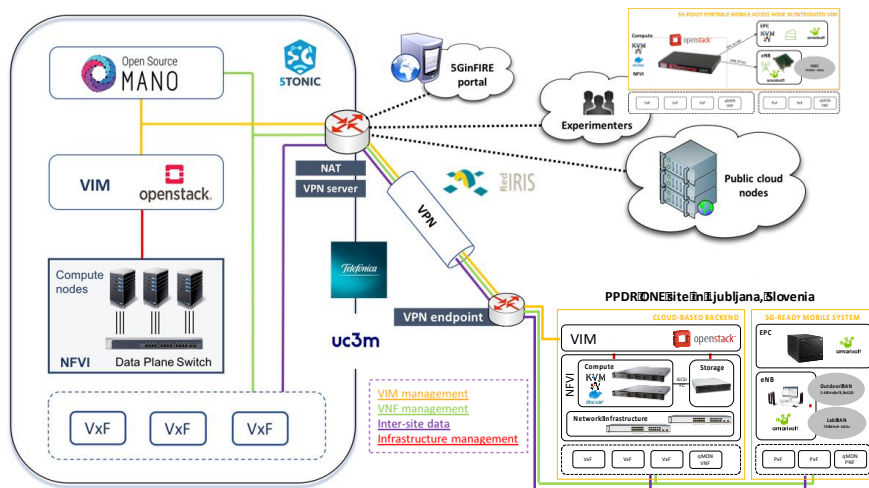
The PPDR ONE facility act as a VIM and NFVI provider, connected through a secure VPN connection with the 5TONIC core site. MANO is connected to PPDR ONE VIM via the OpenStack APIs. The EPC/eNB provisioning is realized through predefined mobile profiles (e.g. different frequency band, bandwidth, QoS profiles etc.). Subject to feasibility, selection of mobile profiles will be integrated into the 5GINFIRE portal to enable remote on-demand 5G slice provisioning for the experiments. Compute monitoring (e.g. CPU/RAM) and network monitoring (e.g. RTT, DL/UL speed) is offered as a cloud-based service in Grafana/Kibana.

Equipment

The PPDR ONE facility offers:
- **indoor experimentation site** (Figure 5), covering laboratory-based testing in all operational frequencies from 70 MHz up to 6 GHz,
- **outdoor experimentation site** (Figure 1, Figure 5), supporting field operation in the 5G pioneering bands (3.4 GHz, 5G band n78, channel BW 100 MHz) and 4G band (3.4 GHz, B42, channel BW 100 MHz), and
- **PPDR ONE node, a portable compact mobile system** (Figure 6) ready to be shipped and deployed on the experimenter's test site anywhere in the EU, covering indoor scenarios (bands from 70 MHz and up to 6.0 GHz) and field operation (based on the available frequencies at the experimenter's location).

The PPDR ONE facility consists of:
- an SDR-based mobile system (Rel.14) providing 5G-enabled PPDR infrastructure (Figure 5, Figure 6),
- an OpenStack-based backend infrastructure incorporating NFV-ready orchestration to manage experimental instances using IaaS model (Figure 5, Figure 6),
- commercial and ruggedized user terminals and IoT devices to conduct the experiments (Figure 3),
- iMON Intervention Monitoring System (www.imon.si) designed for a public safety use, providing a set of PPDR ONE services and apps available for demonstration and evaluation purposes (Figure 4), and
- qMON Quality Monitoring System (www.qmon.eu), a telco-grade toolset for continuous network and service testing, verification and benchmarking (Figure 2).

| 5G-ready mobile system (indoor/outdoor)	OpenStack-based IaaS backend
- SDR-based mobile system (Rel.14) - 5G NSA operation planned, pending vendor SW release and support - Support for: LTE, LTE-Advanced, NB-IoT, LAA - Supported mobile radio frequencies, from 70 MHz and up to 6.0 GHz including PPDR band 700 Mhz[1] - flexible RF channel bandwidth from 200 kHz (NB-IoT) and up to 56 MHz - Up to 3 x carrier aggregation	- CPU: 40 x CORE (Intel(R) Xeon(R) CPU series) - Memory: 256 GB RAM - Storage: Up to 7.2 TB SAN (iSCSI/FC) - Virtualization: KVM-based - Openstack version: Queens - Openstack services: Keystone v3, Nova, Neutron, Cinder, Glance - Openstack networking: provider and self-service - Container support: Docker, LXD/LXC
Compact portable PPDR ONE node	**User terminals and IoT devices**
- Compact portable 5G-ready mobile radio, core and cloud node to be deployed in the field - Includes all 5G-ready mobile system capabilities, with supported mobile radio frequencies from 70 MHz and up to 6.0 GHz - Includes all OpenStack-based IaaS backend capabilities, with internal storage only - Prepared for in-vehicle and field use, ruggedized	- Commercial and Ruggedized Android mobile phones with dual USIM capabilities - Ruggedized industrial platforms (Advantech ARK and Beagle board) with mobile radio support (LTE/LTE-A/LTE-A Pro, NB-IoT) for deployment of experimenters' docker containers - Wearable cameras and vital signs sensors - Environmental sensors (water level)
PPDR services toolset for demonstration and evaluation	**Network and service testing, verification and benchmarking toolset**

iMON Intervention Monitoring solution = services and apps for intervention monitoring and filed operations; developed in tight cooperation with PPDR end-users (TRL8)
- Common operational picture (with a dashboard)
- Real-time video streaming
  o from body worn cameras
  o from drones
- Unit and asset tracking services
- Environmental monitoring/sensing (water level)
- Filed reporting services
	qMON Intervention Monitoring solution = telco-grade 5G-ready measurement automation system for mobile, fixed and cloud environments (TRL9)
	- Probes, management backend and analytics tools
	- Live network and service tests/troubleshooting
	- Real-time performance and SLS/SLA monitoring
	- Drive and benchmark testing for broadband PPDR networks (LTE/4G and 5G)
	- PPDR network coverage and mission critical application performance assessment
	- QoE/QoS prediction in live BB PPDR networks

Table 1: PPDR ONE facility factsheet.
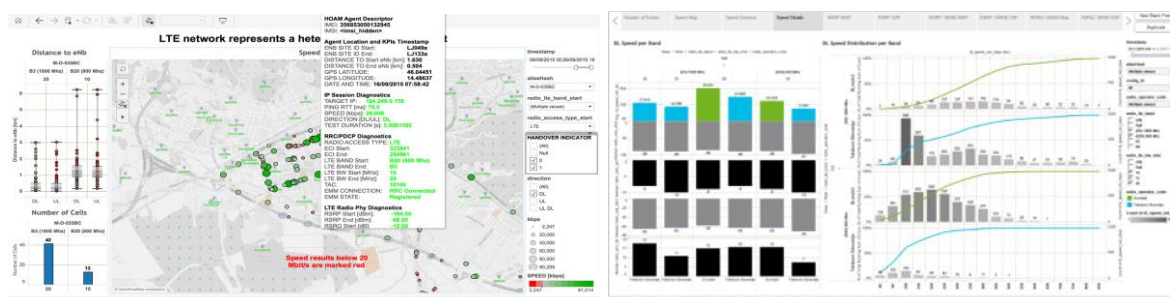
Figure 2: qMON toolset –in-depth analytics for network and service testing, verification and benchmarking with big data capabilities.

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[1] 700 Mhz band is one of the 5G pioneering bands and is also targeted band to be used for the future PPDR system deployments in EU. https://ec.europa.eu/digital-single-market/en/public-protection-and-disaster-relief

Figure 3: Examples of PPDR ONE user terminal and IoT devices – ruggedized industrial platforms, ruggedized Android terminal, wearable cameras, water sensors, drone.

Figure 4: iMON services and apps – RT common operational picture dashboard, triage mobile app, RT streaming, intervention field reporting record.
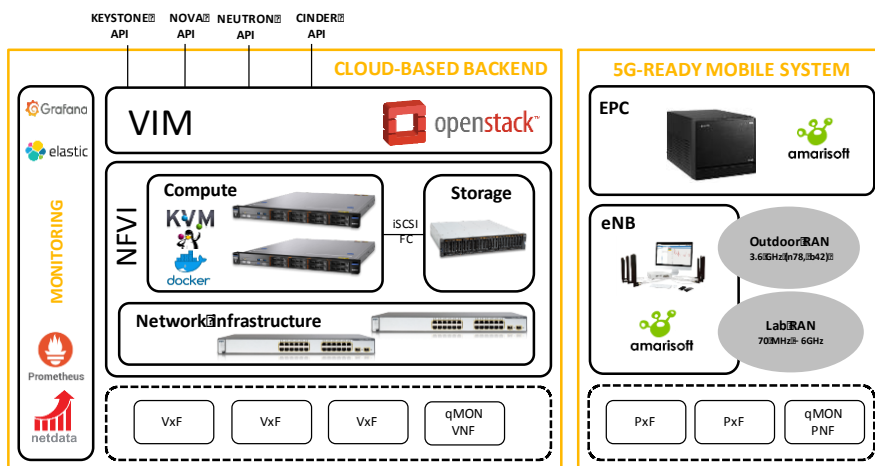

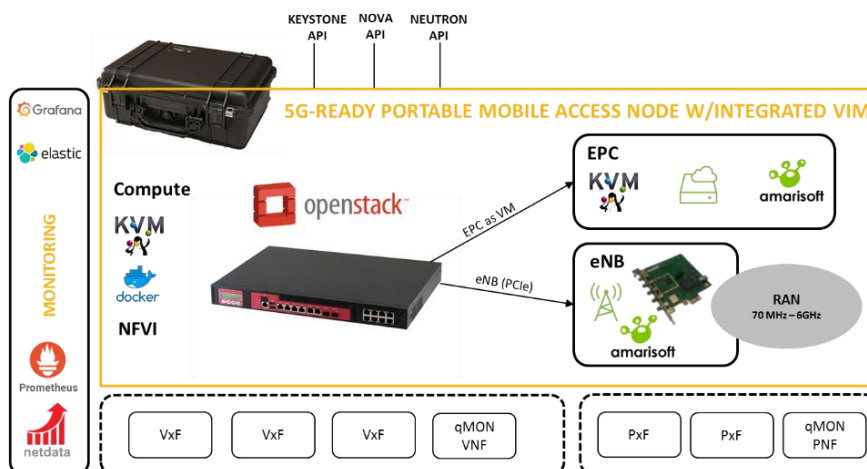**Figure 5: PPDR ONE facility in Ljubljana with indoor and outdoor components.**

Figure 6: PPDR ONE node, a portable compact mobile system for experimentation anywhere in the EU.

Experimentation

In the following is a non-exhaustive list of possible experiments supported with the PPDR ONE facility in two categories.

PPDR network provider related experiments – experimentation relevant to the PPDR network and infrastructure operators, PPDR organizations, system integrators, equipment and network services developers. Some examples of experimentation areas are:
- novel PPDR architectures and feasibility testing with aspects related to radio, mobile network and cloud infrastructure elements and components,
- dedicated PPDR base station deployments with flexible bands and channel configurations,
- radio experiments from functional and performance aspects (Carrier aggregation, NB-IOT),
- QoS enforcement mechanisms (QCI, ARP, GBR, MBR, AMBR, default/dedicated bearer) and performance verification in the context of PPDR services requirements,
- security architectures and deployment models with multi-level authentication (USIM, APN user based) and end-to-end encryption capabilities,
- PPDR network resilience and high availability architecture verification,
- deployment of PPDR IaaS environment in centralized and distributed model supporting 3GPP Isolated Operation for Public Safety (IOPS) and portable system modes,
- end-to-end performance testing of network architecture, IaaS nodes and network services.

PPDR end user and service provider related experiments – experimentation relevant to the PPDR service developers, IaaS orchestrators, PPDR organizations and end-users, cloud based and mobile based application developers. Some examples of experimentation areas are:
- deployment and testing of novel mission critical video and data services,
- deployment and testing PPDR mobile applications in real-world settings,
- verification of deployment models and architectural aspects of new PPDR services in IaaS,
- performance verification of deployed services (cloud and end-to-end perspectives),
- verification of new operational procedures enabled with a new generation of 5G technologies, in cooperation with PPDR end users.

When the PDPR One equipment resources will be successfully reserved, the experimenters will also be able to access them physically at INTERNET INSTITUTE premises in Ljubljana on reserved dates, or INTERNET INSTITUTE team could arrange personnel who will use the equipment on behalf of experimenters.

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