PPDRONE

internet INSTITUTE://

How to build your own mobile network

Janez STERLE
janez.sterle@iinstitute.eu

SINOG 6.0, May 2019, Ljubljana, Slovenia

© 2019 Internet Institute. All Rights Reserved.

INTERNET INSTITUTE Ltd.

- Startup from Ljubljana, Slovenia
- Established in 2014
- Expertise
  - development, deployment and operation of a telco grade Quality Assurance (QA) and monitoring systems
- 2 focus areas
  - Quality assurance of mobile, fixed and cloud systems
  - Solutions for IoT based critical communications (PPDR)

MATILDA

www.matilda-5g.eu

5GINFIRE

5ginfire.eu

5G PPP PUBLIC-PRIVATE PARTNERSHIP

internet INSTITUTE://

 © 2019 Internet Institute. All Rights Reserved.

qMON – quality Monitoring

Quality assurance of mobile, fixed and cloud systems – 5G, PPDR

- QoS/QoE measurement and monitoring solution for real-time telco-grade environments
- End-to-end performance assessment and validation of networks, services and apps

iMON – intervention Monitoring

Intervention monitoring and critical communications – PPDR

- Common operational picture in real time
- IoT-supported intervention management tools, on-site sensing and tracking
- Survivable, scalable and robust communications from the field

Measurement Agent Deployment in Mobile, Fixed and Cloud

qMON NetworkSensor

Real Time Analysis

qMO INsight

Centralize Results Data Storage

qMON Collector

Advanced Data Analysis

qMON Insight

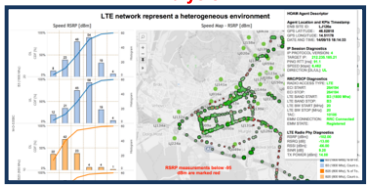


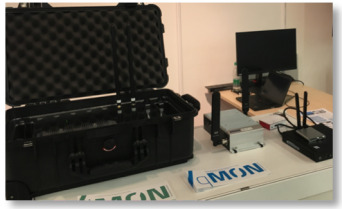
tableau SOFTWARE

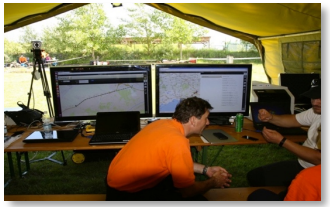
Grafana

kibana

elastic

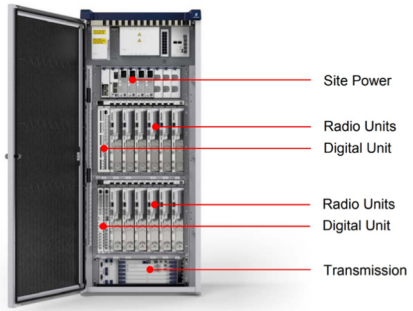
influxdb



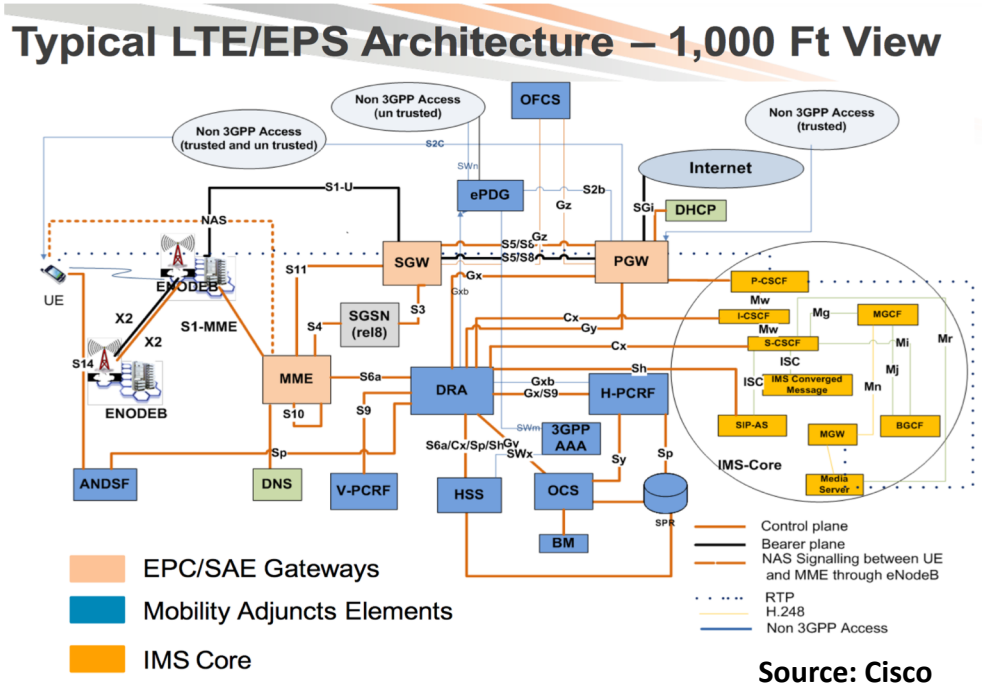


Mobile network components – Heavyweight

Source: Huawei



Source: Ericsson



Source: Cisco

Source: Cisco

Source: Nokia

Vodafone Italia and Telecom Italia each spent €2.4 billion to grab the largest share of spectrum on offer in an Italian auction of 5G-suitable frequencies, which raised €4 billion more than the minimum amount targeted by the government.

internet INSTITUTE://

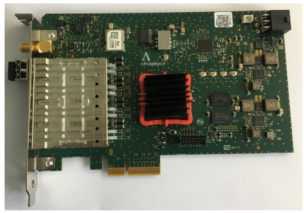
Mobile network components – Lightweight

- LTE base station
  - SDR Radio, eNb SW (femto site)
  - BBU with CPRI & RRH, eNb SW (macro site)
- EPC mobile core
  - EPC SW
- OpenStack based IaaS
  - KVM virtualization
- OSM 4|5 for network orchestration
- Compute power
  - "at least" Intel Core i7-7700K CPU @ 4.20GHz

openstack

amarisoft

OPEN AIR INTERFACE



Open Source MANO

internet INSTITUTE://

 © 2019 Internet Institute. All Rights Reserved.

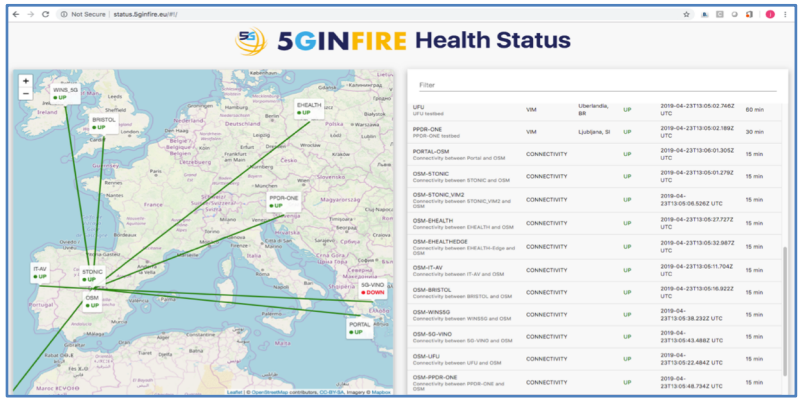
PPDR ONE Facility

5G/NFV enabled development, testing and verification facility for experimentation with 5G network architectures and services for Public Protection and Disaster Relief (PPDR)

© 2019 Internet Institute. All Rights Reserved.

5GINFIRE

- 5G-ORIENTED EXPERIMENTAL PLAYGROUND FOR VERTICAL INDUSTRIES
  - H2020 EU project, GA no. 732497
  - Time frame: 1.1.2017 - 31.12.2019
  - Open calls: https://5ginfire.eu/open-calls/
  - Info: www.5ginfire.eu



CONSORTIUM

EURESCOM

b com

easy global market

it

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΑΤΡΩΝ

Telefónica

University of BRISTOL

USP University of São Paulo Brazil

UFU

uc3m | Universidad Carlos III de Madrid

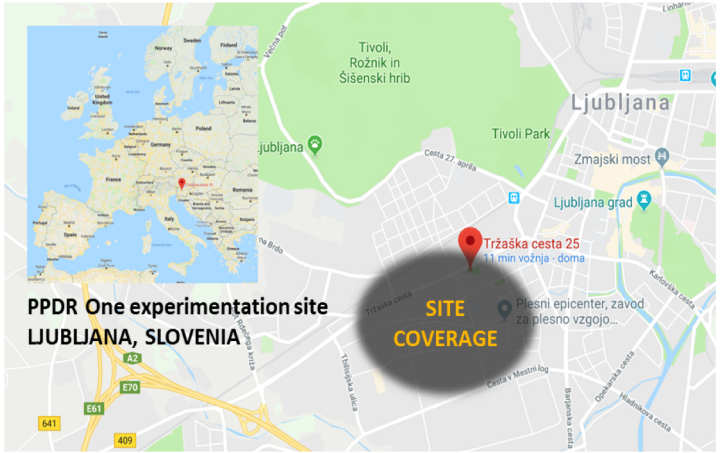
PPDRONE

internet INSTITUTE://

 © 2019 Internet Institute. All Rights Reserved.

PPDR ONE Facility Features

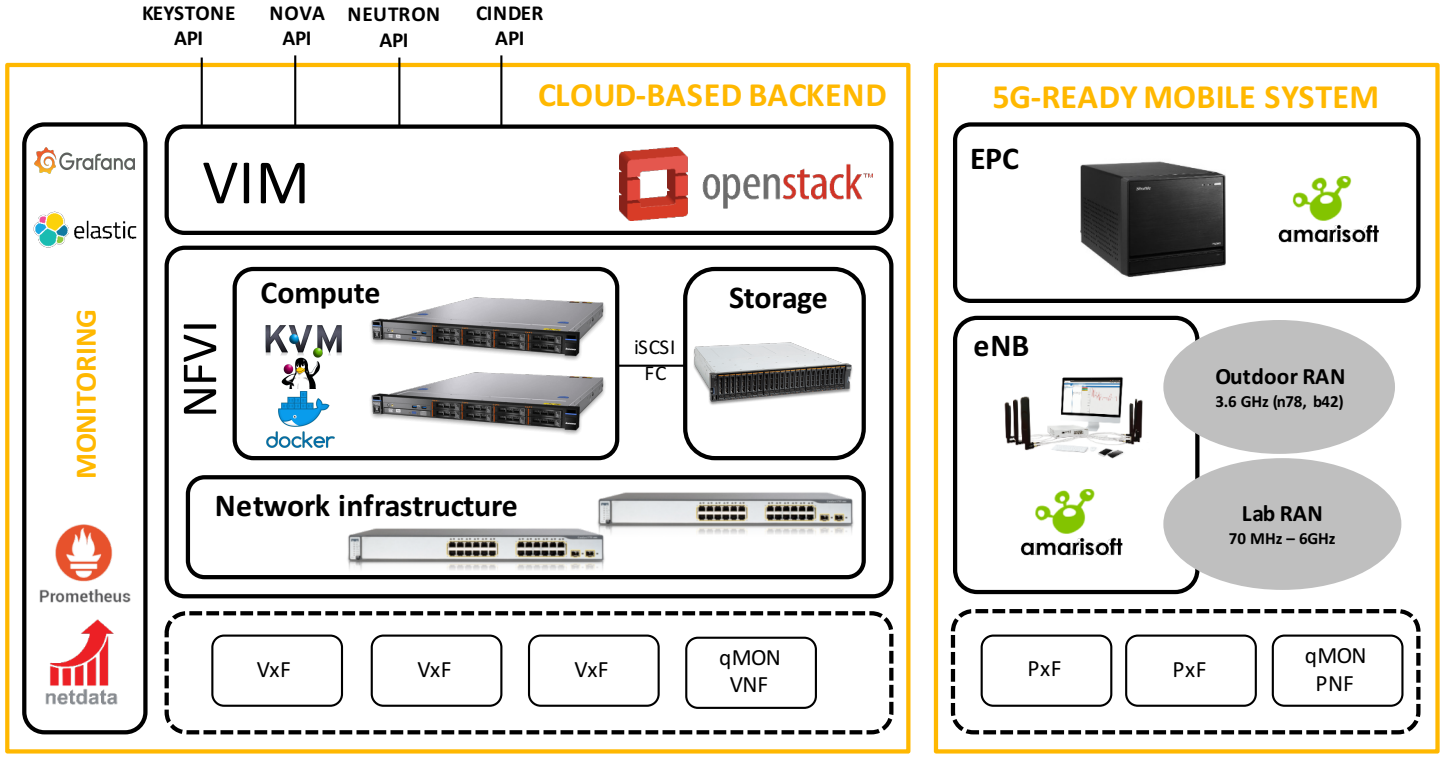
- **PPDR ONE stationary mobile system**
  - **Indoor experimentation site**
    - laboratory-based testing in all LTE/4G operational frequencies from 70 MHz up to 6 GHz
  - **Outdoor experimentation site**
    - field operation in the 5G pioneering band (3.6 GHz, 5G band n78) and 4G band (3.6 GHz, b42)
- **PPDR ONE portable mobile node**
  - **A portable compact mobile system**
    - can be shipped and deployed on the experimenter's test site
    - covering indoor scenarios (bands from 70 MHz and up to 6.0 GHz) and field operation



 © 2019 Internet Institute. All Rights Reserved.

PPDRONE internet INSTITUTE://

PPDR ONE Facility Overview



 © 2019 Internet Institute. All Rights Reserved.

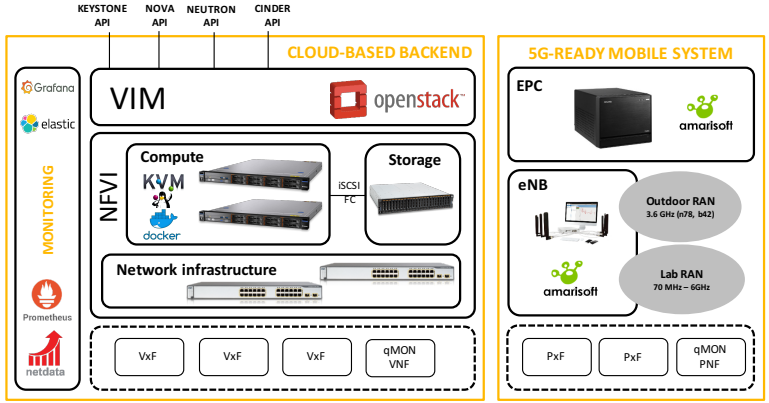
PPDRONE internet INSTITUTE://

PPDR ONE Facility Overview

- 5G-ready mobile system
  - SDR-based eNb and virtual EPC
- OpenStack-based IaaS backend
- PPDR apps, demonstration and user/IoT devices
  - iMON: PPDR services toolset for demonstration and evaluation
  - rMON: IoT based remote measurement automation system
- Network and services testing toolset
  - qMON: Network and service testing, verification and benchmarking toolset

5GINFIRE OSS&BSS

5GINFIRE Open Source MANO



 © 2019 Internet Institute. All Rights Reserved.

PPDRONE internet INSTITUTE://

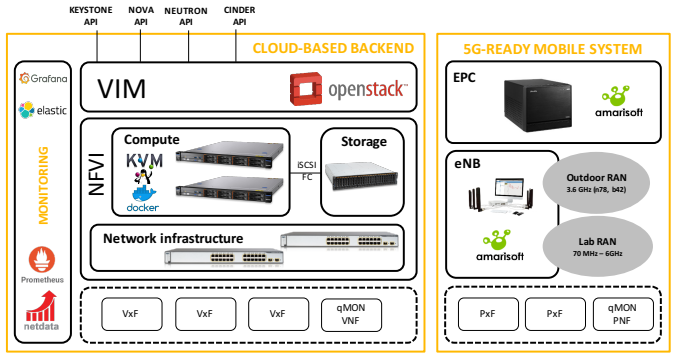
5G-ready Mobile System

5G-ready mobile system (indoor/outdoor)

- 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
- Supported services: EPC, eMBMS and VoLTE

5GINFIRE OSS&BSS

5GINFIRE Open Source MANO



 © 2019 Internet Institute. All Rights Reserved.

PPDRONE internet INSTITUTE://

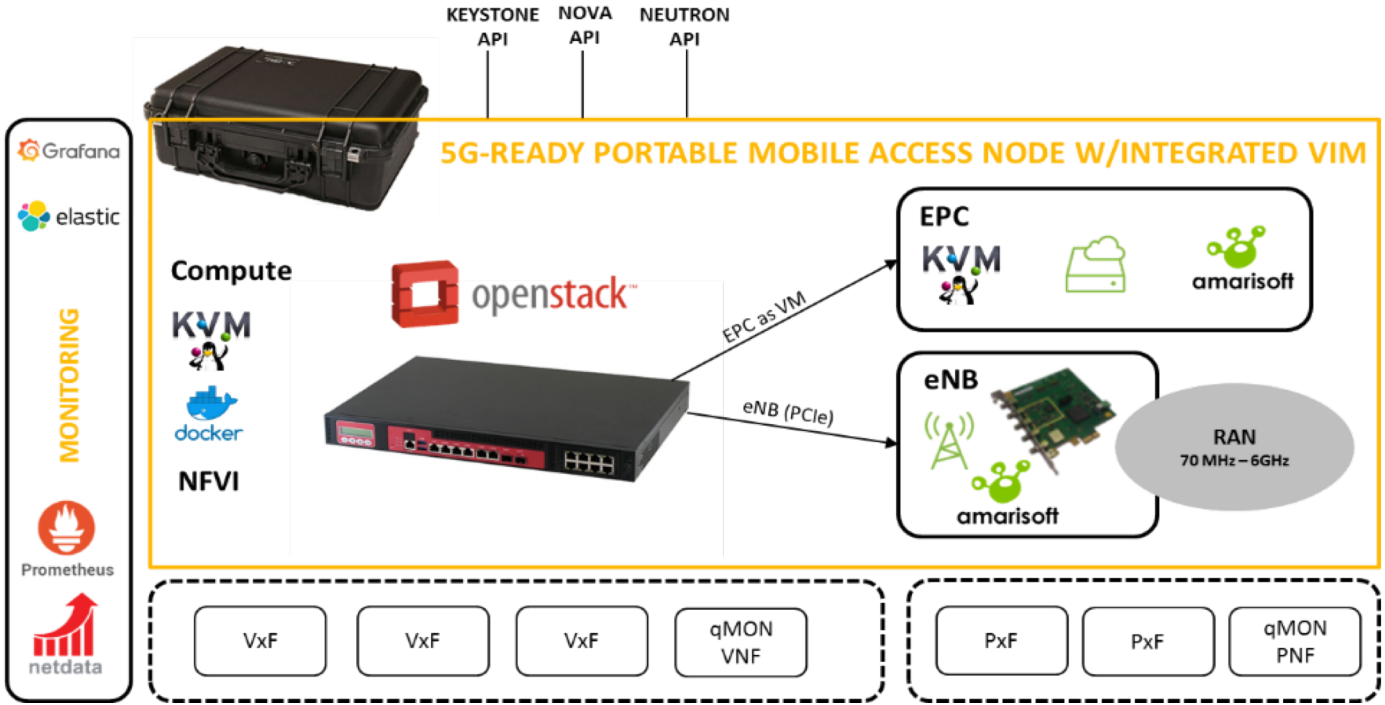
OpenStack based IaaS

OpenStack-based IaaS backend
- CPU: 80 x CORE (Intel(R) Xeon(R) CPU series) - Memory: 256 GB RAM - Storage: Up to 10 TB SAN (iSCSI/FC) - Virtualization: KVM-based - Openstack version: Queens (updated at regular intervals, 3 months after release) - Openstack services: Keystone v3, Nova, Neutron, Cinder, Glance - Openstack networking: provider and self-service - Container support: Docker, LXD/LXC

 © 2019 Internet Institute. All Rights Reserved.

PPDRONE internet INSTITUTE://

Compact PPDR ONE node



 © 2019 Internet Institute. All Rights Reserved.

Compact PPDR ONE node

Compact portable PPDR ONE node

- 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

 © 2019 Internet Institute. All Rights Reserved.

User/IoT devices

User terminals and IoT devices

- 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)

 © 2019 Internet Institute. All Rights Reserved.

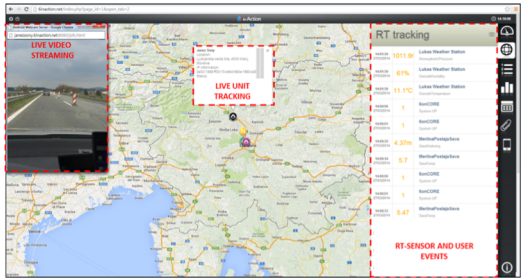
PPDRONE internet INSTITUTE://

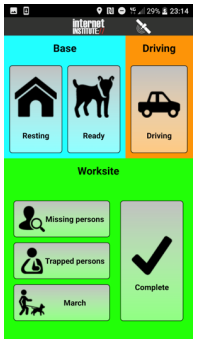
PPDR services toolset

PPDR services toolset for demonstration and evaluation

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
  - from body worn cameras
  - from drones
- Unit and asset tracking services
- Environmental monitoring/sensing (water level)
- Filed reporting services





 © 2019 Internet Institute. All Rights Reserved.

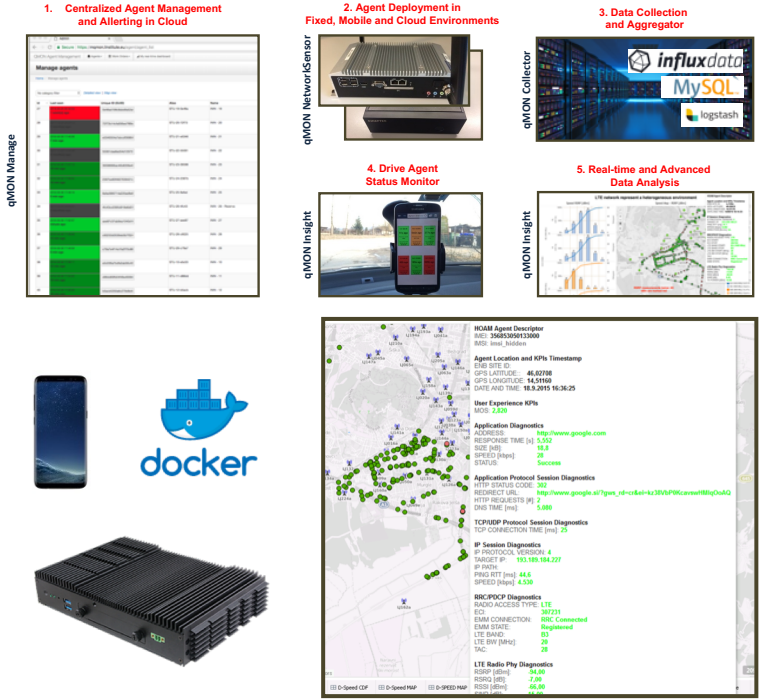
PPDRONE internet INSTITUTE://

Network & service testing

Network and service testing, verification and benchmarking toolset

qMON Intervention Monitoring solution = telco-grade 5G-ready measurement automation system for mobile, fixed and cloud environments (TRL9)

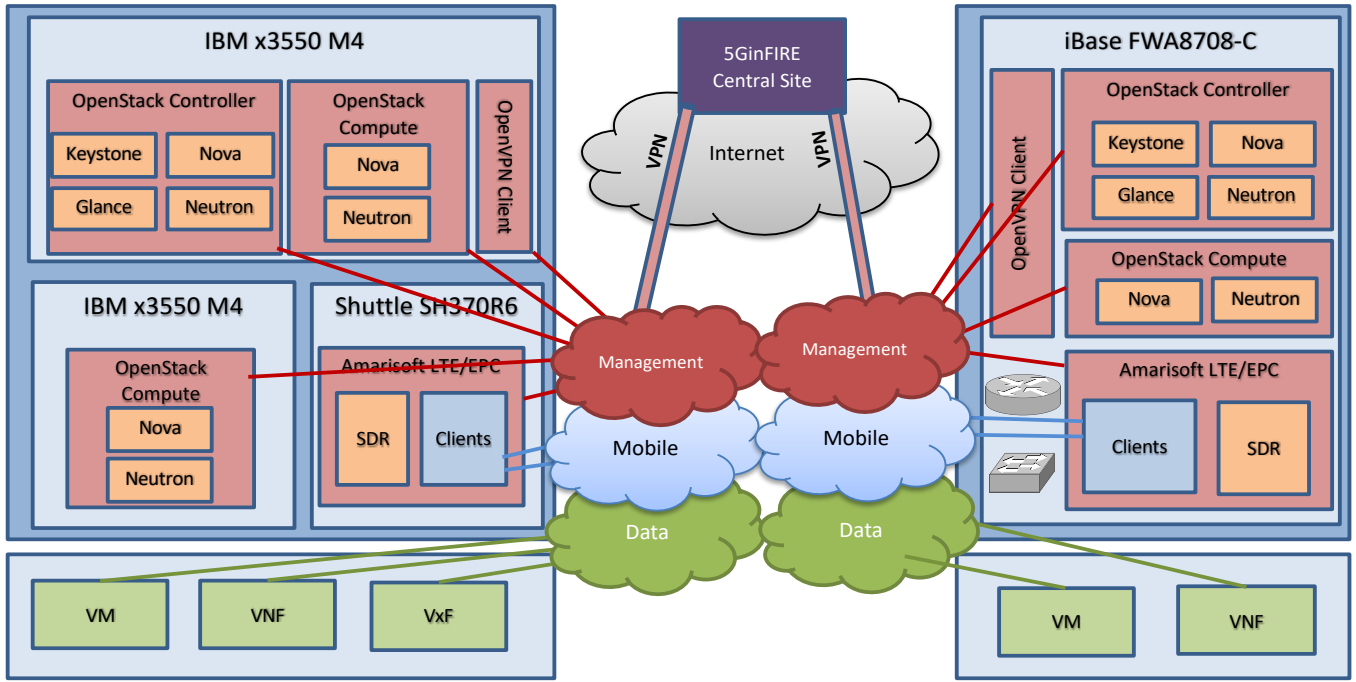
- Probes, management backend and analytics tools
- Live network and service tests/troubleshooting
- Real-time performance and SLS/SLA monitoring
- Drive and benchmark testing for broadband PPDR networks (LTE/4G and 5G)
- PPDR network coverage and mission critical application performance assessment
- QoE/QoS prediction in live BB PPDR networks



 © 2019 Internet Institute. All Rights Reserved.

PPDRONE internet INSTITUTE://

Integration into 5GINFIRE



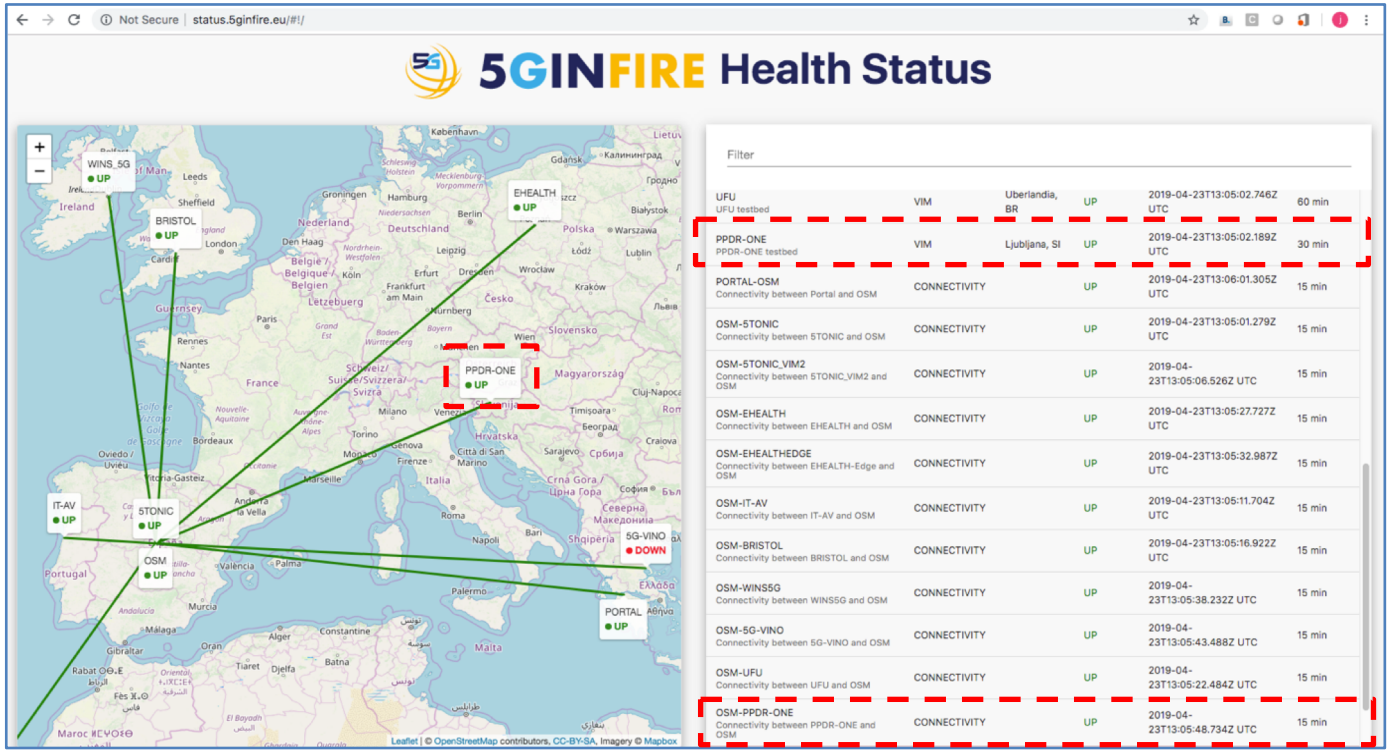
 © 2019 Internet Institute. All Rights Reserved.

Integration into 5GINFIRE

- PPDR ONE: VIM and NFVI provider
- Secure VPN connection (e.g., site-to-site IPsec) with the 5TONIC core site
- MANO connects to PPDR ONE VIM via the OpenStack APIs
- The EPC/eNB provisioning via predefined mobile profiles
- different frequency bands, bandwidth, QoS profiles
- Selection of mobile profiles to 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) will be offered as a cloud-based service in Grafana/Kibana

 © 2019 Internet Institute. All Rights Reserved.

PPDR ONE is operational!



 © 2019 Internet Institute. All Rights Reserved.

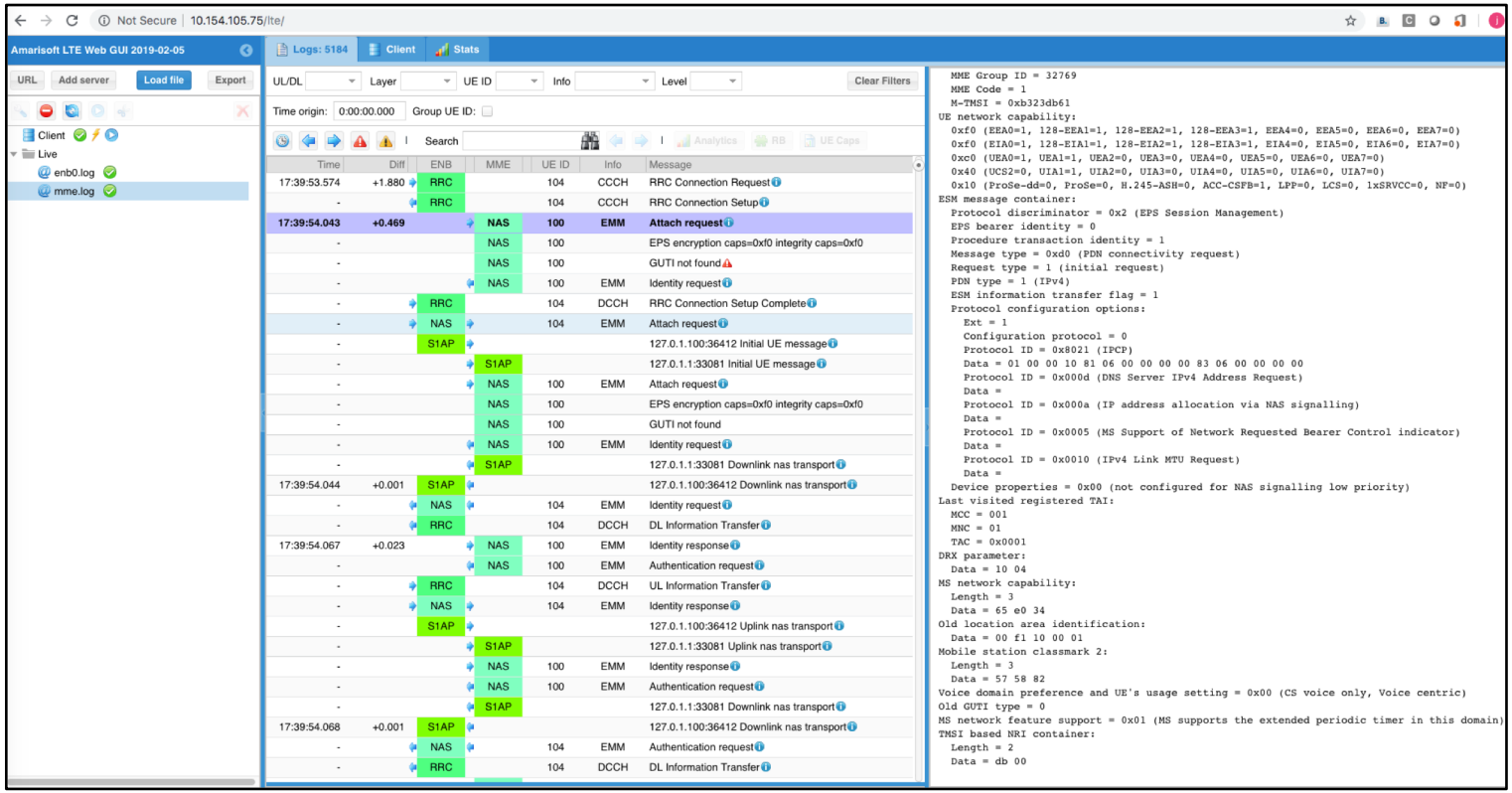
Mobile System Performance

Max speed 354 Mbps
Cat18 Mobile
3 x LTE CA
BW 55 Mhz

 © 2019 Internet Institute. All Rights Reserved.

internet INSTITUTE://

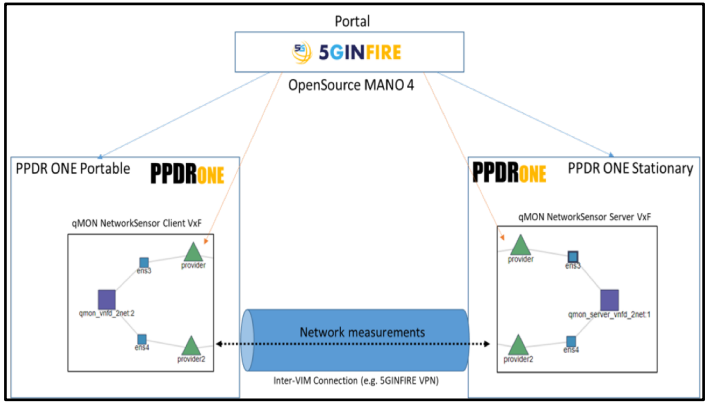
Mobile System Debugging

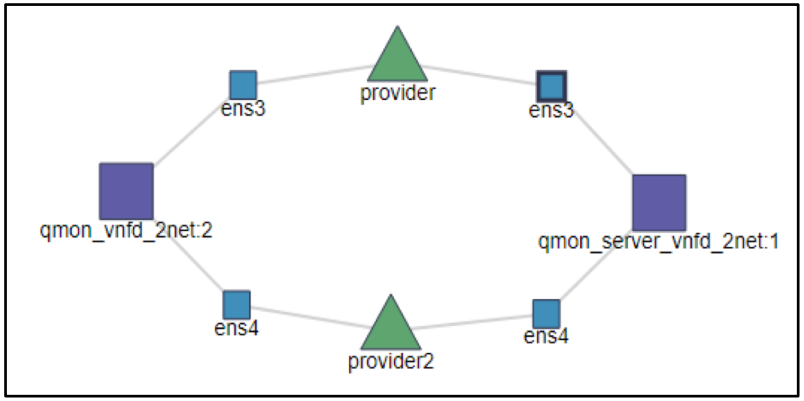


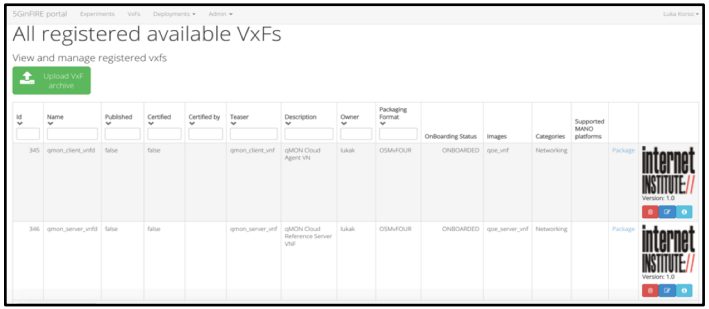
 © 2019 Internet Institute. All Rights Reserved.

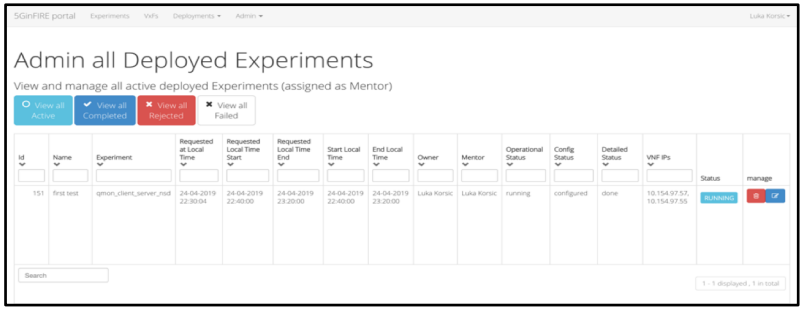
internet INSTITUTE://

qMON VNF deployment example









 © 2019 Internet Institute. All Rights Reserved.

internet
INSTITUTE://

Internet Institute Ltd.
Ljubljana Office
Tržaška cesta 25
SI-1000 Ljubljana
Slovenia (EU)

Headquarters
Črna vas 128
SI-1000 Ljubljana
Slovenia (EU)

info@iinstitute.eu

Thanks!

 © 2019 Internet Institute. All Rights Reserved.