Webinar on verticals onboarding, testing and monitoring in 5G-VINNI

5G-VINNI team, 12 March 2020, webinar
General instructions

• Please mute your microphone
• Q&A after the end of the presentation
• During the presentation send your questions via chat
• The session is being recorded
Agenda

• Introduction to 5G-VINNI facility and architecture
• NSaaS delivery model, 5G-VINNI Service Blueprint and Exposure Levels
• Onboarding
• Testing / Monitoring as a Service (TaaS/MaaS)
• Key Performance Indicators
INTRODUCTION TO 5G-VINNI FACILITY AND ARCHITECTURE

Pål Grønsund
Telenor ASA
5G-VINNI (5G Verticals INNovation Infrastructure)

• Build an open large scale 5G End-to-End facility that can
  – demonstrate that key 5G network KPIs can be met
  – be validated, accessed and used by vertical industries (e.g. ICT-19) to test use cases and validate 5G KPIs.


• Consortium: 23 partners (operators, vendors, academics, SMEs)

• External Stakeholder Board (vertical industries)
• 5G-VINNI Facility is ready for ICT-19 project experimentation.
• 5G-VINNI Facility will be available until 1st July 2022
The 5G-VINNI Architecture is common for all facility site implementations.
5G-VINNI E2E Architecture with Slicing support

E2E Service Operation & Management

5G-VINNI Customer

5G-RAN Orchestrator & Controller

TN Orchestrator & Controller

5G-Core Orchestrator & Controller

E2E Service Operation

Domain Service Operation

Network & Infrastructure

eMBB Slice-as-a-Service

mIoT Slice-as-a-Service

URLLC Slice-as-a-Service

Customised Slice-as-a-Service

RAN Domain(s) supported by 5G-VINNI Facility Site(s)

TN Domain(s) supported by 5G-VINNI Facility Site(s)

CN Domain(s) supported by 5G-VINNI Facility Site(s)

Cross Domain Network Management & Orchestration

5G-VINNI E2E Facility

[Deliverable 1.2]
Slice life cycle management and orchestration roadmap

[Deliverables 1.2 and 1.3]

12/03/2020

5G-VINNI onboarding verticals webinar
5G-VINNI Facility Sites – Technical Summary
(see https://www.5g-vinni.eu/facility-site/, [Deliverable 2.1], [Deliverable 3.2])

**Norway (Oslo, Kongsberg)**
- Slicing (eMMB, URLLC, mMTC)
- E2E Service Orchestration (Nokia)
- NFVI (OpenStack) and MANO (Nokia)
- Edge Cloud (Nokia)
- Five 5G gNBs (Ericsson, Huawei)
  - 3.5GHz, 80MHz BW
  - 26GHz, 800MHz BW
- 5G Core (Ericsson)
- 3GPP compliance
  - Rel’15 in 2019, Rel’16 in 2021
  - NSA in 2019, SA in 2020
- Satellite backhaul option (GEO)

**UK (Martlesham)**
- Slicing (eMMB, URLLC, mMTC)
- Service Orchestration (Nokia)
- NFV MANO, NFVI and vEMS (Samsung)
- 5G RAN incl.
  - 3.5 and 26GHz (Samsung)
- 5G Core (Samsung)
- 3GPP compliance
  - Rel’15 in 2019, Rel’16 in 2021
  - NSA in 2019, SA in 2020

**Spain (Leganes)**
- Slicing (eMMB, URLCC, mMTC)
- Service Orchestration (OSM NBI)
- MANO (OSM), NFVI (OpenStack), and SDN (ODL/ONOS)
- Support for micro-VNFs
- 5G RAN (Ericsson + SDR) 3.5 GHz, band C
- Model-based telemetry for monitoring and analytics
- Edge computing
- 5G Core (Ericsson + open-source)
- GEANT connectivity

**Greece (Patras)**
- Slicing (eMMB, URLLC, mMTC, via OSM)
- Service Orchestration (via OSM NBI services)
- NFV MANO (OSM) and NFVI (OpenStack)+DPDK
- 5G RAN open source radio (Lime, SRS)-700-800MHz, 3.5.-3.8GHz
- 5G Core (Open5GCore)
- NB-IoT, LTE-M (FhG NB-IOT core)
- mmWave backhaul (Intracom)
- GEANT connectivity

**Portugal (Aveiro)**
- NG-PON2-based 5G front/backhaul (Alticelabs)
- MANO (SONATA)
- NFVI (OpenStack)
- SDN (ODL)
- 5G Core (Open5GCore)
- Cloud RAN
- Edge Computing
- Slicing (eMBB, uURLLC, mMTC)

**Germany (Berlin)**
- 5G RAN prototype(s)
- 5G Core (Open5GCore)
- Edge cloud/e2e Orchestration (OpenBaton, OSM)
- mmWave backhaul
- Interconnection with remote islands in Betzdorf and Tokyo
- Large scale events, Nomadic networks, Disaster Relief

**Germany (Munich)**
- 5G NR SA RAN (Huawei) 3.5 GHz
- 5G Core (Huawei)
- MANO and NFVI (Huawei)
- SDN (Floodlight)
- V2I, V2P
- MEC, Edge Computing
- URLLC targeting Rel16/17
- Sensor fusion enabled by 5G

**Luxembourg (Satellite Connected Vehicle)**
- 5G Edge Node on-board satellite connected moving van
- GEO/MEO satellite backhauling
- 5G Core (Open5GCore)
- NFVI (OpenStack)
- MANO (OSM)
- Edge Computing
- Network Slicing (eMBB, mMTC)
- Interconnection w/ Berlin site
Services offered by 5G-VINNI to verticals (Main Facility Sites)

**Network Slice-as-a-Service (NSaaS)**
- eMBB network slice as a service
- mIoT network slice as a service
- uRLLC network slice as a service
- Customised network slice

**Value Added Services**
- Monitoring-as-a-Service
- Testing-as-a-Service
- Security-as-a-Service
- 3rd party VNF hosting
- Distributed data fabric
- Edge and Autonomous Edge
- Flexible backhaul for redundancy (e.g. Satellite)
- Interconnection with other 5G sites

[Deliverable 3.1]

12/03/2020
Jose Antonio Ordóñez Lucena
Telefónica Investigación y Desarrollo

NSAAS DELIVERY MODEL, 5G-VINNI SERVICE BLUEPRINT AND EXPOSURE LEVELS
Network Slice-as-a-Service (NSaaS) delivery model

- NSaaS is a future-proof service delivery model
  - Network Slice Instance (NSI) on demand, as a service
  - NSaaS provider and NSaaS customer roles

- Two complementary service views on an NSI:
  - **Resource-facing** (NSI deployment details) vs. **customer-facing** (NSI exposed capabilities)
  - **Abstraction** to preserve the required **demarcation point** between the provider and the customer
The NSI span across public and non public networks (NPN) → private networks
NSaaS – Two main phases

**Network Slice (aaS) Request**

The NSaaS customer issues a service order towards NSaaS provider, requesting the deployment of a tailored network slice.

**Network Slice (aaS) Operation**

The NSaaS customer monitors and takes (some) control over the network slice, deployed and made available by the NSaaS provider.

- **Slice Topology**: NSI is deployed and activated.
- **Slice Requirements**: Slice performance assurance and fault supervision.
- **Slice Management & Control**:
NSaaS Request - Ordering a VINNI-SB

VINNI-SB = 5G-VINNI Service Blueprint

Slice Service Type (SST)
- eMBB (SST=1)
- uRLLC (SST=2)
- mIoT (SST=3)
- Customised

Service Topology

Service attributes
- Performance attributes
- Functionality attributes
- Network optimization attributes

Service monitoring and testing
NSaaS Operation – Service Capability Exposure

• In vertical-oriented experimentation scenarios, different verticals may want to take a more or less proactive role in the operation of their slices
• 5G-VINNI offers to vertical different “capability exposure levels” → levels of control a vertical can take over the provided slice

<table>
<thead>
<tr>
<th>5G-VINNI is able to consume operations related to….</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>E2E network slice application layer config &amp; management</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Network slice subnet / network function application layer config &amp; management</td>
<td>×</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Network slice subnet / network function virtualized resource layer config &amp; management -&gt; ETSI NFV Network Service (and VNF) orchestration</td>
<td>×</td>
<td>×</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Infrastructure resource control &amp; management -&gt; NFVI with optional enhanced platform awareness capabilities and infrastructural SDN control.</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>✓</td>
</tr>
</tbody>
</table>
NSaaS Operation – Service Capability Exposure

- Depending on the selected “capability exposure level”, a vertical can consume more or less management services within 5G-VINNI admin domain
- Token-based authentication

[Diagram of NSaaS Provider Admin Domain and NSaaS Customer Admin Domain with various domains and functions including RAN Mgmt Domain, TN Mgmt Domain, CN Mgmt Domain, and virtualized management domains with associated resources and connectivity paths.]
Christos Tranoris,
Univ. of Patras

ONBOARDING
Network Slice as a Service (NSaaS) delivery model

5G-VINNI service portal

- Vertical Customer

5G-VINNI Service Catalogue

UK
- Service Order
- Site specific service portal
- Service orchestrator: FlowOne
- NFV-SOL 005
- NFVO (Samsung)
- Network Resources

Norway
- Service Order
- Site specific service portal
- Service orchestrator: FlowOne
- NFV-SOL 005
- NFVO (CBND)
- Network Resources

Greece/Spain
- Service Order
- Site specific service portal
- Service orchestrator: Openslice(OSOM)
- NFV-SOL 005
- NFVO (OSM)
- Network Resources

OpenAPI

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5G-VINNI-SB Template – Model diagram

Parameters for service requirements specifications

<table>
<thead>
<tr>
<th>Group</th>
<th>Parameter Name</th>
<th>Parameter ID</th>
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</thead>
<tbody>
<tr>
<td>Performance</td>
<td>Peak data rate</td>
<td>P.PERF_1</td>
</tr>
<tr>
<td></td>
<td>User data rate</td>
<td>P.PERF_2</td>
</tr>
<tr>
<td></td>
<td>Area traffic density</td>
<td>P.PERF_3</td>
</tr>
<tr>
<td></td>
<td>5G QoS</td>
<td>P.PERF_4</td>
</tr>
<tr>
<td></td>
<td>Reliability</td>
<td>P.PERF_5</td>
</tr>
<tr>
<td></td>
<td>Availability</td>
<td>P.PERF_6</td>
</tr>
<tr>
<td></td>
<td>Service deployment time</td>
<td>P.PERF_7</td>
</tr>
<tr>
<td>Functionality</td>
<td>Deployment option</td>
<td>P.FUNC_1</td>
</tr>
<tr>
<td></td>
<td>Access technology</td>
<td>P.FUNC_2</td>
</tr>
<tr>
<td></td>
<td>Predominant device type</td>
<td>P.FUNC_3</td>
</tr>
<tr>
<td></td>
<td>Radio spectrum</td>
<td>P.FUNC_4</td>
</tr>
<tr>
<td></td>
<td>Isolation</td>
<td>P.FUNC_5</td>
</tr>
<tr>
<td></td>
<td>Support for value-added functionality</td>
<td>P.FUNC_6</td>
</tr>
<tr>
<td></td>
<td>3rd party VNF hosting</td>
<td>P.FUNC_7</td>
</tr>
<tr>
<td></td>
<td>Positioning</td>
<td>P.FUNC_8</td>
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<tr>
<td>Network Optimisation</td>
<td>Number of devices</td>
<td>P.NO_1</td>
</tr>
<tr>
<td></td>
<td>Device density</td>
<td>P.NO_2</td>
</tr>
<tr>
<td></td>
<td>Coverage profile</td>
<td>P.NO_3</td>
</tr>
<tr>
<td></td>
<td>Mobility profile</td>
<td>P.NO_4</td>
</tr>
<tr>
<td></td>
<td>Service lifetime</td>
<td>P.NO_5</td>
</tr>
</tbody>
</table>

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The onboarding and testing process

Install parts of the use case if possible, execute even non-automated with manual parts

- This cycle might be repeated multiple times
- NFV orchestration is key part to repeatability of NF deployments/testing
- Self service onboarding/off boarding, deployment test and access - Access Level 1
- facility might offer to vertical a staging area (e.g. a private OSM to experiment) or NFVO itself – Access Level 2 and 3
- facility might offer to vertical VIM access – Access Level 4

Optional

- Network requirements
- Measurement points
- What can (must) be automated
- What can be parameterized

Prepare onboarding Plan

- VNFD/NSD development
- VNF/NSD testing
- Understand/automate measurement points

Study service specs to network requirements

VNF/NSD onboarding

Study service specs to MaaS & TaaS requirements

Iteratively develop Service and NFV orchestrators “choreography”

- Involve Monitoring asS
- Pre-validation KPI period via NFVO

- Pre-Validation KPI period via service orchestrator

Design the service blueprint NSaaS spec with its characteristics

Test case design

- Test scripts for TaaS

Test deployment/activation of SB

Launch service spec alpha/beta versions

Pre-Validation KPI period via service orchestrator

Service spec is launched

E2E service order fulfilled

Offer the Service Blueprint to the vertical community for repeatable deployments

- Service and NFV orchestration is key part to repeatability of NF deployments/testing

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Openslice is a prototype open source, operations support system. It supports VNF/NSD onboarding to OpenSourceMANO (OSM) and NSD deployment management. It also supports TMFORUM OpenAPIs regarding Service Catalog Management, Ordering, Resource, etc.

Demo
- Openslice demo: http://portal.openslice.io/
- Openslice Service Catalogues and ordering: http://portal.openslice.io/services/

Video demo
- https://youtu.be/KU8JPDFFI9A

Supported APIs
For a quick access check our swagger links:
- TMF APIs: http://portal.openslice.io/tmf-api/swagger-ui.html
Andrea F. Cattoni
Keysight Laboratories, Keysight Technologies

TESTING / MONITORING AS A SERVICE (TAAS/MAAS)
What can possibly go wrong?

5G is a complex system where multiple components need to interplay.

EVERYTHING!
Product Lifecycles and Testing Stages in Networks

Traditional HW-centric

R&D → Production → Deployment → Operation

Testing → Monitoring

5G SW-centric

R&D → Deployment → Operation

Onboarding

Testing → Monitoring
One Ring to Rule Them All...

Tool Types

- L4-L7 Traffic Generators
- App emulators
- Attack/breaching Emulators
- Conformance Tools
- 5G Traffic Generators
- Attack/breaching Emulators
- N/A
- L4-L7 Traffic Generators
- Attack/breaching Emulators
- L2-L3 Traffic Generators

Test Types

- Performance
- QoE
- Security
- Conformance
- Performance
- Security
- Performance

- Testing-as-a-Service (TaaS) is de-facto an implementation of the 5G TestOps
- TaaS is a way to unify the testing functionalities for 5G
- It provides a one-stop-shop for testing service for both CI/CD applications and users
- Test Automation is the keystone of TaaS

*from 5G PPP Test, Measurement, and KPIs Validation WG White Paper
Example of TaaS Consumption

1. Tests are requested
2. Test scripts (TC) present in the TaaS repository are loaded and executed on OpenTAP
3. OpenTAP deploys tools e.g. in an OpenStack cloud
4. OpenTAP configures the tools to target the newly deployed service
TaaS Onboarding Process

Training
- Training webinars will be offered
- Coverage:
  - How to design experiments
  - How to design TCs
  - How to use TaaS tools

Design of Test Cases (TCs)
- Identify KPIs of interest
- Identify KPIs stress/ testing conditions

Development of plugins
- Develop OTAP plugins for the vertical applications
- Expose KPIs from inside vertical applications for harvesting

Development of Test scripts
- Create OTAP scripts
- Create visualization dashboards
Monitoring as a Service (MaaS)

- MaaS is targeted at having a constant overview of the health and performance of the system.
- It consists of two main categories of services: **Network Monitoring** and **Telemetry**
  a) **Network Monitoring** (or visibility) is the traditional overview of the traffic flowing across the network, in particular emphasizing the visibility in specific critical points in the network.
  b) **Telemetry** is focused on providing the health and performance of the individual Network Service or VNFs/application components.
- The two categories are very different despite being offered under the same umbrella of MaaS.
Network Monitoring/Visibility

- Virtual network taps can be deployed in specific points of the network, as described by the NSD.
- The network taps are capable of sniffing (north-south and east-west) traffic, simple filtering, and re-routing the traffic to a specific destination.
- Destination can be an analysis tool (not provided by 5G-VINNI) or a packet broker.
- The packet broker is capable of more advanced filtering, aggregation, and re-routing options to either an analysis tool (not provided by 5G-VINNI) or a traffic recording server.
Telemetry

- The typical example is a VNF that exposes metrics.
- Metrics can be either actively pushed, or passively collected, in order to be stored in a database, as e.g. a Prometheus time series one.
- This is common practice in modern virtualized solutions, and the 5G network is no exception.
- Telemetry can be effectively used for:
  - exposing health metrics
  - exposing performance metrics (e.g. network buffers status)
  - exposing directly measured KPIs
Andrea F. Cattoni
Keysight Laboratories, Keysight Technologies

KEY PERFORMANCE INDICATORS
# Initial KPIs validation results

<table>
<thead>
<tr>
<th>Category</th>
<th>KPIs</th>
<th>Achieved Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>E2E Network Performance</strong></td>
<td>UL Maximum Throughput (Mbit/s)</td>
<td>104.27 Mbit/s</td>
<td>mmWave, 27.3-27.5 GHz, 4T4R, 1 stream</td>
</tr>
<tr>
<td></td>
<td>DL Maximum Throughput (Mbit/s)</td>
<td>883.69 Mbit/s</td>
<td>mmWave, 27.3-27.5 GHz, 4T4R, 40 streams.</td>
</tr>
<tr>
<td></td>
<td>UL Latency (ms)</td>
<td>13.77 ms</td>
<td>3.6GHz, low foot-print traffic profile with 100Kbit/s bandwidth.</td>
</tr>
<tr>
<td></td>
<td>DL Latency (ms)</td>
<td>9.15 ms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>UL Jitter (ms)</td>
<td>1.01 ms</td>
<td>mmWave, 27.3-27.5 GHz, 4T4R, low foot-print traffic profile with 100Kbit/s bandwidth.</td>
</tr>
<tr>
<td></td>
<td>DL Jitter (ms)</td>
<td>0 ms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>UL Frame Loss (%)</td>
<td>0.01%</td>
<td>3.6GHz, low foot-print traffic profile with 100Kbit/s bandwidth.</td>
</tr>
<tr>
<td></td>
<td>DL Frame Loss (%)</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td><strong>NFVI Network Performance</strong></td>
<td>Maximum Throughput (0 Frame Loss)</td>
<td>4.573 Gbit/s</td>
<td>two compute nodes, DPDK was configured in the test environment.</td>
</tr>
<tr>
<td></td>
<td>Latency between VMs</td>
<td>0.067 ms</td>
<td></td>
</tr>
<tr>
<td><strong>NFVI Compute Resource</strong></td>
<td>CPU Benchmarking Score</td>
<td>3,510</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Memory Read Latency</td>
<td>7.97 ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Memory r/w Bandwidth</td>
<td>25.641 GB/s</td>
<td>Yardstick CPU/Memory/Storage tests.</td>
</tr>
<tr>
<td></td>
<td>Storage r/w IOPS</td>
<td>5.65 k / 4.21 k</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Storage r/w Latency</td>
<td>188 / 621 ms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Storage r/w Bandwidth</td>
<td>1,018 / 425 MB/s</td>
<td></td>
</tr>
</tbody>
</table>
5G-VINNI project and facility sites contacts

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