Test as a Service: Main Concepts

5G-VINNI Training Session

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Agenda

- The vocabulary building: Testing, Monitoring, Telemetry
- Test as a Service: principles and vision
- Working Concepts: Test Cases, Test Campaign, Experiment
- Monitoring as a Service: principles and vision
- Conclusions

Main Concepts

VOCABULARY BUILDING

Testing

- **(Network, Slice, Infrastructure, NFVI, VNF) Testing**: taking measures to check the quality, performance, reliability, or conformance of (Network, Slice, Infrastructure, NFVI, VNF) especially before putting it into production.

Monitoring

- **(Network, Slice, NFVI, Interface) Monitoring:** observing and checking the progress or quality of the infrastructure supporting and the traffic flowing through the (Network, Slice, NFVI, Interface) over a period of time. Maintaining regular surveillance over the infrastructure supporting and the traffic flowing through the (Network, Slice, NFVI, Interface).

Telemetry

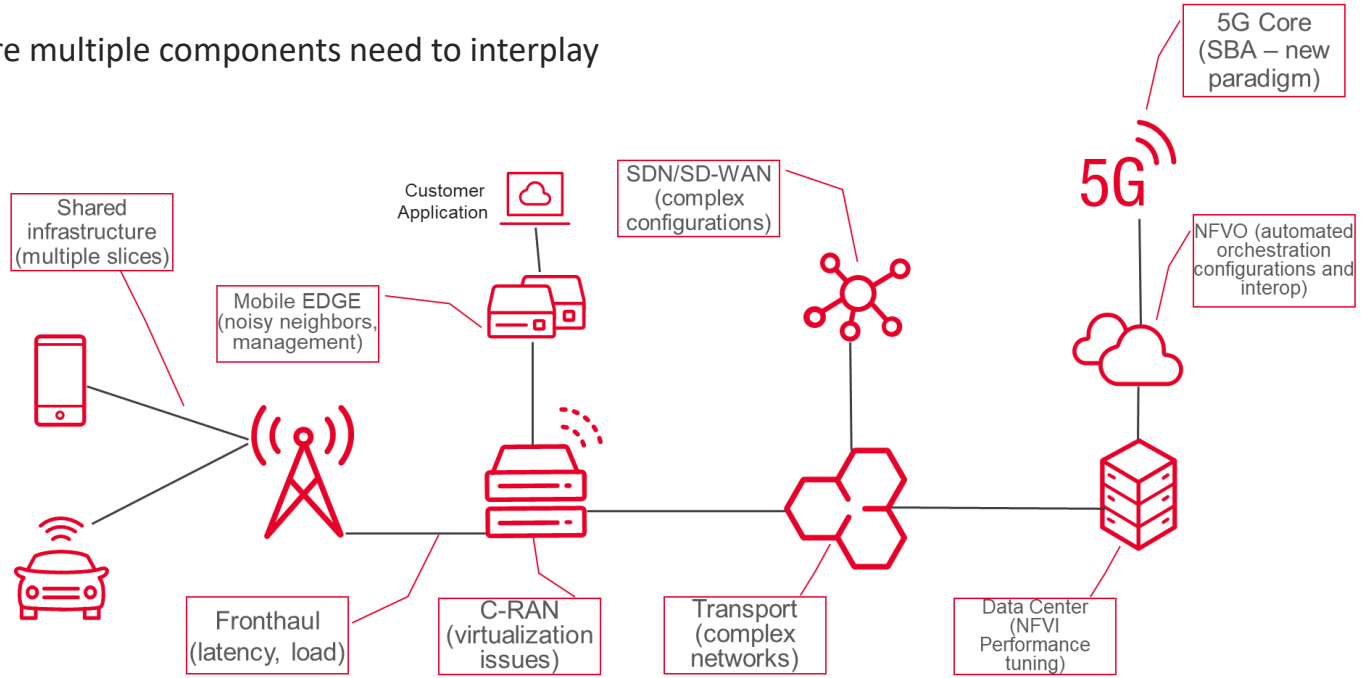
- **(Network, Slice, Infrastructure, NFVI, VNF) Telemetry**: recording measurements or statistical data about the elements or components of the (Network, Slice, Infrastructure, NFVI, VNF) and collecting them into a remote or centralized location or database.

TaaS Principles and Vision

TEST AS A SERVICE

What can possibly go wrong?

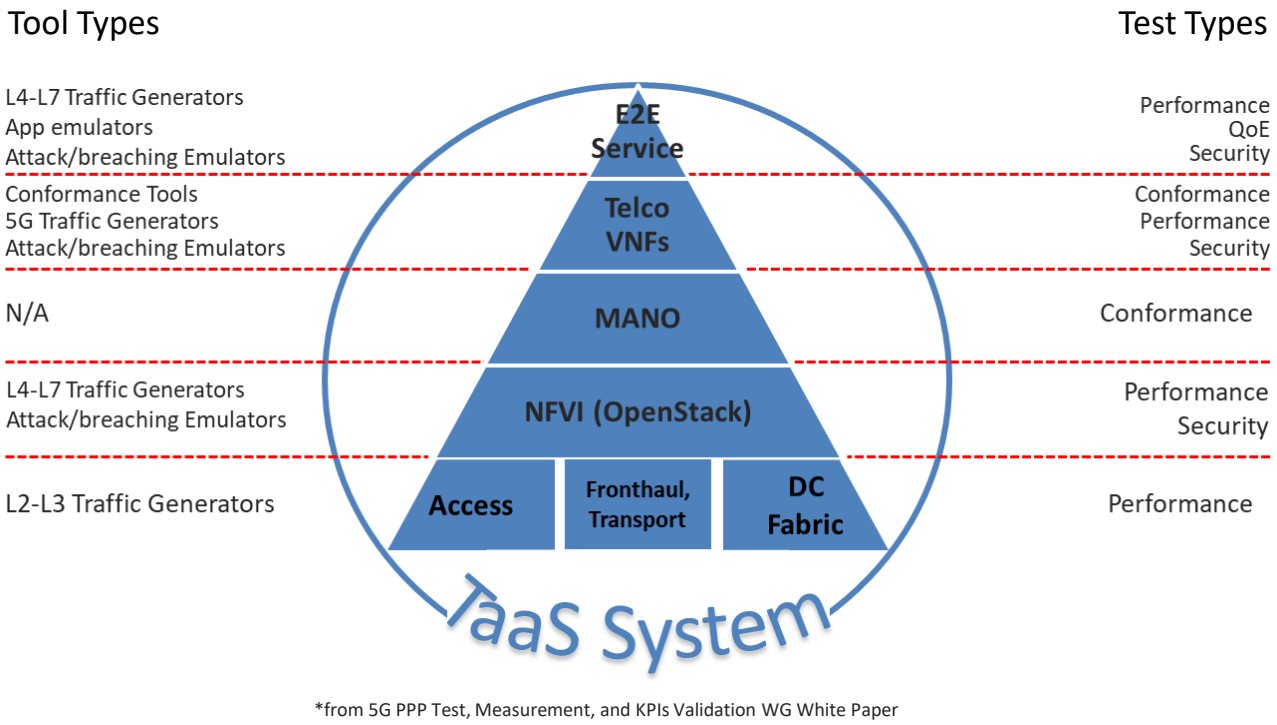
5G is a complex system where multiple components need to interplay



*R.I.P.

5G-VINNI

One Ring to Rule Them All…

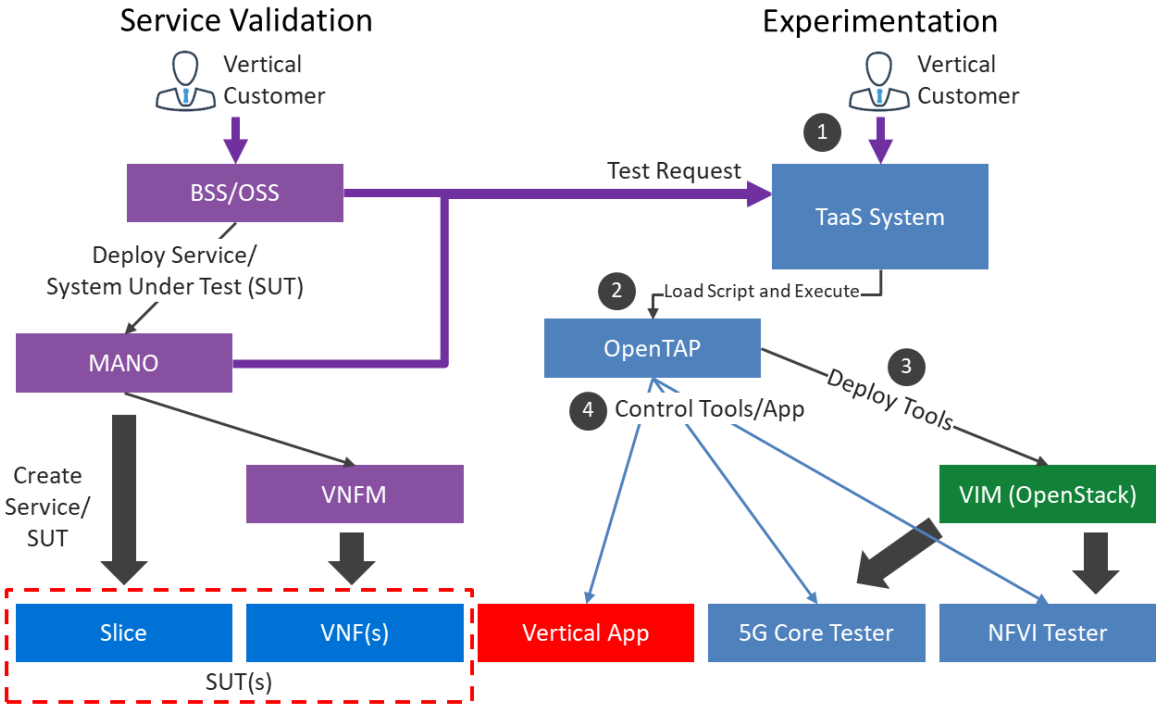


*from 5G PPP Test, Measurement, and KPIs Validation WG White Paper

- TaaS is de-facto an implementation of the 5G TestOps.
- Test-as-aService (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 obviously the keystone of TaaS.

Example of TaaS Consumption

1. Tests are requested
2. Test scripts 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



Working Principles

TEST CASES, TEST CAMPAIGN, EXPERIMENTS

> **Testing has a known list of stimuli and observation points which can be used to determine if a system is working correctly**

> **In contrast, experimentation is the search for the right stimuli and observation points that are useful for a reasonable assesment of the system**

Experimentally driven research white paper

ICT FIREWORKS

Starting point: what we measure

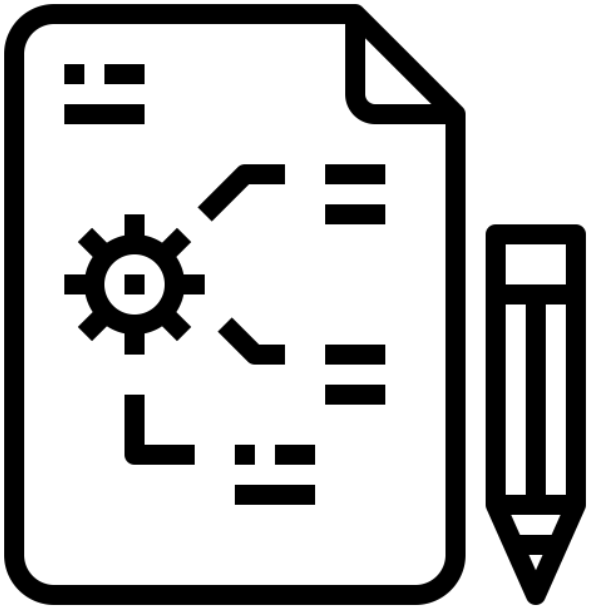
- Different KPIs serve different purposes:
  - Testing vs Monitoring
  - SLA test vs Technology validation
- Sets of KPIs shall be tied to specific use cases (as well their SLA values)
- The first step is to identify which specific KPI we are interested in measuring and computing.

	KPI name	KPI measurement points	5G-PPP KPI Validated
SLA	Minimum Expected Upstream Throughput	UE transmitting IP packets to the N6 interface.	P1
SLA	Minimum Expected Downstream Throughput	UE receiving IP packets from the N6 interface	P1
SLA	Maximum Expected Latency	RTT of UE IP packets transmitted to the N6 interface.	P1, P4
SLA	Network Reliability	Transport packets are lost between the UE and the N6 interface	P4
Technology Validation	Quality of Experience	Measured at the UE side at application or application API level	P1, P4
Technology Validation	UL Peak Throughput	Single UE transmitting IP packets to the N6 interface.	P1
Technology Validation	DL Peak Throughput	Single UE receiving IP packets from the N6 interface	P1

P1: Providing 1000 times higher wireless area capacity and more varied service capabilities compared to 2010.
P4: Creating a secure, reliable and dependable Internet with a “zero perceived” downtime for services provision.

Test Case

- A **Test Case (TC)** is a specification of the inputs, execution conditions (test environments), testing procedure/methodology, and expected results that define a single test to be executed to verify a specific KPI (or set of KPIs).



Testing Phases and SUTs

Phases

- Integration
- Acceptance
- Regression

SUTs

- Unit
- Sub-system
- Service/system

- **Wrap around test**: testing tools are used to emulate/simulate other components of the system in order to isolate the SUT.
- **End-to-End test**: the entire infrastructure is a SUT.

Test Environments

- **Isolated Test Environment (ITE):** test environment with assured and separate resources, according to IETF RFC2544 and RFC6815. (“Sandbox”)
- **Semi-Isolated Test Environment (STE):** test environment with no or limited interaction with external environments, but with partially shared resources. (Test Slice, Slice Under Test)
- **Non-Isolated test Environment (NTE):** test environment that fully interacts with other environment, contains non-test traffic, fully shares resources with other test and non-test environments.

Test Types

- **Performance**: verifies the performance of the SUT. Mostly related to operational speed.
- **Capacity/Scale**: verifies the capability of the SUT to scale up/out and down/in.
- **Interoperability**: verifies the interworking capabilities between the SUT and other infrastructure and service components.
- **Functional**: verifies the compliancy of the SUT

Test Case - Example

- Test Phase: Any
- SUT: Service/System (vEPC)
- Test condition: E2E
- Test Environment: STE/NTE
- Test Type: Performance

1.1.1 **vEPC NSA Network Performance Measurement**

Purpose	Measure the end to end performance of vEPC mobile core which supports 5G radio network based on 3GPP Rel15 NSA system architecture.
Description	These test procedures verify the performance of the NSA mobile core. The traffic generators will emulate the radio access network along with the UE traffic and external data networks (i.e. Internet, IoTGW, MCSGW).
Initial Conditions	The following initial conditions are applied for this section: 1. Setup TG to run RFC 2544 / ITU-T Y.1564 test to measure the network performance. 1. Configure the emulated EN-DC UEs based on Table 52 2. Configure 3 emulated PDNs (eMBB, URLL, MTC) 3. Connect Traffic Generator to the physical DC switch, with two VLANs (VLAN_GTPc, VLAN_GTPu)
Parameters	Use the specific test case parameters described below.
	Table 54: Parameters for vEPC NSA network performance measurement Parameters derived from KPIs | Values
Procedures & Expected Results	The following table describes the Procedures & Expected Results in detail. For each test step, all packet sizes should be tested separately.

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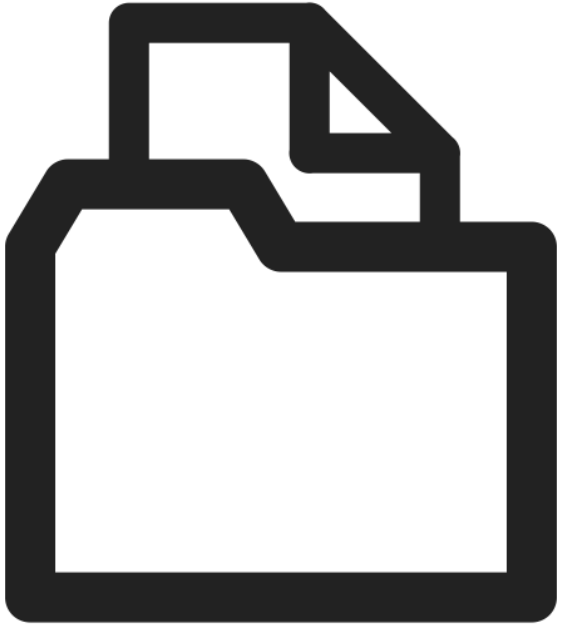
Table 55: Procedures & Expected Results for vEPC NSA network performance measurement

Steps	Procedures	Expected Results
1.	Verify TG IP connectivity from UE emulator to the emulated Data Network.	TG has IP connectivity from UE emulator to the emulated Data Network.
2.	Measure the latency to register a single user	Emulated one UE registered successfully which matches the attachment latency requirements in section 9.4
3.	Run RFC 2544 / ITU-T Y.1564 test on TG to measure the upstream traffic latency	matches the upstream traffic latency requirement stated in section 9.4
4.	Run RFC 2544 / ITU-T Y.1564 test on TG to measure the downstream traffic latency	matches the downstream traffic latency requirement stated in section 9.4
5.	Run RFC 2544 / ITU-T Y.1564 test on TG to measure the upstream traffic throughput	matches the upstream traffic throughput requirement stated in section 9.4
6.	Run RFC 2544 / ITU-T Y.1564 test on TG to measure the downstream traffic throughput	matches the downstream traffic throughput requirement stated in section 9.4
7.	Run RFC 2544 / ITU-T Y.1564 test on TG to measure the upstream traffic jitter	matches the upstream traffic jitter requirement stated in section 9.4
8.	Run RFC 2544 / ITU-T Y.1564 test on TG to measure the downstream traffic jitter	matches the downstream traffic jitter requirement stated in section 9.4
9.	Run RFC 2544 / ITU-T Y.1564 test on TG to measure the upstream traffic packet loss	matches the upstream traffic jitter requirement stated in section 9.4
10.	Run RFC 2544 / ITU-T Y.1564 test on TG to measure the downstream traffic packet loss	matches the downstream traffic jitter requirement stated in section 9.4
11.	Repeat step 3-6 for 3 times, collect the results	
12.	Collect all logs and result files, upload to the log server	All logs archived in log server.

Measurements	Calculate the results for each KPI according to the computation procedure defined in section 9.3.
Postambles	Execute the postamble procedure defined in section 9.5.

Test Campaign

- A **Test Campaign** is a bundle of Test Cases.
- I maintains the structured nature of the TCs.
- It might contain a high level definition of the test environments and test setup.

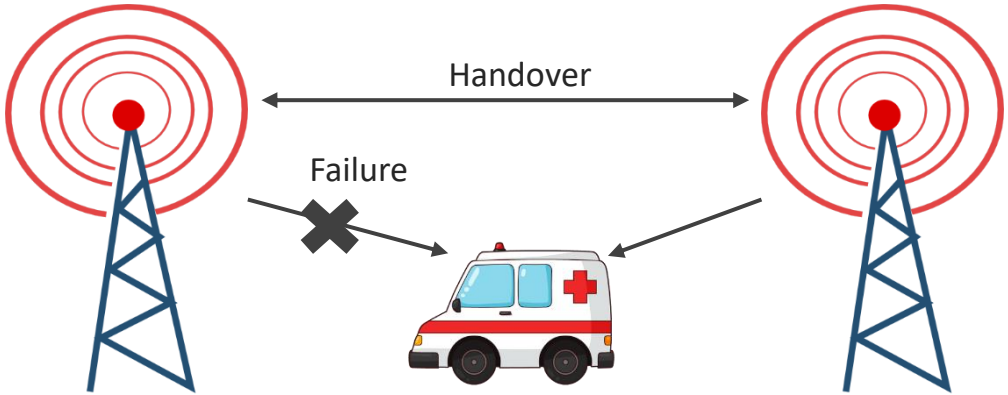


Experiment

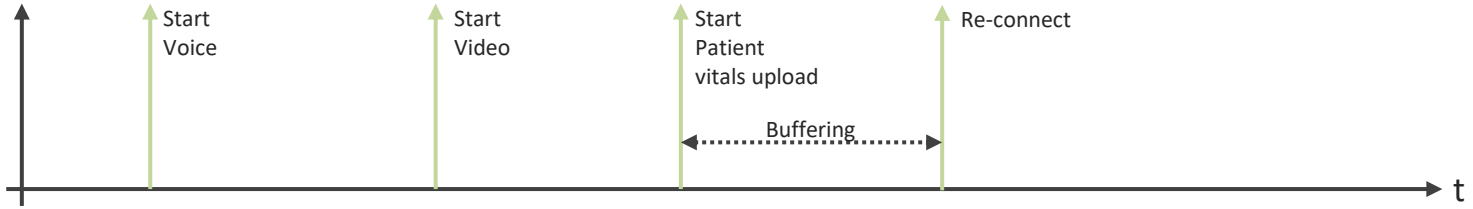
- Experiments provide insight into cause-and-effect by **demonstrating what outcome occurs when a particular factor is manipulated**.
- Experiments vary greatly in goal and scale, but **always rely on repeatable procedure** and logical analysis of the results.
- While TCs define very rigid procedures, with specific stress inputs, experiments are more loose in methodology and scope.
- An experiment can though be defined through one or more TCs (considering the TC only a formalization scheme)

PPDR Example - Ambulance

- An Ambulance is driving at high speed on the road during an emergency with a patient on board.
- The Ambulance is in voice contact first and then in video contact with the hospital.
- The Ambulance starts then transmitting the vital signs of the patient to the hospital.
- During the running the Ambulance crosses a cell border and performs an Handover.
- The Handover fails, there is a reconnection to the source cell, and then a new HO to another cell.



Service:
Ambulance



Let’s describe the experiment as a Test Case

- Test Phase: Any
- SUT: Service/System (PPDR App)
- Test condition: E2E
- Test Environment: STE/NTE
- Test Type: Functional/ Performance

Formalization

Purpose	Verify the behavior of the PPDR App in case of temporary loss of connectivity due to handover
Description	This procedure will verify the behavior and resiliency of the PPDR transmitting App while the vehicle is moving across cells and suffer temporary loss of connectivity due to being handed over from one cell to the other.
Initial Conditions	The PPDR App server needs to be available and reachable, the mobile device connected in a location inside the cell with good connectivity (cell-center)
Parameters	Use the specific parameters in the table below
	• Video buffer size: 1MB, 2MB, 3MB • Audio buffer size: 64KB, 128KB • **Vehicle speed: 40Km/h, 60Km/h, 90Km/h**
Procedures & Expected Results	See next table

PPDR: Test Procedure

1. Verify the connectivity with the network and Application server
2. Start Audio, Video, and patient vitals Applications
3. Start driving from PointA to PointB through route XYZ at the speed defined in the parameters
4. Start measuring frame rate, reconnection attempts, jitter,...
5. Repeat Step 3 in the opposite directions 5 times
6. Stop all applications
7. Repeat Steps 2 to 6 10 times
8. Collect all the logs, measurements and upload to server

NOTE: There are no ”Expected Results”. We are not setting specific expectations, we want to understand freely the behavior.

MaaS Principles and Components

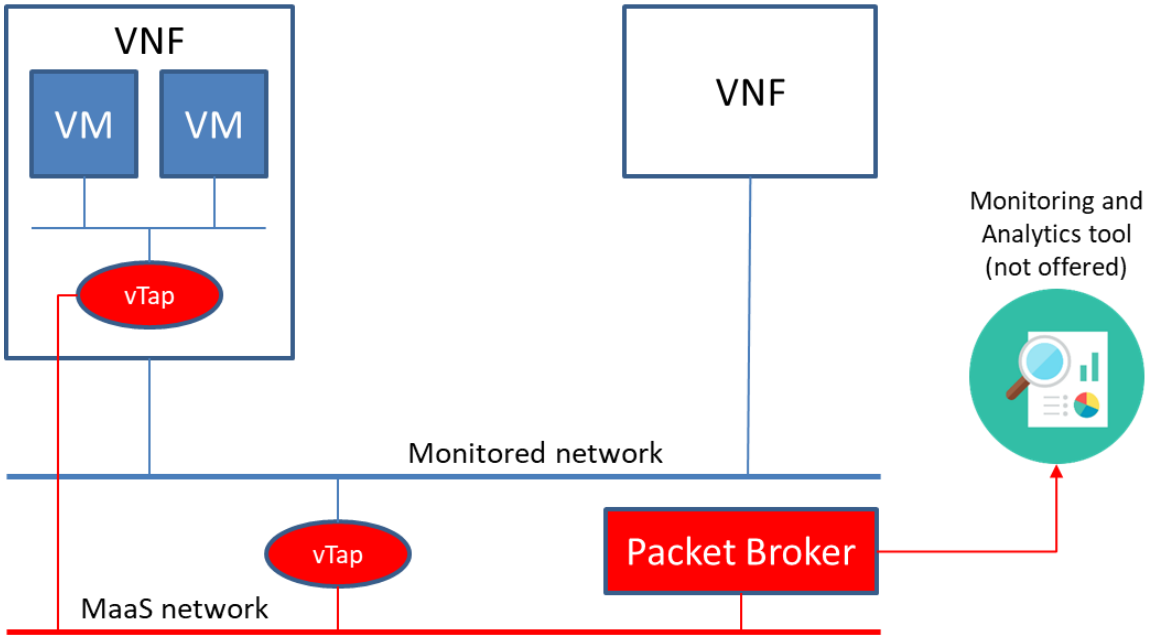
MONITORING AS A SERVICE

Monitoring as a Service

- 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.

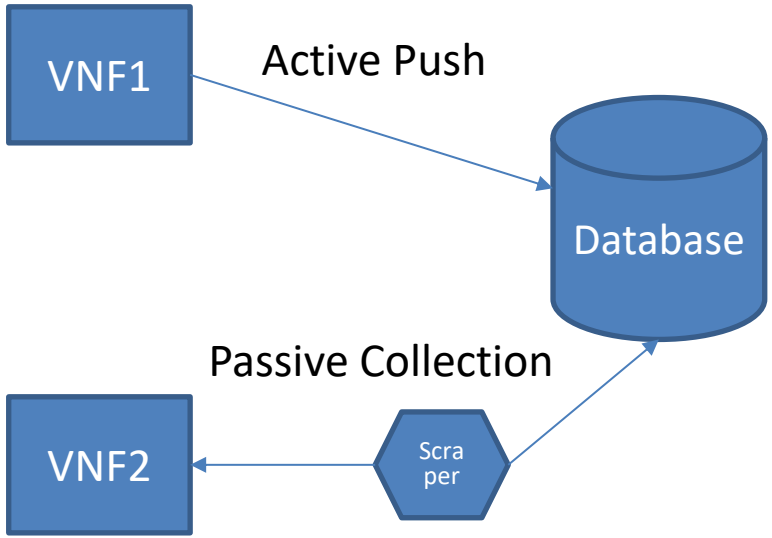
Network Monitoring/Visibility

- 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



Conclusion

- In this presentation we have reviewed:
  - A definition of the key terms for testing and experimentation
  - Motivation, definition, and examples of TaaS
  - Test Case, Test Campaign, Experiments definitions and examples
  - MaaS definition and envisoned architectures

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