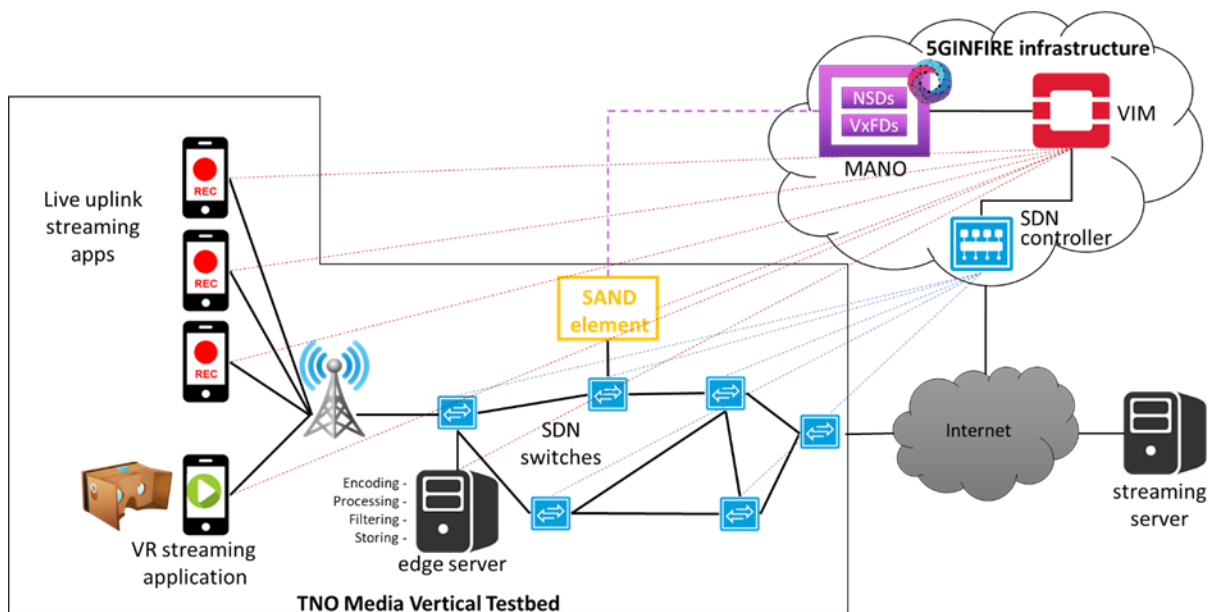# 5G Media Vertical Testbed

Testbed overview

The TNO 5G Media Vertical testbed extends the 5GINFIRE infrastructure with a new, state of the art, testbed facility targeted at the 5G Media Vertical industry. This facility will be complemented with several functionalities that will be needed to enable the execution of media use cases beyond the state of the art of what is possible today. Specifically, we look at two target areas: (i) 6-degrees-of-freedom (6DoF) VR streaming, where users can move in the virtual world, and (ii) professional video production (uplink streaming) for live TV. The first class of use cases require close-to-zero network latency, while the second class of use cases need stable and high quality upload links. To enable these classes of use cases, the TNO 5G Media Vertical testbed brings the following media-specific 5G/cloud functionalities:

1. Network assistance
   - Coordination between media application and network orchestrator
   - Based on and extending (where needed) 3GPP-SAND and TNO's innovative SAND-cloud communication protocol
2. Edge processing
   - Caching
   - Transcoding, tiling, filtering, conditioning to better fit the coded content representation to the application's need
3. 3rd party monitoring / managing APIs
   - Monitor metrics related to users' QoE
   - Request and configure a network slice with specific characteristics
   - Discover and recommend network assistance channel to media applications
4. Automated, reproduceable testing framework
   - Experiment lifecycle automation
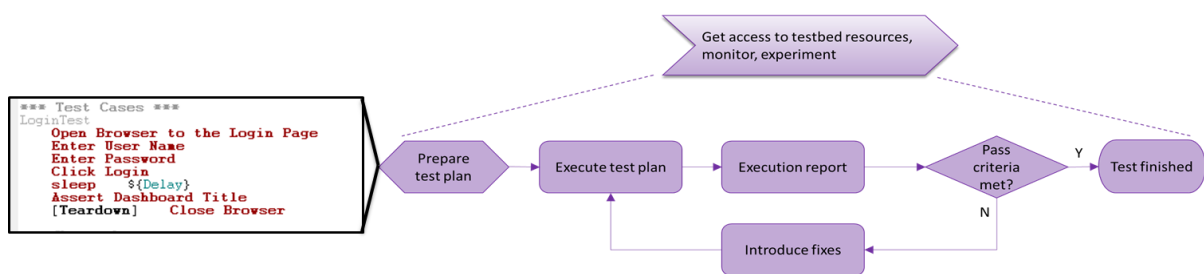   - Generic component, usable beyond the 5G media vertical testbed

Architecture

Figure 1 pictures the TNO 5G Media Vertical testbed in relation to the 5GINFIRE infrastructure.

Figure 1: TNO Media Vertical Testbed in the context of 5GINFIRE

Figure 2 shows the automated testing framework in the context of the 5GINFIRE experimentation workflow.

Figure 2: TNO automated testing framework within 5GINFIRE experimentation workflow

The testbed will provide several ETSI-compliant Virtual Functions (VxFs), such as: streaming servers, streaming applications for the two classes of media use cases, network assistance elements, measurement agents, network forwarding elements (SDN switches), dynamic service reconfiguration module.

Furthermore, TNO will provide hardware components, such as data plane acceleration modules, encoding/decoding modules, GPUs, to complement the software components in providing the necessary requirements, in terms of bandwidth and latency, to the target classes of future media applications.

Finally, the testbed will be equipped with 3rd party access APIs to enable experimenters to monitor and manage the applications running in their experiment, in a similar fashion as it is envisioned that 3rd parties will do when using slicing functionalities from 5G operators. The 3rd party APIs will enable overview and (partial) control over the orchestrated cloud environment of the testbed. We envision using reactive framework (JuJu/charms) exposed by the Orchestrator (OSM) to achieve this goal.

Infrastructure backend

TNO will use its research infrastructure for 5G Media Vertical developments and experimentation. Specifically, the TNO Research Cloud and the Hi-5 platform will be employed. A brief characteristics of these assets are the following:

- TNO Research Cloud

  - OpenStack (Queens)/Ceph private cloud infrastructure

  - OSM for orchestration

  - JuJu/MAAS for management

  - 12 physical servers (high availability design)

  - 2 top-of-the-rack switches

  - Programmable NICs (Netronome CX/LX)

  - 5 SDN switches (including NoviFlow with full hardware acceleration of OF1.5)

  - GPU Nvidia Tesla V100

  - Hardware traffic generator Spirent N4U

- Hi5 - 5G development platform

  - Open5GCore (Fraunhofer), orchestrated by OSM

  - Physical eNBs (Ericsson, Nokia, OpenAirInterface)

  - Indoor spectrum, own SIM cards

  - Geographically distributed

Experimentation

Experimenters will have access to the 5G Media Vertical Testbed via the 5GINFIRE portal. Experimenters will be able to:

- Reserve experimentation timeslot
- Instantiate network slice for experiment
- Create and deploy VxFs
- Request specific resources such as accelerators or UE (emulated or physical, if feasible)
- Monitor performance metrics of network slice (VxF execution, traffic, latency and connectivity status)
- Execute automated experiments
- Access experiment results

The aim of the testbed is to automate the whole experimentation lifecycle as much as possible, thus also reducing the need of manual intervention. In any case, human staff support will be made available upon request, according to the contract rules.

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