High quality media streaming over long-distance network using FELIX experimental facility

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***Abstract*—This demo paper presents the FELIX project [1] approach of implementation the *"High Quality Media Transmission over long-distance networks"* use case. A virtual slice built on demand over European and Japan infrastructure allows to perform the experiments and shows capabilities of the test-bed and its availability for high quality media streaming experiments over a long distance federated network. It is also the first time when the FELIX Control Framework is used for provisioning the SDN resources for the experiments. Two experiments for use case implementation and validation in the FELIX test-bed are proposed and described.**

***Keywords*—SDN application, QoE, H.264, media transmission**

I. Introduction

High Quality Media Transmission over long-distance networks is one of the use cases proposed by FELIX [1] and assesses the FELIX Control Framework [3] for provisioning SDN resources for experiments. The provision process involves dynamically creating a virtual slice over the federated infrastructure of European and Japanese test-beds. The slice allows to demonstrate the capabilities of the involved test-beds and judge the test-bed fitness for long-distance, high-quality media streaming. This is because the demands and requirements for streaming technologies make them highly sensitive testing engines to detect transmission problems. The technology developed for this use case to automatically adjust connection paths and parameters can be leveraged to detect network failures and problems. The multimedia streaming tool used in these experiments offers a number of quality measurement capabilities for evaluation purposes. In this use case, two studies were performed: i) examining long distance network capabilities and evaluating user experience (QoE), and ii) examining a new intelligent network application to control high quality media streaming.

II. Architecture

Figure 1 depicts some of the experiment configurations and the employed infrastructure:

- SDN resources – switches in five OpenFlow Islands (EU and Japan): AIST, KDDI, iMinds, i2cat and PSNC,
- UltraGridv3 software [2] for media streaming, decoding and visualizing (streamer at AIST and player at PSNC side)
- Monitoring system gathering information about media and network conditions: FPS (frames per second that the decoder is able to decode and visualize), movie frames losses, traffic volume on the receiving interface, round trip delay between UltraGrid streamer and player,
- Ryu SDN Controller for OpenFlow path configuration over the network,
- HQmon - SDN application for path reconfiguration based on the monitoring parameters,
- Software Rate-limiter module for capacity configuration over the links,
- Experiment GUI for setting up the experiment conditions and visualizing of its current state.

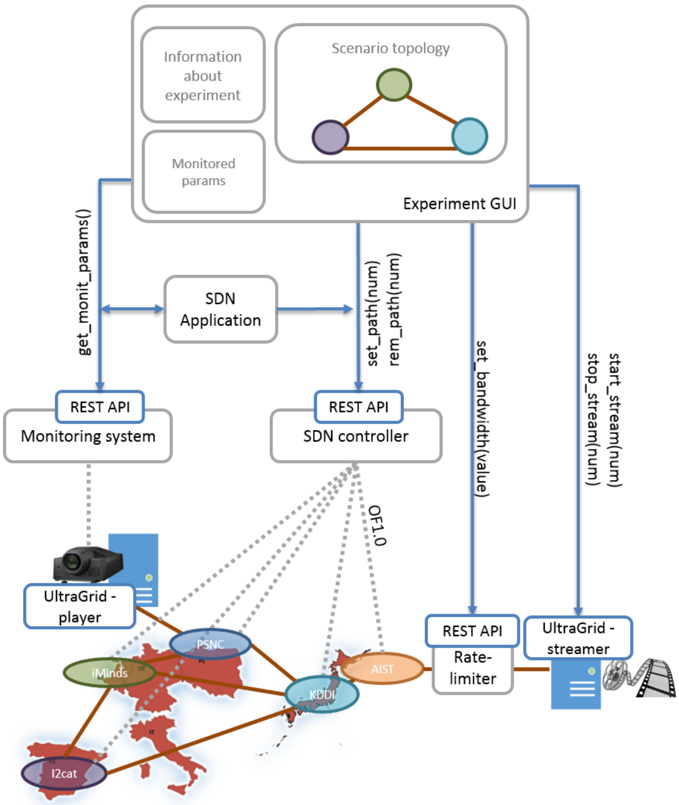

Figure 1. Experiments configuration

III. DEMONSTRATION

To perform the experiments the SDN slice is created as shown in Figure 2. The slice is composed of OpenFlow 1.0 switches (NEC IP8800, NEC PF5240, HP ProCurve 3500, Juniper MX80, OVSs) in five islands: AIST, KDDI, iMinds, i2cat and PSNC as well as two graphical workstations. The rate-limiter deployed in AIST enables setting the capacity over links from 20 to 80Mbps.

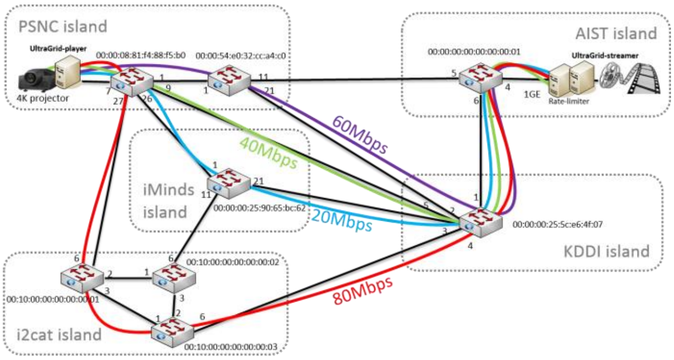

Figure 2. Network topology and configuration

Géant MD-VPN and NSI services are used to interconnect distributed SDN resources.

Four different media contents are streamed over the network during demonstration. Each of them is a Full HD movie composed of video channel encoded using H.264 codec at a rate of 20Mbps and audio channel which is transmitted at a speed of 112kbps. The graphical workstation in PSNC is equipped with two graphical cards, each of them with four output interfaces interconnected to 4k projector (to perform the experiment it is also possible to use 4 Full HD screens installed on the wall).

The experiment scenario is as follows: two physical machines (media source and consumer) are reserved on two different federated test-beds and UltraGrid streaming software is installed on both machines. Then network connectivity is dynamically established between the two machines. Instead of following a direct path, traffic is deliberately routed via a different OpenFlow island as shown in Figure 2 for evaluation purposes. Finally, using UltraGrid a high quality media transmission is started at one end and visualized at the other end.

During the first experiment we check the boundary condition of the network capacity needed for transmission of the high quality media (based on user QoE) and thus provide information about the minimum bandwidth required for media delivery with satisfying quality. In case of insufficient capacity of the link a user can observe series of artifacts and movie degradations as a result of lost movie frames. Due to the nature of H.264 coding affected regions are related to macroblocks. The experiment shows that for transmission of content encoded in H.264 at a rate of 20Mbps we need at least 28Mbps of the end-to-end pipe. It is because of the overhead of transmission protocols (Ethernet, IP, UDP), transmitted in parallel control as well as audio channels.

During the second experiment we examine behavior of the novel smart SDN network application that is able (based on the monitoring parameters) to rearrange the network. During the tests, the experimenter may monitor various performance metrics of the network connections, e.g., bandwidth, round trip time, correctly decoded video frame per second and lost video frames due to reordering, excessive delay, etc. thus observe possible stream degradation due to traffic congestion on the paths. The experiment provides information on the impact of various network parameters on the transmission quality. Moreover, in this experiment we demonstrate behavior of the network application for automatic network configuration and adjustments caused by the degradation of parameters. The experimenter can run up to four different contents, each encoded using the H.264 coder at a rate of 20Mbps. Four different routes can be provisioned at rates of 20, 40, 60 and 80Mbps, accordingly (Figure 2). The application constantly monitors parameters of the visualized media. If the values of FPSs decrease below 24 and frames losses are over 1% during the period of 10 seconds, HQmon automatically switches the path to the one with higher capacity according to the static routing table.

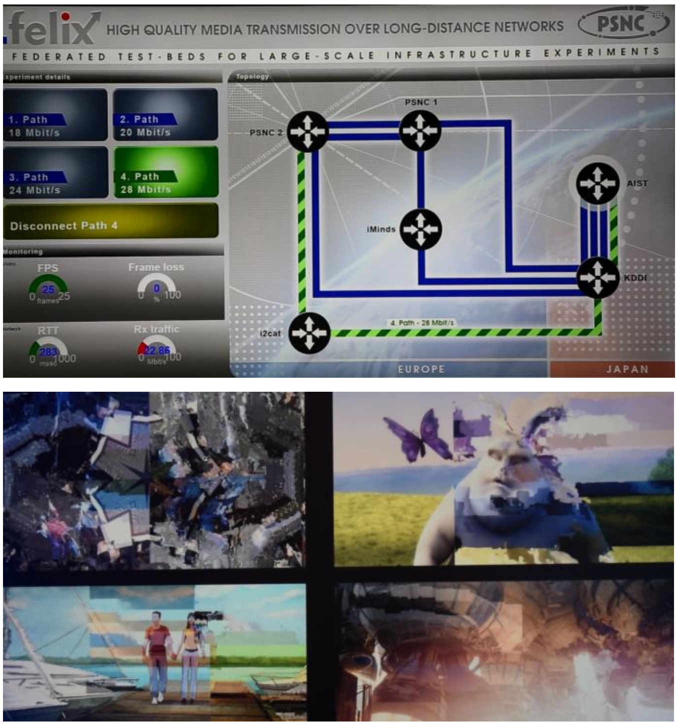

Figure 3. Control panel together with video wall

To perform both above-mentioned experiments access to the Internet network with bandwidth of 100Mbps is required at least. Then GRE tunnels may be used to interconnect UG-player to the SDN test-bed in PSNC and then to the FELIX infrastructure.

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REFERENCES

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