UNCOMPRESSED UHD VIDEO STREAMING OVER MULTIPLE VIRTUAL PATHS DYNAMICALLY CONFIGURED BY OPENFLOW/SDN SWITCHES

Tatsuya Fujii, Julio Ibarra, Matt Zekauskas and Iara Machado

NTT Network Innovation Labs, Florida International University
Internet2, Rede Nacional de Ensino e Pesquisa
Uncompressed UHD Video Streaming over Multiple Virtual Paths Dynamically Configured by OpenFlow/SDN switches

CONTENTS

- Dynamic SDN for Fat Streaming Application, NTT labs/Japan
- AL3S for Demo and Network Virtualization, Internet2
- Remarks about 4K Contents, RNP/Brazil
- AmLight, FIU
Introduction

• Research Goal
  – Provide virtual network for fat applications
    • Uncompressed 4K video needs at least 7 Gbps bandwidth. (30 frames per sec)
    • Still tough to transmit them without IP packet losses.

• Background
  – 100 Gbps ultra-high-speed IP networks have become familiar in NRENs.
  – Shared networks are suitable for temporal use of users, but fickle.
  – SDN technologies are being deployed in every networks.

• Problems
  – How to secure the bandwidth required for “fat” applications like >7Gbps streaming?
  – How to secure the condition of the data path continuously against congestions, malfunctions & maintenances?
Dynamic SDN

Solution for Fat Applications using broadband networks Anytime & Anywhere

• Build as “Overlay Network” on existing shared L3 and/or L2 networks with multiple paths

• Defined dynamically

• Provides QoS (ex. bandwidth) required by “Application”
Dynamic SDN for Fat Applications

Network Address Translation (NAT) based overlay SDN technology.

- **Multiple Path Streaming**
  - Carefully finding the preferred links from well-conditioned paths in shared IP networks.
  - Aggregate them and virtualized into single link for the 4K streaming.

- **SDN-NAT: Path Control by OpenFlow Switches on Nodes**
  - Routing control by changing the destination addresses of data-flows.
  - Free from tagging-based (VLAN/MPLS), capsuling-based (IP-SEC/PPTP) path control.
  - No IP packet loss in transition of routing reconfiguration.

- **Continuous Networks Monitoring**
  - Initial selection of links.
  - Detect the degradation of the link conditions to replace.
Lesson Learned in SC14

- Switch global path with SDN-NAT monitored traffic data
  - Trial in global, multi-domain multi domain connection of NRENs.
  - Alternative receive & display at SC14 venue.
  - Various video format of HD (~1.5Gbps)
Dynamic SDN Live Experiment at I2 Tech. Exch. 2015

- 7 Gbit/s uncompressed 4K videos transmitted to the booth from Japan and Brazil.
- 4K video divided into 4 HD streams traveling via 4 different locations in US.
- 4K live camera from Japan
- VoD server from Brazil
Base technologies of “Dynamic SDN”

SDN switch: Lagopus
- High speed **software** based OpenFlow switch
  - Replace destination IP address as you like
- High-utilization of Intel’s DPDK (> 10Gbps)
- High-compliance to OpenFlow specification

4K Video/IP gateway: QG-70
- 4 independent IP video streams 1.7 Gbps x 4 = 6.8 Gbps
- Low latency conversion by line by line operation.

Ultra high-speed PC-cluster video server: XMS
- Multiple IP video streaming Input/Output.
- > 50 Gbps.

High time-resolution network monitor: Presta
- Capture and display traffic **up to 100GbE!** with micro-second order time resolution in real time.
Network Configuration for I2 Tech Ex. Demo.

- User control of 4 Lagopus OF switches.
- Synchronization of 4 streams
  - Traveling in each link with different RTT.
  - Frame timing adj. using buffered data.
Terminal System Configuration at Demo Booth

- **7 Gbps streams** (1.7G x 4) coming from JPN / BRA via SEA & SAN & MIA & W.DC.
Summary (NTT part)

• Trial to provide virtual network for fat applications.
  – Ultra high definition video streaming, Huge amount data transfer between clouds.

• Dynamic SDN
  – Multipath streaming for bandwidth aggregation.
  – Path selection by SDN-NAT to use preferred/well-conditioned links.

• We confirmed,
  – Construct proposed “Dynamic SDN” over the combination of existing NRENs.
  – Switch global parallel path dynamically with multi-location OF-sw and NW monitoring.

• Future Work
  – Virtualization calculation resources in networks connected by Dynamic-SDN.
  – Continue evaluating Dynamic-SDN with various fat applications

• Please see our demo!!
  – Booth No. 228
Remarks about the 4K contents (3840x2160 pixels)

• 2 new pieces specially produced for Internet2 TechX demo

• Created in collaboration with Brazilian Universities by professors and students
  • UFPB – Visualization Lab
  • Mackenzie - Cinematic Arts

• Both contents will be freely available to the academic community
  • Planned: upload to CineGrid Exchange repositor

• Enjoy the “Avant-première”!
Openmouthed (*Boquiabertos*).

Duration: 2'55"
Frame rate: 24fps
Director: prof. Jane de Almeida (Mackenzie University – São Paulo)
Total filesize (TIFFs): 203.78 GB

Note: Originally recorded in 6K at 84fps. “Downgraded” for this demo.
Parahyba - wet and dry

Duration: 3'10"
Frame rate: 30fps
Director: prof. Valdecir Becker (Paraiba Federal University)
Total filesize (TIFFs): 189.21 GB
AmLight

4 x 10G links and two topologies:

- **SDN ring**: Miami-Sao Paulo-Chile-Miami
  - 20 Gbps of total capacity
  - Full Openflow and network virtualization support

- **MPLS ring**: Miami-Brazil-Miami
  - 20 Gbps of total capacity
  - Layer 2/3 support

Soon: new **100 Gbps** between Sao Paulo and Miami
- Part of the SDN domain
- Focused on experimentation

Total capacity in place for the next 2 year:
- **140 Gbps**

Consortium involving FIU(USA), RNP and ANSP(Brazil), RedClara(Latin America) and AURA(Chile)
Thanks for the partners