Sapporo Snow Festival 2019 - 8K Live Video Streaming

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Summary

• About NICT’s Network Testbed JGN
• 8K(UHD) Video Transmission Experiment in Sapporo Snow Festival
  • Brief explanation about 8K(UHD)
  • Security Penetration Test to Video Transmission System
  • Replacing 8K Uncompressed with DPDK (Man in the Middle)
  • Software Router “Kamuee”
  • 400G Interoperability Trial
Network Testbed JGN

- **JGN**: High-Speed Wide Area Testbed Network
- NICT has been enhancing R&D testbed
- “JGN” is an network infrastructure of ICT technology development.
- [http://www.jgn.nict.go.jp/english](http://www.jgn.nict.go.jp/english)
8K-UHD Video Transmission Experiment in Snow Festival 2019

- Video Transmission Experiment in Sapporo Snow Festival
  - Since Feb. 2003
  - Trying Different Technical Challenges
    - Ex.) International Multicast-Multipath
    - 25Gbps real-time video encryption
  - 49 organizations (companies / universities / institutions) including broadcasting companies, and over 150 people joined the project this year
What is 8K-UHD?

- **8K UHDTV (Ultra High Definition TeleVision):** 33 million pixels
  - 4K: 3840 x 2160 pixels (4 times as many pixels as HDTV)
  - 8K: 7680 x 4320 pixels (16 times as many pixels as HDTV)
  - Proposed by NHK Science and Technology Research Laboratories
  - Defined and approved by ITU-R and SMPTE
  - There are several formats in uncompressed 8K.
    - In this experiment: **8K-DG(Dual Green)** format.

<table>
<thead>
<tr>
<th>8K Format</th>
<th>Consumer</th>
<th>Sampling</th>
<th>Frame Rate</th>
<th>Gradation</th>
<th>Bit Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dual Green (8K-DG)</td>
<td>O</td>
<td>60Hz</td>
<td>10bit</td>
<td>24Gbps</td>
<td></td>
</tr>
<tr>
<td>Full-Specification 8K</td>
<td>4:4:4</td>
<td>120Hz</td>
<td>12bit</td>
<td>144Gbps</td>
<td></td>
</tr>
</tbody>
</table>
8K-UHD Dual Green format

- 8K-UHD Dual Green is two Green
  - Green elements are the high ratio for brightness, so big influence for human eyes
- Realizing video with resolution feeling like 8K while suppressing information

Dual Green(DG) Imaging method

![Diagram of Dual Green (DG) Imaging method]

- 8K-DG signal HD-SDI mapping
  - Pixels of DG
  - 4320 (R), 7680 (G1), 2160 (B)

NHK STRL R&D No. 148/2014.11
Basic Installation of
8K Uncompressed Video Transmission over IP

Sender

8K Video Camera

3G-SDI/12G-SDI

PFU QoolTornado
QG70
(4K * 4 = 8K)

Switch/Router

10G * 4

IP Transmitter
IP Transmitter

Receiver

8K Monitor

HDMI

Media Converter
*4

IP Transmitter
IP Transmitter

Switch/Router

10G * 4

IP Transmitter
IP Transmitter

PFU QoolTornado
QG70
(4K * 4 = 8K)

Bandwidth is 25Gbps/stream
(Uncompressed, Dual Green)

Network
8K Camera

- Astro Design/SHARP and Ikegami’s 8K UHD Camera (3 Models)
  - 3G-SDI * 8 / 12G-SDI*4
8K Uncompressed Video IP Converter

• Video transmission device (RTP over UDP/IP)
  • IP network (10Gbps) transmits uncompressed video up to 4K 30P
  • Multiple video streams can be transferred simultaneously

• Tandem operation provides up to 8K uncompressed video transmission
  • The QG70 allows the synchronization of multi-channel signals and multi-devices for transmitting 4K/8K images
  • Using four QG70, these operation can provide uncompressed 8K DG 60P system.

Other Video Transmission Equipment

- HD Video Enc./Decoder
- 4K + PTP (Precision Time Protocol) Experient
- 4K Compress Video (BlackMagicDesign)
- 4K Compress Video (For-A)
- 8K Compress Video (Miharu)
Traffic Graph (OBSERVIUM) at Osaka Venue (Uplink port)

Over 50G Total Traffic
Uncompressed 8K*2,
Compressed 8K, 4K, HD
Trials of 2019 Security Penetration Test

- Security Penetration to Video Transmission Network
  - Conducted by IPA*’s ICSCoE (Industrial Cyber Security Center of Excellence)
  - ICSCoE’s Core Human Resources Development Program trainee joined this experiment
  - Training facility in Akihabara, Tokyo

- Penetration testing to various types of professional video transmission (HD/4K/8K) / network equipment

* IPA: Information Technology Promotion Agency, Japan
Trials of 2019(cont’)
MITM: 8K Live Video

• Replacing 8K(UHD) Live Video Streaming with Man-in-the-Middle (MITM)
  • Conducted by Kanagawa Institute of Technology (KAIT)
  • OpenvSwitch with DPDK*
  • (KAIT team already succeeded 100G Network Monitoring with DPDK)

*DPDK: The Data Plane Development Kit

![Diagram of MITM: 8K Live Video Streaming]

Video A
(Original/Valid)

25.6Gbps

DPDK Switch
Input: 51.2Gbps
Output: 25.6Gbps

Video B
(Invalid)

Replace Video A’s Packet Payload to Video B

OpenvSwitch Server

25.6Gbps

Icons made by https://www.flaticon.com/
Replacing 8K with MITM
Trials of 2019(cont’)
High Speed Software Router: Kamuee

• PC-based high speed software router
  • With DPDK and Poptrie*
  • Participated in the Interop Tokyo Shownet as a Core-Router
  • Conducted by Kamuee Developer Team (NTT Communications co. Ltd)
  • Trial to construct mixed environment with JGN hardware Routers and Kamuee

Trials of 2019 (cont’)
400Gbps Interoperability Test

- 400Gbps Interoperability Test between Cisco Nexus and Juniper QFX Switches
  - 400G-FR4
  - Interfaces: QSFP-DD (with DAC cable)
- Contents: 8K Video (Replacing with DPDK, about 50Gbps (25Gbps*2))
400Gbps Interoperability Test

Cisco 400G Nexus SW (Pre-Release Model)

Juniper 400G QFX SW (QFX5220) (Pre-Release Model)

DAC Cable

400G-DD Interface
Daytime
Night
(Projection Mapping)
Wrap-up

- About NICT’s Network Testbed JGN
- 8K(UHD) Video Transmission Experiment in Sapporo Snow Festival
  - about 8K(UHD) / 8K camera/8K IP converter
  - Network topology
  - Trial: Security Penetration Test to Video Transmission System
  - Trial: Replacing 8K Uncompressed live movie with DPDK (Man in the Middle)
  - Trial: Software PC-based Router “Kamuee”
  - Trial: 400Gbps Interoperability Trial
Thank You!

Sapporo, Shooting Venue

IPA, Tokyo (Penetration Team)

Osaka, Demonstration Venue