Media Alert Title	Kanagawa Institute of Technology successfully edits and processes uncompressed 8K ultra-high-definition video (16x the resolution of HDTV) through cloud-based live streaming, and distributes it over network
Leading Text	The Kanagawa Institute of Technology (KAIT) participated in the annual verification test hosted by the National Institute of Information and Communications Technology (NICT) during the Sapporo Snow Festival. KAIT used the 100Gbps test bed network connecting Tokyo, Osaka, and Hokuriku, along with cloud-based technology, to successfully edit and process uncompressed 8K ultra-high-definition (UHD) live streaming video and distribute it over the network.
Article	The Kanagawa Institute of Technology (KAIT, President Kazumi Komiya), in collaboration with the National Institute of Information and Communications Technology (NICT), the National University Corporation of the Nara Institute of Science and Technology (NAIST), Nippon Telegraph and Telephone Corporation (NTT), NTT-IT Corporation (NTT-IT), PFU Limited (PFU), ASTRODESIGN Inc. (ASTRO), successfully edited and processed UHD live streaming video on the cloud and distributed it to multiple sites. This team also successfully created real-time video using motion capture technology. In the world's first such experiment, during the Sapporo Snow Festival Verification Test Event[1] hosted by NICT in February 2015, this team used JGN-X's 100-Gbps line and StarBED[3]'s[2] cloud computing equipment to transmit, store, edit, and process uncompressed 8K (7680×4320 pixels, 16x the resolution of HDTV) UHD video[3] as live-streaming big data on the cloud. The team then distributed multiple 8K UHD live-streaming videos to multiple hubs throughout the network while selectively switching the videos. Up to now, a dedicated system has been required to store, edit, process, and distribute uncompressed 8K UHD live-streaming video; however, this experiment proved that all these functions can be performed virtually and remotely using cloud nodes. As part of this experiment, the team also synthesized 4K UHD live-streaming video[3] with CG (computer graphics) in real time, using motion capture[4] data from multiple sites, and provided Hokkaido Television Broadcasting (HTB) with live video from the Sapporo Snow Festival. This test video was exhibited at the Knowledge Capital ("The Lab") inside the Grand Front Osaka on February 6, 2015. **Background and Overview of this Test** The 2020 Tokyo Olympic Games is driving R&D on applications using 4K and 8K UHD live-streaming video. The production of 8K streaming video requires a very high-capacity transmission bit rate of approximately 24Gbps. This means that a complete video editing and video effects system must be constructed at a local site. Since April 2013, KAIT has been working with the above team of companies to research and develop streaming cloud technologies to transmit, store, and distribute UHD live-streaming video using NICT's JGN-X[5] test bed. In last year's successful Sapporo Snow Festival experiment hosted by NICT, with additional bandwidth supporting 100-Gbps transmission, the test proved that uncompressed 8K UHD live-streaming video could be transmitted and stored using multiple existing 4K video transmission systems[6] and wide-bandwidth IP video servers[7]. In this environment, 8K cameras[8] and other advanced video equipment can be connected to the network, and remote cloud facilities can be coordinated seamlessly.

As the next phase, KAIT will develop a system by which the UHD video production environment can be used exclusively as a cloud service when such an environment is necessary. In this year's experiment, KAIT and the team achieved the first step by virtually constructing 8K video storage/distribution and video processing functions on the cloud. Using motion capture data from two locations, they also verified 4K video creation technology for real-time CG synthesis.

This experiment successfully demonstrated a 24Gbps function in which real-time storage and distribution of 8K UHD live-streaming video is enabled through synch-processing[9] of wide-bandwidth IP video servers using multiple cloud nodes. The team also successfully processed 8K UHD streaming video to create a preview video that could be viewed on a PC. In this experiment, a multicast[10] distribution function was implemented in multiple IP routers connected to the 100Gpbs lines to selectively receive multiple 8K UHD video streams (24Gbps) and achieve virtual video switching. This multicast distribution function was also used to distribute content generated from 8K UHD video to KAIT and NAIST at various rates.

Finally, to provide stable distribution of the video stream over networks, transmission status was monitored in real-time using both high-accuracy network measurement technology[11] and the 8K video traffic meter[12].

Next Steps:
Building on the success of this verification test, the team will establish a cloud-based video production workflow using UHD streaming video. The team will also continue its R&D to establish a new media production method in conjunction with multimedia studies.

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Notes
1. Sapporo Snow Festival Verification Test Event:
In the Sapporo Snow Festival Verification Test Event, NICT uses the JGN-X test bed to provide a field-testing and verification venue for next-generation network and broadcasting technologies. Various project teams use this venue to demonstrate their technologies.

2. StarBED^3 (StarBED Cubic)
With over 1300 test nodes, NICT's StarBED3 is the world's largest emulation test base. This cloud equipment is deployed in NICT's Hokuriku StarBED Technology Center.
http://starbed.nict.go.jp/index.html

3. 8K/4K ultra-high-definition streaming video:
8K ultra-high-definition streaming video has 33 million pixels, about 16x the resolution of the current full Hi-Vision system. Out of various proposed test methods, this test used the 8K dual-green method with a 60-P frame rate and 10-bit video stream (24 Gbps).
4K ultra-high-definition streaming video is the next-generation high-quality

	television standard, targeted for release in 2014. Of the various versions of this standard, this test used the 4K@60P video stream (12 Gbps), a video industry standard. **4. Motion Capture** Motion capture technology is used to digitally capture and record the movements of humans and inanimate objects. The digitally recorded data is used for various purposes, such as analysis of an athlete's physical movements, production of human images in animated films, and reproduction of human actions in games. Various capture technologies are available, including optical and magnetic methods. For this verification test, an optical method with multiple infrared cameras and reflection markers was used. **5. JGN-X:** JGN-X is a test bed environment that NICT has operated since April 2011to develop and realize next-generation network technologies. In April 2013, KAIT launched a project to verify streaming cloud functions using realtime-oriented network computing technologies. KAIT serves as the project leader in collaboration with NICT, NAIST, NTT-IT, PFU, and ASTRO to achieve text transmission, storage, and distribution of ultra-high-definition streaming video. KAIT uses a 10-Gbps connection with JGN-X to conduct various tests between its system and NAIST's system. **6. 4K video transmission system** Based on technology developed by the NTT Network Innovation Laboratories, PFU presents QoolTornado (QG70). A single QG70 system can send and receive four 15Gbps uncompressed high-definition (HD) video streams simultaneously. One QG70 system's internal synchronization processing is sufficient to send and receive uncompressed 4K video. Multiple systems can be synchronized to send and receive 8K UHD video. http://www.pfu.fujitsu.com/qooltornado/ **7. Wide-bandwidth IP video server** Based on technology developed by NTT Network Innovation Laboratories, NTT-IT offers the viaPlatz XMS server. This server alone can store and distribute 4K 60P (12Gbps) videos. The 2015 verification test used two viaPlatz XMS servers and four viaPlatz 4K media gateways (for input and output) to store and distributes 8K UHD video. http://www.viaplatz.com/ **8. 8K camera:** This test used video shot with ASTRO's single-plate compact 8K camera head unit, the AH-4800. The AH-4800 was connected to ASTRO's 8K Camera Control Unit (CCU), the AC-4802, to output streaming video using the 8K dual-green method. http://www.astrodesign.co.jp/japanese/product/ah-4800 **9. Synchronization:** This test used multi-lane transmission by bundling multiple 1.5-Gbp lanes of high-definition streaming video. Therefore, the video frame numbers and frequencies had to be synchronized to avoid video lags between lanes. **10. Multicast**

Multicast is a technique used for one-to-many communication over an IP network. Data from the source is duplicated at an intermediate node, then transmitted through channels selected on an as-needed basis, making it possible to transmit data efficiently using minimum bandwidth. For this test, PIM-SM (Protocol-Independent Multicast Sparse Mode) was used as the multicast routing protocol to switch multicast groups so that the data to be received could be selectively changed. This was the first experiment to verify IP multicast communication over wide bandwidth at a rate exceeding 10Gbps.

11. High-accuracy network measurement technology

PRESTA 10G is a high-accuracy network measurement system with capture/generator functions that can monitor networks at the nanosecond level. In the JGN-X environment, multiple PRESTA 10G systems are configured to allow versatile measurement over networks. NTT–IT brands this system as SHS-NM10G and this system is based on technology developed by NTT Network Innovation Laboratories. During this test, traffic was extracted from the 100-Gbps band and measured.

http://www.viaplatz.com/

Thanks to the team members' generous contribution of products, including Glean Corporation's *QP Series Platform*, Napatech Japan's *NT100E3-1-PTP, 100GbE Network Analysis Accelerator*, and Sumitomo Electric Industries's *CFP4 Optical Transceiver* for 100Gbps communication, a 100Gbps stream monitor prototype was configured for this verification test to directly measure the 100Gbps line.

12. 8K video traffic meter

The 8K video traffic meter is a new real-time network monitor. It monitors multiple 4K video transmitters simultaneously and displays the usage status as a visual representation of the actual transmission status. For the 2015 verification, this equipment was expanded so that traffic transmission up to 80Gbps could be monitored visually.

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Achieving the environment to edit 8K UHD video through wide-bandwidth network and cloud-based facilities

Edit, process, store, and distribute 8K UHD live streaming video

StarBED

Uncompressed 8K video

24G

24G

Hokuriku

100

JGN-X

Osaka, Umekita

Tokyo, Otemachi

Sharp
8K display

4K Gateway X 4
PFU QG70

24Gbps Uncompressed 8K UHD

4K Gateway X 4
PFU QG70

ASTRO
8K@60P
Camera

100

100Gbps

Umekita

Dojima

Otemachi

Multicast network

ASTRO
8K recorder

24Gbps Uncompressed 8K UHD

4K LCD x 4
8K Display made by KAIT

4K gateway X 4
PFU QG70

Redistribution

Single 8K UHD video source
→ Multi-usage distribution

Selective usage of 8K UHD live streaming video

Multicast distribution to each university

Institute of Science and Technology NAIST

KAIT

Real-time 4K video creation with motion capture technology

Using motion capture data from two locations, 4K real-time video of two mascot characters was created via CG synthesis and shown in the HTB booth at the Sapporo Snow Festival.