Immersive Live Experience Showcase
“Cyber Teleportation Tokyo at SXSW”

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He received a B.E., M.E., and Ph.D. in communication engineering from Osaka University, Japan in 1992, 1994, and 2005. He joined NTT (Nippon Telegraph and Telephone Corp.) in 1994 and - since then - has been engaged in researching video-on-demand systems and metadata-related interactive video systems and services, especially those related to IPTV and digital signage services. His current interests include standardization of digital signage and ILE (Immersive Live Experience).
Summary of Session

This session provides the report of the brand-new immersive live experience performance event at SXSW 2017 including the video demonstration.
Summary of "Cyber Teleportation Tokyo at SXSW"

Remote interactive live performance between Tokyo and Austin at SXSW 2017

- Utilizing NTT’s Immersive Telepresence Technology “Kirari!®” and high-speed communications networking technologies
  - Live video image real time extraction of the artists in Tokyo
  - Transportation in various media formats synchronously over the network
  - Dynamic projection on multiple double-sided transparent screens
- Using the network infrastructure: NTT's GEMnet2®, in cooperation with Internet2, and the University of Texas System and Greater Austin Area Telecommunication Network
- Providing immersive live experience as if they were seeing the live stage of DJ interplaying with the artists in Tokyo who were teleported to Austin beyond time and space
Introduction
Outline of NTT Group

- Consolidated operating earnings: 11,095.3 billion JPY
- Consolidated operating profit: 1,084.6 billion JPY
- Number of employees: 241,600 persons
- Number of consolidated subsidiaries: 917 companies

*Numbers are comparison of main subsidiaries with voting rights (as of March 2015)
Aiming to be a value partner that customers continue to choose, the NTT Group strives to create innovative ICT service to enhance social life by using its core technologies for fields such as advanced media processing, cloud computing, and security.
GEMnet2® connects three NTT R&D centers in metropolitan Tokyo area by optical fibers. Three R&D centers are equipped with ROADM and WDM, which constitute a trunk network with a capacity of several tens of gigabits per second.

- NTT Musashino R&D Center (Tokyo)
- NTT Atsugi R&D Center, Kanagawa
- NTT Yokosuka R&D Center, Kanagawa

JGN

GEMnet2 International link

Pacific Wave (Seattle)

Internet2
Features of GEMnet2®

- GEMnet2® (Global Enhanced Multifunctional Network 2) is owned and operated by NTT’s laboratories for their research and development.

- The network has connections with research and education (R&E) networks and other research organizations in Japan and other countries to enable the testing of ultra high-speed applications and other experiments.

- While GEMnet2® is mainly used for the internal R&D activities within NTT, it is also actively promoted for the experiments with other organizations.
History of the collaborations

1998  NTT’s first participation to Internet2 meeting
1999  NTT has become an Internet2 corporate member
2001  GEMnet Connected to Internet2 network in San Jose (then moved to Seattle)
2001  Remote monitoring of ASTE/ALMA radio telescope in Chile
2003  International e-VLBI observation between MIT Haystack and CRL Kashima
2006  Uncompressed HDTV tele-conference between Tampa and Tokyo at SC06
2007  Uncompressed HDTV transmission from Boston to Osaka for a live broadcast
2011  Global distributed video production trial using SDN at SC11
2012  Super Hi-Vision (8K) video transmission trial from London to Tokyo
2014  Super Hi-Vision (8K) video transmission trial from Rio de Janeiro to Tokyo
2016  Immersive Live Experience (video viewing) Trial of Kabuki performance
(traditional Japanese theatrical play) between Las Vegas and Tokyo
2017  Immersive Live Experience Showcase “Cyber Teleportation Tokyo at
SXSW”
Super Hi-Vision (8K) video transmission from London to seven cities in UK, US and Japan

In collaboration with Internet2, JANET, GÉANT and SINET4, NTT has created a high performance experimental network connecting UK, US and Japan for a global SHV (8K) video transmission. It was used for the public viewing of a big sporting event held in London in 2012.
Super Hi-Vision (8K) video transmission
from Brazil to Japan

NTT has created an extremely reliable experimental network with RNP, Internet2 and other partners using a highly redundant IP network configuration and efficient FEC technology between Brazil and Japan. It was used for the SHV (8K) public viewing of a big sports event in Brazil in 2014.
Immersive Live Experience
Immersion Live Experience (ILE)

• Viewing experience which provides users high-realistic sensation on public viewing site.
• Expecting that audiences anywhere in the world can cheer their favorite sport teams or artists at remote sites even if they are not in the event venue, and they can feel a sense of togetherness and get passionate as if they were in the event venue.
Kabuki Trial

Nippon Telegraph and Telephone Corporation (NTT) and Shochiku Co., Ltd (Shochiku) started joint experiments to create a new way of appreciating a kabuki performance. On May 7, 2016, NTT and Shochiku conducted the first experiment of the project, Ultra-high-presence video live viewing of KABUKI LION “SHI-SHI-O” Las Vegas Performance produced by Shochiku.
Network for Kabuki Trial

Total bandwidth 750 Mbps (13 video streams for 4K multi screens (up to 50 Mbps) and 100Mbps for HMD demonstration)
Keep the rates of packet losses below the level which the FEC function can correct.
Prepare for two network paths with physically different routes
Immersive Telepresence Kirari!®

• NTT has researched and developed Kirari!® as an immersive live experience service.
• Feeling as if they are experiencing the atmosphere of the sporting venue, wherever they are

Feeling “speed”, “height”, “strength”

Kirari!
Hope to make user’s eyes twinkle
Challenges for Kirari!

- Media acquisition part (what do we need to capture?)
- Media processing part (a part of making kirari! contents)
- Media delivery part (we use MMT but is not limited to use other)
- Media presentation part (how to use pseudo 3D image effectively?)

Super realistic media synchronization technique

Advanced MMT

Stadium

Remote venue

Size: 10m x 5m x 5m
Projector: 4K x 4
Speaker: 5.1ch
Light: 5
......

(i)\[ f(x, y, z) \]

(ii)

(iii)
NTT’s Technology for Kirari!®

NTT Developed:

1. **Real-time image extraction technology** for simple background and for a few target images
2. **Real-time distortion correction and stitching technology** for video captured by multiple 4K cameras
3. **Synchronized transmission technology** for spatial information (such as size of target image, positional relationship, and direction of sounds, etc), as well as audio/video
4. **High-realistic images and sounds field reconstruction technologies**
Cyber Teleportation Tokyo
JAPAN FACTORY

CYBER TELEPORTATION TOKYO
Feel the Synchronicity between Tokyo and Austin!

• TOKYO-AUSTIN: 6543mile via Shared NW (Bandwidth 1Gbps, Latency 75ms, Packet loss ~0)
• Movie: 5 x HD(H.264), Sounds: 3 x AAC 320kbps synchronized with MMT
• Real-Time Image Extraction, Transparent Screens
Want to see a music live here on the other side of the world?
Real-time Image Extraction

Extracted only objects in real time for any background
Developed a new object segmentation algorithm using multiple sensor data and color information of pictures
Real-Time Image Extraction Technology For Any Background

Robustness : Any background
Fineness : Details like individual hairs of 4K image
Real-time : 3-5 frame delay @ 60fps (~80ms)
Synchronized Transportation by Advanced MMT

Delivering synchronized spatial environmental information as well as picture/audio to remote venues over IP-network by Advanced MMT

Sharing excitement between Tokyo and Austin by synchronized transmission and reproduction of every information

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**Scheme**

- Record both video and audio simultaneously onto the film
- Synchronize the limited to be able to multiplex on the same device

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**Transmission of spatial information / Reproduction**

- Picture info. position, relationship
- Sound field info. coordinate, volume
- Objects info. coordinate, size
- Lighting info. direction and intensity of sunlight and reflected light

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*1 MMT (MPEG Multimedia Transport):
Media transport standard that established by international standards associations such as ISO / IEC JTC1 / SC 29 / WG 11 MPEG
Low Delay Media Synchronous Transmission Technology

Existing technologies

Movies : 5 x HD (H264)
Sounds : 3 x AAC 320kbps
Real-time : 550ms delay including NW latency

Advanced MMT
Reproducing Venue and Display
Network interconnection

Route

<table>
<thead>
<tr>
<th>Route</th>
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<tbody>
<tr>
<td>Studio in Tokyo – Commercial Ethernet - GEMnet2 - PW - Internet2 – LEARN - UT System - Wireless network by RightRound – Venue in Austin</td>
</tr>
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PW: Pacificwave
LEARN: Lonestar Education and Research Network
UT System: University of Texas System
Traffic measurement

Musashino
Spirent
TestCenter3U

to
9F-SW 0/4
1/1
1.21

tokyo
AQ1300 Loopback on SW21

Route1
VLAN1916 (3306)
Uni-direction Unicast
Loopback Unicast

Seattle
AQ1300 Loopback on Cat6504

Austin
AQ1300 Loopback on SW11

Austin Trinity Warehouse
Spirent TestCenterC1
to
SW11 9

1.7
.1.19 .1.14 .1.5

Musashino
Spirent
TestCenter4U

to
9F-SW 0/3
1.21

Route2
VLAN1910,1911 (3310,3311)
Loopback Unicast

Austin Convention Center
Catalyst2960

1/0/13

0

1

1/0/23

Hard Loopback By LAN cable
Traffic measurement towards the event

Observation for 100Mbps streaming
• A few burst traffic losses were observed.
  • The losses could be assumed to be happened in the wireless network, but not sure.
• The packet losses of 1 or 2 frames (0.12-0.24%) were observed several times.

Checking the feature of the packet losses in advance, we could control the network at the event time.
Cyber Teleportation Tokyo was selected in the shortlist of Innovation. The credits includes the Internet2 (Thanks for your great support!).

https://www.spikes.asia/winners/2017/innovation/entry.cfm?entryid=700&award=99&order=0&direction=1
Standardization Work
Standardization of ILE

- The standardization of ILE in ITU-T SG16 (Multimedia) was launched on May, 2016.
  - Implementing immersive live experience services based on standardized designs.
  - Activating a market for the ILE systems and services
  - Conducted by Q8/16 (Immersive Live Experience Service and System)

http://www.itu.int/en/ITU-T/studygroups/2017-2020/16/Pages/q8.aspx
Technologies for ILE

• Reconstructing event sites virtually with presentation of real-sized objects and sound direction by transmitting environmental information together with audio and video streams.

• Needed technologies;
  • High-definition video coding (e.g. H.265)
  • High-realistic audio coding (e.g. MPEG4-ALS)
  • Extended media transmission (e.g MMT)
  • Optical illusion
  • Reconstruction sound and light fields
  • Adaptive object extraction
  • Etc.
Framework for ILE

Source Sites
(Stadiums, Halls, etc)

- Cameras
- Microphones
- Sensors
- Special effect, etc

Capturing Environment

Immersive Live Experience Application

- Media Processing
- Asset (Media, Lighting, Sound) Processing
- CODEC

- Signaling Processing
  - Spatial Info Processing
  - Synchronous Info Processing

Synchronous Media Transport

- Transport layer

Viewing Sites
(Halls, Theaters, etc)

- Projectors and Displays
- Speakers
- Five senses presentation equipment

Presentation
Definition of ILE

Immersive Live Experience (ILE):

“the shared viewing experience which stimulates emotions within audiences at both the event site and remote sites, as if the ones at remote sites wandered into substantial event site and watched actual events in front of them, from high-realistic sensations brought by a combination of multimedia technologies such as sensorial information acquisition, media processing, media transport, media synchronization and media presentation.”
Contribution from the showcase

The draft Recommendation H.ILE-SS “Service Scenario of ILE” includes the showcase as an example of ILE.

(8) Use case- Interaction with images (NTT)

On March 13, 2017, Music Live Showcase “CYBER TELEPORTATION TOKYO at SXSW” was presented a remote interactive live performance between Tokyo and Austin.


The live video images of the artists in Tokyo are extracted in real time and transported in various media formats synchronously over the network, then dynamically projected on multiple double-sided transparent screens which are spatially set up in the Austin live space (see Fig. 2) by utilizing NTT’s Kirari! technologies. The latency is about 400ms, so the interaction could be sufficient.

The network infrastructure used for this showcase was established using NTT’s network testbed GEMnet2, in cooperation with Internet2 (a consortium of US universities providing an advanced networking environment), LEARN (Lonestar Education and Research Network) and the University of Texas System and Greater Austin Area Telecommunication Network.

These technologies will provide the audience in Austin a new immersive experience as if they are seeing the live stage of DJ interplaying with the artists in Tokyo who are teleported to Austin beyond time and space.
Conclusion
Conclusion

Immersive Live Experience Showcase
“Cyber Teleportation Tokyo at SXSW”
• achieved by NTT’s Immersive Telepresence Technology “Kirari!®” and the high-speed network GEMnet2® cooperated with the interconnected networks of Internet2
• provided a brand-new immersive live experience as if they were seeing the live stage on the remote venue
• contributing the standardization in ITU-T SG16