

Uncompressed 8K Video Streaming over 100Gbps Experimental Network

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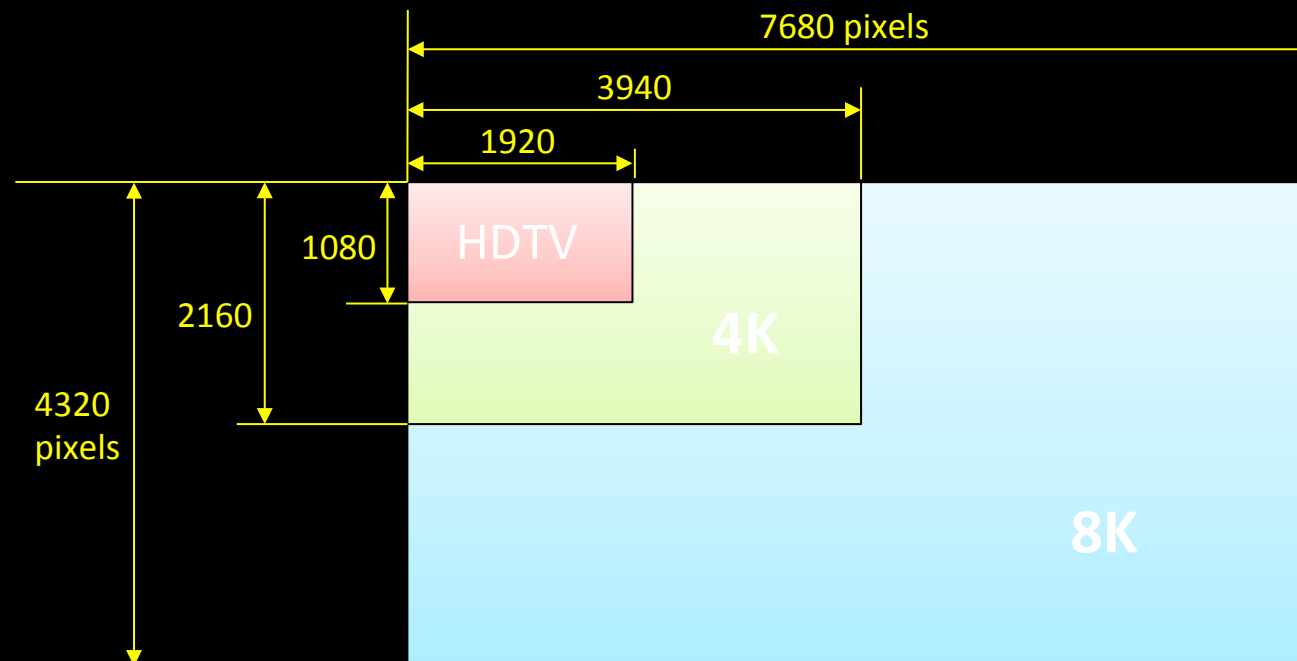
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Outline

- What is 8K video?
- Motivation
- 8K video format
- 8K video transmission system
 - Synchronization mechanism
- Experiments
 - On-demand streaming & real-time transmission
- Conclusion

What is 8K video

- **UHDTV (Ultra High Definition Television)**
 - 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 (NHK Giken)
 - Defined and approved by ITU-R and SMPTE



Motivation

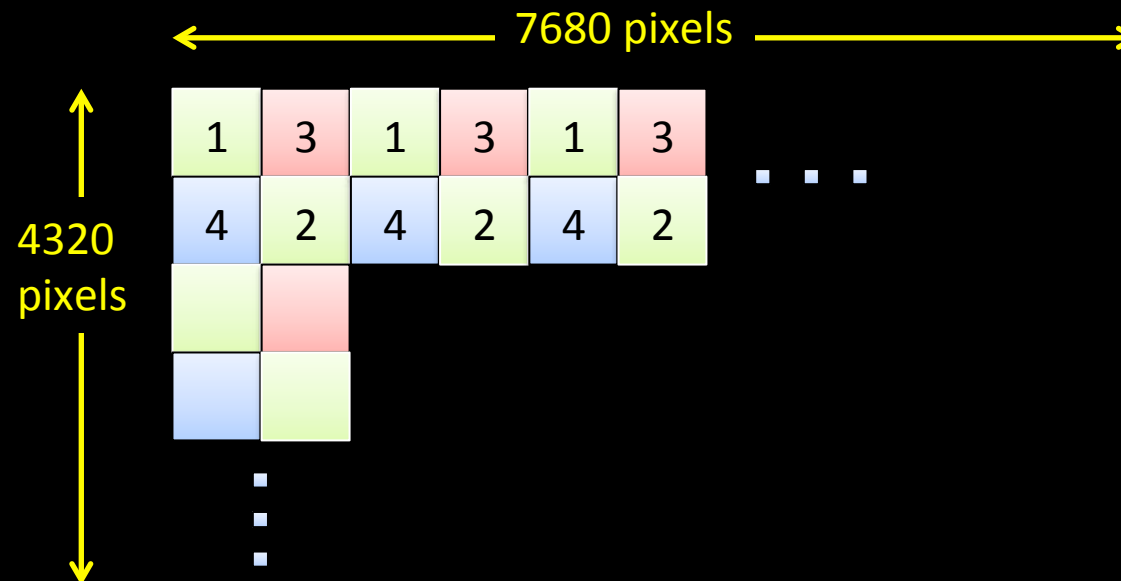
- Demand of handling high-resolution video increases
 - Handling: Send, receive, store, playback, etc
 - ex. Sports events are shot and delivered to public viewing as UHDTV (4K, 8K)
 - Olympic games, World cups, Major league baseball games, Football, etc
 - Transmitted 8K video of World Cup games from Brasil to Tokyo and other cities in 2014
- 8K video equipment is now available in Japan
 - 8K camera: AH-4800 (Astrodesign, Inc.)
 - 8K recorder: HR-7512-C (Astrodesign, Inc.)
 - 8K projector: DLA-VS4800 (JVC Kenwood Corp.)
 - 8K glass-free 3D LCD monitor: Prototype (Sharp Corp.)

Motivation of research (Cont.)

- Network carriers started providing over 10-Gbps ultra-high speed such as 100-Gbps network as commercial service
 - NTT Communications, etc
- Major network switch vendors started providing 100-Gbps Network equipment (Routers and Switches)
 - Cisco, Juniper, etc
- Equipment to handle not 8K but 4K video over ultra-high-speed network without compression is now available
 - Except for video transmission equipment, such as
 - Video – IP packet converter
 - IP video server
- Research goal
 - Establishing a technique which enable to construct environment to handle 8K video in real time

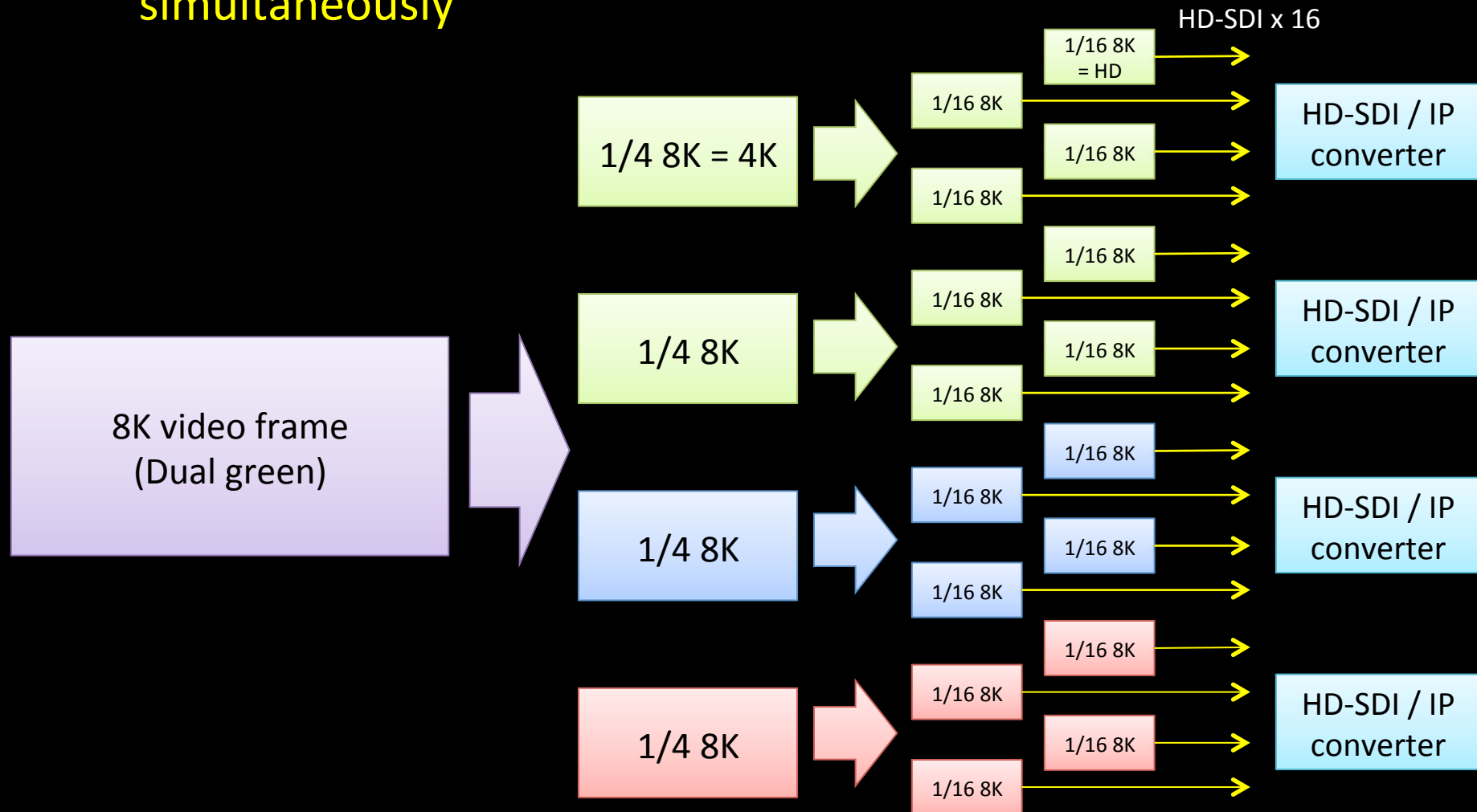
8K video format

- “Dual green format” – Currently available 8K format
 - Not full spec but very similar quality as full spec 8K
 - Enable to make camera from four 4K CCDs
 - Green x 2, Red x 1, Blue x 1
 - Full spec 8K CCD is NOT commercial based product
 - 60 fps (progressive), 10 bits/pixel
 - Data rate : 24 Gigabit/sec (includes ANC area)



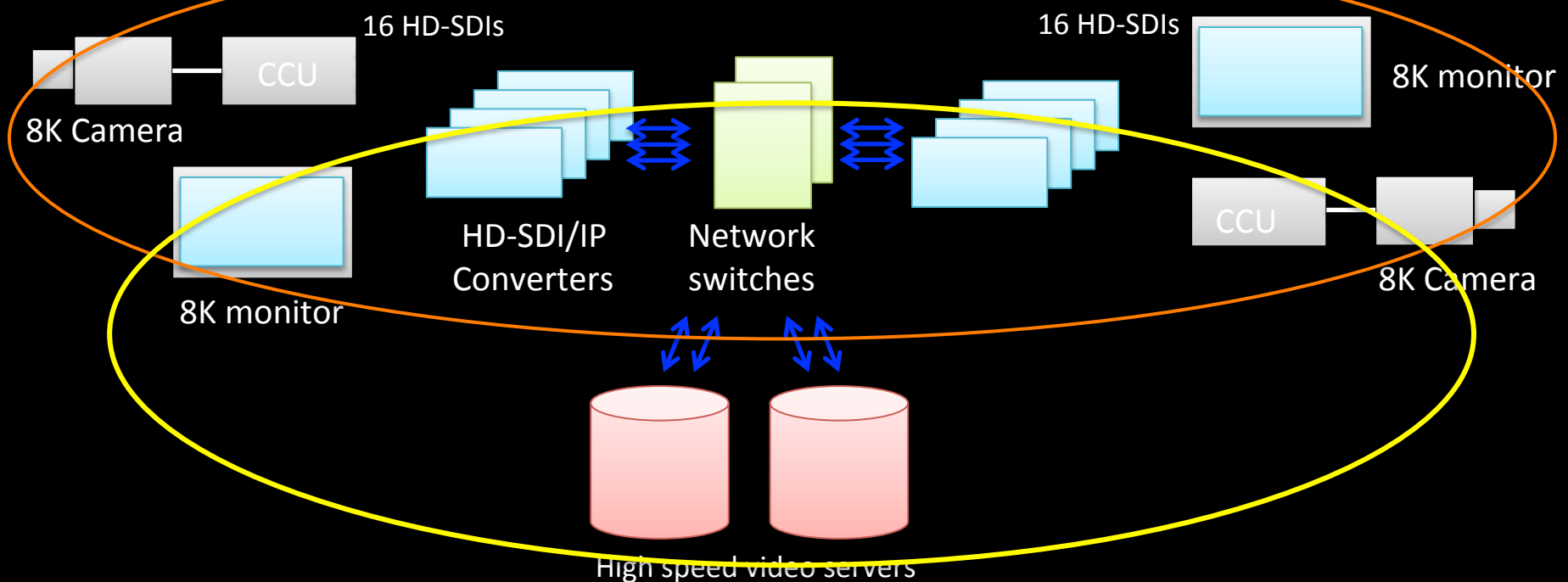
8K video signal output

- Dual-green format 8K camera CCU outputs 16 HD-SDI signals
- Handling 8K video requires to **handle 16 HD-SDI signals simultaneously**



Outline of 8K video transmission system

- Real-time 8K video transmission system
 - Integrate two systems
 1. Sending and receiving 8K video from cameras in real time
 2. Storing 8K video from camera into storages and playing back any 8K-video to monitor on demand



8K video transmission system

- Two main components
 - XMS server
 - Scalable ultra-high speed IP video server system based on PC cluster technology developed by NTT Labs.
 - Sends and receives multiple uncompressed 4K video streams in real time through IP network
 - Accepts and transfers video files with FTP protocol
 - Supplied by NTT-IT Corp. as commercial product
 - Smallest system, which can be configured with one PC, can record and play back up to 4K@60p high-resolution video
 - Please refer: <http://www.mediaorchestra.com/ipvs/english/product/p01/index.html>



8K video transmission system (Cont.)

- Two main components (Cont.)
 - QG-70
 - Uncompressed IP video transmission system with low latency
 - Supplied by PFU Limited
 - Sends and receives up to 4K@30p video each unit via 10GbE
 - Developed with NTT Labs' technology
 - Please refer: <http://www.pfu.fujitsu.com/en/ipvideo/>

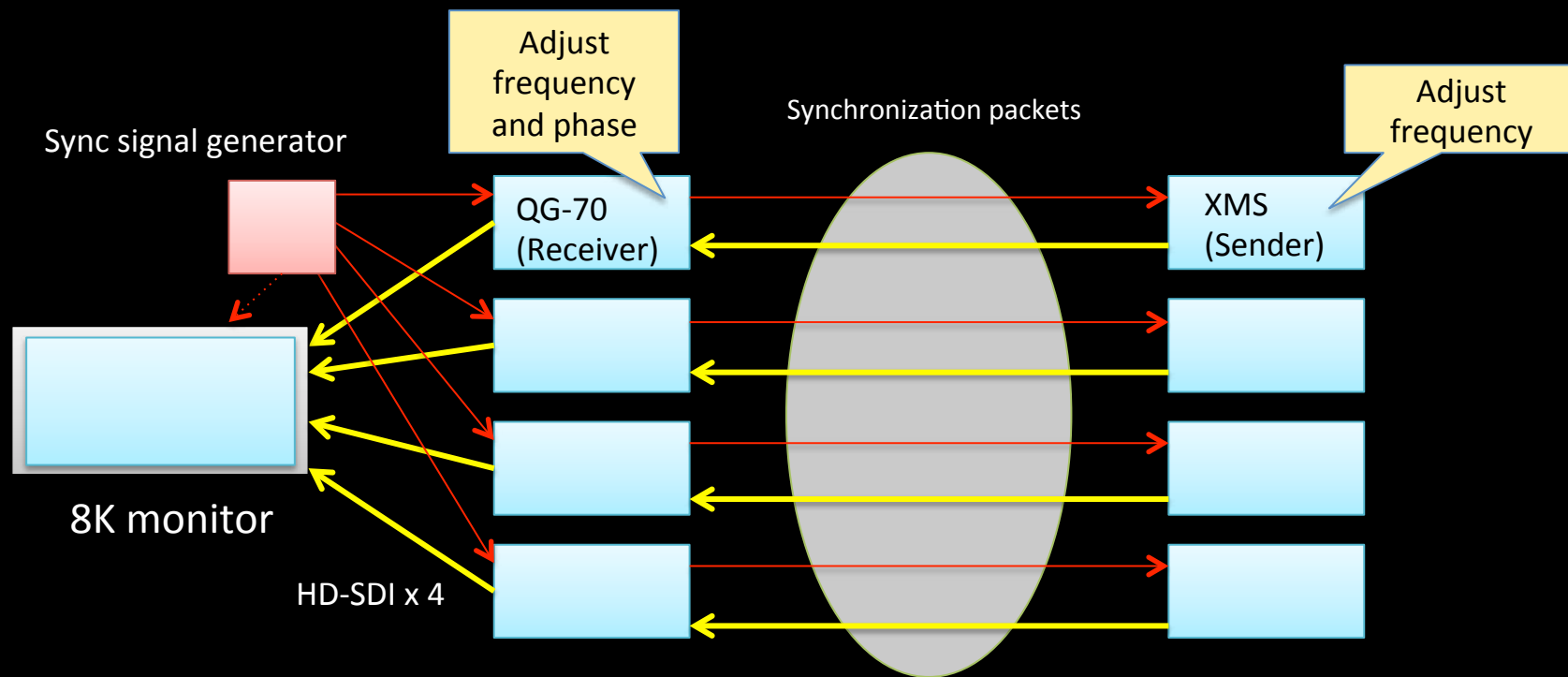


Synchronization

- Why “synchronization” is required?
 - 8K monitor requires 16 HD-SDI signals which have completely same frequency and same phase each other
 - 8K monitor does not have enough buffer to absorb jitter or difference of frequency of input HD-SDI signals
 - XMS system
 - Smallest system is highly cost-effective, but it can not play back 8K (up to 4K@60p) per unit
 - XMS records 8K video as independent 16 HD video streams for scalability reason
 - It is PC-based system which has low accuracy quartz. So, each XMS system maybe work with different clock
 - QG-70
 - High accuracy quartz
 - Four QG-70s are required for 8K-video transmission
 - Maybe output HD-SDI signals different phase each QG-70
 - Multiple XMSs and QG-70s must be introduced for 8K video transmission system
 - Synchronization is required in case of play back 8K video from XMS systems
- We have developed and implemented synchronization mechanism shown in following slides for XMS and QG-70 to transmit UHDTV

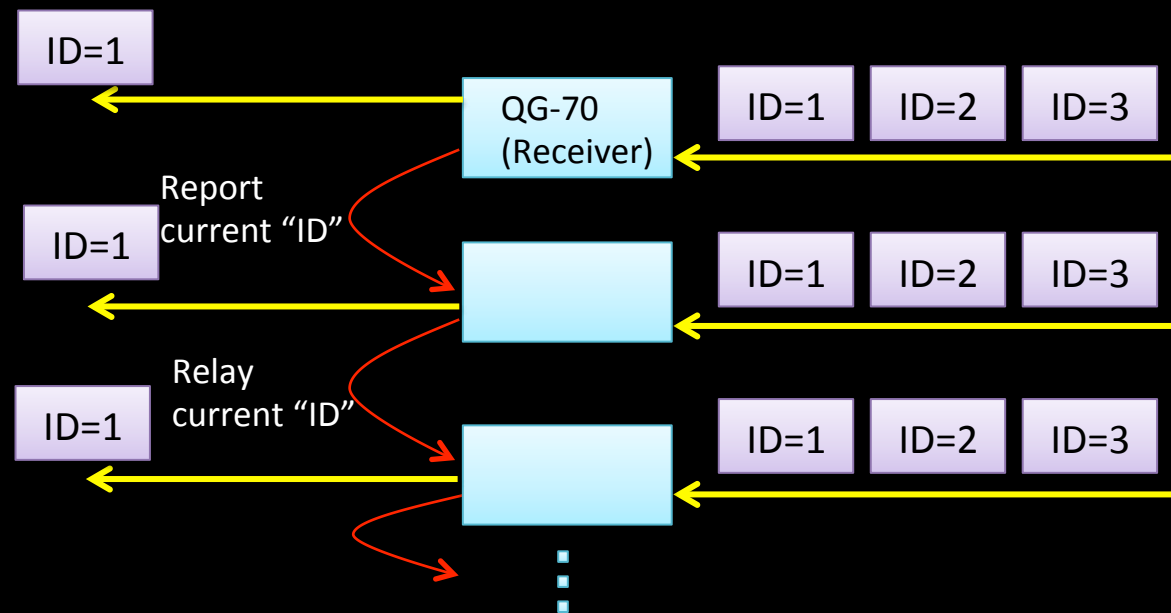
Synchronization (Cont.)

- Frequency and phase synchronization
 - Introduce reference signals into all receiver QG-70s to synchronize frequency and phase between all output HD-SDI signals
 - Each receiver QG-70 sends “synchronization packets” to sender XMS system to synchronize frequency between receiver and sender



Synchronization (Cont.)

- Frame number synchronization
 - XMS records 16 fragments of same 8K-video frame with same ID
 - Select one QG-70 among receivers as “Master”
 - Master QG-70 broadcast the ID with which it currently play back frame to all other receiver
- We can get complete synchronization at receiver side by using above methods
- And also get complete synchronization using multiple 10-Gbps networks with different delay because of this scalable method

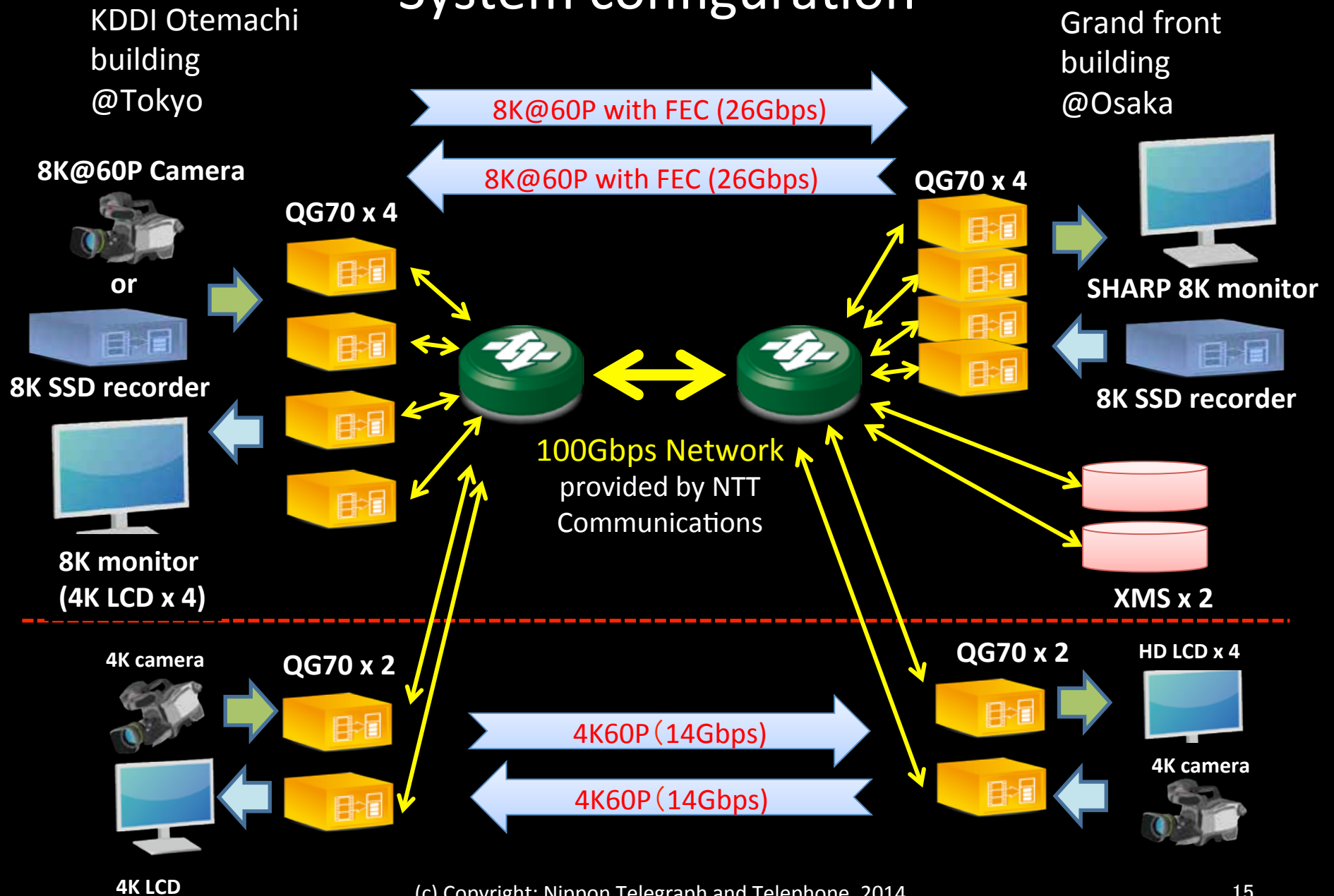


Experiment

- Objective of experiment
 - Establishing way to configure 8K video handling (send, receive, store, and play) system
- Outline of experiment
 - Send and receive one uncompressed 8K@60p video bi-directionally between Tokyo and Osaka (Osaka is 400 km apart from Tokyo)
 - Send and receive one uncompressed 4K@60p video bi-directionally for video conference at the same time
- Date
 - Feb. 5, 2014 – Feb. 7, 2014
- Experiment team was organized by :
 - Kanagawa Institute of Technology (KAIT)
 - Nara Institute of Science and Technology (NAIST)
 - PFU Limited
 - Astrodesign Inc.
 - NTT-IT corporation
 - National Institute of Information and Communication Technology (NICT)
 - NTT Network Innovation Laboratories



System configuration



Results@Otemachi



8K real-time streaming video from XMS@Osaka
on 8K monitor made from four 4K LCDs



4K live video from Osaka



QG-70s @ Otemachi

Results@Osaka



8K real-time streaming video on SHARP 85" 8K LCD
from Recorder@Tokyo

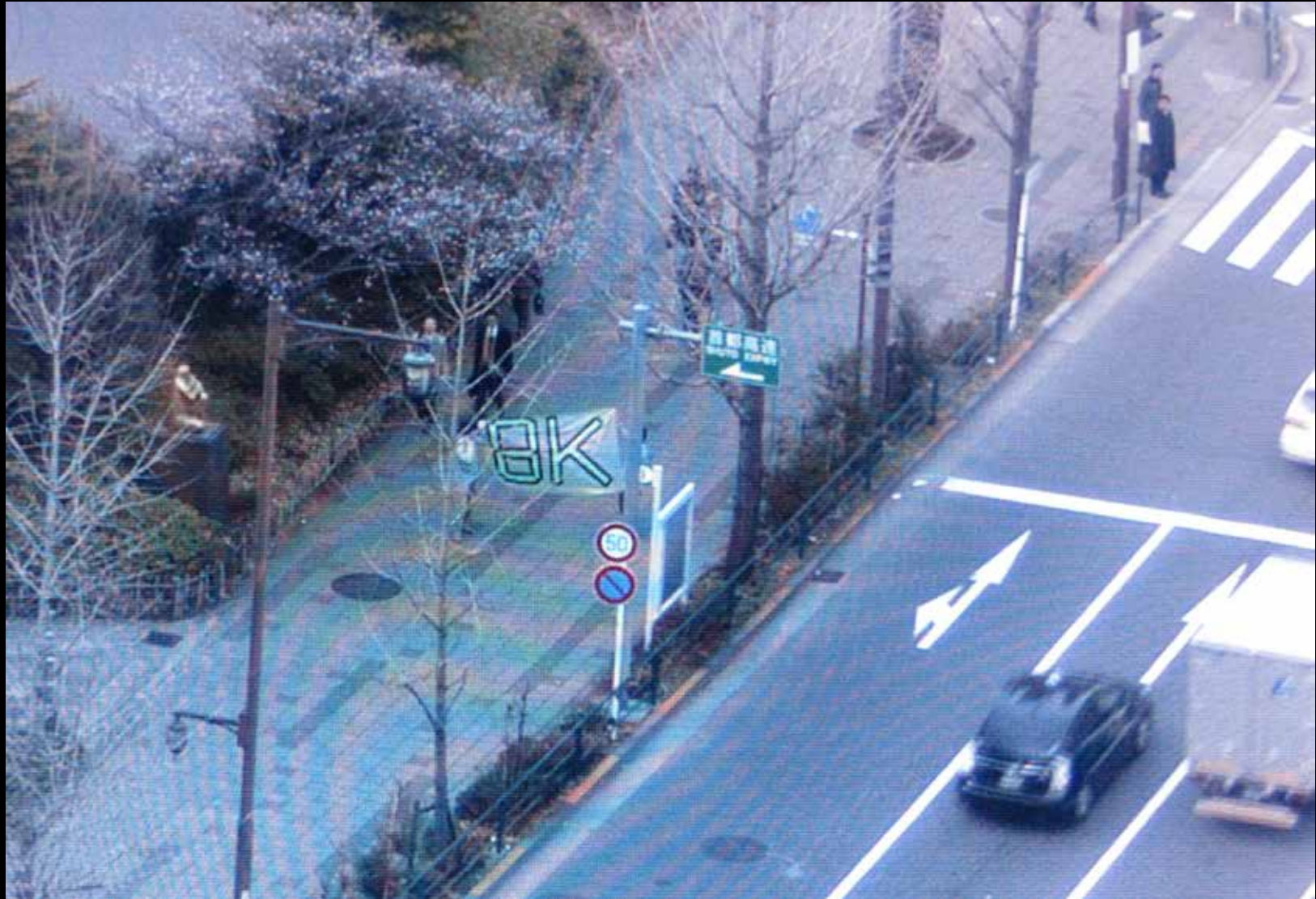
High time-resolution traffic meter
developed by KAIT (measured only
8K video stream)

High resolution test?

- Make sure resolution limitation of 8K video
- Shot outside from Otemachi building and send it to Osaka
- Watch it in Osaka!



High resolution test? (Cont.)



Summary

- **Summary**

- Succeeded in bi-directional transmit uncompressed 8K and 4K video
 - Total bandwidth is about 40 Gbps
- This experiment results show:
 - Synchronization mechanisms work correctly
 - We can get environment which is enable to handle over 10-Gbps high quality video over network in real time
- This is NOT our goal – This is starting point of our research

- **Acknowledgement**

- We would like to express deepest appreciation to:
 - **NTT Communications Corp.** provided 100-Gbps network
 - **Sharp Corp.** provided 8K LCD monitor
 - **Hokkaido Television Broadcasting Co. Ltd.** shot 8K video for this demo during deep snowing