Future of Computing and Networking for AI-Integrated Communications

May 2023

Masahisa Kawashima,

Technology WG Chair, IOWN Global Forum

IOWN GLOBAL FORUM ™

Evolution of Video/Content Delivery Systems

I assume you are interested in …

- Deliver **great user experience** with emerging technologies
  - Augmentation with AI
  - Angle-free view with rendering

- Cloudification of the service infrastructures
  - for content delivery
  - for content production
  - for content archives

- Leverage the open computing/networking ecosystem

Are today's IP and cloud infrastructures good enough for the above?

IOWN Global Forum

- An open community that aims to **redefine** compute/network infrastructures and application designs to achieve quantum leaps in capacity, latency, and energy-efficiency.

  Carriers' infrastructures will continue to accelerate with the evolution of optical and wireless technologies. But, without redefining computing and application designs, we would not be able to create new user experiences.

- IOWN GF puts more emphasis on the **full-stack** and **end-to-end** technology integration rather than specific components or layers.

End-to-End Capacity

Depends on the efficiency in computing

End-to-End Response Time

Slowed by the window size control at L4

ROI/Green ROI

Infrastructure resources are often statically assigned regardless of the actual traffic/workload.

Reliability

Needs application-infrastructure cooperation

IOWN GLOBAL FORUM

IOWN

Rearchitect,
e.g., revisit today's abstraction models

- Application Design
- Compute Infrastructure
- Network Infrastructure

optical and wireless communication technologies

IOWN Global Forum Members

Sponsor Members

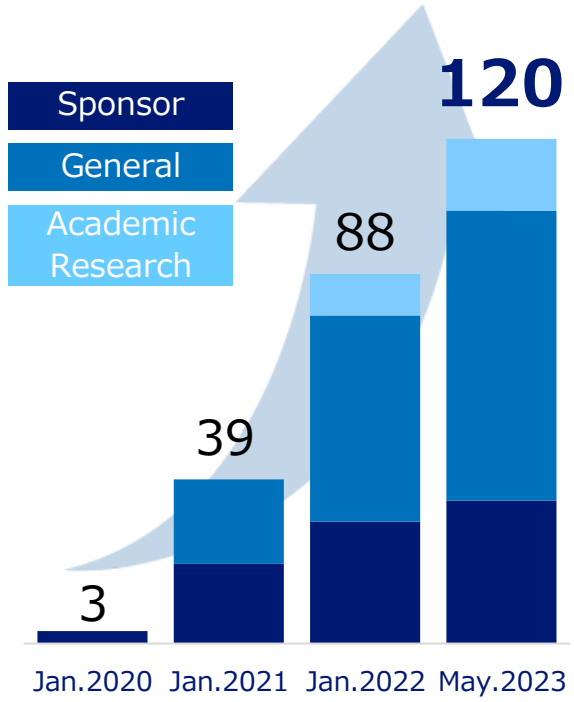
Accenture Japan
Chunghwa Telecom
Ciena
Cisco Systems
Dell Technologies
Deloitte Tohmatsu
Delta Electronics
Ericsson
Fujitsu
Furukawa Electric
HAKUHODO
Intel
KDDI
KIOXIA
Microsoft
Mitsubishi Electric
Mizuho Bank
MUFG Bank
NEC
NICT
Nokia
NTT
Oracle Japan
ORANGE
PwC Japan
Rakuten Mobile
Red Hat
Samsung Electronics
SK Hynix
SK Telecom
Sony Group
Sumitomo Electric Industries
Toyota Motor
VMware

General Members

Accton Technology
AISIN
ADVANTEST
AGC
AIOCORE
AJINOMOTO
ANRITSU
Avago Technologies
CommScope
Dai Nippon Printing
Dentsu Group
DIC
DriveNets
e-solutions
EXEO Group
Fujikura
HAKUSAN
HAZAMA ANDO
Hewlett-Packard Japan
Hitachi
HONDA TSUSHIN KOGYO
I-PEX
IBIDEN
Infinera
IP Infusion
ITOCHU Techno-Solutions
JGC Japan
JSR
Juniper Networks
JX Nippon Mining & Metals
Keysight Technologies
MIRAIT
MIRISE Technologies
Mitsubishi Corporation
Mitsubishi Chemical
Mitsubishi Heavy Industries
Mitsubishi Research Institute
Mitsui Knowledge Industry
Murata Manufacturing
NetApp
Net One Systems
NISSHO ELECTRONICS
Nissan Chemical
Nitto Boseki
NVIDIA
OKI Electric Industry
Olympus
OPTAGE
Peers
Preferred Networks
ProteanTecs
Qualcomm
Renesas Electronics
RICOH
Santec
SCSK
SENKO Advanced Components
Shin-Etsu Chemical
SHINKO ELECTRIC INDUSTRIES
SKY Perfect JSAT
SUMITOMO BAKELITE
Sumitomo Corporation Kyushu
TELEFÓNICA
Toppan
Toshiba
Toyo Ink SC Holdings
UNIADEX
Wistron
Yazaki

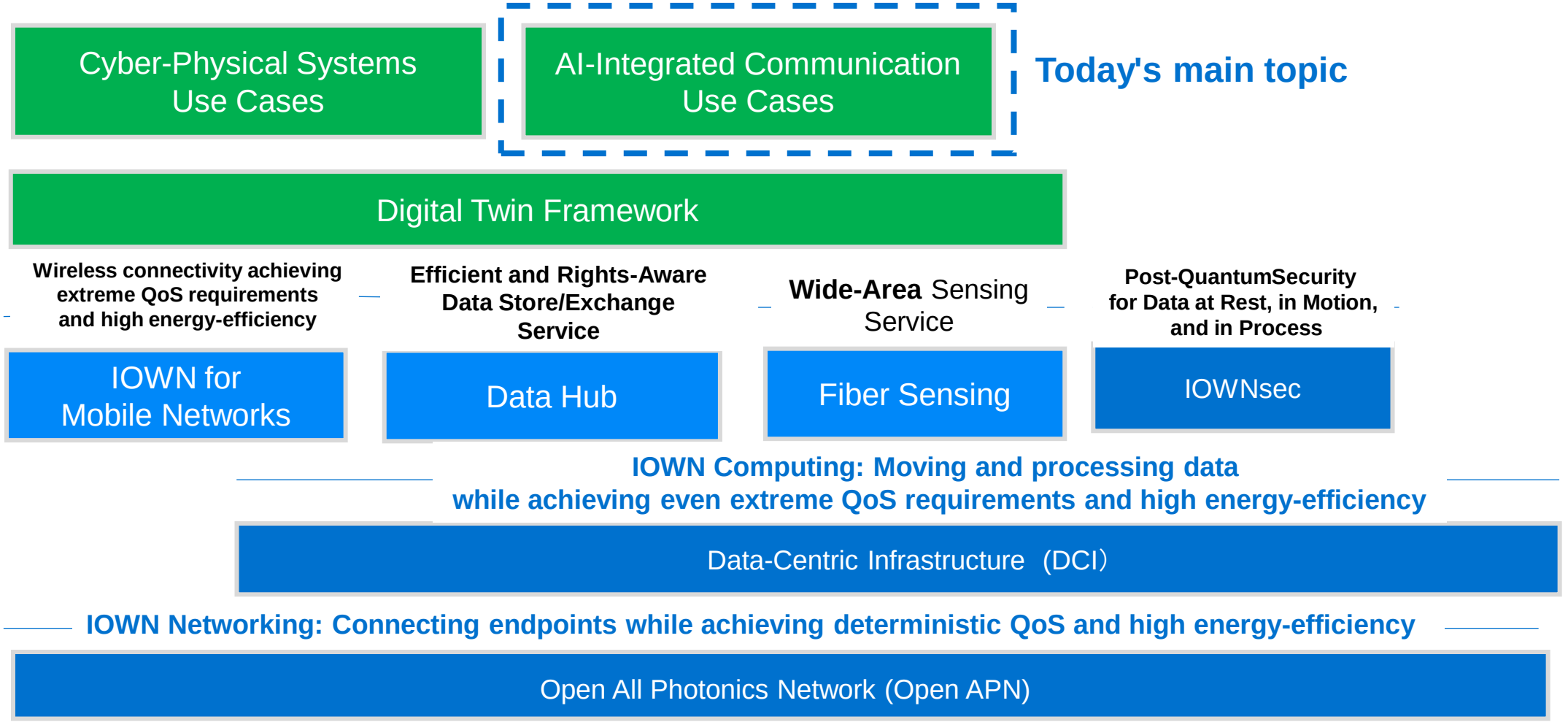
Academic or Research Members

The National Institute of Advanced Industrial Science and Technology (AIST)
Central Research Institute of Electric Power Industry (CRIEPI)
Cloud Computing & IoT Association in Taiwan (CIAT)
Hiroshima University
Institute for Information Industry(III)
Industrial Technology Research Institute (ITRI)
Japan Aerospace Exploration Agency (JAXA)
Keio University
National Institute of Informatics (NII)
National Research Institute for Earth Science and Disaster Resilience (NIED)
Osaka University
Photonics Electronics Technology Research Association (PETRA)
Photonics Industry & Technology Development Association (PIDA)
SBI Graduate School
Taiwan Association of Information and Communication Standards (TAICS)
Tohoku University
The University of Tokyo



As of May 5, 2023

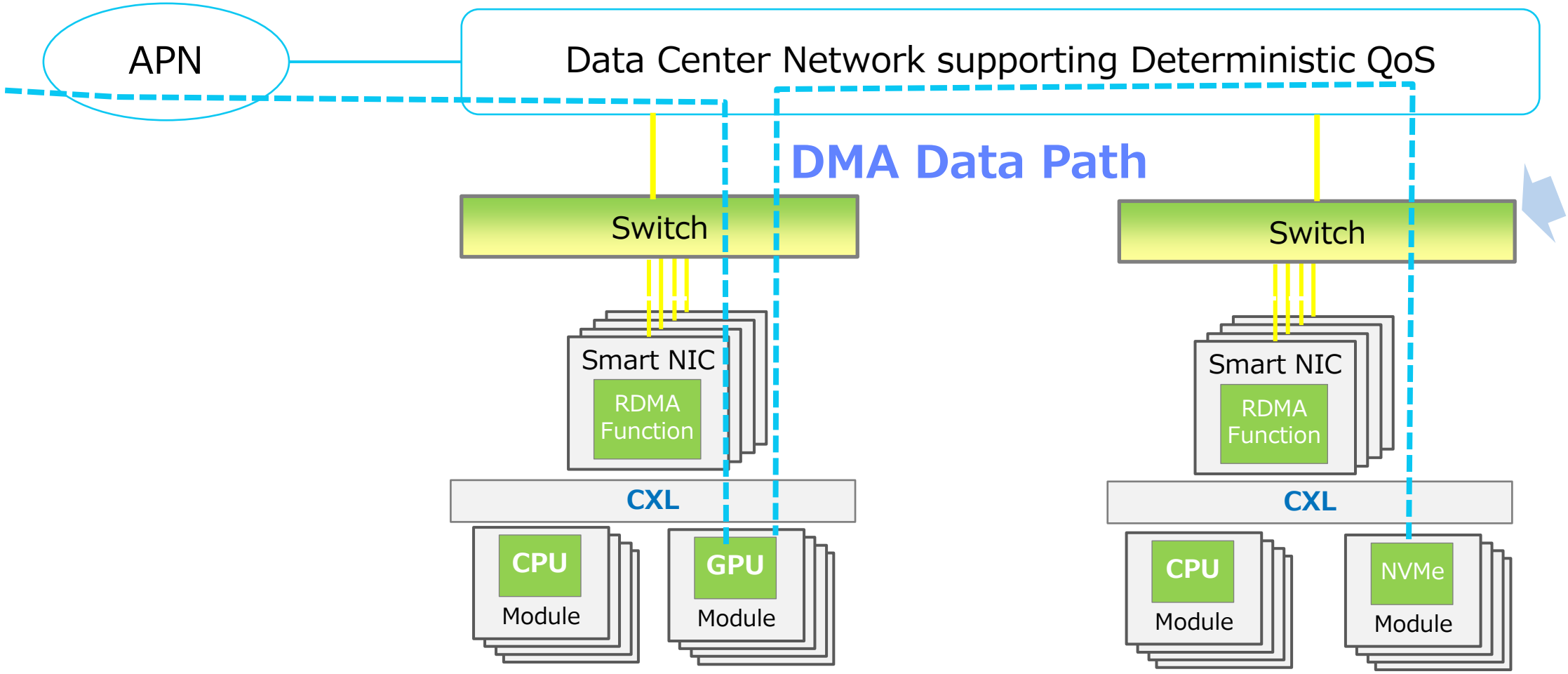
Technology Stack for IOWN Computing and Networking



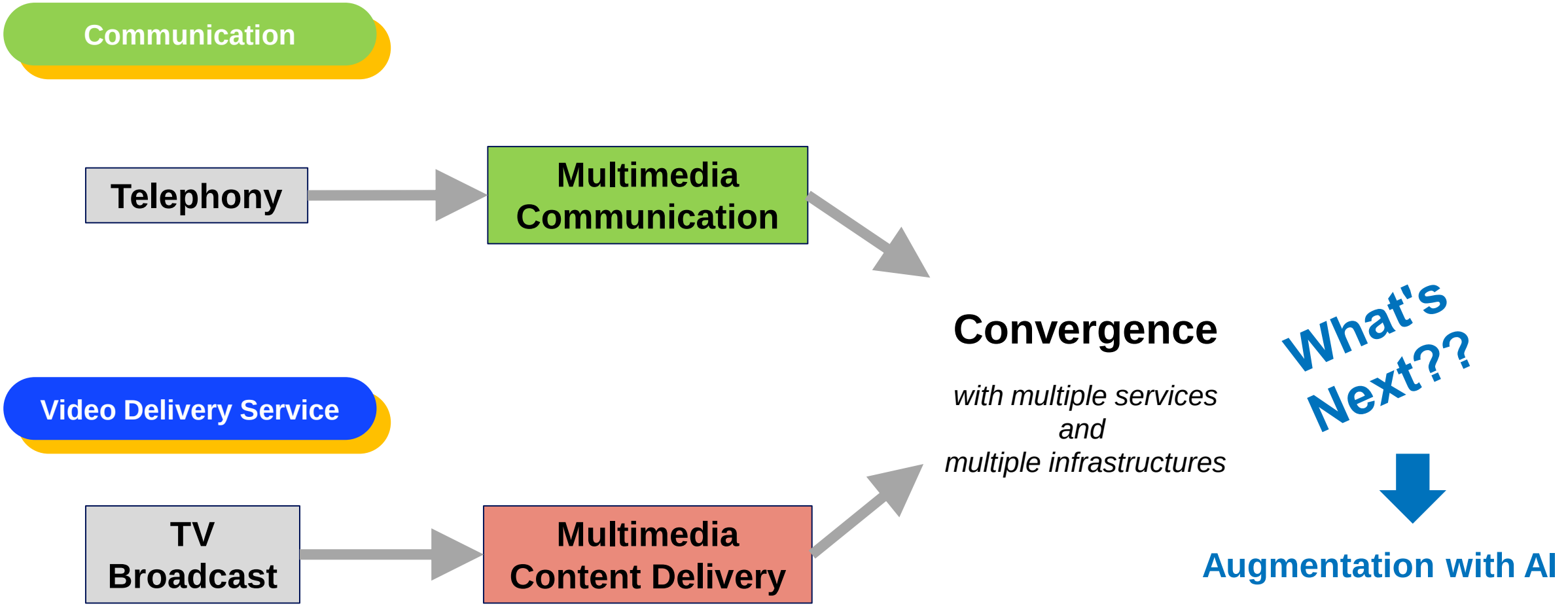
IOWN GLOBAL FORUM

IOWN GF Data-Centric Infrastructure (DCI)

Computing infrastructure to streamline data transferring and processing at the speed of optical communication



Service Evolution and New User Experience



AI-Integrated Communications

Human-Centric Application enhancing remote Communication & Operation

Prospective use case enabled by computing power integrated all photonics network

Entertainment

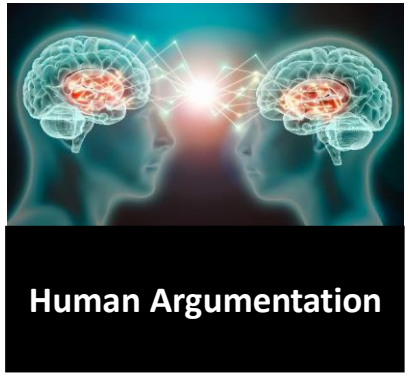
Interactive Live Music
Interactive Live Sport
Cloud Gaming

Remote Learning

Professional Training

Navigation

Immersive XR



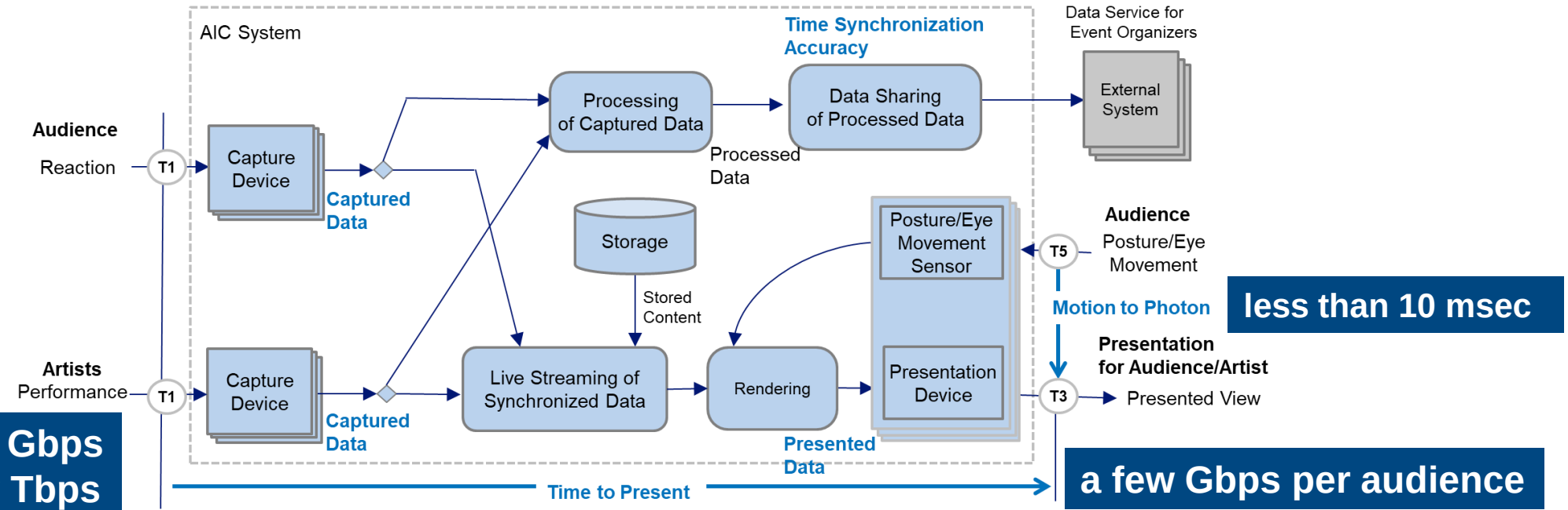
Human Argumentation

Enhancing smooth communication

KEY REQUIREMENTS IMPOSED by Use Cases:

- Acquisition of large amount of spatial information leading to immenseness
- Injecting data into the distributed computing resources for content production/augmentation
- Powerful/Flexible Processing pipeline integrated into network infrastructure
- Distributing multi-point fat-pipe connections to “feel being together” in remote
- E2E Low Latency—Real Time/Interactive Data Flow

IOWN GF's Activities/Contributions
Identify Key Requirements



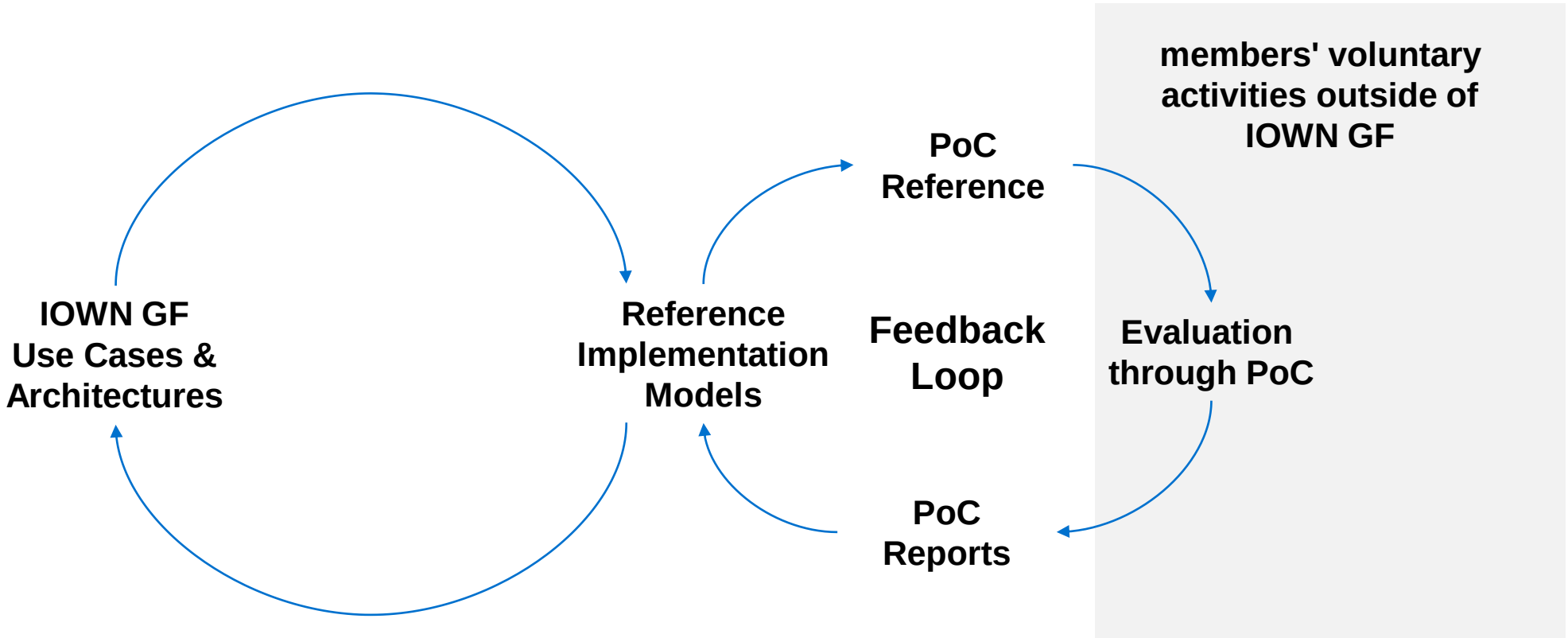
USE CASES	REQUIREMENTS
Volumetric Video	140-230 Gbs/object
8K@60FPS in JPEG-XS	2 Gbps/camera

USE CASES	REQUIREMENTS
8K in Visual Field	2.35 Gbps[1]
8K@60FPSin JPEG-XS	2 Gbps

Source:
[1] S. Mangiante, G. Klas, A. Navon, Z. GuanHua, J. Ran, and M. D. Silva, "VR is on the Edge: How to Deliver 360° Videos in Mobile Networks," proceedings of the Workshop on Virtual Reality and Augmented Reality Network, pp. 30–35, 2017.
[2] S. Mogi, Y. Ichioka, K. Tanaka, N. Nishinaga, and M. Katsumoto, "A Study of Real-time Ensemble Collaboration over Broad-band Network", The IPSJ Special Interest Group on Distributed Processing System (SIG-DPS), 2002 (in Japanese).

IOWN GF's Activities/Contributions
Develop technologies with implementers' feedback

- Develop truly viable and practically operable solutions through iterative technology development

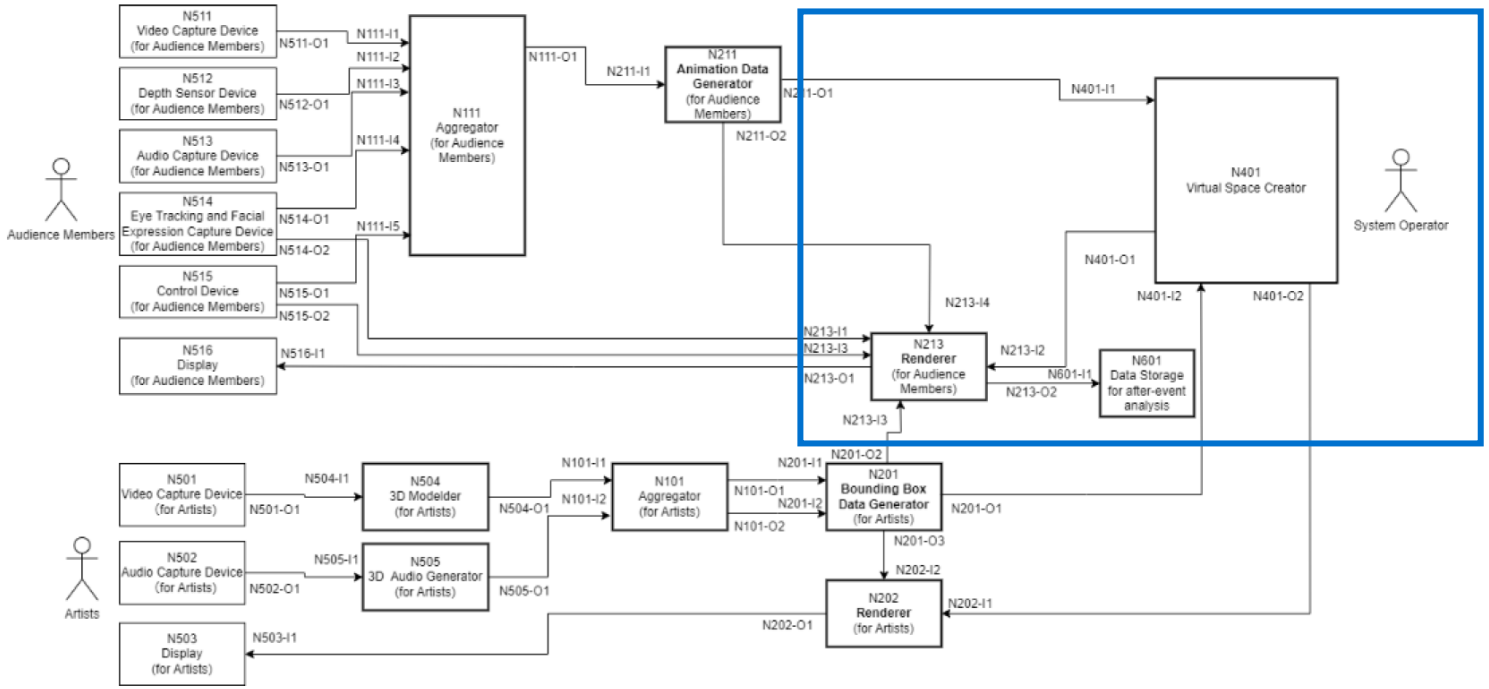


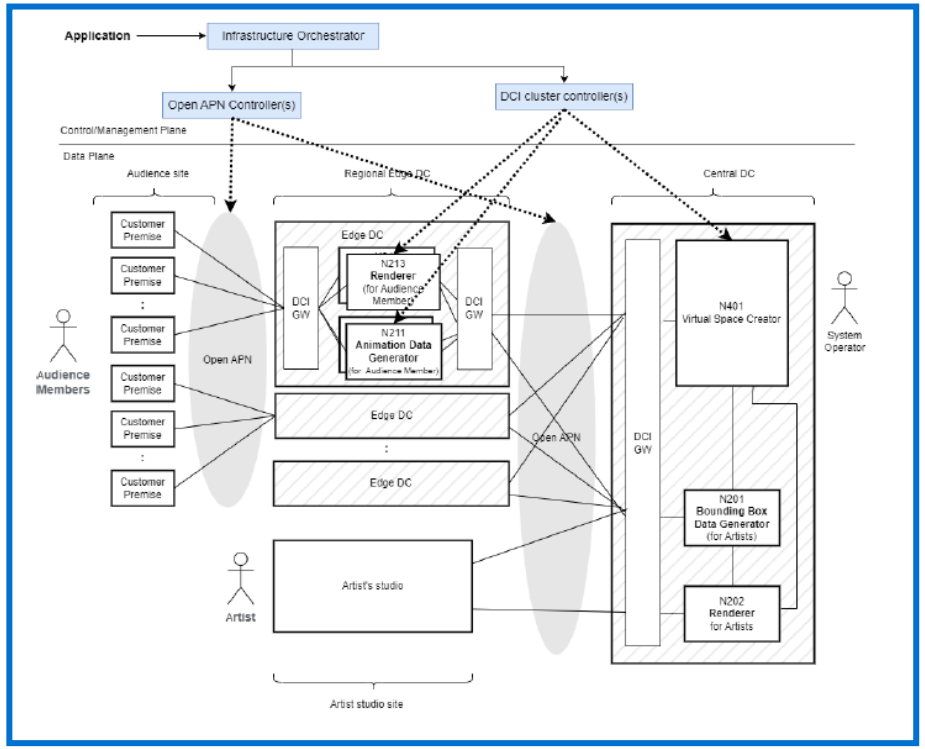
IOWN GF's Activities/Contributions
Reference Implementation Model

- An end-to-end data pipeline for a system to support target use cases
- Technology choices for each data processing stage of the pipeline

Data Pipeline Diagram for AIC Interactive Live Entertainment

Data Pipeline Diagram for AIC Interactive Live Entertainment





IOWN GF's Activities/Contributions
Identify gaps and issues

Gaps and Issues in AIC Interactive Live Music Implementation

1. High Bandwidth Cost Caused by Centralized Cloud Computing
2. Lack of Deterministic Service Quality Caused by Best-Effort Networking
3. Virtualization Overhead for Tag-Based Multi-Tenancy Operation
4. Non-Orchestration Mechanism for Dynamic Network and Computing Resource Allocation
5. Insufficient Resource Utilization Caused by Box-Oriented Computing Platform
6. CPU Overwhelmed by Software-Based Data Transfer
7. Increased Energy Consumption and Latency Caused by Data Hub Tier
8. Too much latency caused by the distance from Customer Premise to Centralized Cloud

Conclusion

Evolution of Video/Content Delivery Services

- Deliver **great user experience** with emerging technologies
  - Augmentation with AI
  - Angle-free view with rendering

- Cloudification of the service infrastructures
  - for content delivery
  - for content production
  - for content archives

- Leverage the open computing/networking ecosystem

This would require end-to-end and full-stack re-engineering.
IOWN GF would be very happy to collaborate with you.

13