IOWN Concept for the Sustainable World
(Innovative Optical and Wireless Network)

19th of October 2021
Dr. Yosuke Aragane, NTT
Estimating the amount of information distributed through the Internet

- Rate of traffic growth:
  - 2006: 637 Gbps
  - 2010: 121 Tbps
  - 2025: 190 times the 2006 rate

Data growth

- 2010: 2 ZB
- 2025: 175 ZB
- 90 times the 2010 data growth

Estimation of IT equipment power consumption

- 2006: 470 billions of kWh
- 2025: 2,400 times the 2006 amount
- 2050: 5,500 billions of kWh
- 12 times the 2006 amount

Stagnation in technological evolution

- Operating frequency barrier:
  - 2006: 5 times
  - 2020: 5,000 GHz

- Power consumption barrier:
  - 2006: 1,000 Watts
  - 2020: 4,000 Watts

Source: https://www.karlrupp.net/2018/02/42-years-of-microprocessor-trend-data/
### Key Requirements and Leap toward 2030

**Cognitive and Communication Capacity**
- **Beyond Human (Natural)**
  - 20-150,000 Hz sound,
  - 120 FPS motion, etc.
- **Human-Level (High-Quality Digital)**
  - 20-20,000 Hz sound,
  - 30 FPS motion,
  - encoded at fine-for-human quality
- **Low Quality Digital**
  - 10 FPS motion, etc.

**Response Speed**
- **Beyond Human (Natural)**
  - Act in 10 msec
- **Human-Level**
  - Act in 0.1 second
- **Act in a second**
- **Act after several minutes**

**Scalability in Computing**
- **Dynamic Scaling with Linear Efficiency**
  - e.g. 300 mWsec per event
- **Dynamic Scaling (with Diminishing Effect)**
- **Semi-Static Computing Scaling**

**Energy Efficiency**
- **Event-Driven, LED-Light-Level Consumption**
  - e.g. 10-15 W per camera
- **Unit-Driven, Light-Bulb-Level Consumption**
- **Dominated by Very Large Fixed Consumption**

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How finely, precisely, and multisensory the system can capture objects in the physical world and process the captured data.

How responsively the system can react to an event. Can be represented with turn around time (TAT).

How efficiently the system can accommodate varying and uncertain workload.

How energy-efficiently the system can run.

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Key Technology for IOWN: Photonics Electronics Convergence Technology

“Transmitting” by Photonics Technology

“Processing” by Electronics Technology

Combination of photonics & electronics for next gen networking and computing

“Photonics Electronics Convergence”
Optical transistor with high speed and ultra-low power consumption

Published in Nature Photonics in Apr. 2019
Optical device technology improvements

Apr. 2019
Photonics transistor

Nov. 2019
All-optical switch

Mar. 2020
Optical logic gate

Oct. 2020
Directly modulated laser

Published in:
Nature Photonics
Nature Photonics
Communications Physics
Nature Photonics
IOWN:

“Converged infrastructure for next gen communication and computing”
by using cutting-edge technologies like photonics and computing technologies

Aim for:
- Lower power consumption
- Large capacity and high capacity
- Low latency

Photonics technologies into:

- Photonics-electronics convergence devices
  - "Transmitting" by Photonics Technology
  - Connection around the chip

- Photonics-electronics convergence processing
  - Combination of photonics and electronics

COSA
Co-packaged optics
Inter-chip connection
Photonics-electronics convergence processor

"Transmitting" by Photonics Technology
Connection around the chip
Combination of photonics and electronics

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Photonic disaggregated computing
NTT Green Innovation toward 2040

NTT is challenging to achieve conflicting objectives of "zero environmental impact" and "economic growth" by "Reduction of Environmental Impact through Business Activities" and "Creation of Breakthrough Innovation."

Illustration of NTT Group greenhouse gas emission reductions (domestic and overseas)

Global Collaboration is crucial for developing cutting-edge IOWN technologies and global eco-system

- In January 2020, NTT, Intel and Sony established Innovative Optical and Wireless Network (IOWN) Global Forum for the future communication
- Global non-profit organization for developing the next generation communication and computing infrastructure with new technologies, frameworks, specifications and reference architectures
IOWN Global Forum will work on technology components and use cases for enabling a smarter world.

**Forum Activities**

Create Specific Use Cases

Establish Technical Roadmap

Develop Technical Specifications (i.e. Architecture, Requirements)

Popularization and deployment (Cooperation with standardization organizations)

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**Use cases and applications**

(IOWN Global Forum vision, motivating use cases, potential business impact estimations, technology requirements)

- Smart Energy
- Smart Cities
- Smart Mobility
- Smart Finance
- Smart Entertainment

More Use Cases and Applications

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**Technical solutions**

(reference architectures, protocols, interfaces, specifications)

- Networking
- Optical & Wireless
- Distributed Computing
- Photonics & Optoelectronics
- Devices, Interfaces & Terminals

More Technologies
## IOWN Global Forum members

### Sponsor Members

| Chunghwa Telecom | Intel | ORANGE |
| Ciena            | KIOXIA | PwC Japan |
| Cisco Systems   | Microsoft | Red Hat |
| Dell Technologies | Mitsubishi Electric | Samsung Electronics |
| Delta Electronics | NEC | Sony Group |
| Ericsson        | NICT | Toyota Motor |
| Fujitsu         | NTT | Wistron |
| Furukawa Electric | Oracle Japan | |
| Hewlett-Packard Japan | |

### General Members

| ADVANTEST | I-PEX | OKI Electric Industry |
| AGC | IBIDEN | Peers |
| AIOCORE | Infinera | Santec Corporation |
| AJINOMOTO | IP Fusion | SENKO Advanced Components |
| ANRITSU | ITOCHU Techno-Solutions | Shin-Etsu Chemical |
| Avago Technologies | JGC Japan | SKY Perfect ISAT |
| Deloitte Tohmatsu | Juniper Networks | Sumitomo Corporation Kyushu |
| Dentsu | KYOTO SEMICONDUCTOR | Sumitomo Electric Industries |
| DIC | Keysight Technologies | TELEFÓNICA |
| EXEO Group | MIRAIT | Toshiba |
| Fujikura | MIRISE Technologies | Toyo Ink SC Holdings |
| HAKUSAN | Mitsubishi | UNIADEX |
| Hitachi | Mitsubishi Chemical | Yazaki |
| HONDA TSUSHIN KOGYO | NVIDIA | |

### Academic or Research Members

- The National Institute of Advanced Industrial Science and Technology (AIST)
- Central Research Institute of Electric Power Industry (CRIEPI)
- Consorzio Nazionale Interuniversitario per le Telecomunicazioni (CNIT)
- Industrial Technology Research Institute (ITRI)
- National Research Institute for Earth Science and Disaster Resilience (NIED)
- National Institute of Informatics (NII)
- Photonics Electronics Technology Research Association (PETRA)
- Photonics Industry & Technology Development Association (PIDA)
- Tohoku University

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**As of Oct. 4, 2021**

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Thank you for your attention

IOWN

Get Smarter with No Carbon!