New value creation led by Beyond5G

Sachiko Oonishi

Executive Vice President,
Head of Research andDevelopment Market Strategy
NTT Corporation

Starting with the telephone, which connects people,

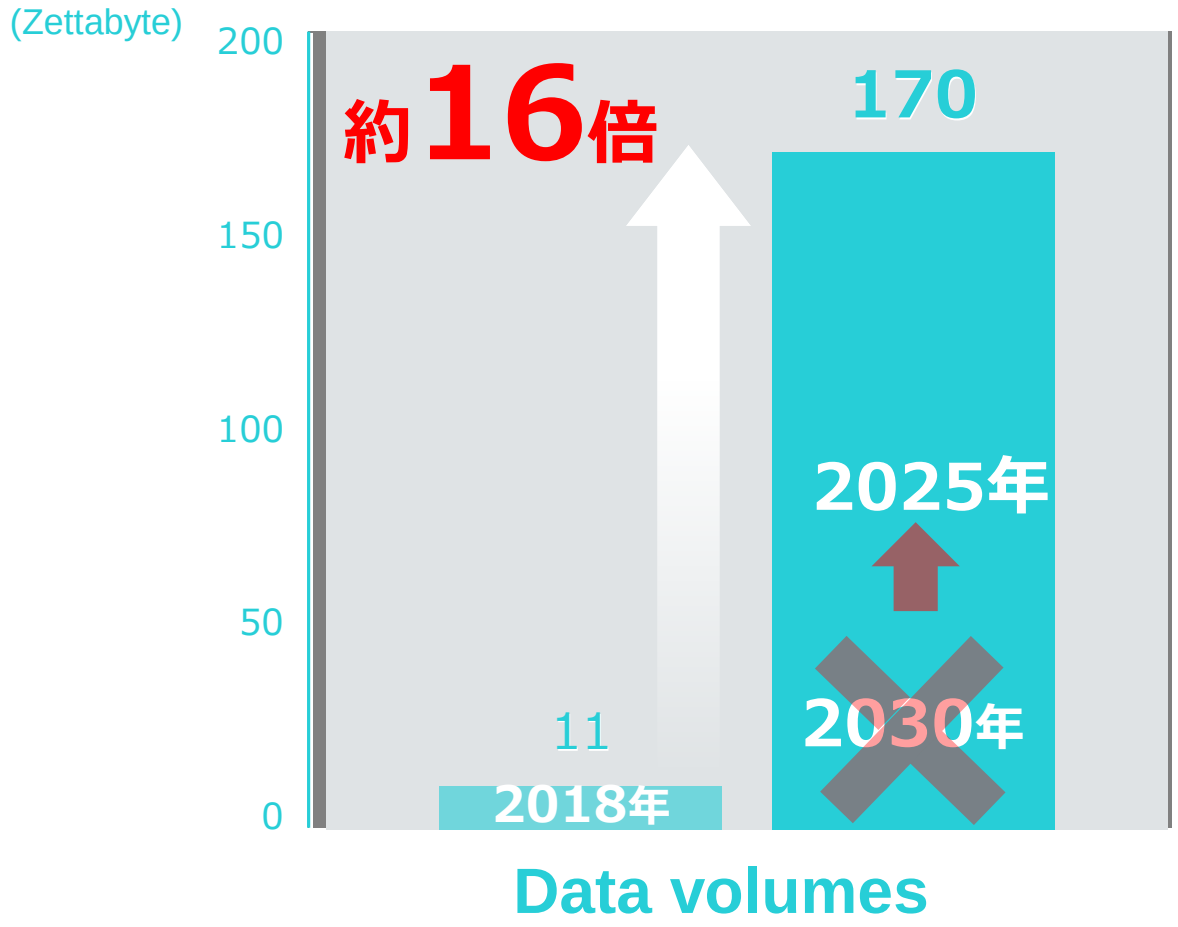
Information and Communication Technology has linked

people with information, people with things, and the real with the virtual,

digitalizing everything and transforming it into information and data

Data volumes

as of 2017 estimation、in 2030 170zettabyte
With the spread of generative AI 5 years ahead of schedule



Massive power consumption due to accelerating AI adoption and training models

Large language models at GPT-3 (175B) scale require an enormous amount of power for one training session.

Approximately **1,300MWh**

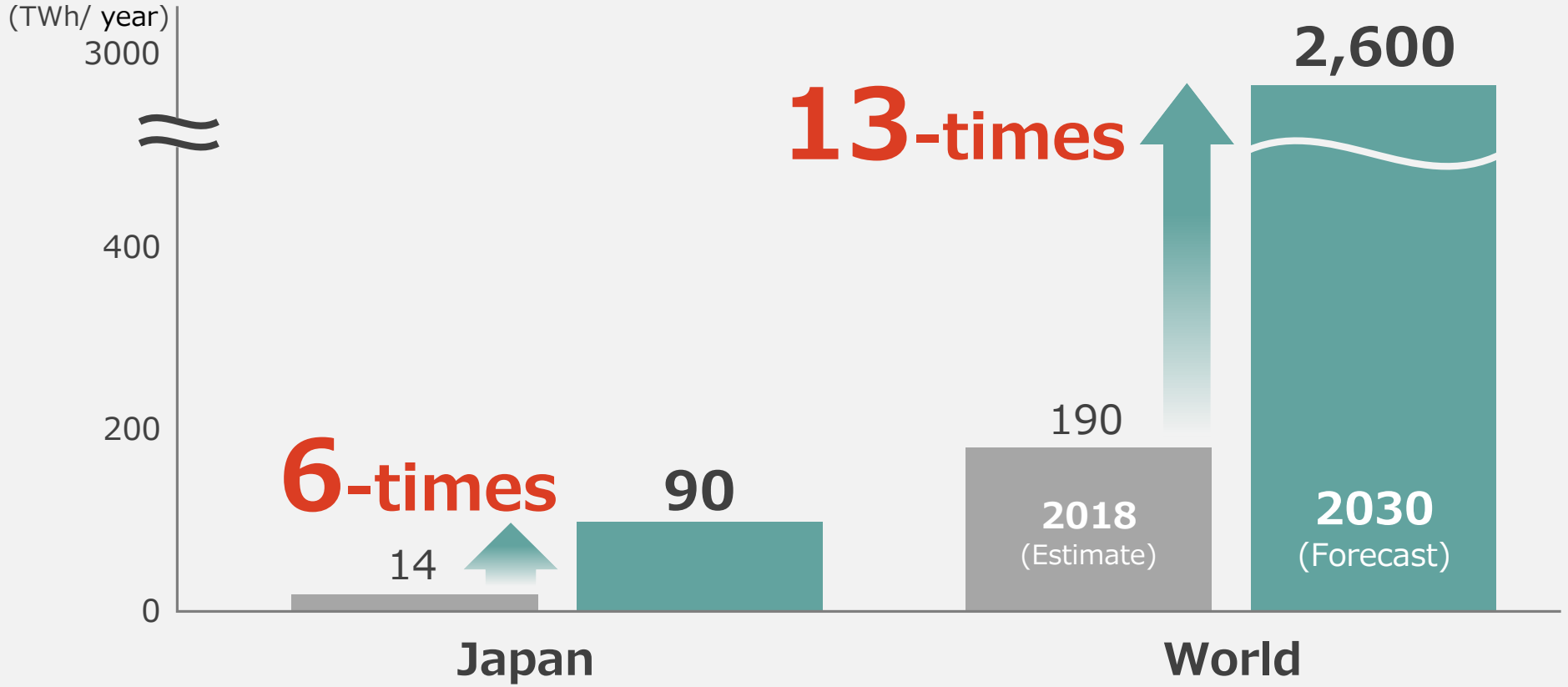
The amount of electricity generated by operating one nuclear power plant for one hour

1,000MWh

Source : Carbon Emissions and Large Neural Network Training https://arxiv.org/pdf/2104.10350.pdf

Increase in global Data Center power consumption as data volume increases

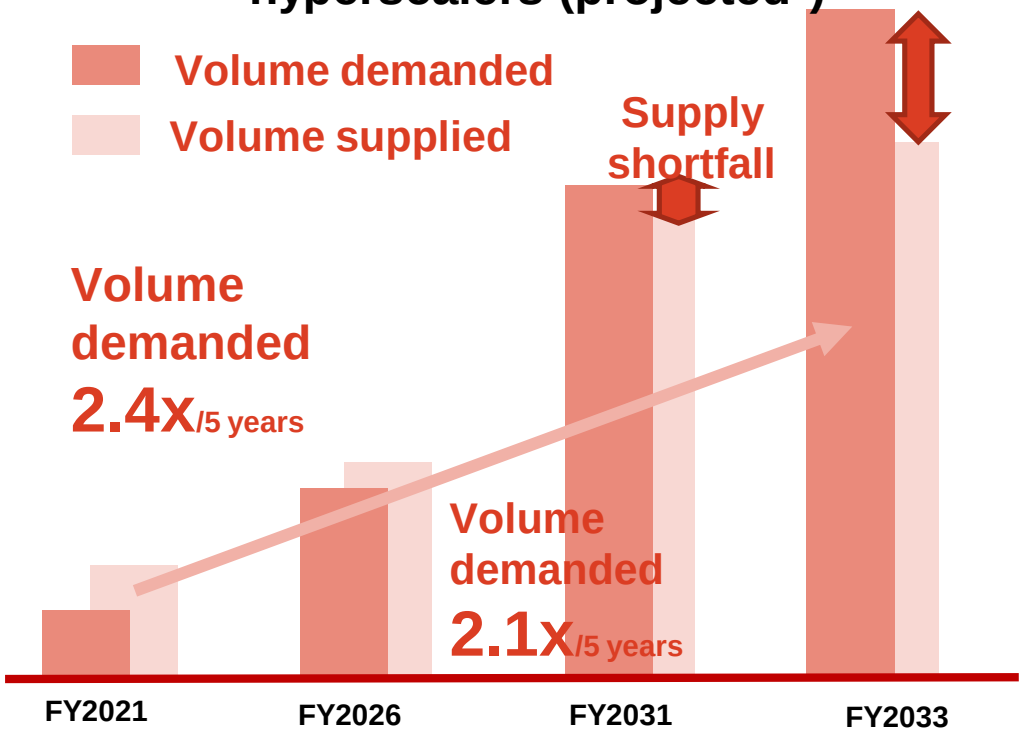
Power consumption of data centers



Source: Center for Low Carbon Society Strategy, Japan Science and Technology Agency

DCs already face the risk of supply shortfalls. In urban areas in particular, both locations and power supplies are in short supply, and development of new DCs is being blocked in some places.

Demand-supply gaps for DCs using hyperscalers (projected*)



* Fuji Chimera Research Institute: estimated based on domestic demand forecasting

Netherlands (Amsterdam)

- 2019 – 2020
  Temporary ban on DC development
- 2022 (summer)
  Nine-month ban on hyperscaler DCs issued

Singapore

- DC power consumption made up 7% of total power consumption in 2020
- Second quarter of 2022 onwards
  Moratorium (temporary ban) on new DC constructed lifted

Ireland

- DCs' power consumption forecast to reach 31% of total power demand by 2030; policies currently under consideration.

Escalating Global Situation and Social Issues

Food Loss

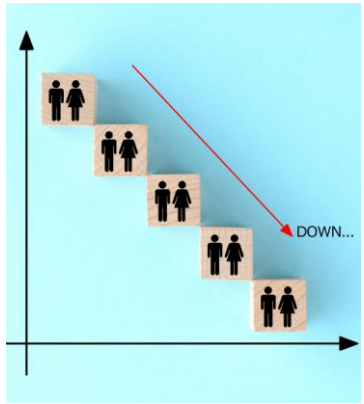
Out of the food produced globally,
40% or 2.5B tons
is being discarded

Clothing Waste

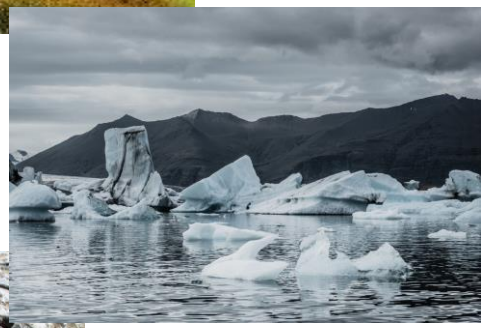
In Japan, **out of 2.9B** garments produced annually, **1.5B** garments are discarded

Declining Birthrate /Aging Population

Labor Shortage



Environment/Energy

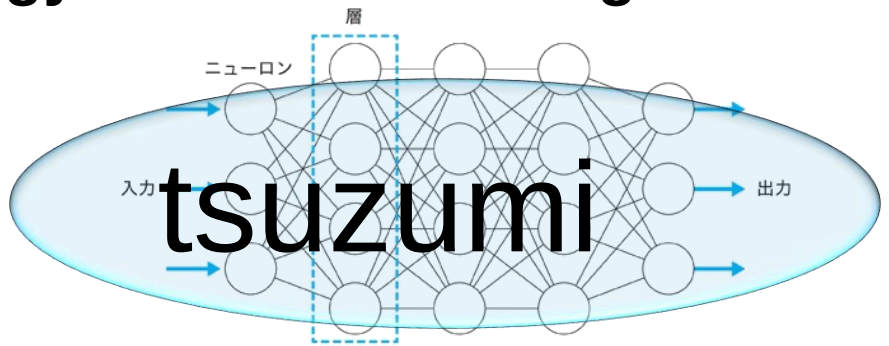


Beyond 5G

Reduce power consumption dramatically through technology
Achieve both efficiency and value creation

"Transmission" × "Data Processing" × "AI Models"

Optical Technology | **Electronic Technology** → **Optical Technology** | **Natural Language Processing**



Improve power efficiency, processing efficiency, and learning efficiency

Beyond 5G Era

Through the evolution of technology,

we aim to realize
an “**Earth- and People-Friendly Social Well-Being**,”

where diverse people can live
healthily and happily,
while resolving social challenges

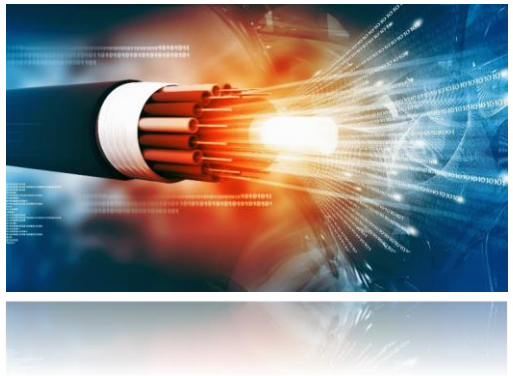
Beyond 5G era

IOWN ACCELERATION

From Vision to Realization

Transmission

Optical technology



2023.3.16

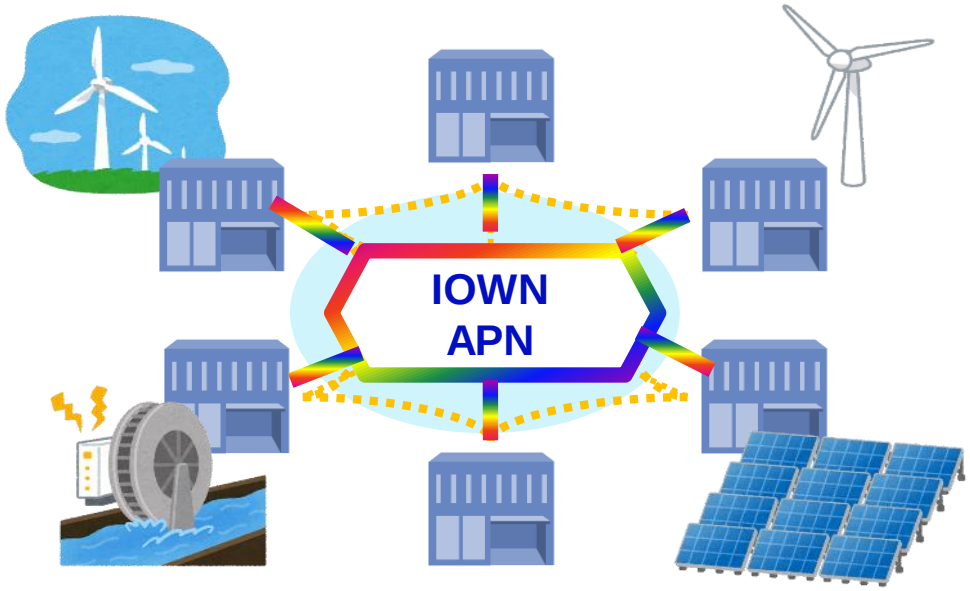
APN IOWN1.0

Start of services

IOWN enables distributed networks of DCs

DCs can be located up to 100km apart and connected with low latency
(Distances are limited to 60km when only traditional systems are used)

Distributed DCs



Distributed network of small/medium DCs; can work with “local power for local consumption”

Creating distributed data centers - Implementing APN between Data Centers in overseas markets

- In order to promote distributed data centers, we plan to conduct APN connection tests in the U.S., U.K. and Japan
- It will be possible **to operate data centers approx. 100 kilometers apart as if they were a single data center**
- In the future, we will also begin testing in other areas beyond the U.S. and U.K.

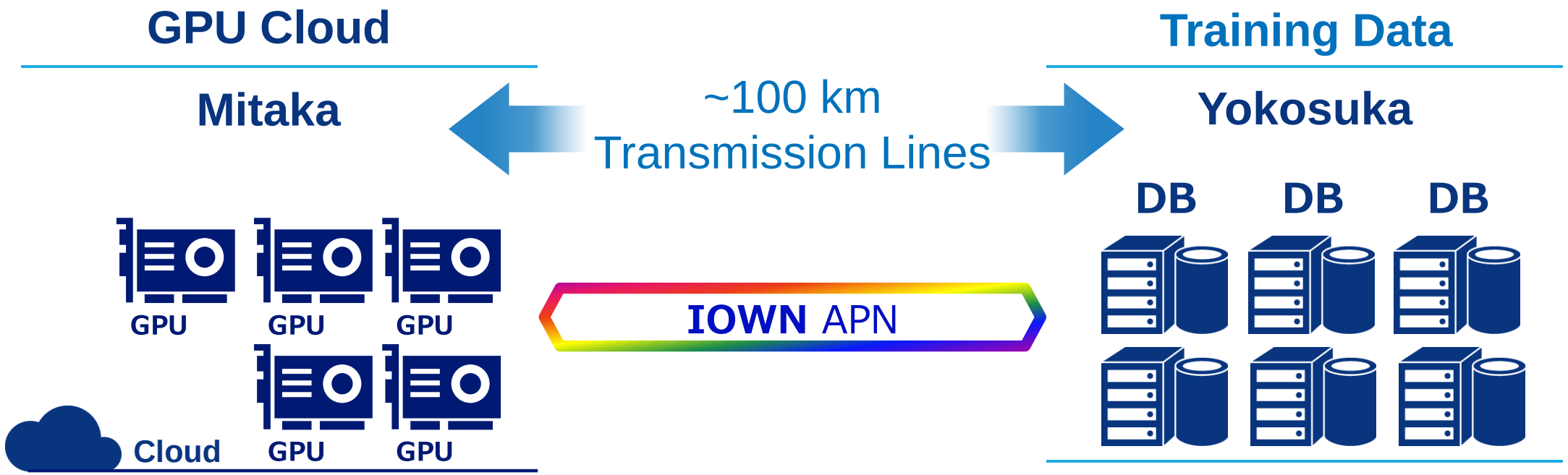
【UK】Hemel – Dagenham

【USA】Ashburn

Scheduled to Complete Test Implementation in the U.S. and U.K. (within FY2023)

Creating distributed data centers – Remote training environment through APN×LLM

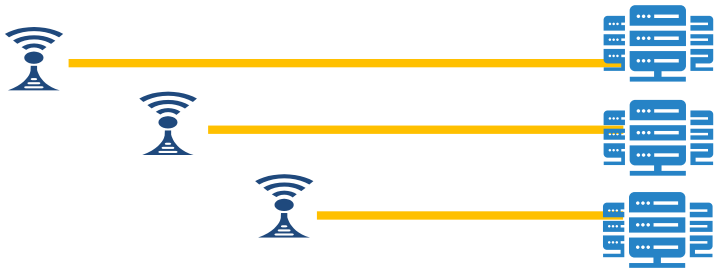
- Using APN to develop a remote LLM training environment
- Keep training data nearby and use GPUs in data centers located hundreds of kilometers away
- **Able to create a secure, low-latency LLM training environment comparable to being local**



Mobile Fronthaul over APN

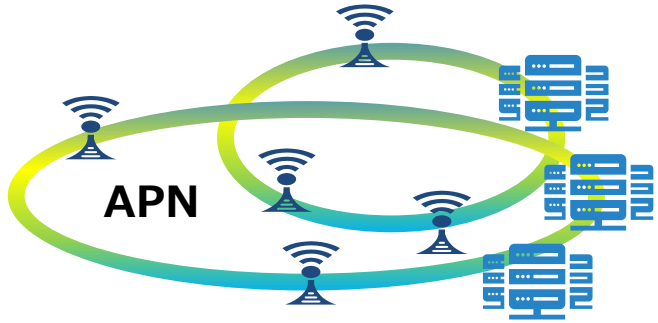
Today's mobile network

Antennas (RUs) are connected to independent dark fibers.



Mobile fronthaul over APN

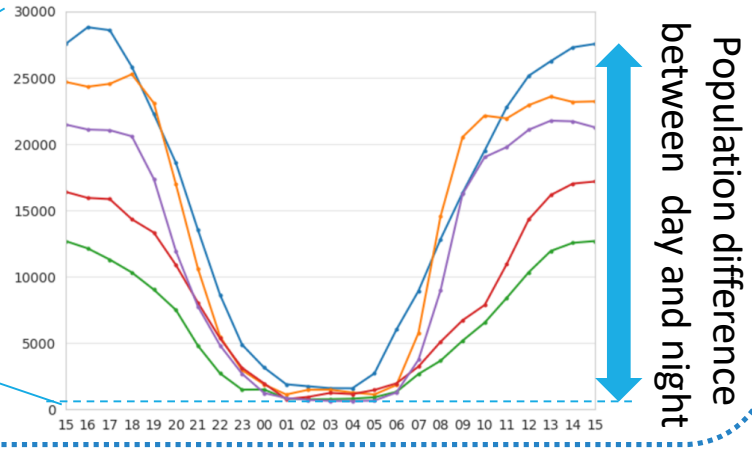
Antennas (RUs) & servers (DUs) are integrated by APN.

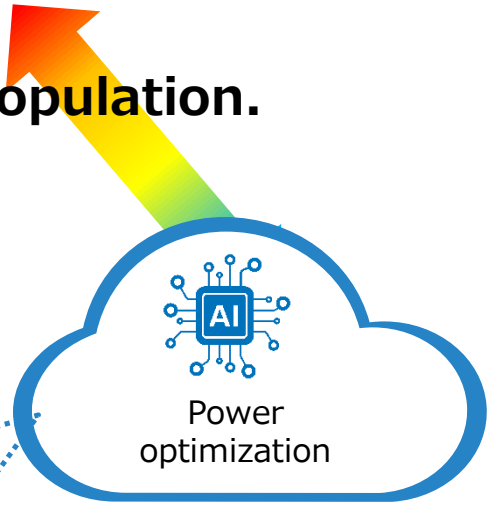


Optimizes energy consumption in response to changes in area population.

Service area

Changes in area population（hour）





Remote operation of construction equipment through IOWN

- Utilizing APN for the remote operation of construction machinery systems, which is being increasingly utilized in the construction industry
- **Able to achieve an operating environment close to on-site operation** by using a high-volume, low-latency and stable connection

(Tokyo, Musashino)

EARTHBRAIN × NTT

APN + Wireless

(Chiba, Mihama)

JIZAIE, Takenaka Corporation × NTT

"TawaRemo®" Tower Crane Remote Control System
(jointly developed by Takenaka Corporation and Kajima Corporation with Actio)


(Tokyo, Musashino)

APN

Work at high locations where
It is difficult for wireless signals to reach


(Osaka, Sakai)

Osaka Expo

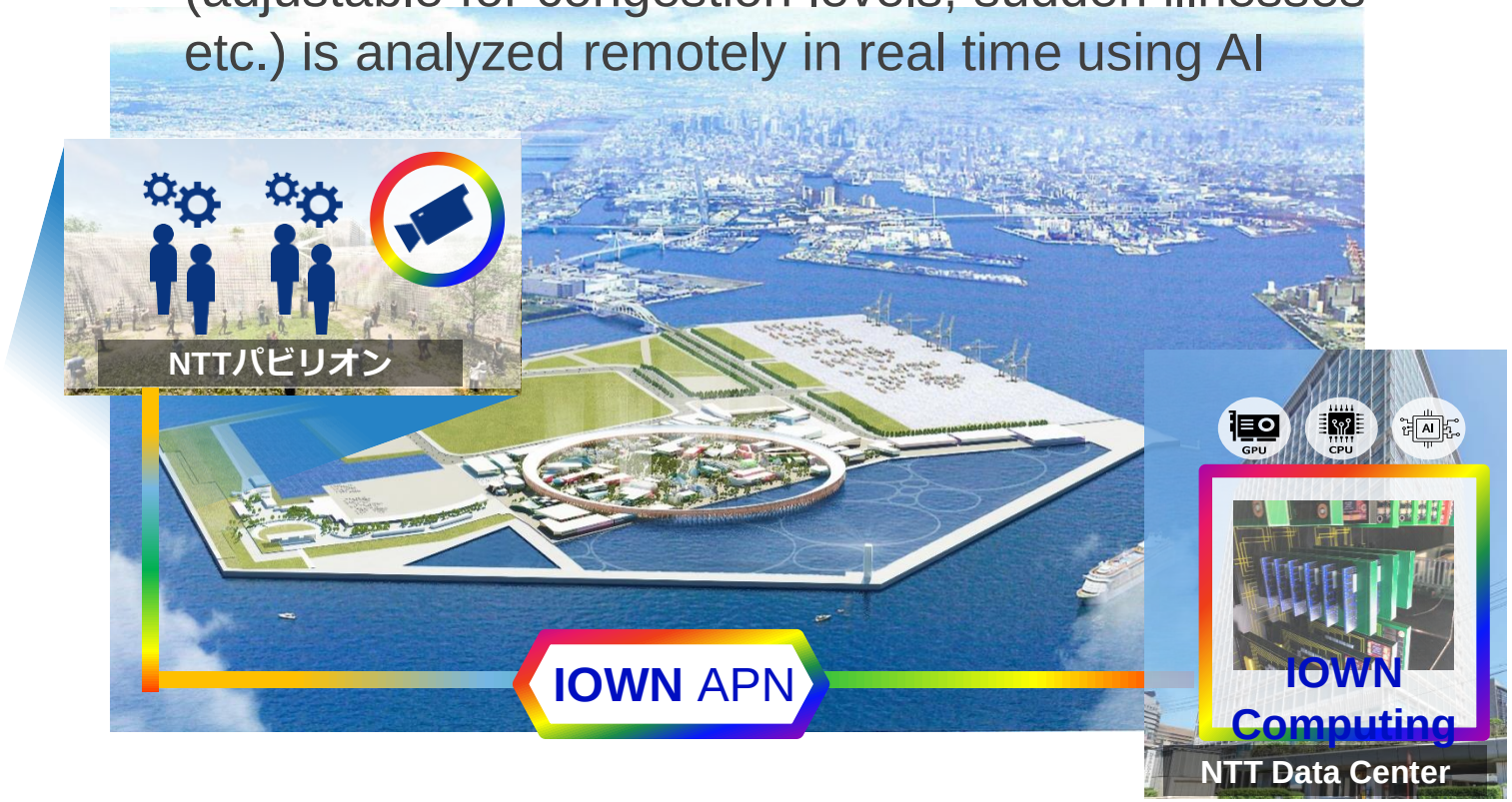
1970

NTT’s first cordless phone

2025

We are transmitting the IOWN APN space

The information for the NTT Pavilion venue (adjustable for congestion levels, sudden illnesses etc.) is analyzed remotely in real time using AI



Beyond 5G era

IOWN ACCELERATION
From Vision to Realization

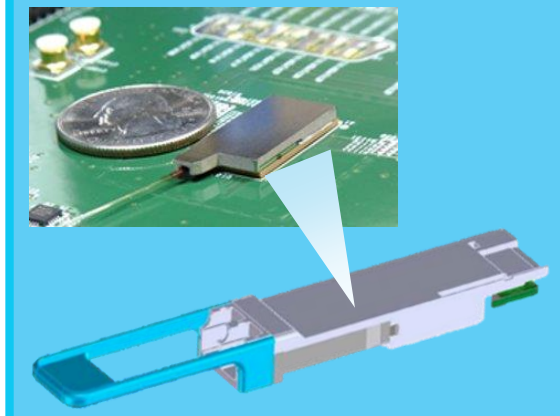
Data processing

Electronic technology → Optical technology

IOWN 2.0

Roadmap for Photonics-Electronics convergence devises

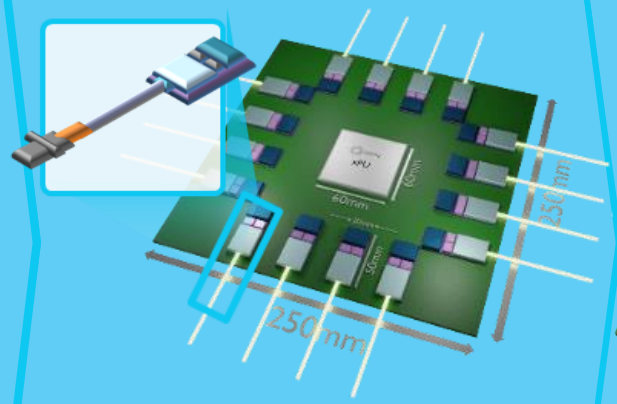
FY2022-



Interconnection

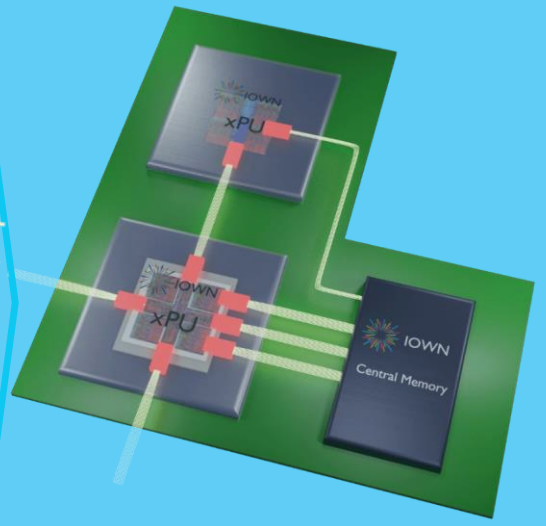
FY2025-

Optical engine



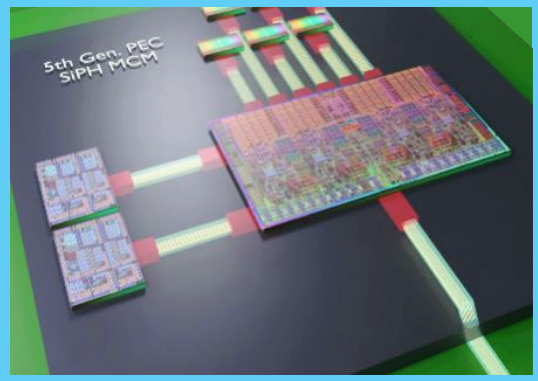
Inter-board connection devices

FY2028-



Inter-chip connection devices

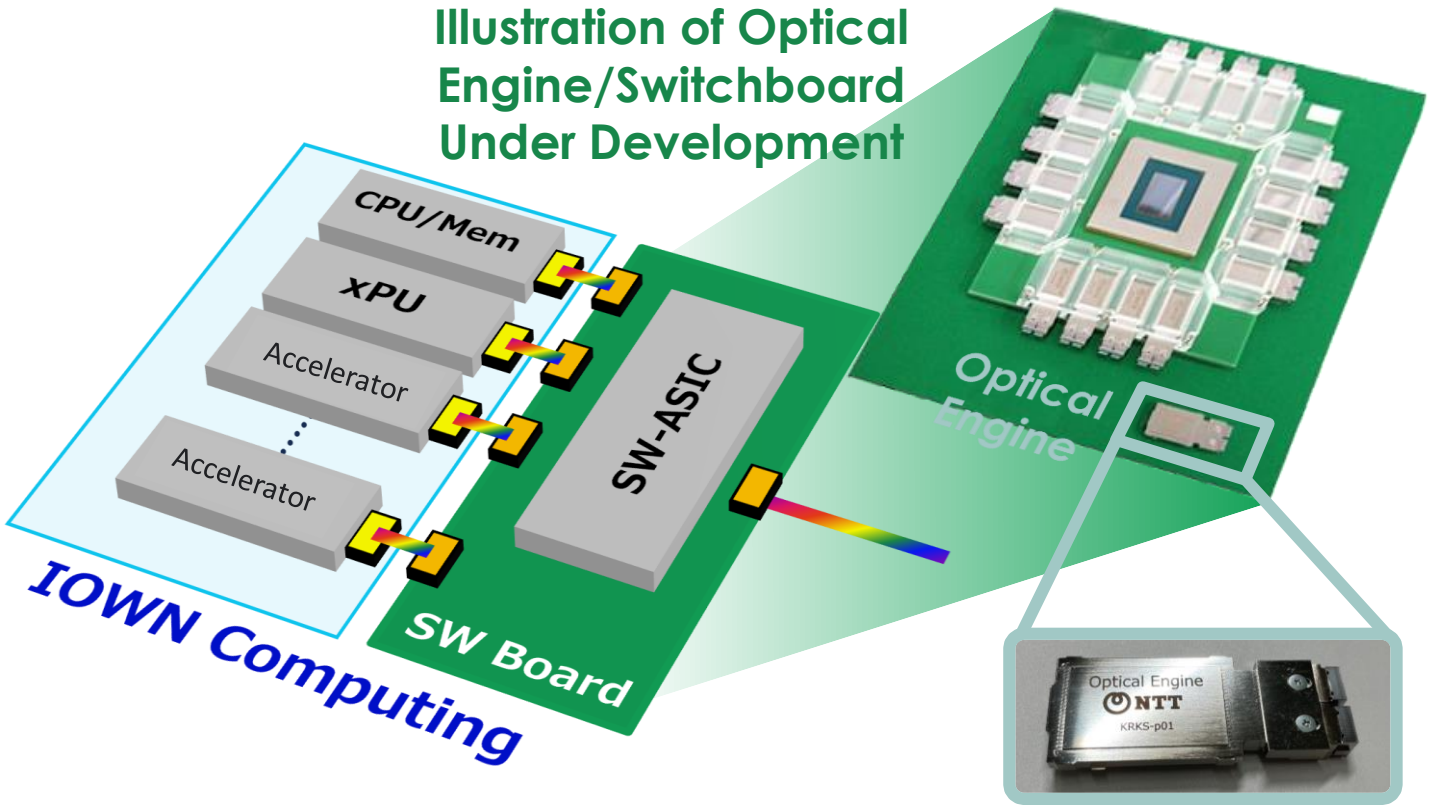
FY2032-

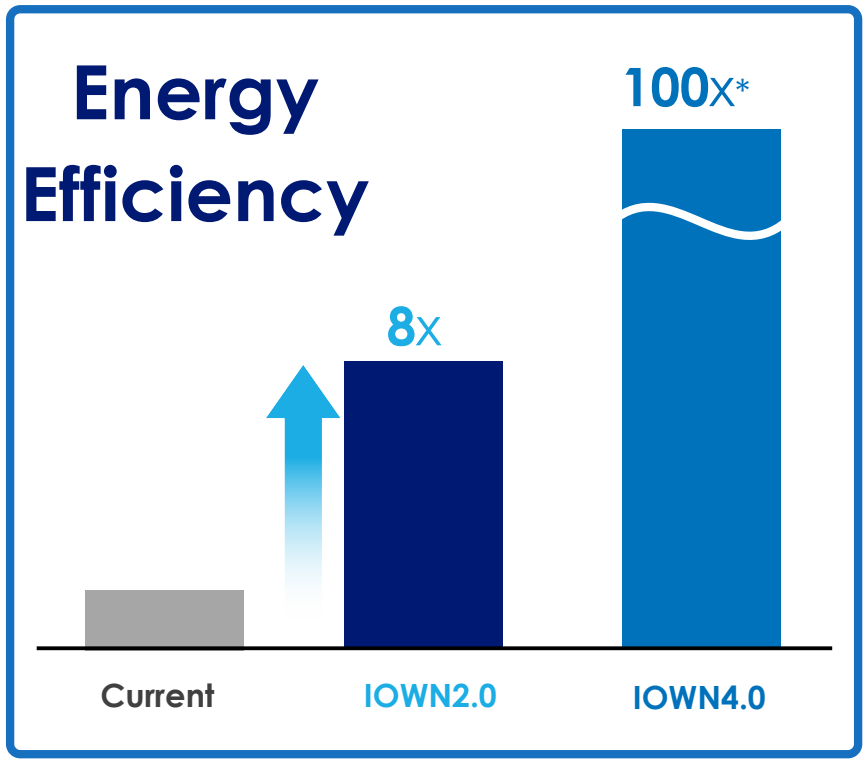


Optical Intra-chip connection

IOWN2.0 - Optical Based Computing

- **Developing a high-capacity, low-power consumption compact optical processing engine that will open up new possibilities in the world of computing**
- Connecting xPU and memory optically instead of electrically to achieve ultra-low-power-computing
- In process of conducting tests for commercial implementation with the launch of a switching device equipped with optical engines scheduled for FY2025



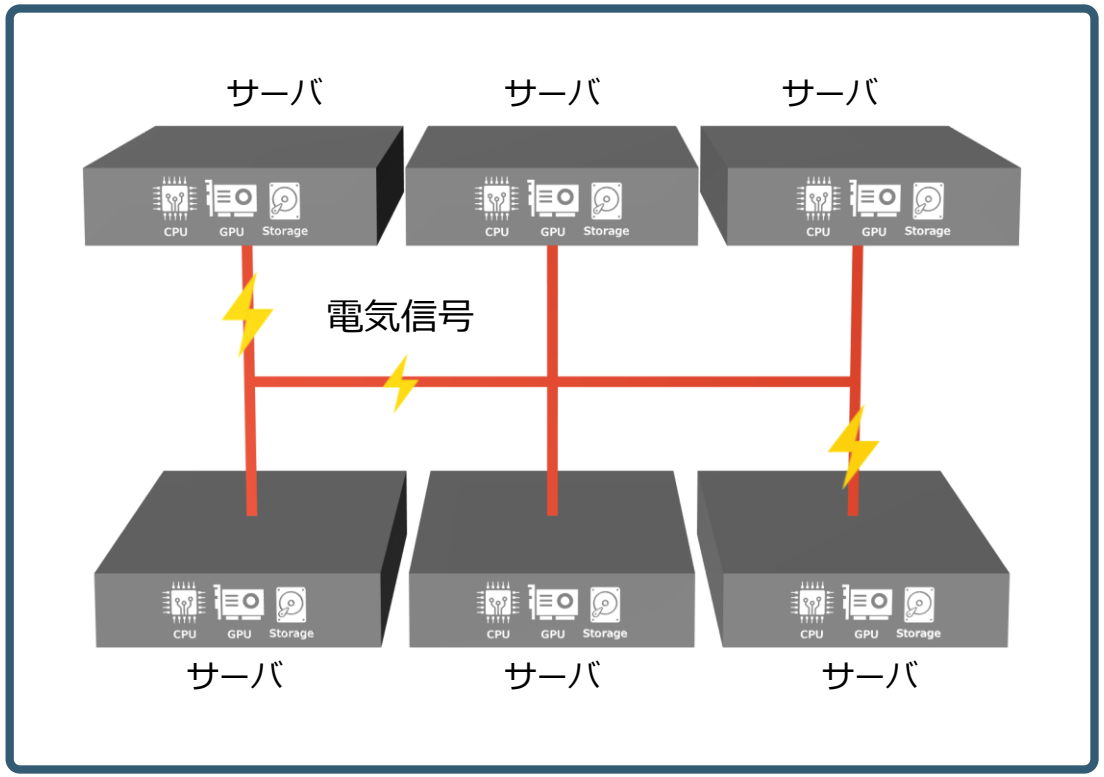


* Energy efficiency rate across the entire photonics application area, including APN and servers

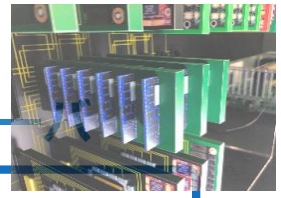
DC server using IOWN2.0

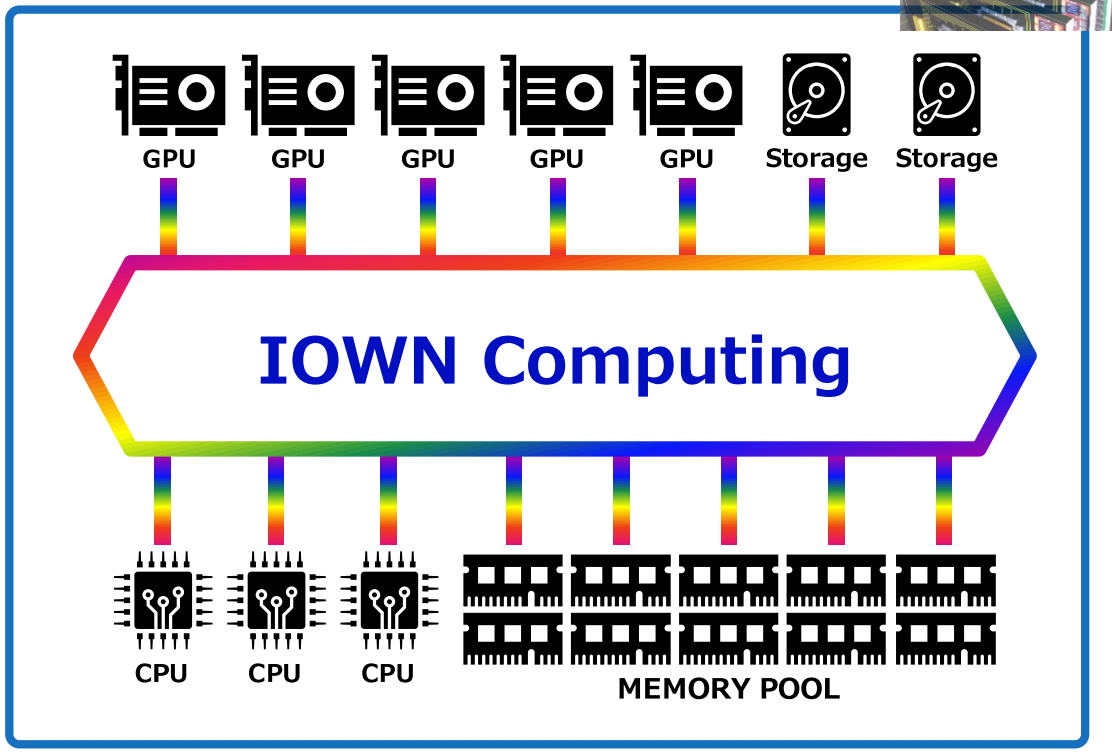
This setup switches from electrical signals to optical connections between xPU/memory/storage
It operates more efficiently due to sharing of resources(xPU/memory/storage etc.)

既存のデータセンタのサーバ



IOWN2.0を利用したデータセンタのサーバ





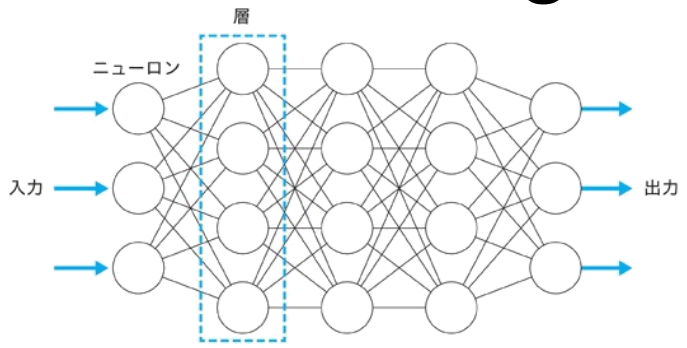
Beyond 5G era

IOWN ACCELERATION

From Vision to Realization

"AI Models"

Natural Language Processing



2024. 3

NTTLLM tsuzumi

Start of services

NTT's LLM **tsuzumi's Strengths**

1 The result of over 40 years of research on natural language processing

Japanese/English Compatible with World-Class Japanese Language Capability

2 Extremely lightweight and highly functional

High Level of Cost Performance

3 Flexible and low-cost customization, capable of learning from closed data sets

Customizable and Upgradable

4 Japan's first multi-modal (capable of reading and understanding charts and tables)

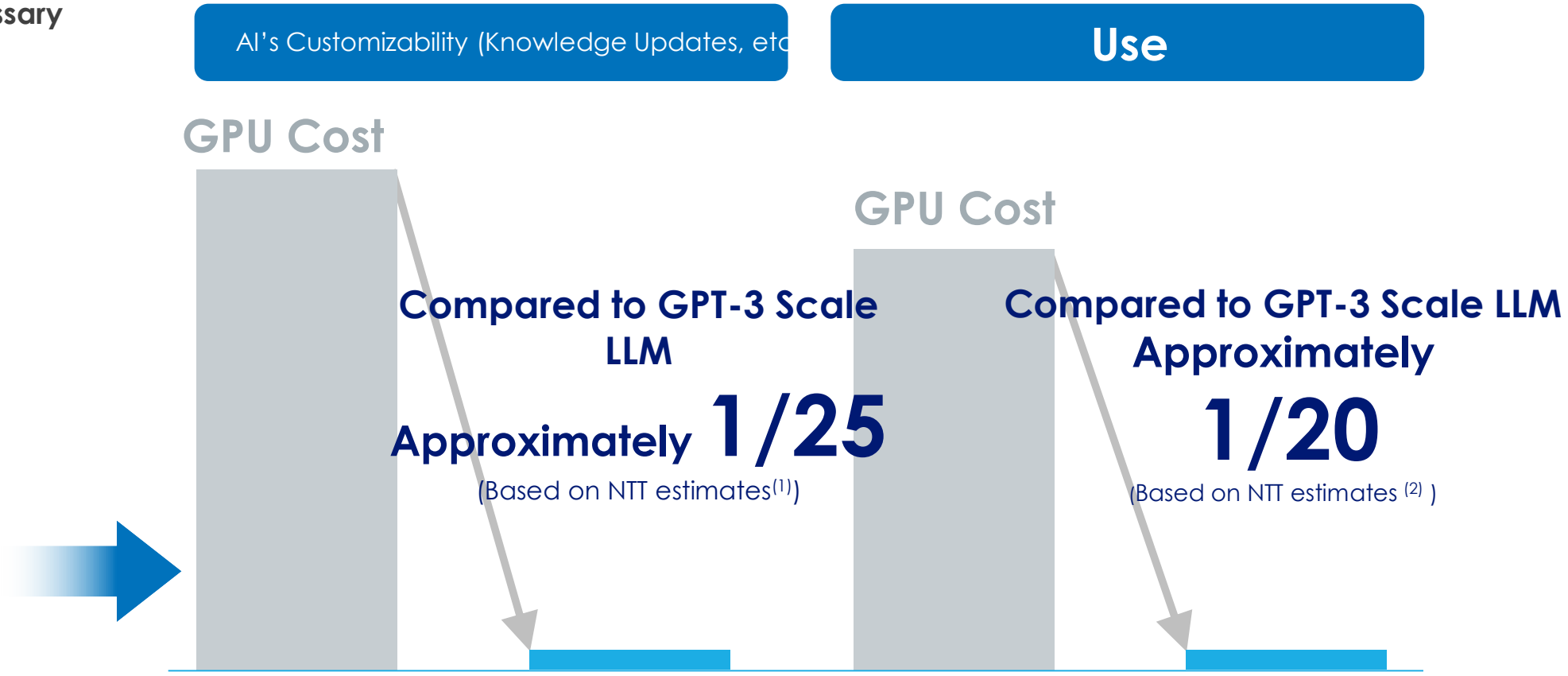
Capable of Reading a Wide Variety of Input Modes

High Level of Cost Performance

- Achieves high capability while reducing hardware costs necessary for the implementation and operation of generative AI

Main cost components necessary for generative AI

- **Operation Cost** (Operators, etc)
- **Software** (the LLM, etc.)
- **Electrical Power**
- **Hardware /DC**



(1) Calculated from the parameter ratio from the same training dataset

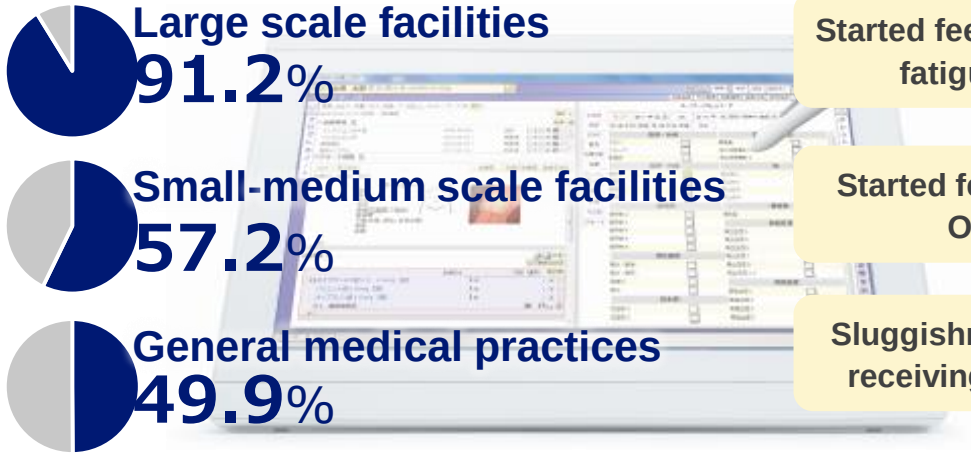
(2) Calculated from expected costs of utilized GPU models

Structured patient record data by tsuzumi

■ Speeding up Pharmaceutical Development and Personalized Healthcare Offerings

京都大学医学部附属病院 KYOTO UNIVERSITY HOSPITAL　PRiME-R　×　“tsuzumi”

Implementation % of Digital Patient Records*



- Large scale facilities **91.2%**
- Small-medium scale facilities **57.2%**
- General medical practices **49.9%**

Normal Patient Records

- Started feeling symptoms of fatigue yesterday
- Started feeling weak from October 31
- Sluggishness a week after receiving chemotherapy

Multiple records with the same meaning

tsuzumi

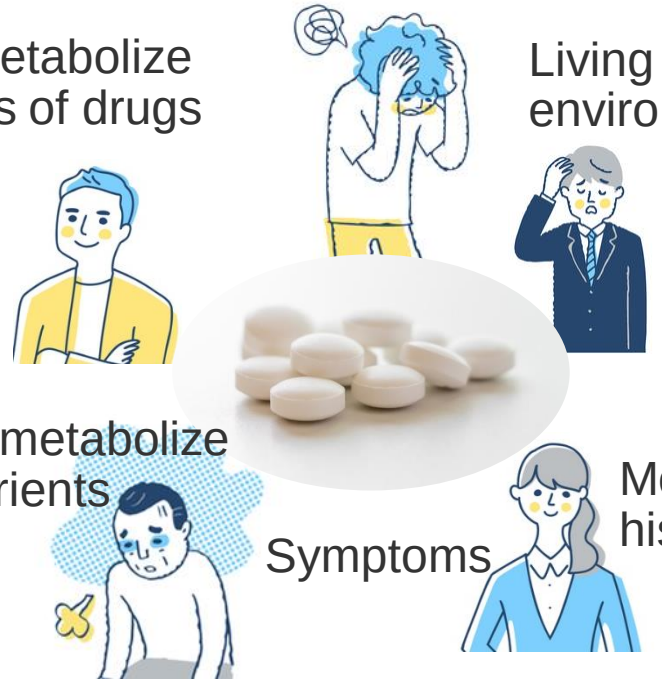
Structured Patient Record Data

	Adverse Event	Grade	Date
111	Fatigue	1	October 31, 2023
222	Fatigue	3	October 25, 2023
333	Fatigue	2	December 14, 2022

Levels of fatigue are graded
(In accordance with international standard CTCAE)

* Source: Ministry of Health, Labour and Welfare, “Changes in the status of the dissemination of digital patient records” (2020). Large scale facilities are general hospitals with over 400 beds, small-medium scale facilities are general hospitals with under 400 beds

Drug effects and side effects vary from person to person



NTTライフサイエンス　ゲノビジョン Genovision

Genetic testing
Genome analysis

Some people, in the quest to find a regimen that is suited to them, have to take multiple medications without obtaining the desired effects

Structured Digital Patient Records

Digital Patient Records × tsuzumi

Improving Quality of Life

Precision Medicine

While a patient diagnoses suitable treatment, it may be necessary to take multiple medications, many of which may not be effective.

If diagnosis is provided sooner, medications will be more effective, and costs will decrease. The medical industry can become more efficient.

Improving Pharmaceutical Development

Resolving Issues* in Pharmaceutical Development

1. **Long** research and development period (**9~16 yrs**)
2. **Low** success rates (**1/25,000**, **approximately 10%** after starting clinical trials)
3. Research and development requires a **high cost** of investment (**300.0 billion yen**)
4. **Strong international competition** = speed

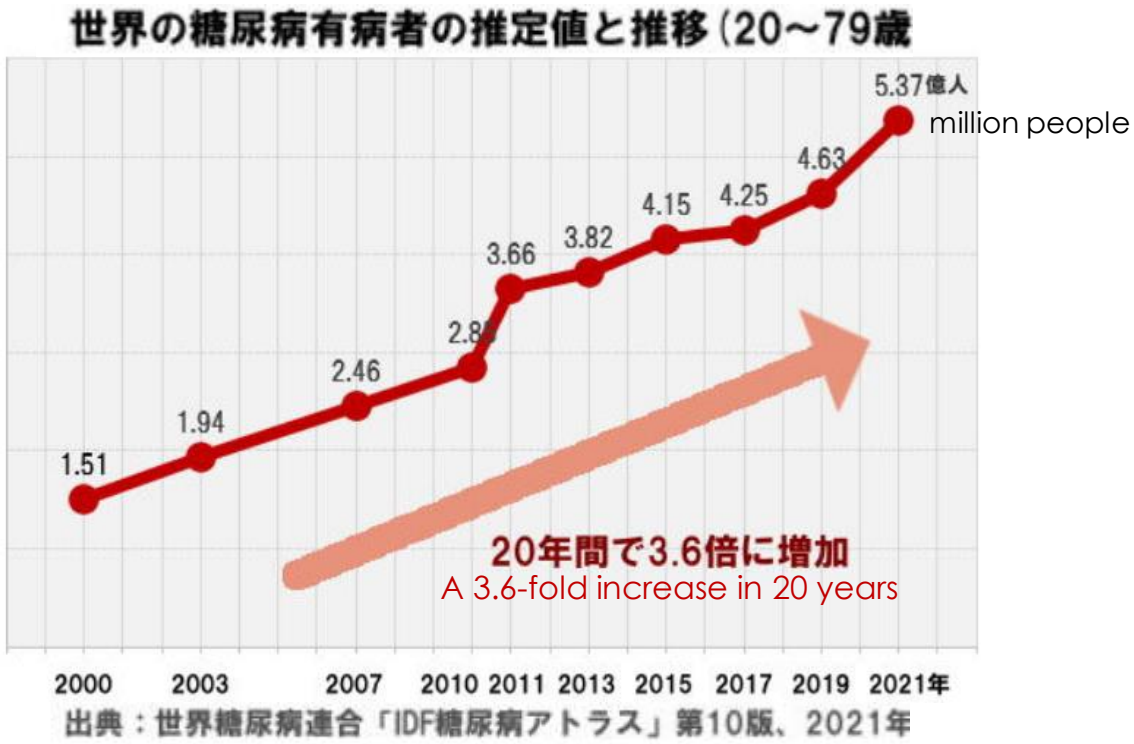
Efficient and Effective Pharmaceutical Development

* Source : Japan Pharmaceutical Manufacturers Association, "Expectations and issues with utilization of medical health data by pharmaceutical companies."

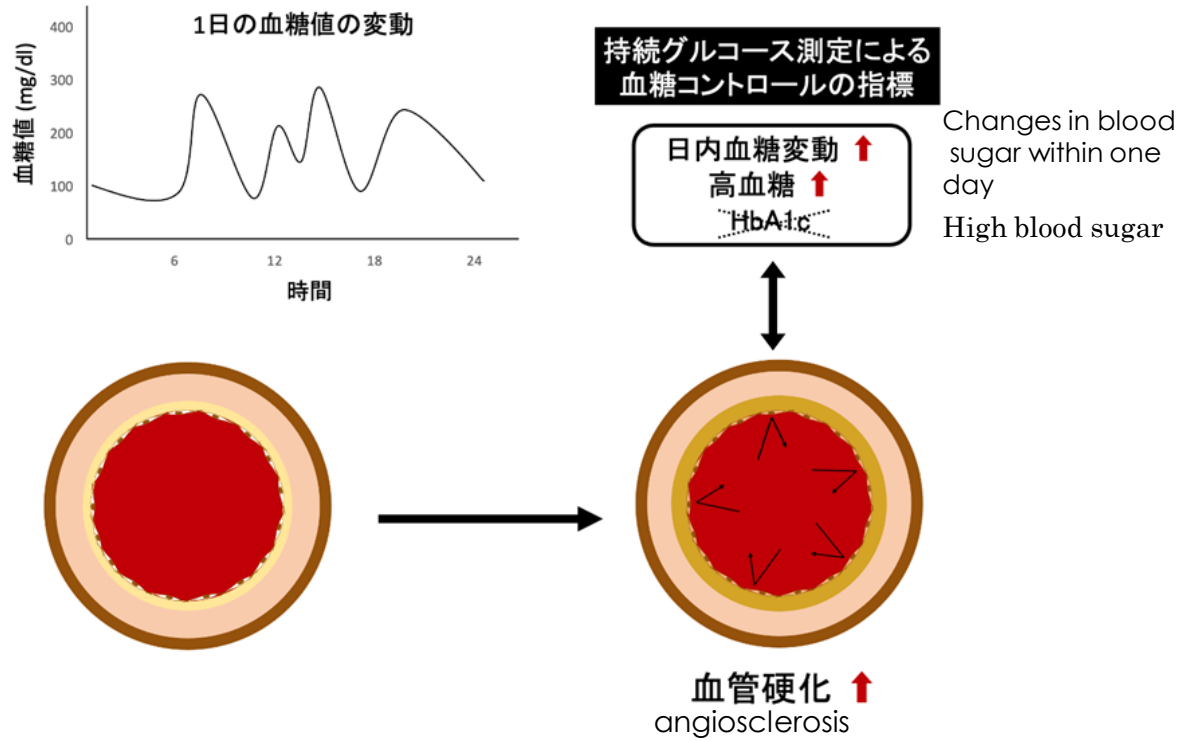
Sharp rises and falls in blood sugar raise the risk of diabetes and cardiovascular diseases.

Stabilizing blood sugar after meals reduces the risk of heart disease and cancer.
Blood sugar values have a major impact on your health in general.

Trends in estimated numbers of people with diabetes worldwide (aged 20-79)



Changes in blood sugar over one day



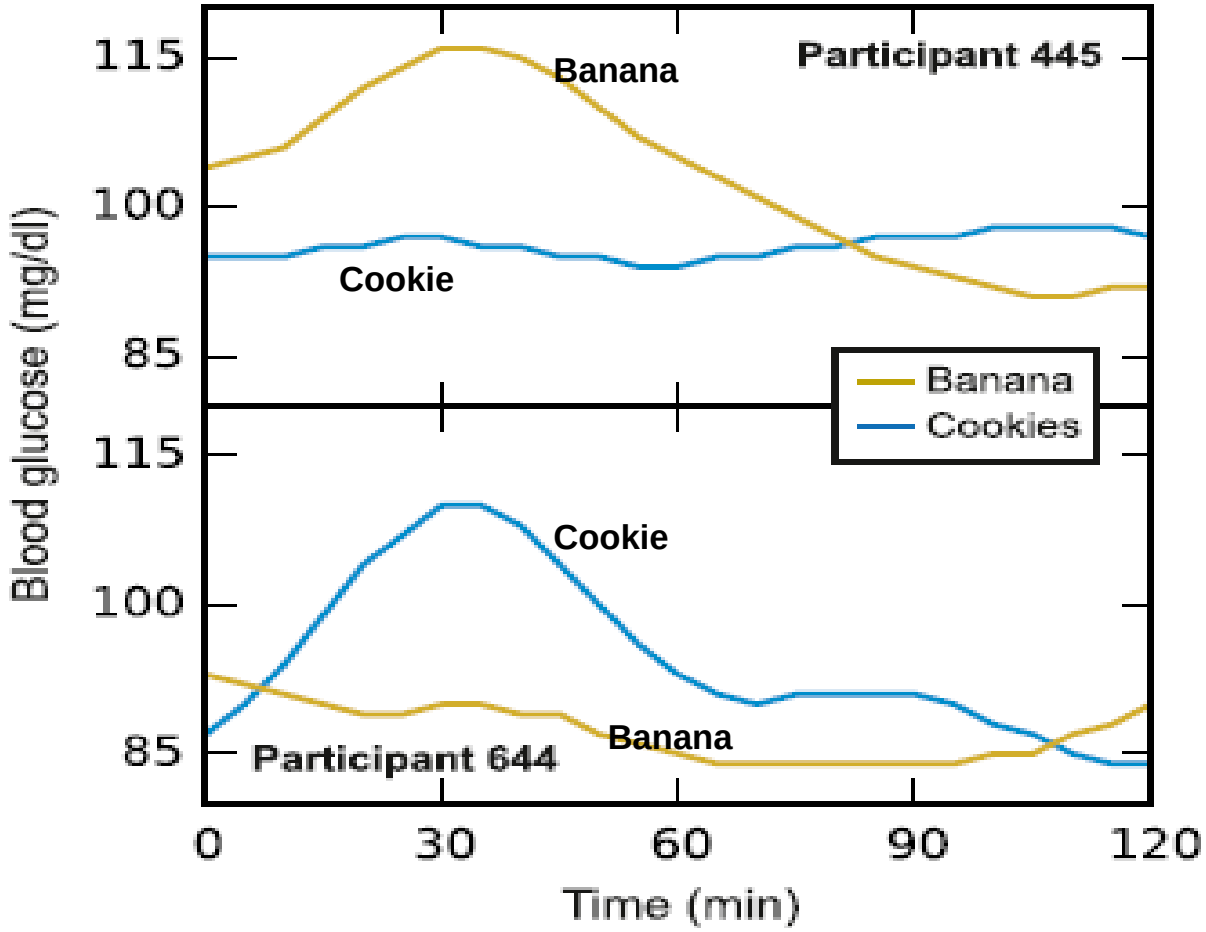
Chronically high blood sugar levels damage blood vessels generally, causing hardening of blood vessels

Question

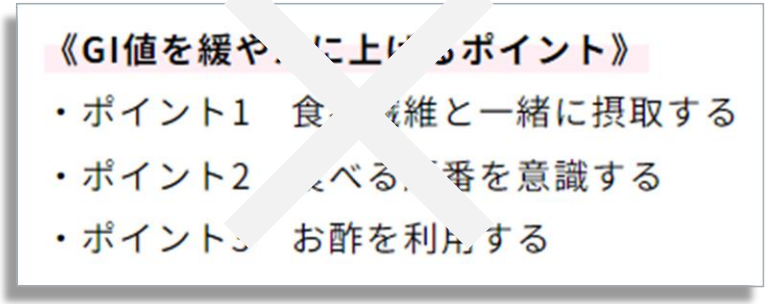
A banana or a cookie?
Which raises blood sugar levels more?

Changes in blood sugar vary among individuals even after eating the same foods

Rises and falls in blood sugar vary individually depending on genes, metabolism, age, lifestyle and microbiome (microorganisms living in the human body)



These rules (order of eating foods, dietary regimens) are based on average values, whereas in reality…

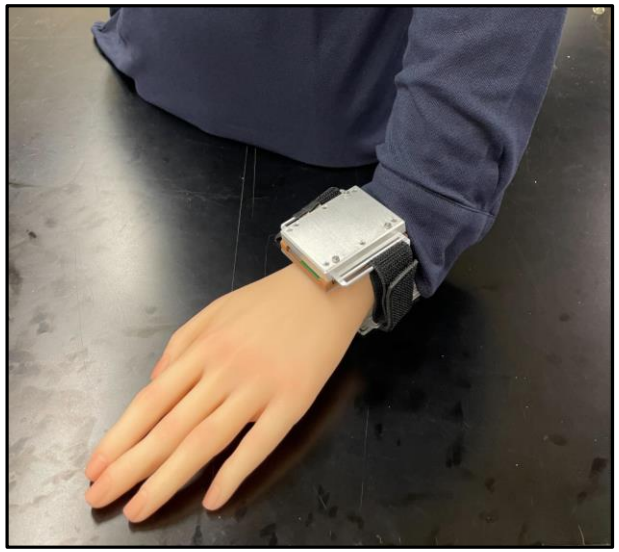


Blood sugar monitoring using a biodigital twin

This wearable device monitors blood sugar values by being worn against the skin

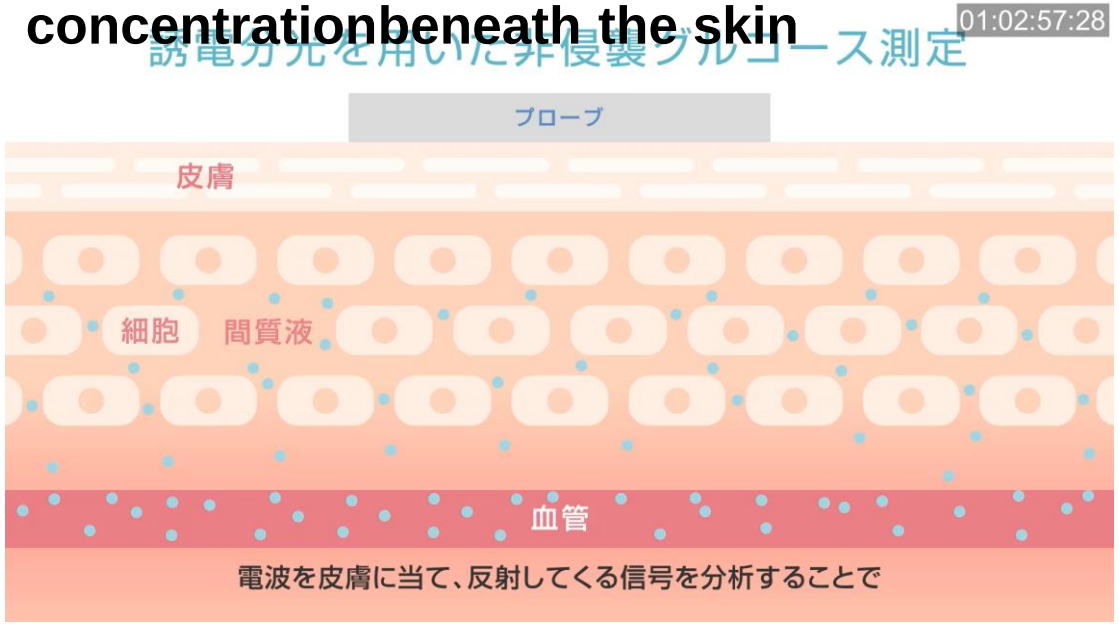
Commercially available blood glucose monitoring device

This monitors blood sugar by blood draw/pinprick



How the device is worn

As electrical waves pass through the skin, the signals reflecting this are analyzed Measurement of changes in glucose concentrationbeneath the skin



Beyond 5G era

IOWN

tsuzumi

Personalization,
visualization, optimization, energy-saving

an “**Earth- and People-Friendly**
where diverse people can live healthily and happily,

“Social Well-being”

and・・・

Go on Stage One More Time

What would you like to do if you could move your body?

As a DJ, I would like to party with the audience.

DJ MASA（Masatane Muto）

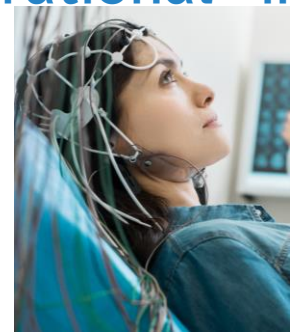
developed ALS (amyotrophic lateral sclerosis)

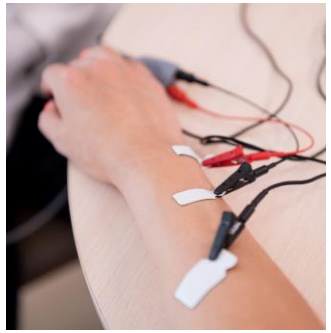
Pursuit of Well-being (Project Humanity)

- For people who are paralyzed ⇒ An avatar can produce physical expressions using motor-skill-transfer technologies(muscle movements/brain waves)
- For people with speech disabilities ⇒ Cross-lingual speech synthesis technology allows for personalized speech in multiple languages

Motor-Skill-Transfer Technologies

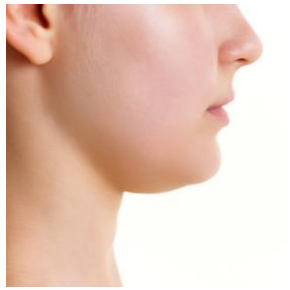
:Convert weak muscle activity into operational information to control an avatar

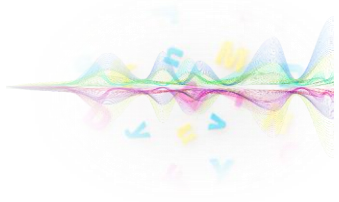


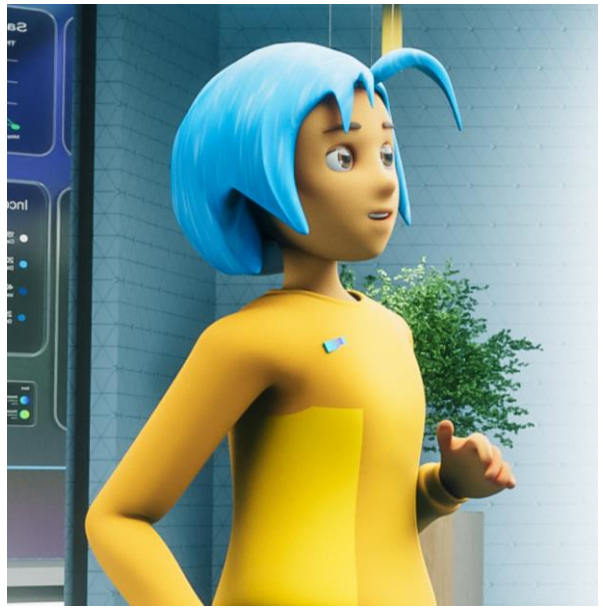


Cross-Lingual Speech Synthesis Technologies

:Learn from past Japanese speech and generate English voices







Own Voice × Physical Expression


NTT
docomo

IOWN Global Forum Members

Sponsor Members (34)

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
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Toyota Motor
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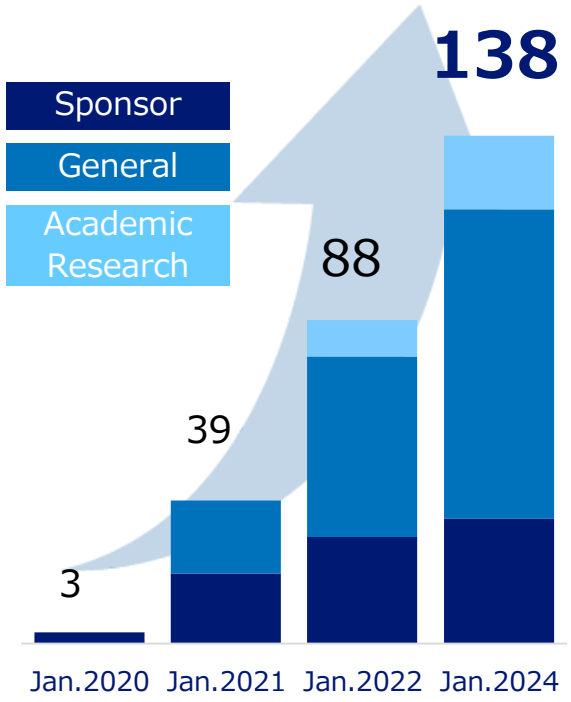
Accton Technology
Advanced Micro Devices
ADVANTEST
AGC
AIOCORE
AJINOMOTO
ANRITSU
APRESIA Systems
Avago Technologies
CommScope
Dai Nippon Printing
Dentsu Group
DriveNets
East Japan Railway Company
e-solutions.inc
EXEO Group
Fujikura
HAKUSAN
HAZAMA ANDO
Hewlett-Packard Japan
Hitachi
Honda Motor
HONDA TSUSHIN KOGYO
I-PEX
IBIDEN
Infinera
IP Infusion
ITOCHU Techno-Solutions
JGC Japan
JSR
JTOWER
Juniper Networks
JX Nippon Mining & Metals
KEL
Keysight Technologies
KYOCERA
Kyushu Electric Power Transmission and Distribution
MIRAIT
MIRISE Technologies
Mitsubishi Corporation
Mitsubishi Chemical Group
Mitsubishi Heavy Industries
Mitsubishi Research Institute
Mitsui Chemicals
Mitsui Knowledge Industry
Murata Manufacturing
NetApp
Net One Systems
NGK Insulators
NIPPON STEEL Chemical & Material
NISSHO ELECTRONICS
Nissan Chemical
Nitto Boseki
NVIDIA
OKI Electric Industry
Olympus
OPTAGE
Panasonic Holdings
Peers
Preferred Networks
ProteanTecs
Qualcomm
Renesas Electronics
RICOH
Santec
SCSK
SENKO Advanced Components
Shin-Etsu Chemical
SHINKO ELECTRIC INDUSTRIES
SKY Perfect JSAT
Sompo Holdings
SUMITOMO BAKELITE
SUMITOMO CHEMICAL
Sumitomo Corporation Kyushu
Taisei
TBS Holdings
TELEFÓNICA
Tokio Marine & Nichido Fire Insurance
Toppan
Toshiba
Toyo Ink SC Holdings
UNIADEX
VIAVI Solutions
Yazaki

Academic or Research Members (20)

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
Nagoya 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
Shiga University
Taiwan Association of Information and Communication Standards (TAICS)
Tohoku University
The University of Tokyo
Waseda University



As of January 8, 2024

Realization by beyond 5G Social Well-being is just around the corner

Innovating a Sustainable Future for People and Planet