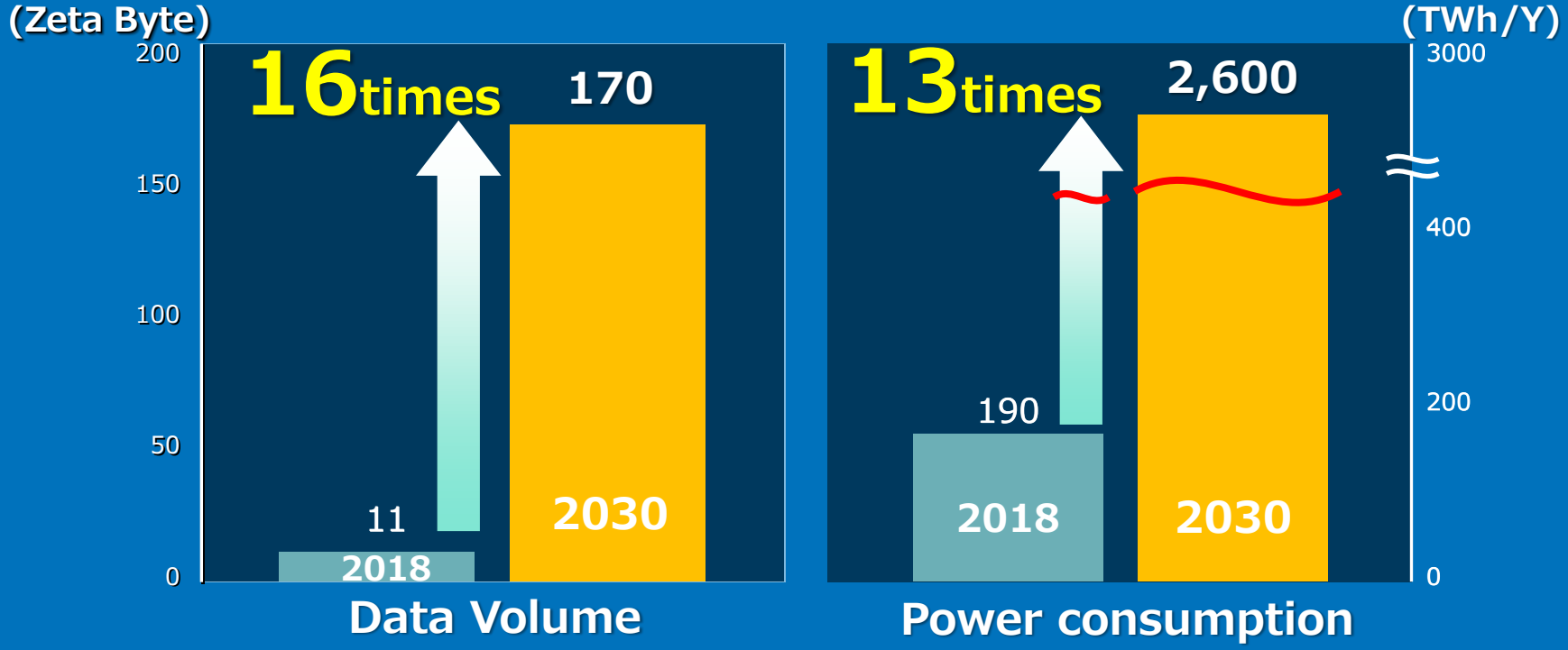
From Electronics to Photonics: Toward Innovations that Break Limitations

December 11, 2024

Yuji Maeda, Ph.D.
NTT Space Environment and Energy Laboratories

Global datacenter data volume & power consumption

AI will accelerate the increase in power requirements



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

Energy required to learn LLMs

Training in the scale of GPT-3(175B) requires a massive amount of energy.

Ca. 1300MWh[1] /per training session

1000MWh from one nuclear power plant

[1] https://gizmodo.com/chatgpt-ai-openai-carbon-emissions-stanford-report-1850288635

Breakthrough Innovation

IOWN

Innovative Optical and Wireless Network

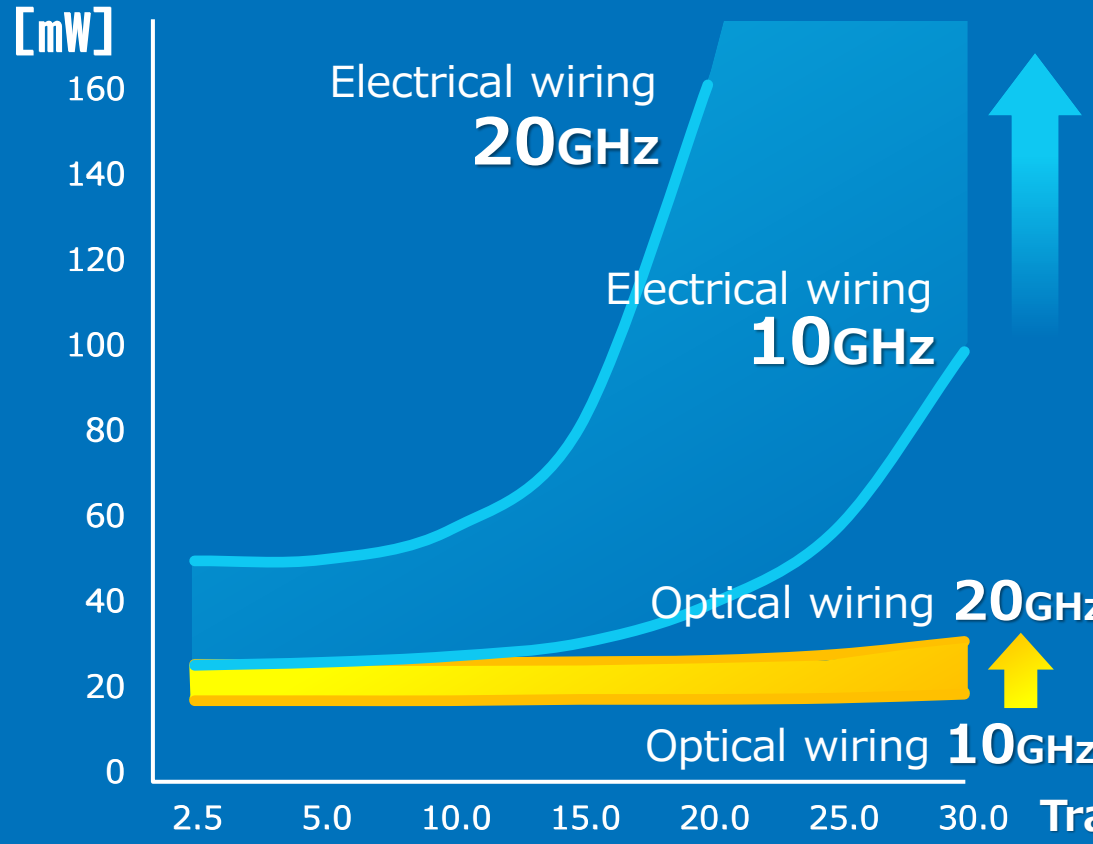
Electronics to Photonics

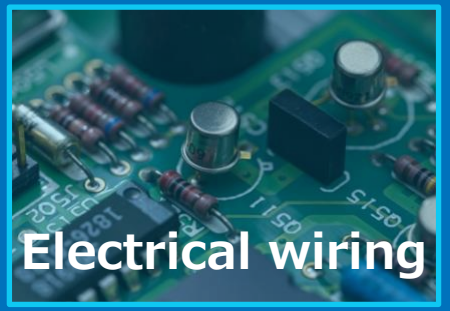
“Transmitting” by Photonics Technology	“Data Processing” by Electronics Technology

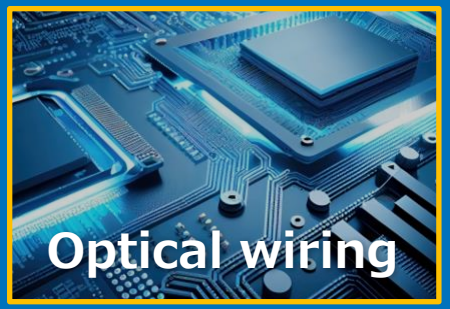
Combination of photonics & electronics for next gen computing

“Photonics Electronics Convergence Technology”

Why Photonics?







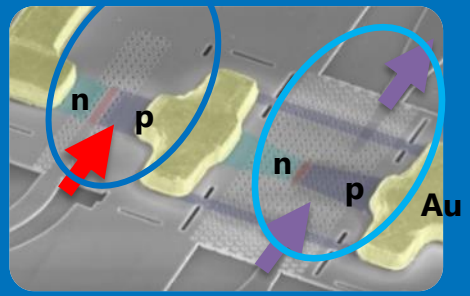
Source: Material from NEDO Optoelectronics Symposium (June 16, 2015)

Improvements of Photonics technologies

(NTT labs.)

Apr. 2019

Optical transistor



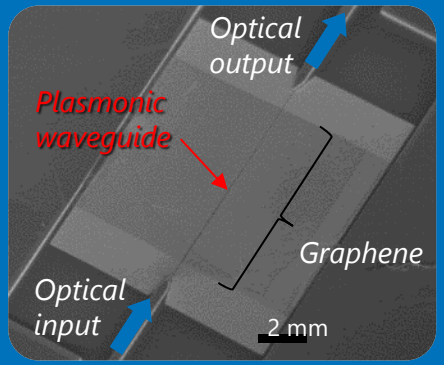
Power consumption 94%reduced

Published in:

Nature Photonics

Nov. 2019

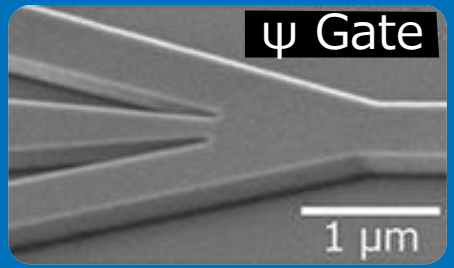
All-optical switch



Nature Photonics

Mar. 2020

Optical logic gate



Communications Physics

Oct. 2020

Directly modulated laser

Nature Photonics

IOWN is an answer

Increasing data volume

Increasing power consumption

Need for low latency

IOWN

Innovative **O**ptical and **W**ireless **N**etwork

IOWN target performance (By FY 2030+)

High-capacity/ high-quality	Low-power consumption	Low latency
Transmission capacity*2	Power efficiency*1	End-to-end latency*3
125-times	**100-times**	**1/200**

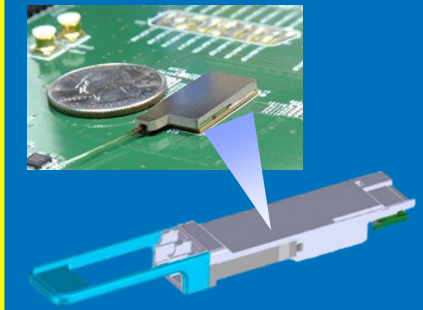
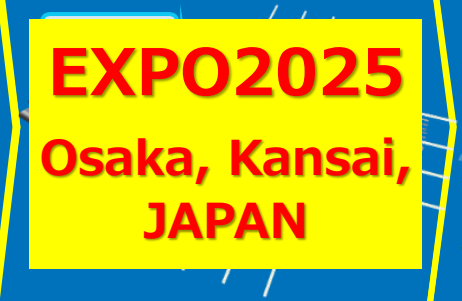
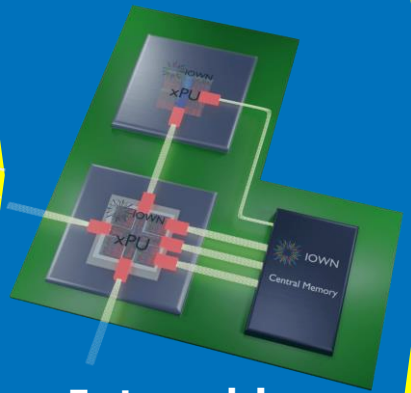
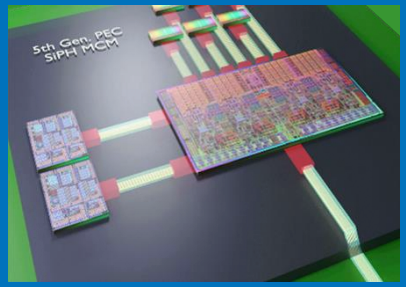
1 Target power efficiency of the parts to which photonics technology is applied.

2 Target communication capacity per optical fiber cable

3 Target latency for video traffic within the same prefecture, requiring no compression processing.

Roadmap

- Photonics Electronics convergence devices -

CY2023-	CY2025-	CY2028-	CY2032-
IOWN1.0	**IOWN2.0**	**IOWN3.0**	**IOWN4.0**
	Optical engine 		
DC – DC Connection	**Inter-board connection**	**Inter-chip connection**	**Optical Intra-chip connection**

Network evolution by IOWN

Up to now

All-Photonics Network (APN)

WSS: Wavelength-selective switch

IOWN Disaggregated Data Center

Global Data Center Interconnection

United Kingdom

Latency	**0.893** msec
Jitter	**0.035** µs

India

Latency	**Being measured**
Jitter	**Being measured**

United States

Latency	**0.062** msec
Jitter	**0.045** µs

World's first International APN Connection

Only 17 msec latency between Japan and Taiwan of 3,000 km away

Innovating a Sustainable Future for People and Planet