

Fujitsu All Photonic Network Vision v2

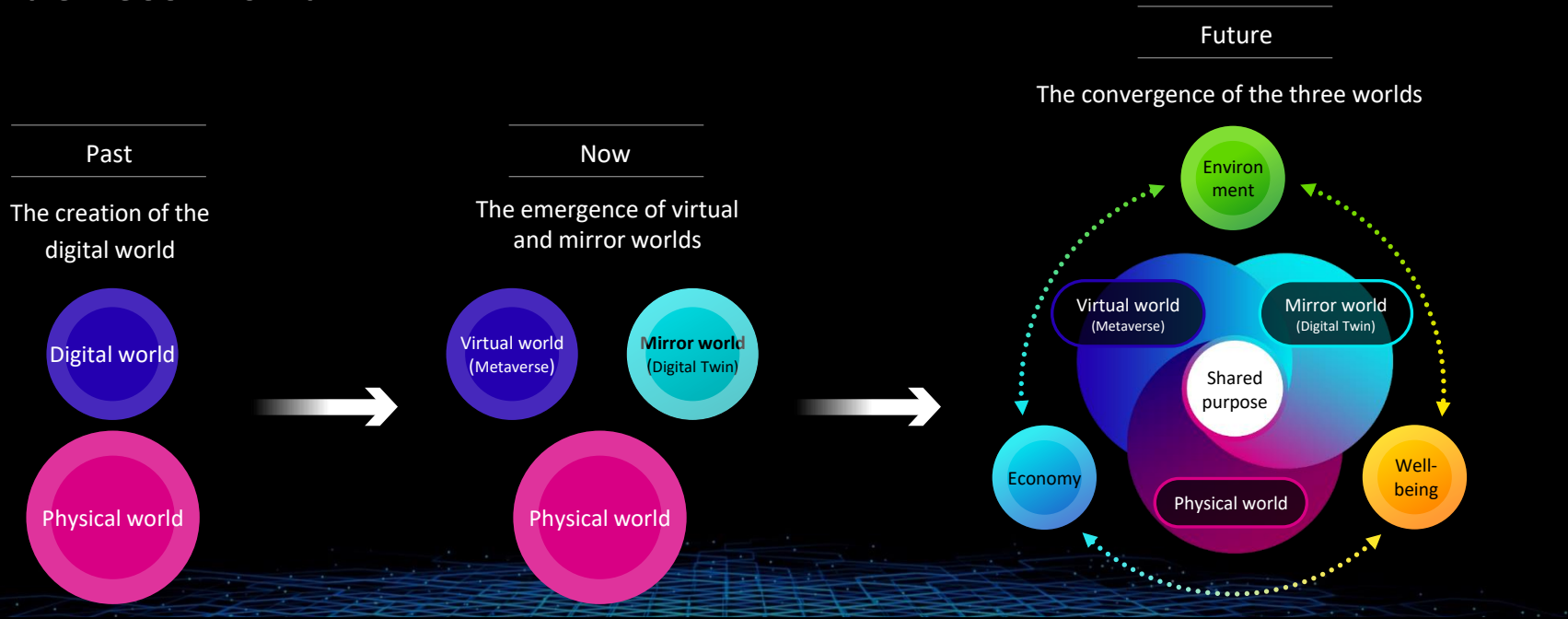


Our purpose

Make the world more sustainable by building trust in society through innovation.



A borderless world



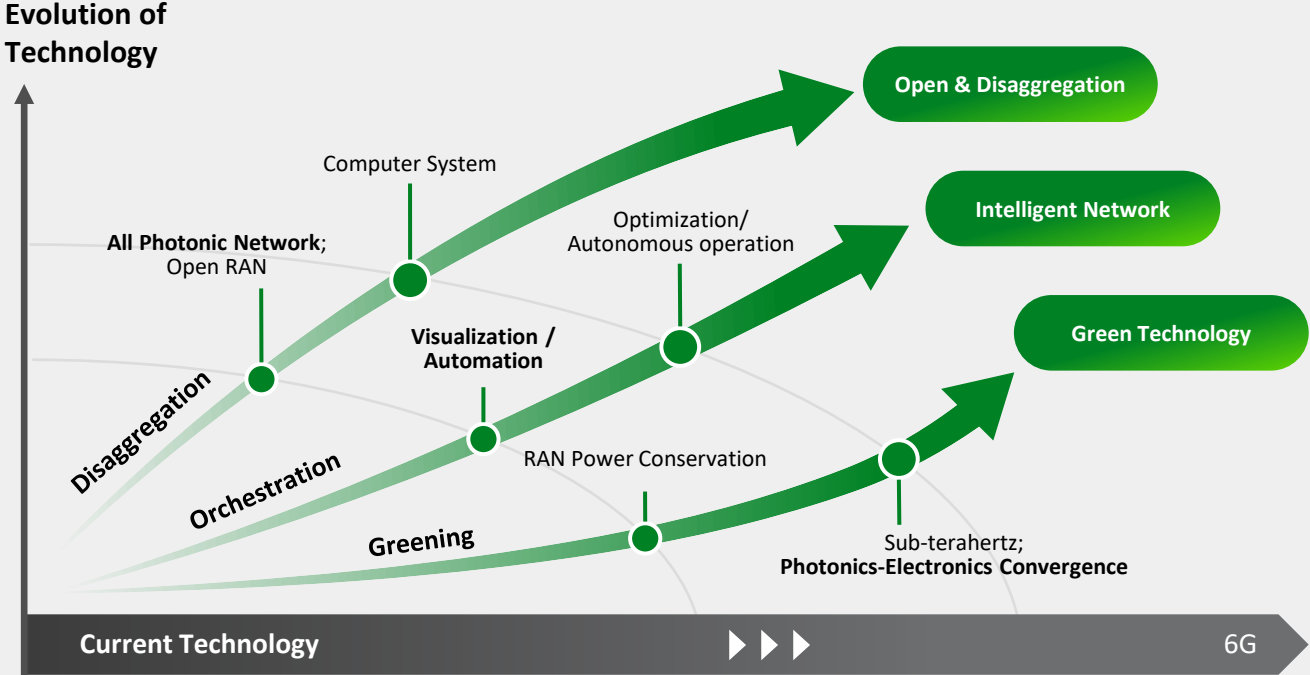
- The virtual world can enable more inclusive experiences for everyone
- The mirror world has the potential to enhance the resilience of our physical world.
- The physical, virtual and mirror worlds will gradually merge. This will create a seamless, borderless world.

Network Architecture and Platforms

All Photonic Network

Technology Trends for Realizing a borderless world

- Deploying end-to-end fully virtualized cloud-native networks throughout the world



Open & Disaggregation

All Photonic Network, Mobile Base Stations (Open RAN), Computer System

Intelligent Network

Network Visualization, Automation & Optimization, AI/Machine Learning

Green Technology

Sub-terahertz, Photonics-Electronics Convergence (PEC), liquid-cooling Technology

All Photonic Network (APN) Concept

End to end direct optical path



Lower Power Consumption

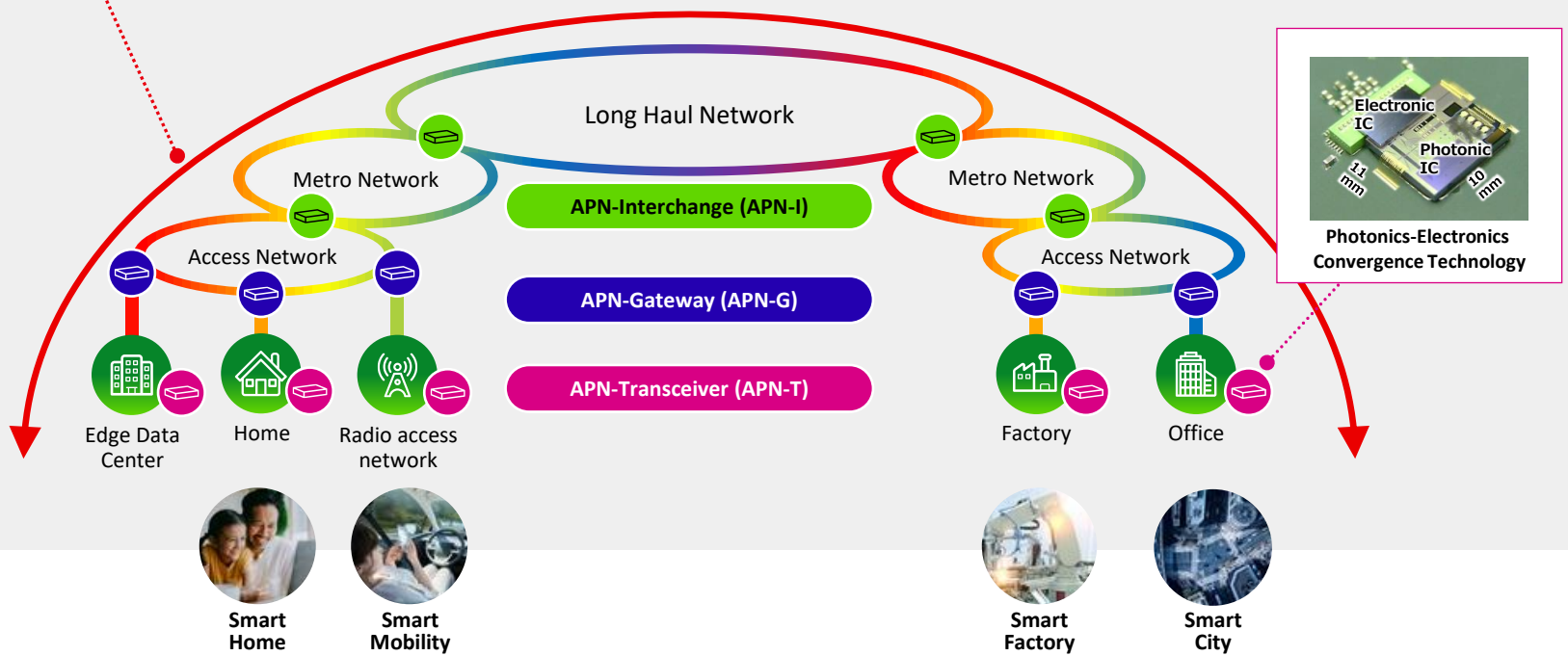


Higher Transmission Capacity



Lower end-to-end Latency

End to end direct optical path connection for lower power consumption, higher Transmission capacity and Lower end-to-end latency by APN nodes (APN-T/G/I) without intermediate electrical router and switch nodes



Future APN Vision



GA Products

PoV Products

~FY2025 5G (Enhanced)

~FY2027 6G (Trial)

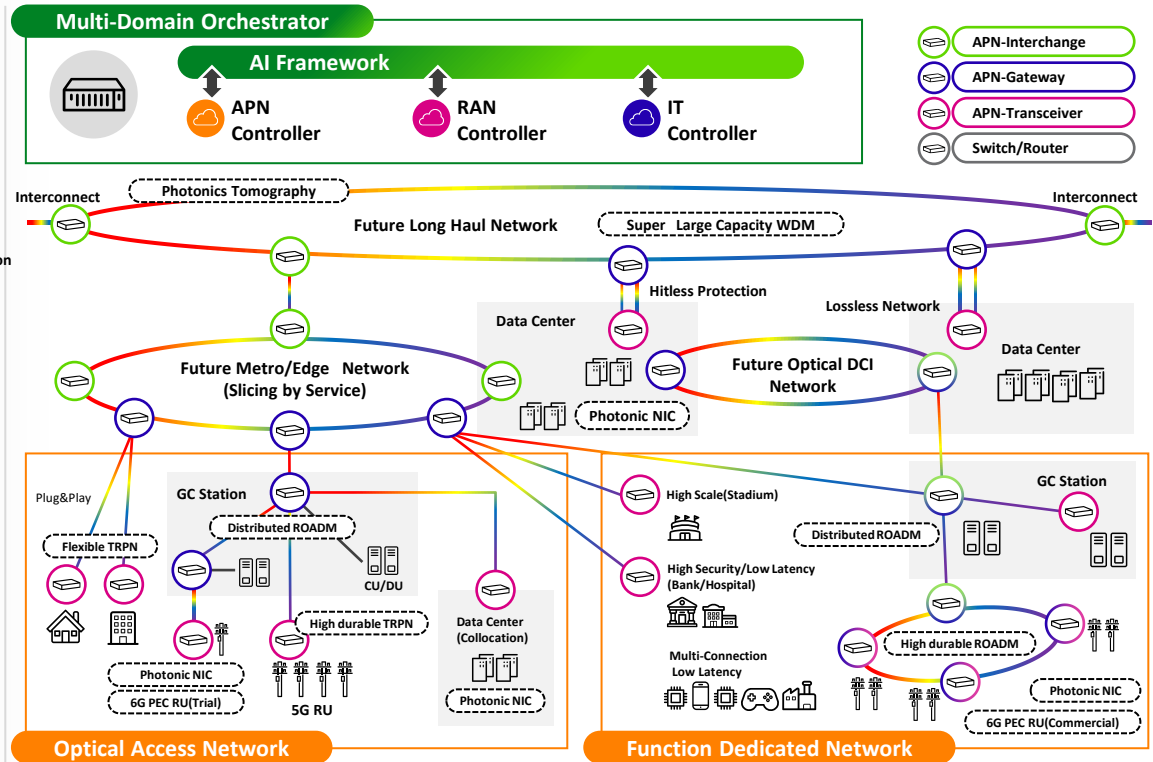
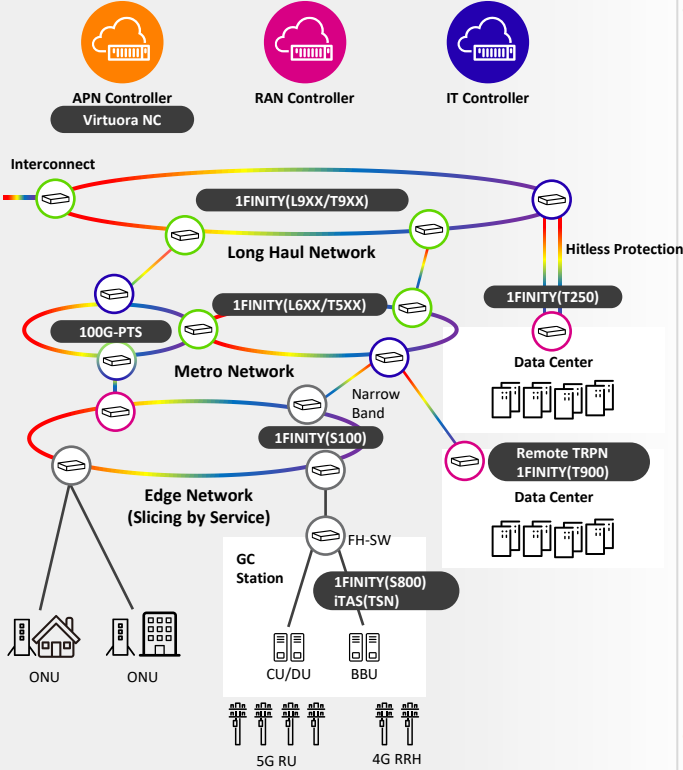
~FY2030 6G (Ready)



Ready for Long Haul/Metro NW, Underway for Edge/Access NW



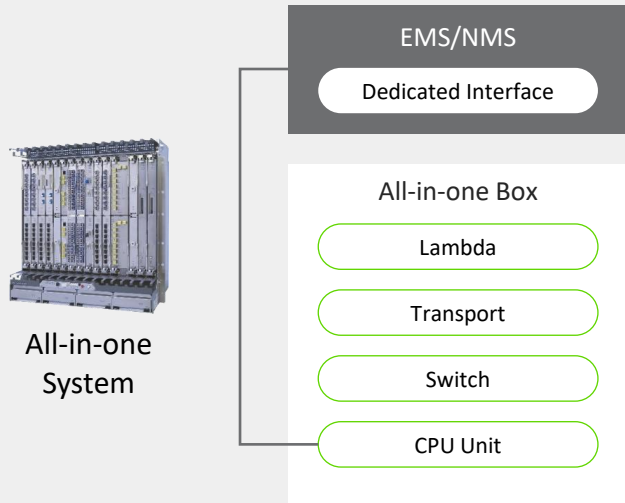
Preparation for Function Dedicated Network



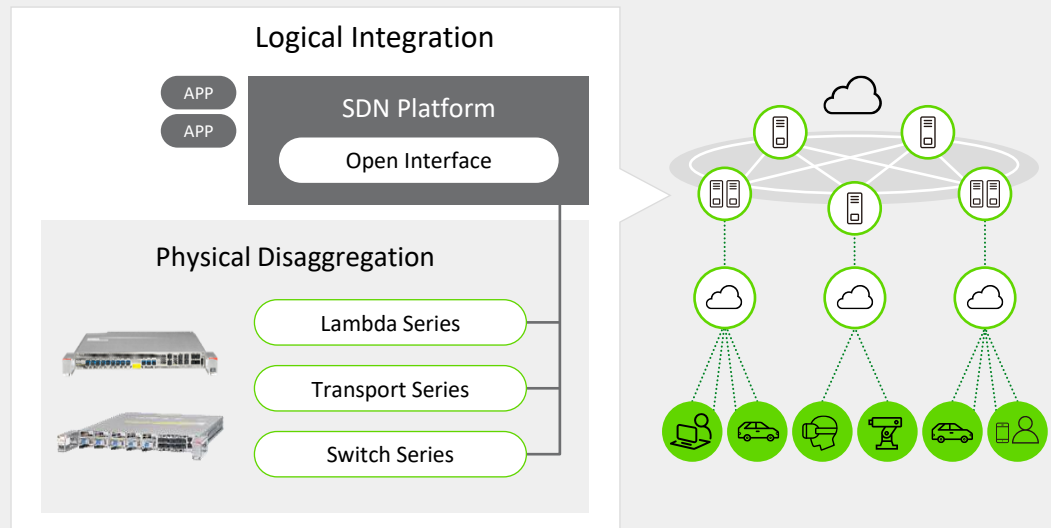
Open APN: Optical Transport System

- Transitioning from a conventional all-in-one-box type system to a disaggregated system
 - SDN control allows for optimal, rapid network building
 - Optimized power consumption across the network

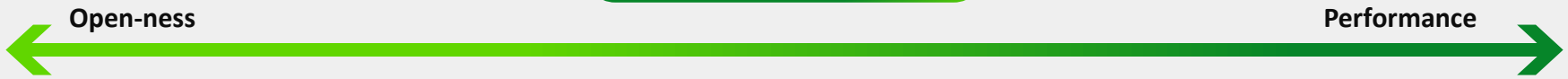
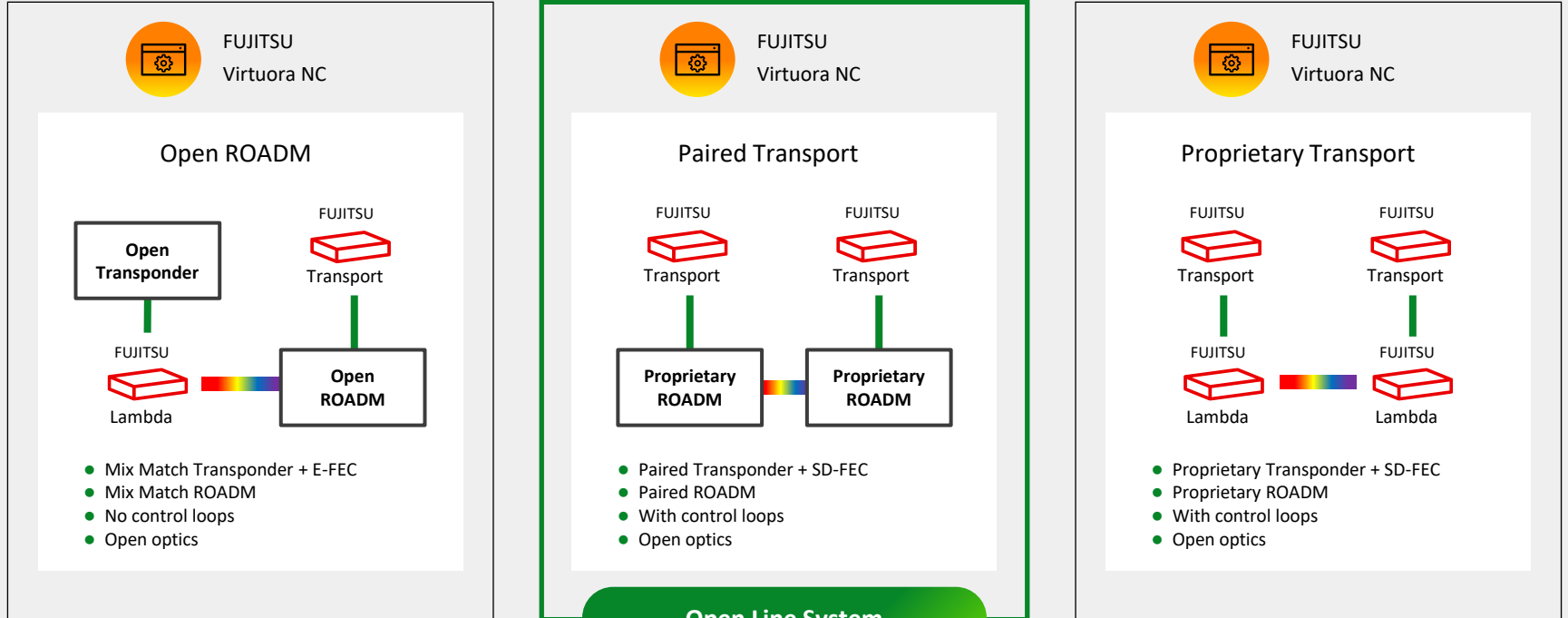
Conventional System



Open Disaggregated System



Open APN: Open Line System (OLS)

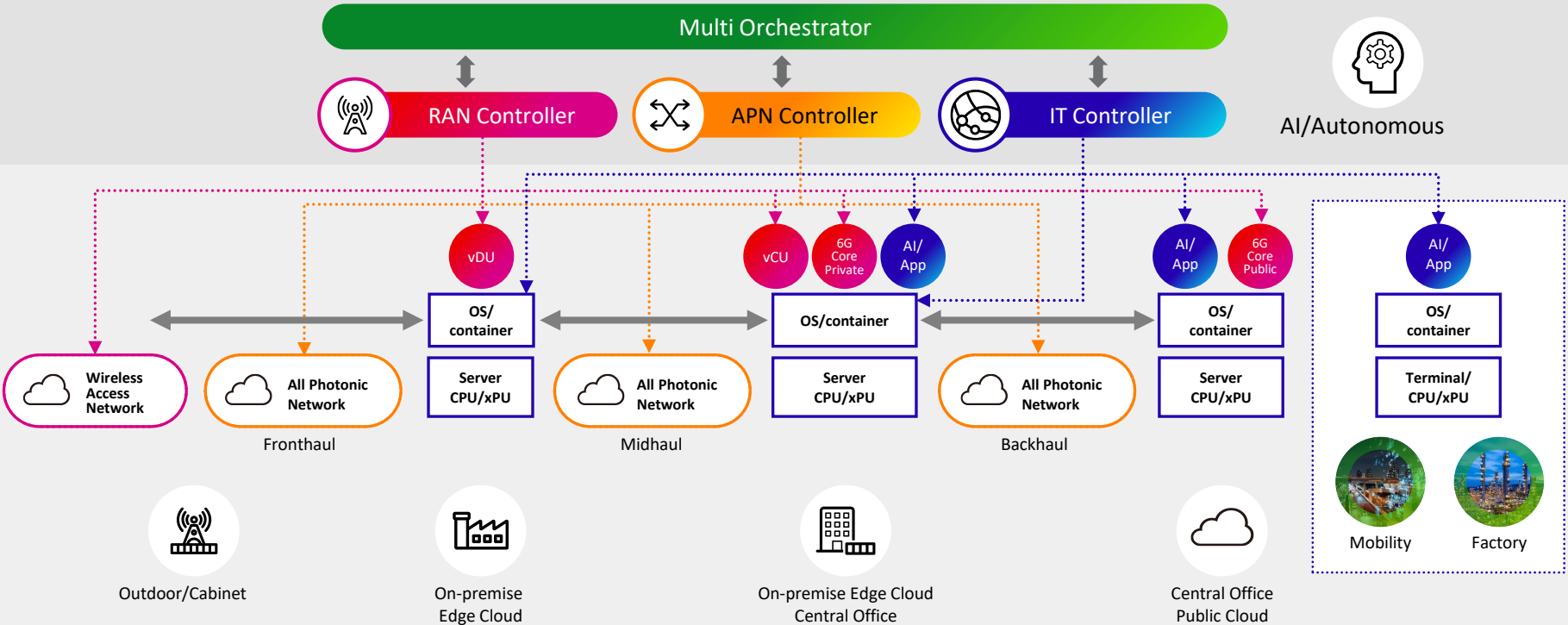


Open-ness

Performance

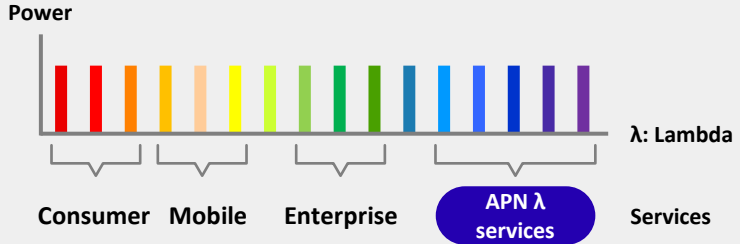
APN Interconnections by Multi Orchestrator

Data centric infrastructure for various type of data processing by all photonic network interconnection of function dedicated node

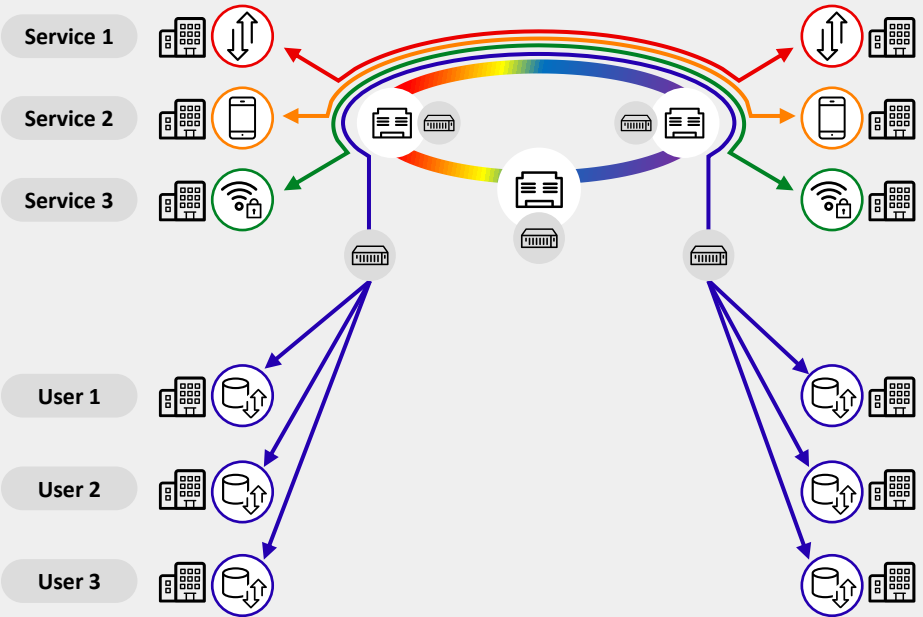
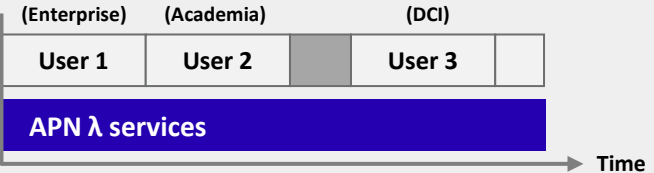


Lambda Centric Services of APN

Services Assignment to Lambda

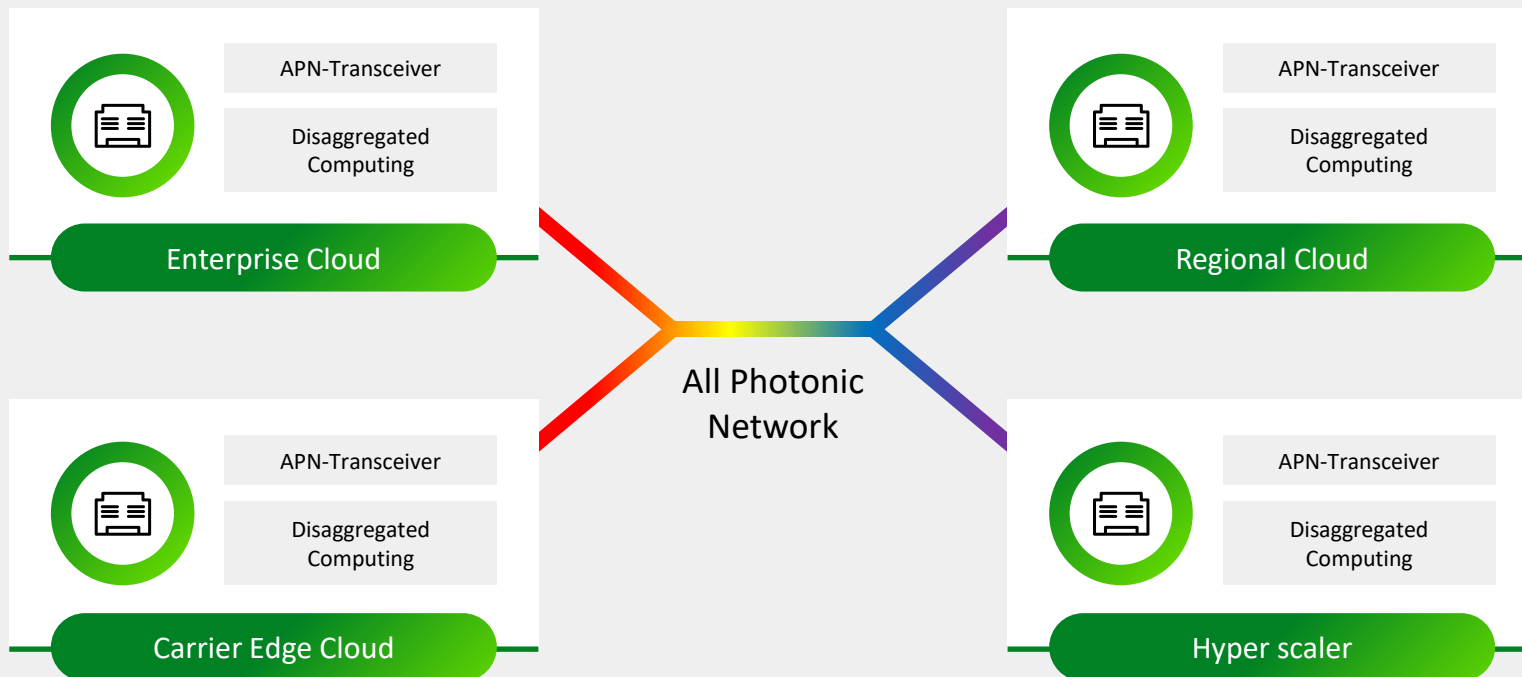


Time Sharing per Lambda

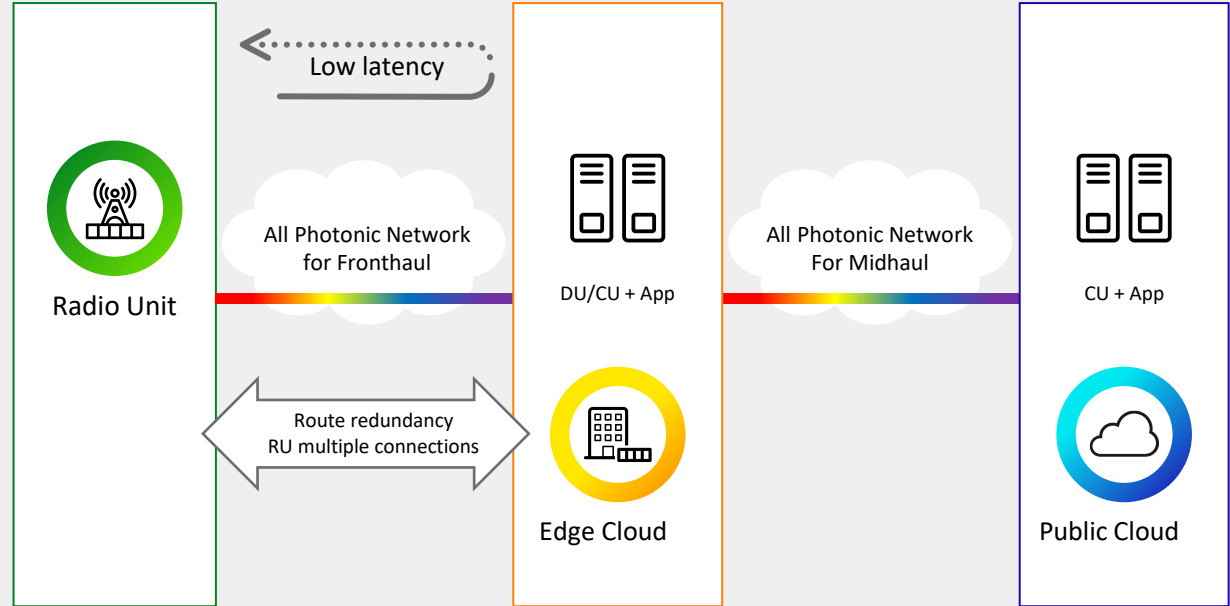


Service / User centric services for Multiscale/Multi-User Network

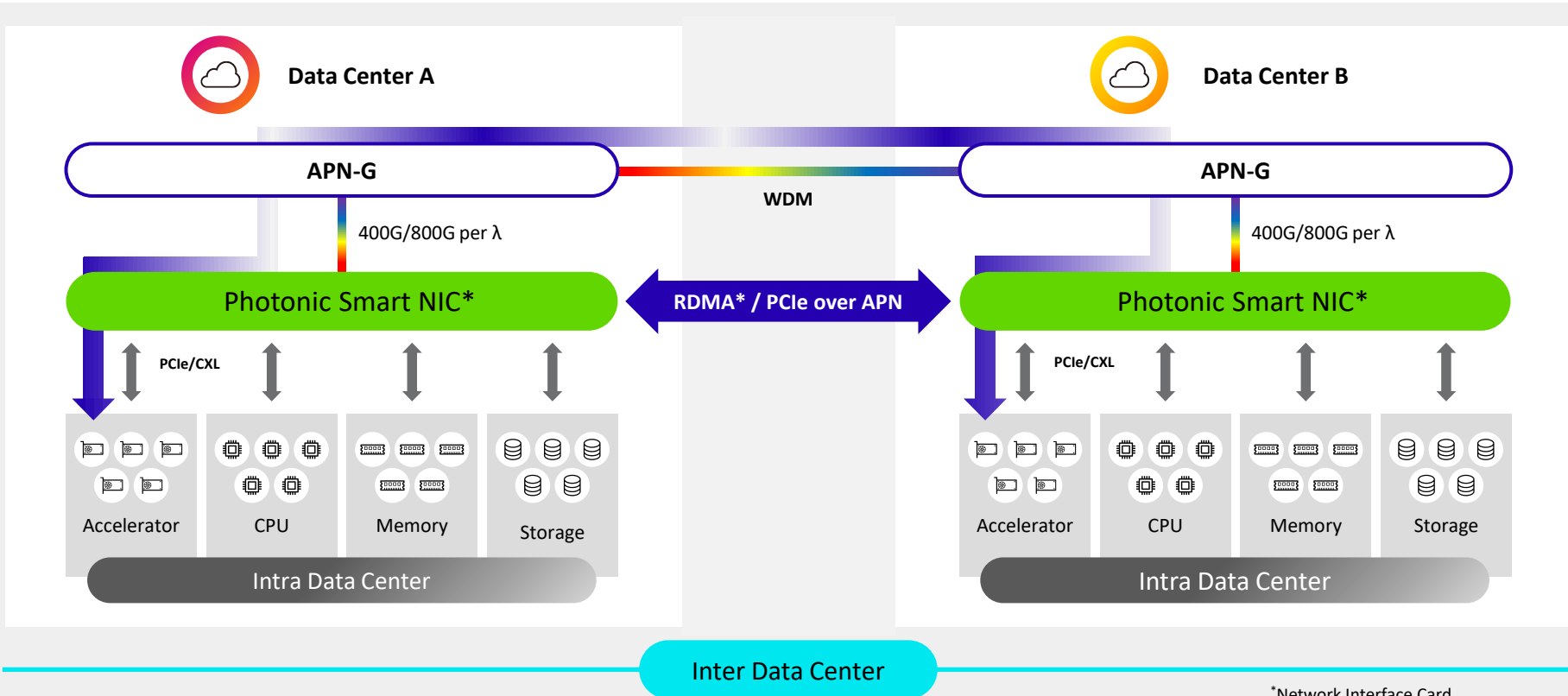
- Metro/Nation-wide Distributed Data Center interconnection by APN for resilient DC services



Sensor/IoT



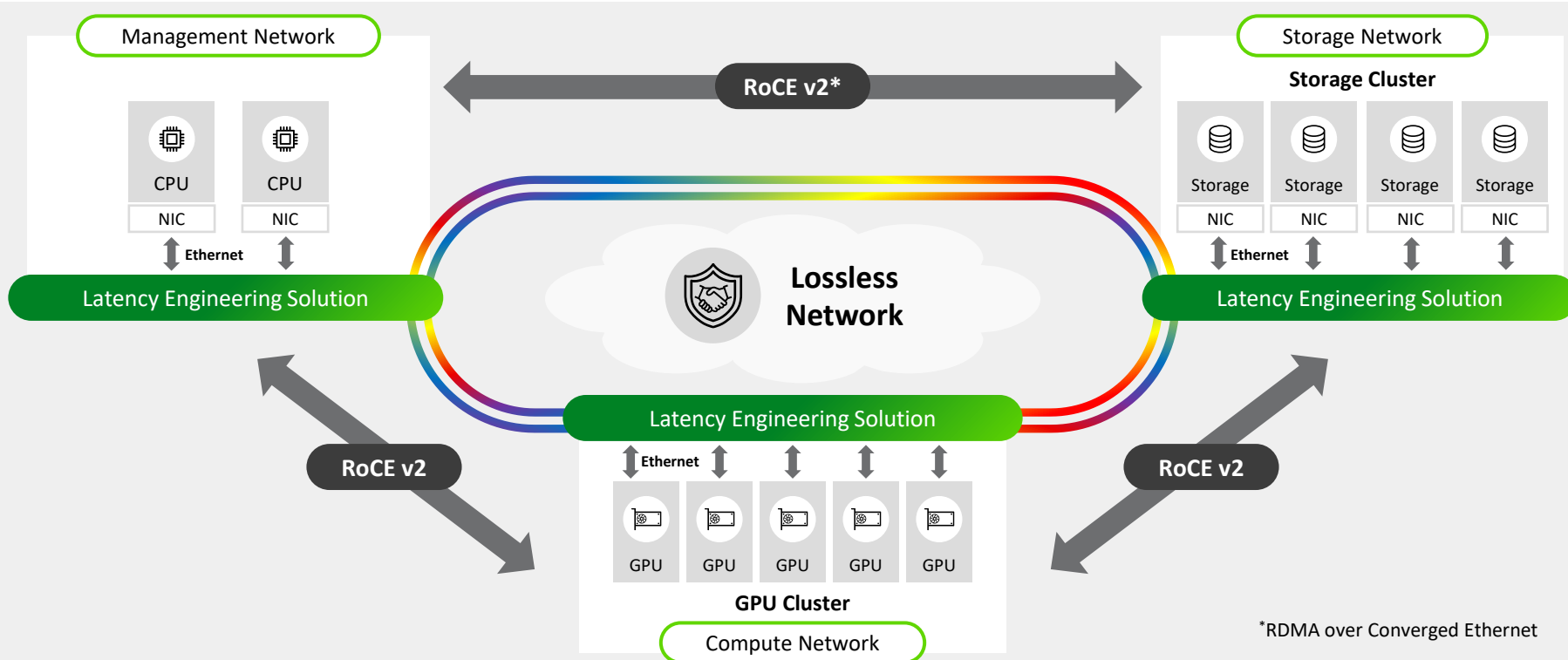
Wide Frequency range from MHz to Sub-THz



*Network Interface Card
 *Remote Direct Memory Access

Enable Lossless Network by APN hitless switching

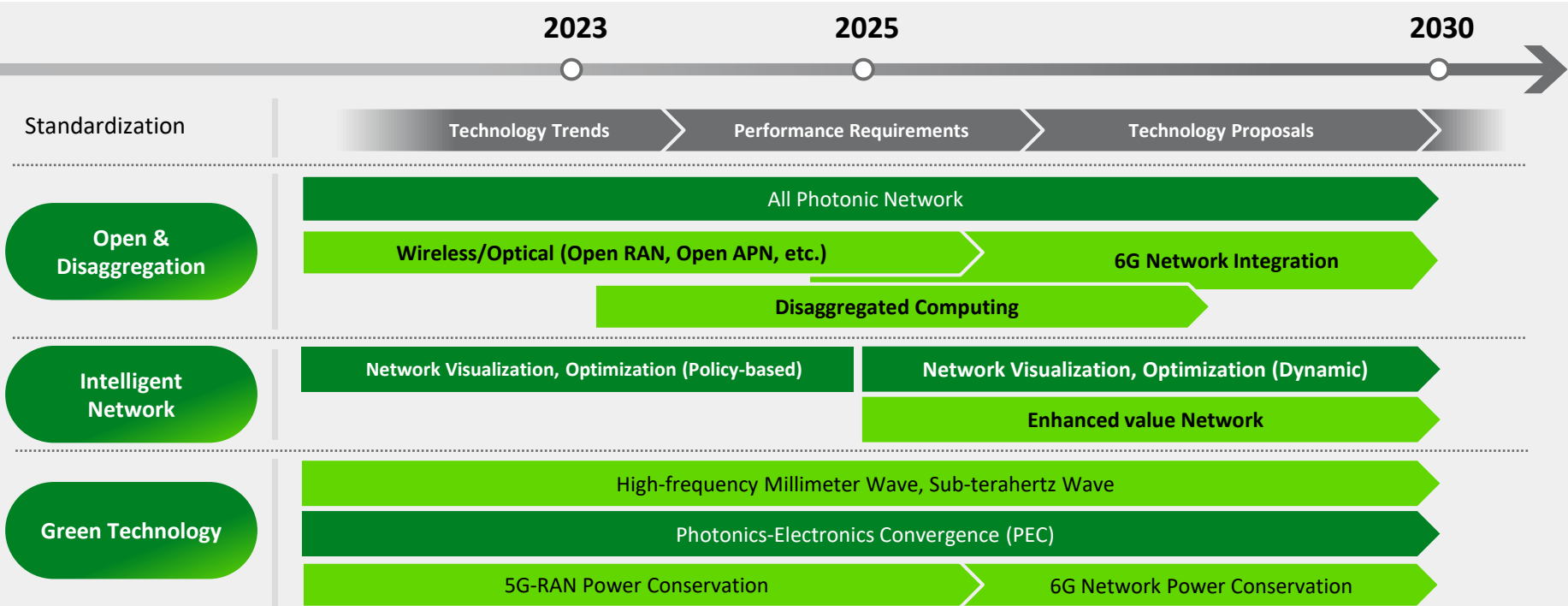
High performance tuning of kernel parameters with high reliable network



Connecting the borderless world with APN



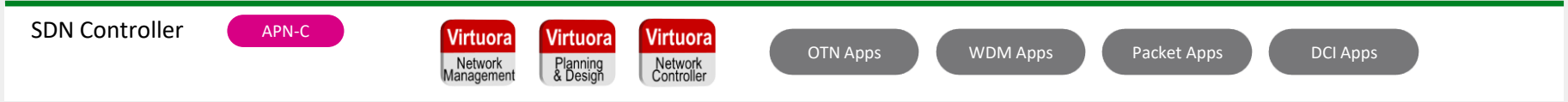
Fujitsu is developing future network technologies to create seamless experiences and a sustainable future



Note: The above is based on Fujitsu's current projections and is subject to change without notice.


Enabling technologies and Fujitsu Products

Fujitsu's Product Overview



LAMBDA


APN-I/G



- L100/L600 : 9 port ROADM on Blade
- L130 : 32 port ROADM on Blade
- L110/L120 : CD Add/Drop Base Blade, C-band
- L610/L620 : CD Add/Drop Base Blade, L-band
- L140/L220 : CDC Add/Drop Base Blade
- L160/L810 : Backward Raman Blade
- L200/L680 : Compact ILA Blade
- L310/L320 : Point-to-Point Line System, C-band
- L900 : Next Generation ROADM
- L910/L920 : Next Generation ILA

TRANSPORT


APN-T



- T300/T500 : 200G Transponder
- T310/T510 : 200G Muxponder
- T700 : 400G Transponder/Muxponder
- T900 : 1.2T Transponder/Muxponder
- T600 : 600Gbps Flex Muxponder for DCI
- T950 : 1.2T Transponder/Muxponder for DCI
- T250 : Hitless Optical Switch

SWITCH


APN-T



- S100 : 1.2Tbps Ethernet Switch
- S800 : 400G TSN Switch
- S900 : 120Gbps Access Switch

COMMS INTEGRATOR(CI)

C20x : 36 port Communications Integrator Rack Manager



HOUSING

6 Blade Housing Power Distributor



Multi-Functional Programmable Blades Optimized for SDN

APN T/G/I nodes : 1FINITY Ultra Optical System

- New Optical Transport platform achieves top-level long-distance transmission capacity of 1.2Tbps
- Incorporate the latest technologies
 - A digital signal processor (DSP) LSI using latest semiconductor processes
 - Liquid cooling delivers 2x the cooling capacity
 - C+L ROADM architecture able to handle multiple wavelength bands in one product
 - Forward Raman amplification
- 60% reduction in CO2 emissions
- Support for AI/ML automation to optimize performance

More is less . . .



More wavelengths
per fiber



More capacity or reach per
wavelength



Less effort to install,
operation, and maintain



Less power
consumed per bit

The ideal balance of cost, capacity and reach – simplified

1FINITY L900 terabit-optimized OLS



- C+L band in one device ensures high reliability
- Using optical backboards to reduce cable connections during initial construction
- Forward Raman amplification increase maximum transmission
- Max transmission capacity 76.8Tbps, Max 16degree

1FINITY T900/T950 extreme-performance transponder



- High Baud Rate and Compensation Technology Realize High OSNR and Long-Distance transmission
- Space saving and low power consumption by liquid cooling technology
- Max transmission capacity 1.2Tbps/Lambda, 14.4Tbps/blade

APN Terminal node : Latency Engineering Solution

OTN terminal product overcoming distance constraints

- ⚠ Network challenges between geographically distant sites**
 - Physical latency during optical fiber propagation due to distance difference
 - Transmission latency caused by passing through the devices
 - Latency caused by variations in network quality

✔ **Transmission-time Visualization and adjustment** Measure the latency in the NW between sites on a path-by-path basis to visualize and adjust the latency difference in transmission time.

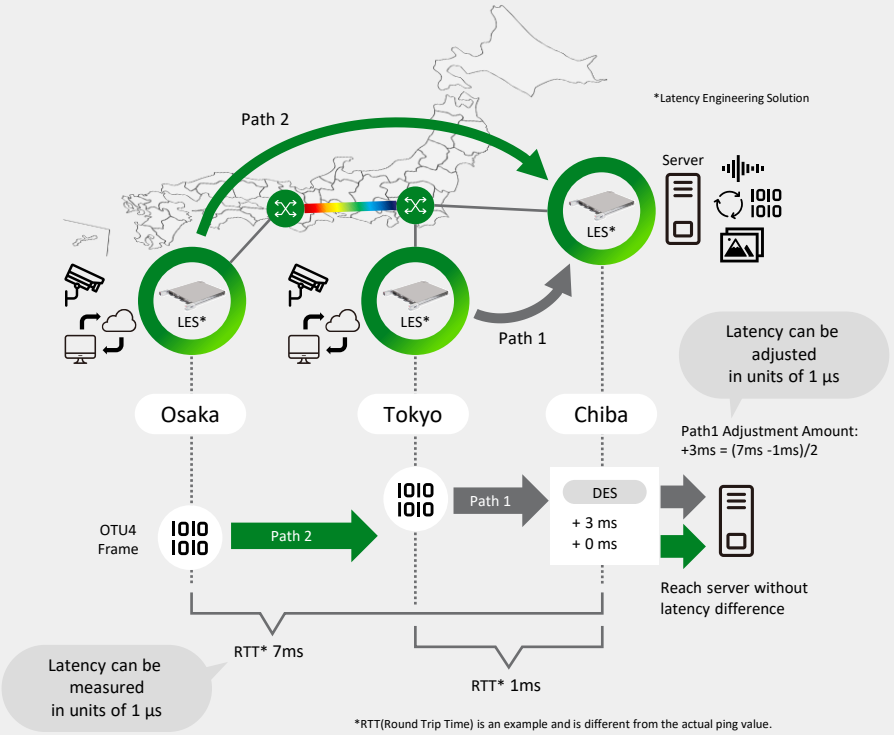
✔ **Low power consumption and large-capacity communication** Low power and high capacity optical transmission (OTU4) as terminal equipment for All Photonic Network

Achieve high reliable network and lossless network through **hitless optical switching** by utilizing LES

Achieve a sustainable network by maintaining high reliable network among sites
➡ A range of services that transcend space and do not require movement

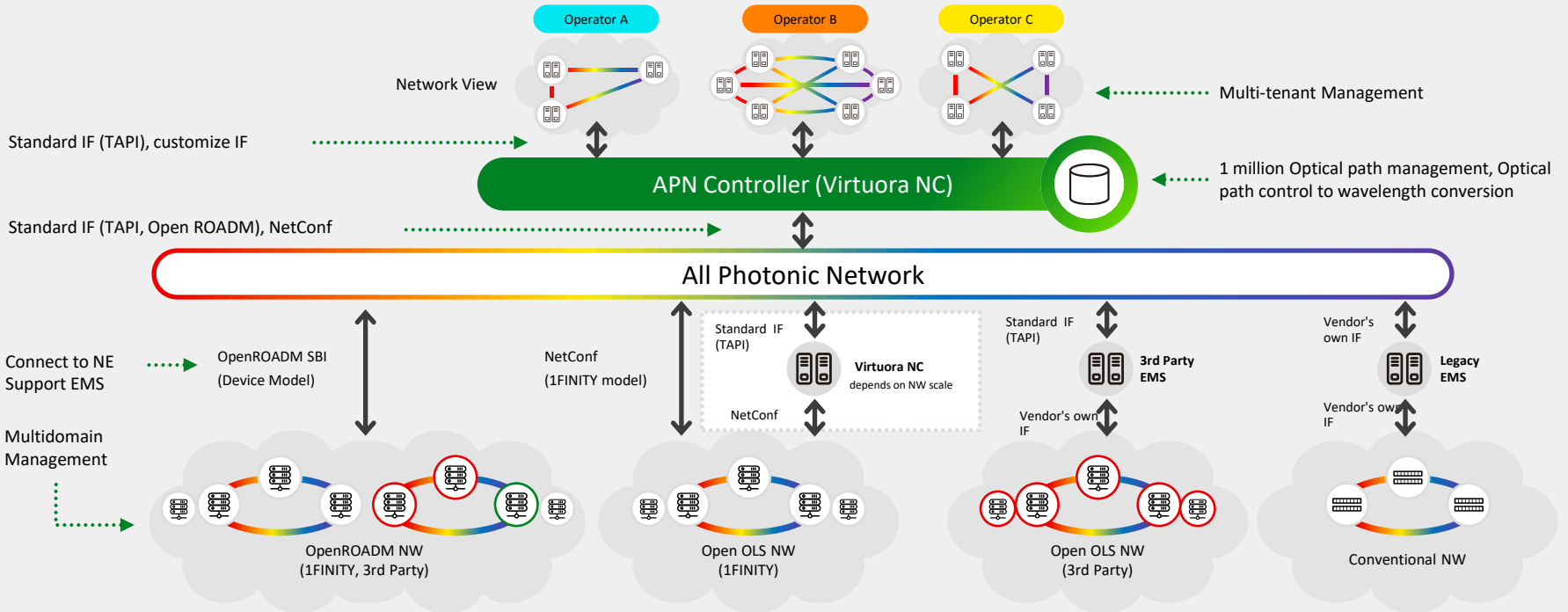
Example of Point to Point Network configuration

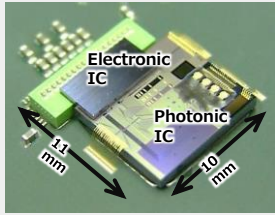
Service applications examples:
Multi-site video broadcasting, telemedicine, and e-SPORTS



APN Controller : Virtuora NC

- On-demand optical path control : An optical path can be controlled on demand and a fixed optical path can be set between arbitrary terminals
- Domain Controller Management : Integrated management of multi-vendor networks with end-to-end, containing a domain controller (EMS) terminating vendor IF
- Multi-tenant Management : Supports network view management for multiple operators to provide services on the same network



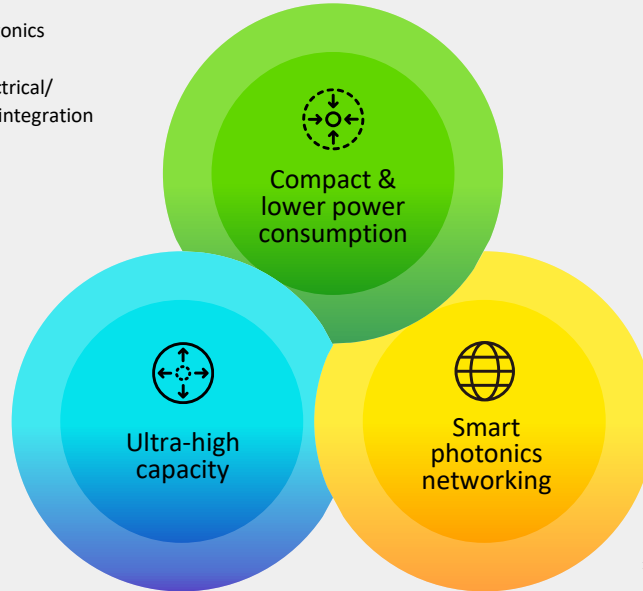


Scalable transceivers

- Integrated photonics
- DSP algorithm
- MCM (DSP, Electrical/ Optical device) integration

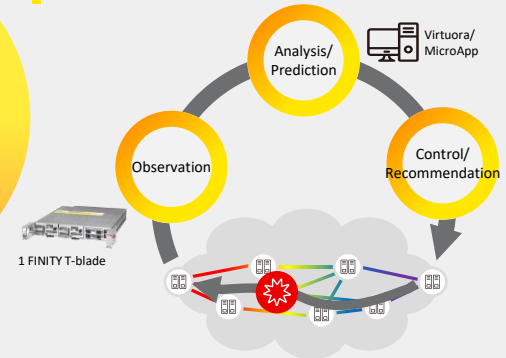
Ultra-wideband optical transmission

- Multi-band transmission
- Node architecture
- Optical signal processing



Optical network automation & Optical NW digital twin

- Photonics tomography
- Flexible/Adaptive optical system architecture



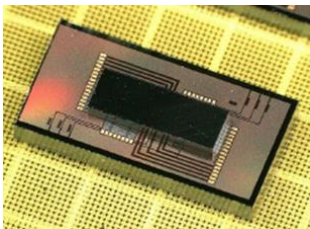


Scalable transceivers

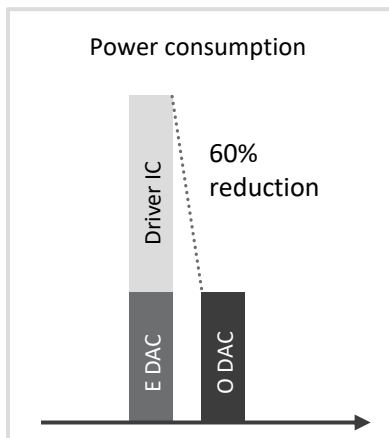
In optical transmission and computing – reduced power consumption and improved data transfer

Photonics-Electronics Convergence Device

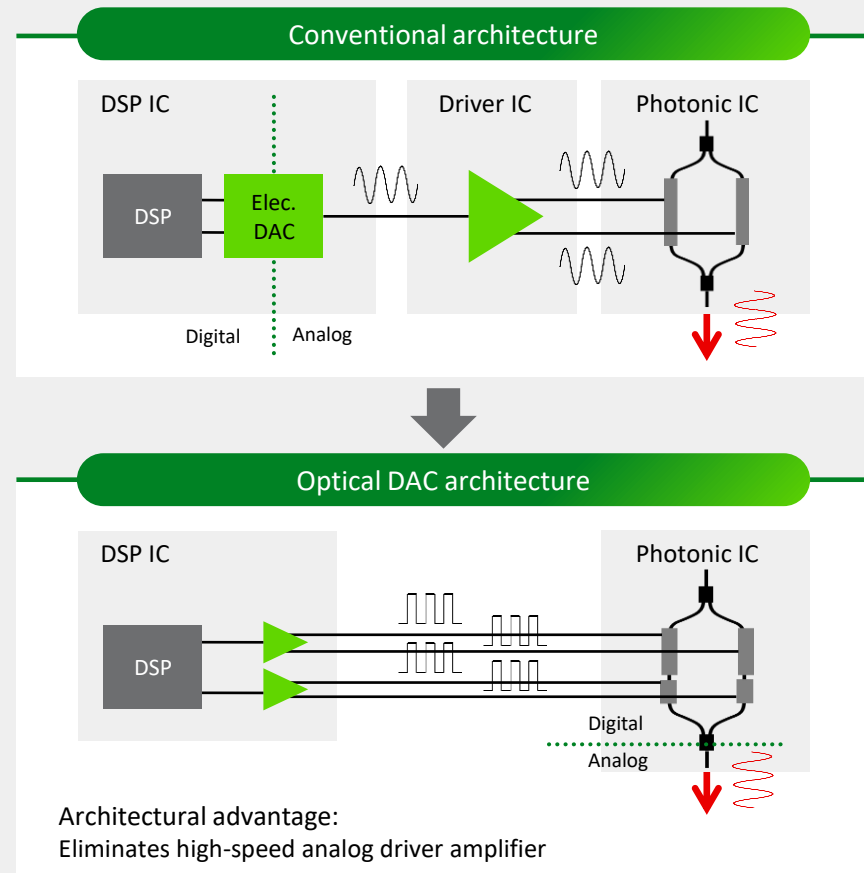
Compactness and high energy efficiency is achieved by implementing optical and electrical processing in the same package



Si photonics chip
2.75 x 4.0 mm



※This technology is based on results obtained from a project, JPNP13004, 14004, 16007 commissioned by the New Energy and Industrial Technology Development Organization (NEDO).





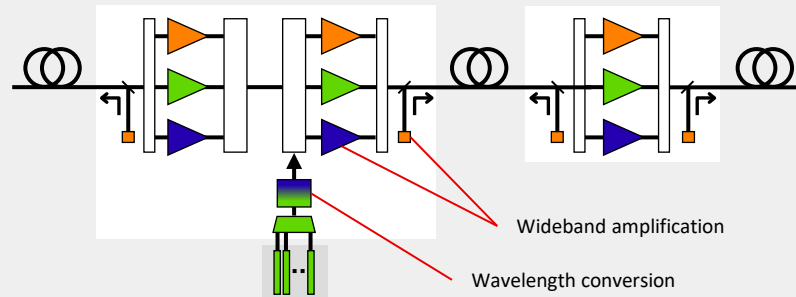
Ultra-wideband transmission (Beyond C+L)

- Ultra-wideband optical transmission node to expand the operating wavelength band
- Enable to connect multi-band network for direct optical path

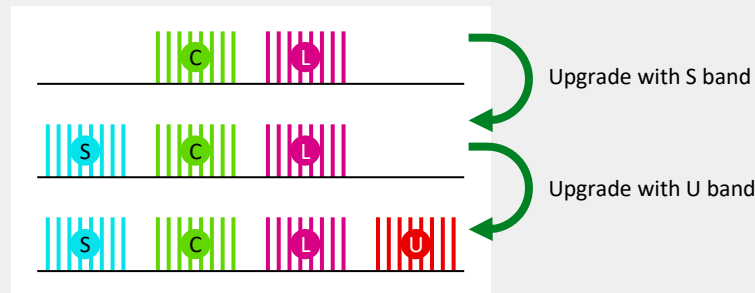
- Fujitsu has unique and novel ultra-wideband system concept using wavelength conversion technology and introduce the concept into the node through a collaboration with partners

- Convert the WDM signals to any wavelength bands
- No need to develop the new transponders for S band or U band

Example of ultra-wideband node configuration



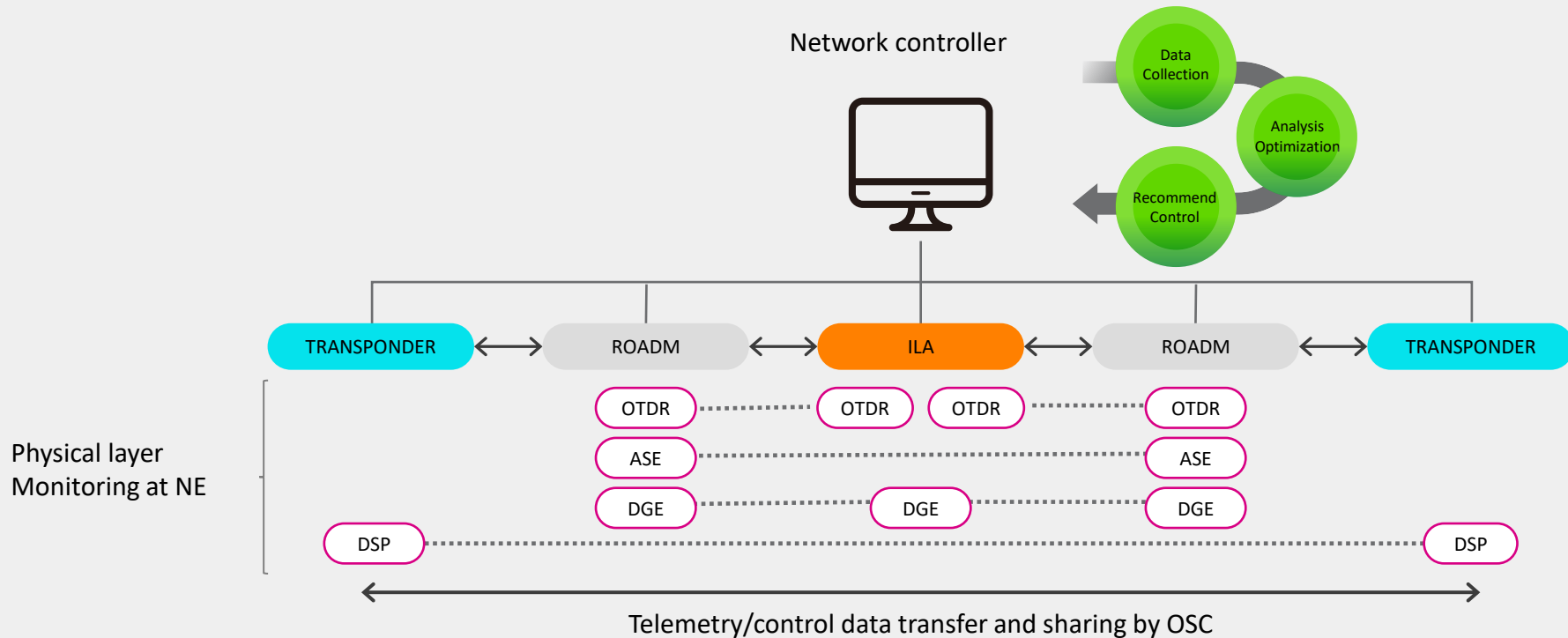
Wavelength conversion (example of upgrade)





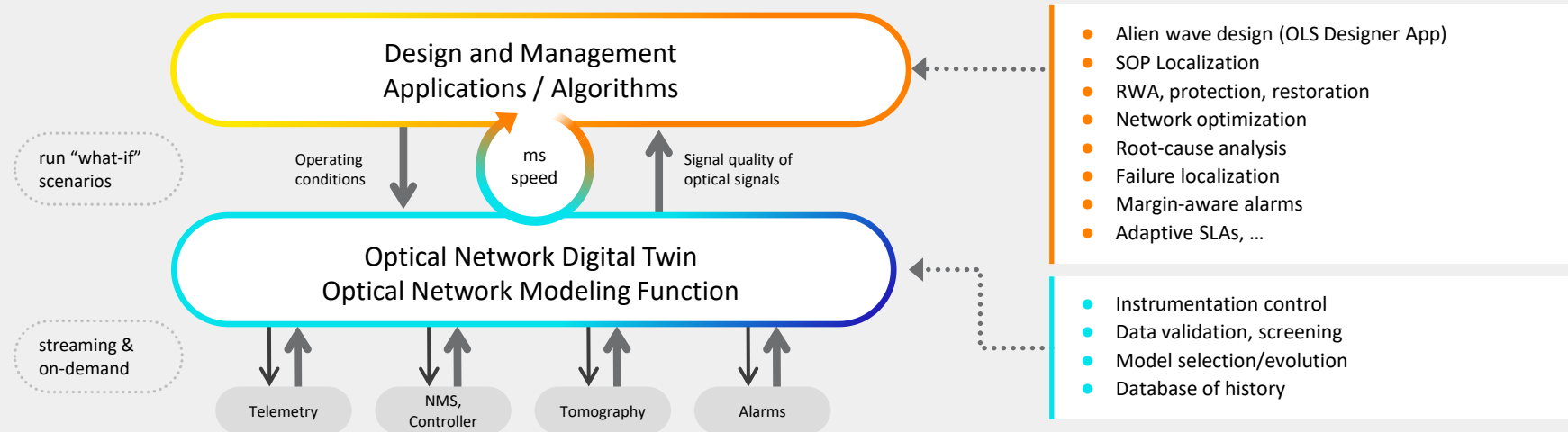
Photonics Tomography

End-to-end photonic network monitoring





Optical Network Digital Twin



▲ Digital world Potentially Perfect, Automated

▼ Physical world Inherently Fragile and Manual



Fujitsu Collaboration



Open Optical/Radio Network

cbars IOWN GLOBAL FORUM MEF
Open air interface Open RAN Open ROADM
O-RAN OREX TELECOM INFRA PROJECT

Open Software Platform

ONAP ONF
OPEN DAYLIGHT Warrior
LINUX Foundation

Standards development organization/Certification, Academic community

ARIB ETSI 3GPP IEEE ITU OIF OPTICA TTC

Industry Affiliations

atis Beyond 5G promotion consortium cca CIAJ Ethernet Alliance
National Rural Electric Cooperative Association Next G alliance Next generation Mobile Network
NTCA SCTE TechTitans TIA tmforum UTC

Thank you

