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CAICT 中国信通院

# ION-2030 Vision, Trends and Usage Scenarios

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# Content

# The Four Main Driving Scenarios of Optical Networks

## DC Network

- **DC networking architecture and high speed & bandwidth**
  - ✓ **DCN**
  - ✓ **DCI**
  - ✓ **DCA**
- **Energy efficiency and energy saving**
  - ✓ **LPO/CPO/OIO…**

## 6G

- **IMT-2030(6G) Network**
  - ✓ **Core Network:** central and distributed architecure, AI enhanced features
  - ✓ **NTN:** satellite communication and internet access
  - ✓ **RAN:** Cell-free MIMO, AI-RAN and Open-RAN

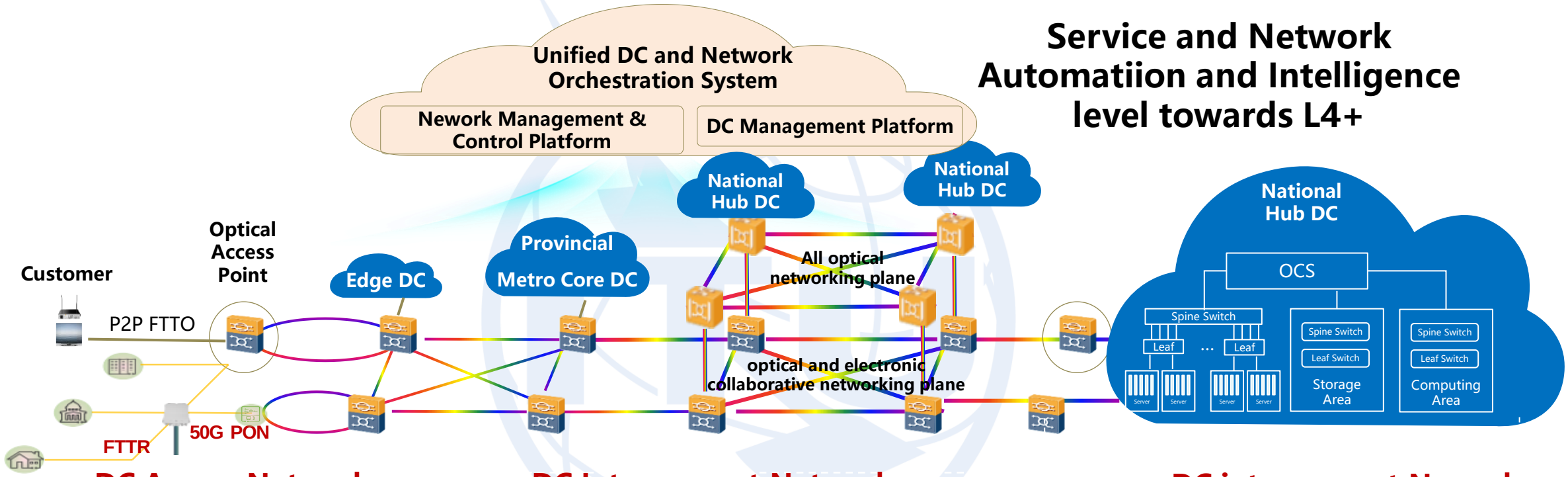
## AI

- **AI for Network**
  - ✓ Network lifecycle automation and intelligence
  - ✓ Services intention perception and QoS guarantee
- **Network for AI**
  - ✓ Distributed AI training, reasoning, and application with high performance and lower latency

## Broadband Access

- **50G PON and VHSP**
  - ✓ 50G PON start field trail and deployment
  - ✓ 200G PON under-developing
- **FTTR**
  - ✓ X-Gigabit optical access to home and office.
  - ✓ 10Gigabit optical access to the Industry park.
  - ✓ Optical and Wifi converged access

# DC Orinted Network Architecture and Requirements




## DC Access Network (DCA)

- Internet access bandwidth increases to 10Gbps.
- The services quality of DC resources access should be guaranteed.

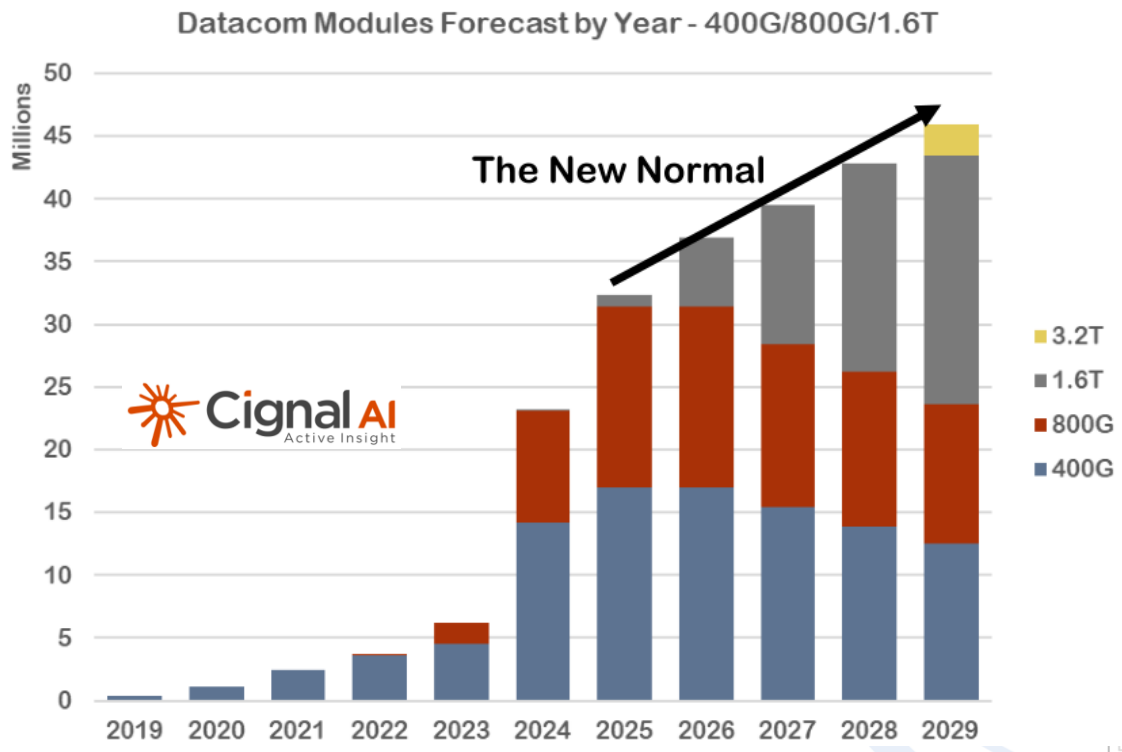
## DC Interconnect Network (DCI)

- Internet bandwidth now in the hundreds of Terabites range
- High reliability and lossless for huge data traffic transmission

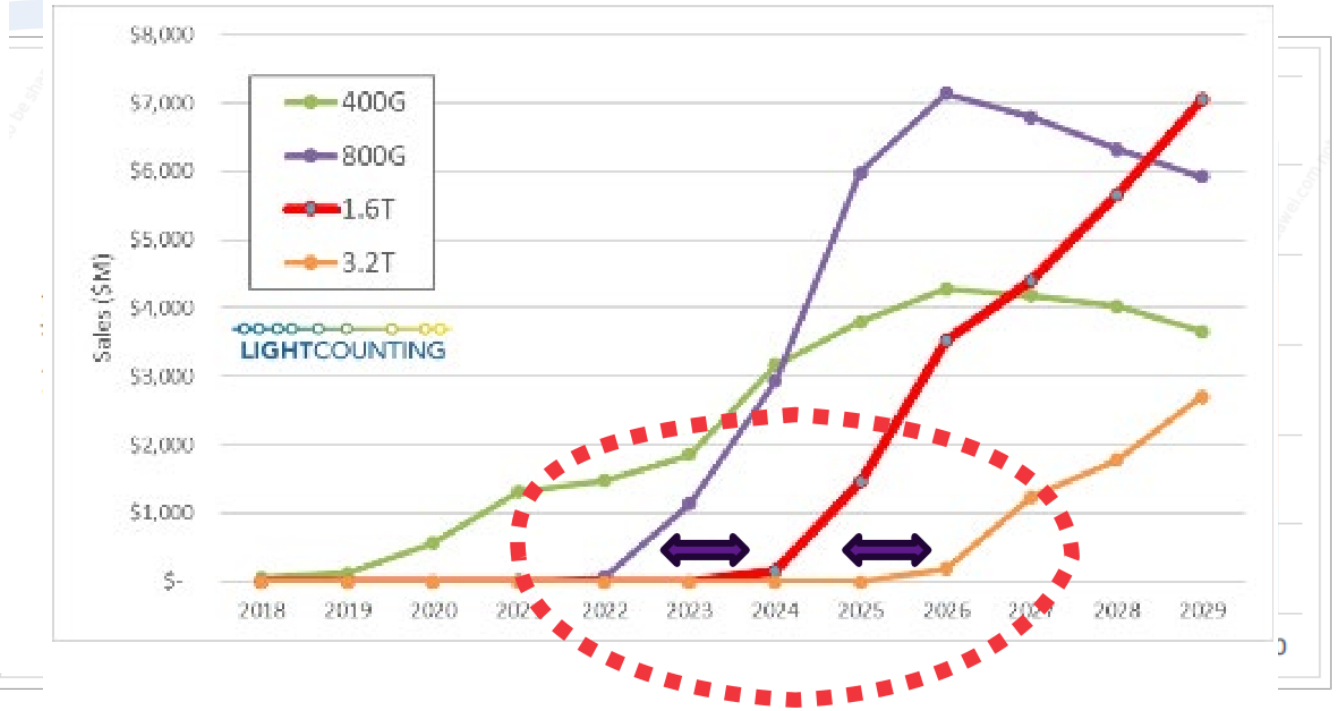
## DC intraconnect Nework (DCN)

- High speed optical connection
- High throughput and lossless data transmission
- Ultra low latency requirement

# DCI&DCN: Speeds Increased Dramatically by AI




## Cycles only 2 years between new speeds




## The fastest speeds for AI interconnection

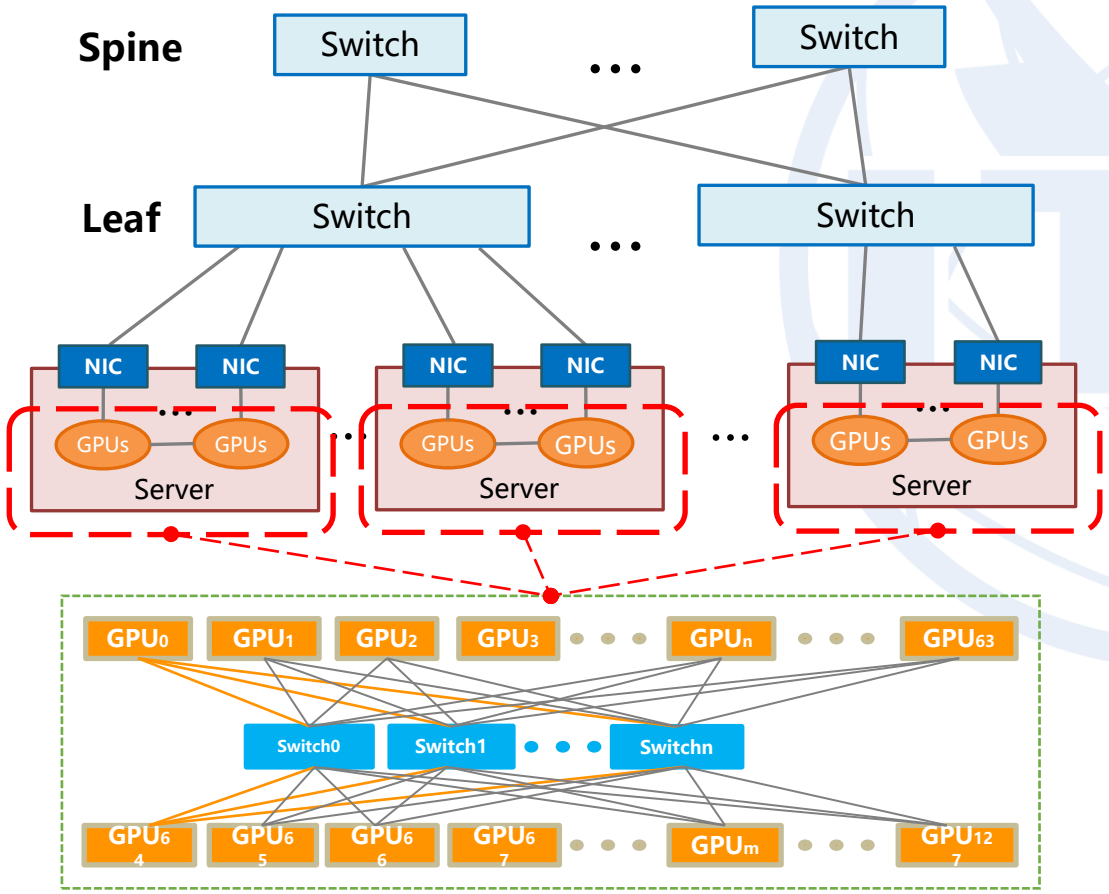
- 50G/lane (400G) peaks in 2025
- 100G/lane (800G) peaks in 2026
- 200G/lane (1.6T) starts shipping in 2025
- 400G/lane (3.2T) forecast to delivery in 2029?

## Time to market in short R&D and validate stage

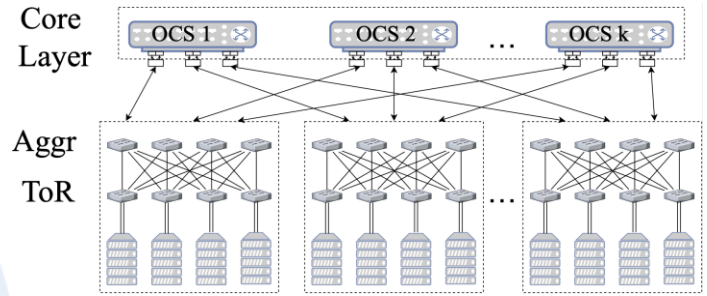
- 800G speeds up since 2023, sales amount exceeded 400G in 2024, and dominates in 2026
- 1.6T speeds up in 2025, and dominates in 2028
- 3.2T to market in 2027, and increases fast in 2030?

# DCN: Communication Capability Becomes a Bottleneck

- Network communication capability will become a **bottleneck** restricting the improvement of GPU clusters' computing power.

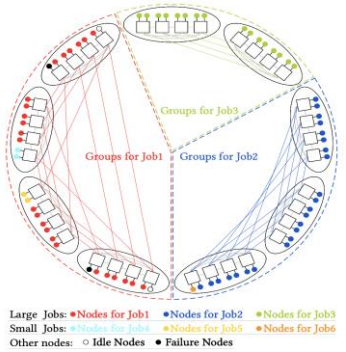


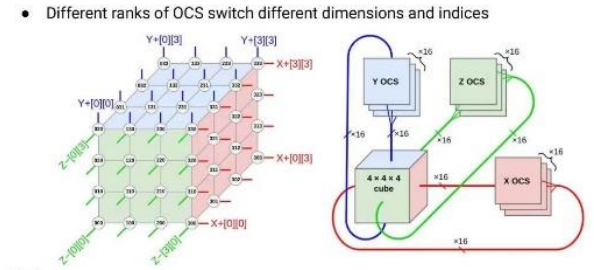

- Using OCS to optimize topology & latency




**Inter-Server connection**

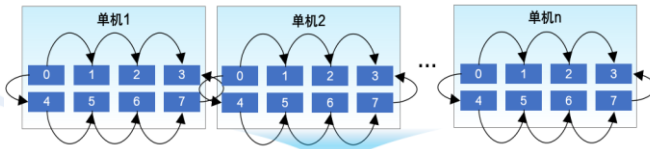
**Scale out**



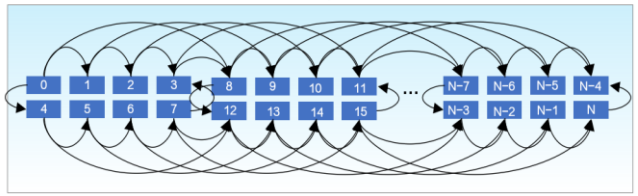




**Intra-Server connection**

**Scale up**

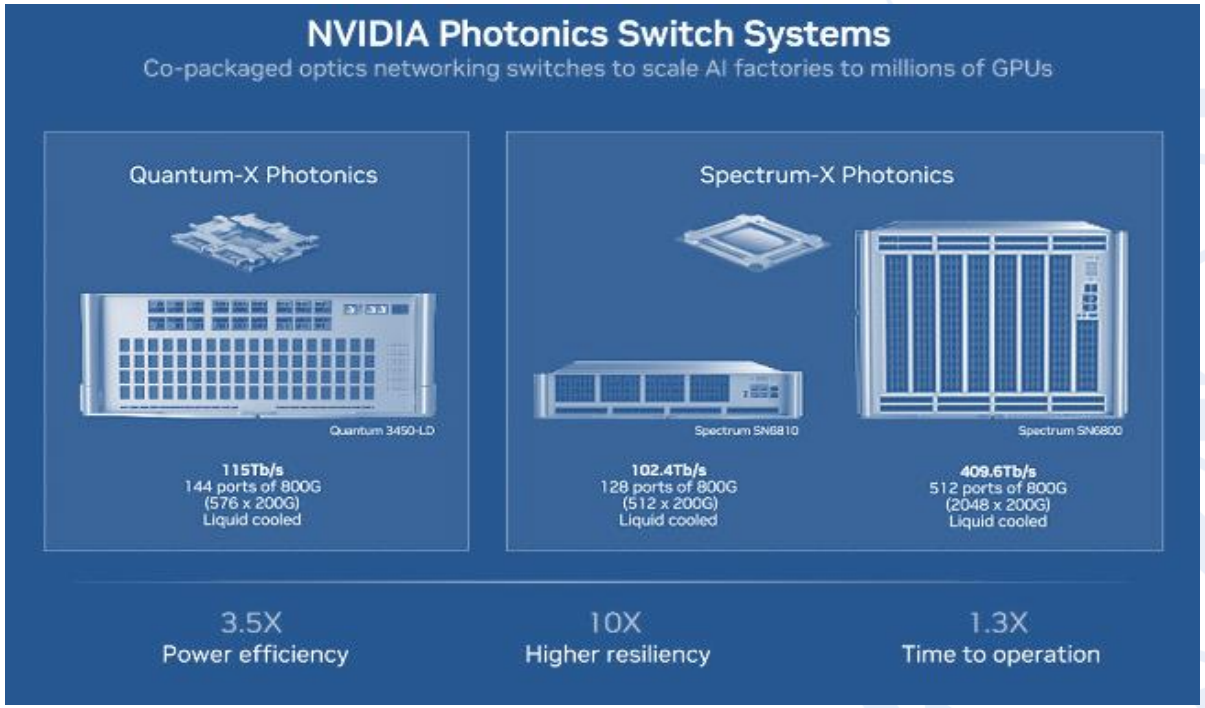


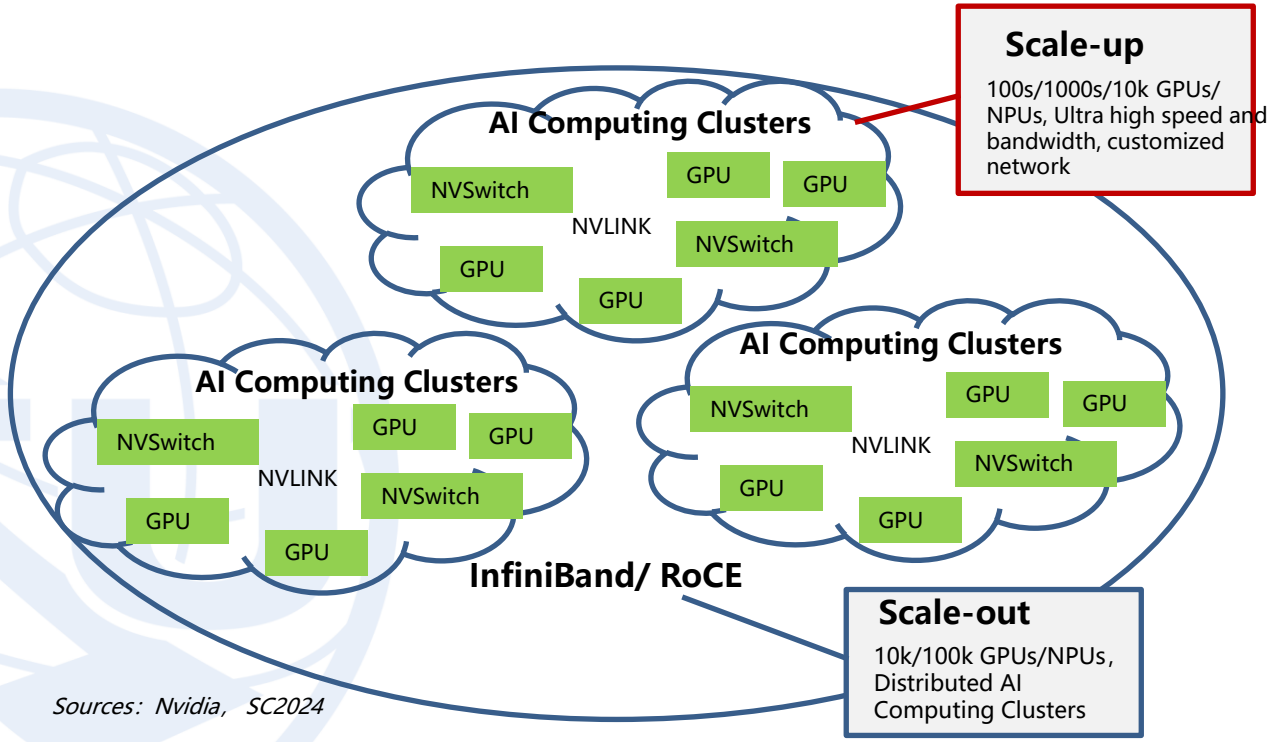

Normal Server with 8 XPUs



**Super Server Node** with Hundreds XPUs

# DCN Photonics Switch: From LPO/LRO to CPO and OIO

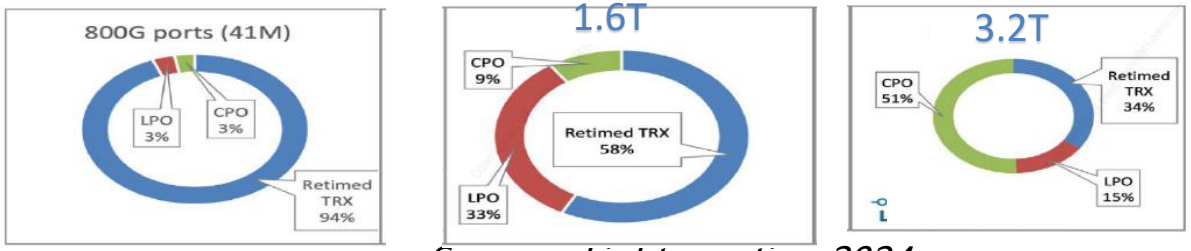



*Sources: Nvidia, SC2024*

**All pointing to preliminary mass production in 2026**

- Nvidia Spectrum-X CPO Ethernet Switch
- TSMC COUPE 2.0
- BROADCOM Bailly CPO Ethernet Switch

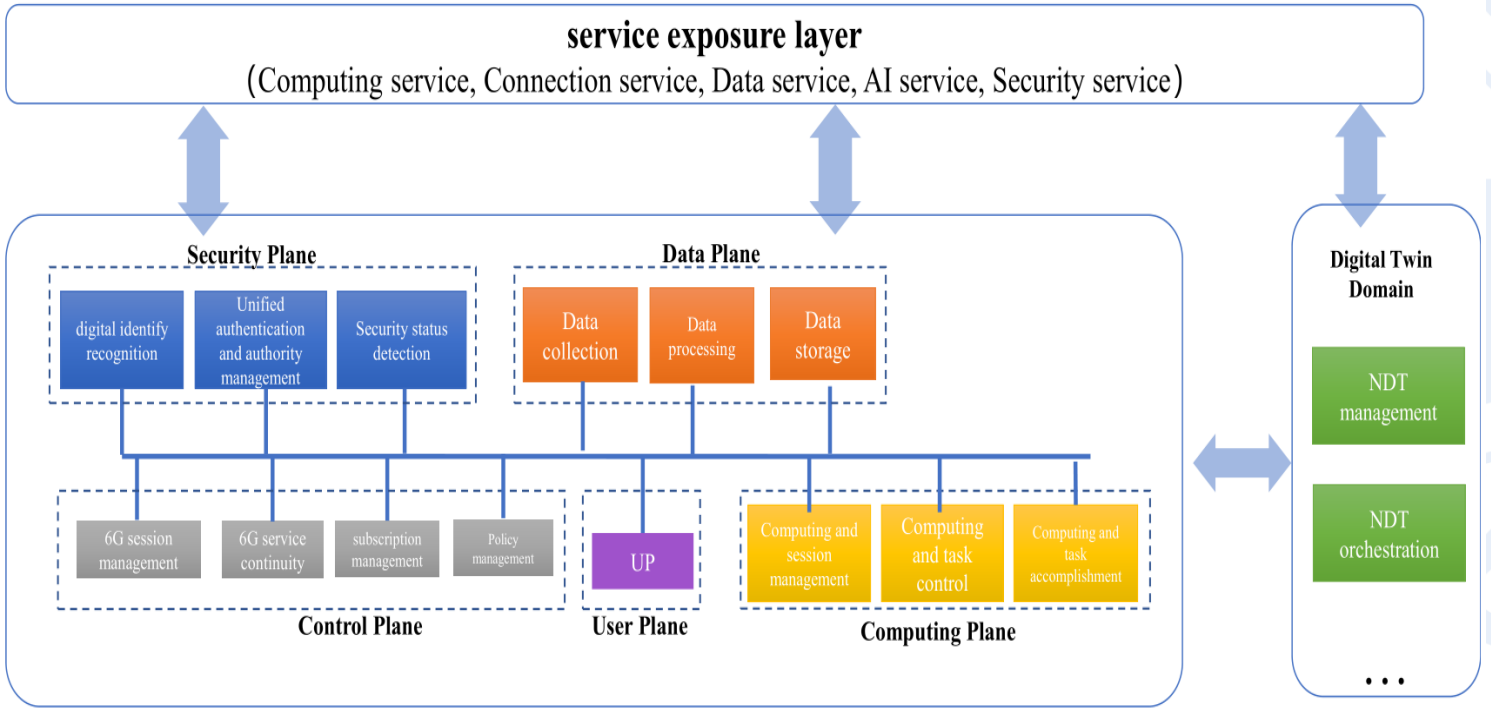



*Source: Lightcounting 2024*

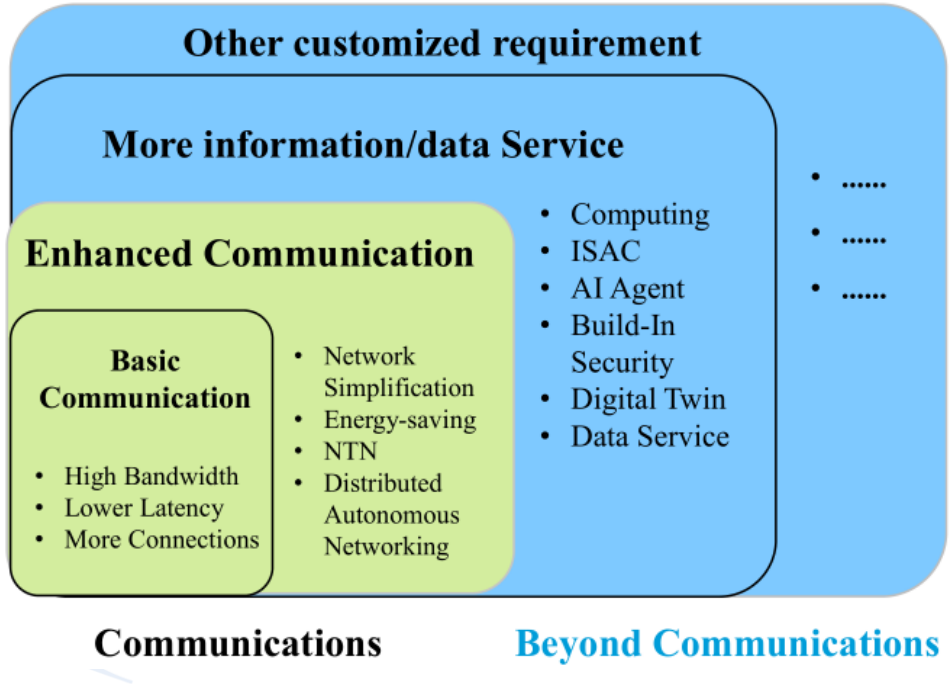
- **For 1.6T Optical interface, CPO is only 9%; For 3.2T Optical interface, CPO will increases to 51%**
- According to the requirements proposed by the OIF EEI Compute Optics Interface project, **the OIO interconnection target is >1Tbps/mm, <3-5 kJ/bit,<10ns+TOF, with no FEC or low latency FEC.**

# 6G CN: Visions of Core Network Architecture Design

## 6G Core Network Architecture Visions
## SBA based, AI native, Computing integrated




## Diverse Requirements Beyond Communications and Customized

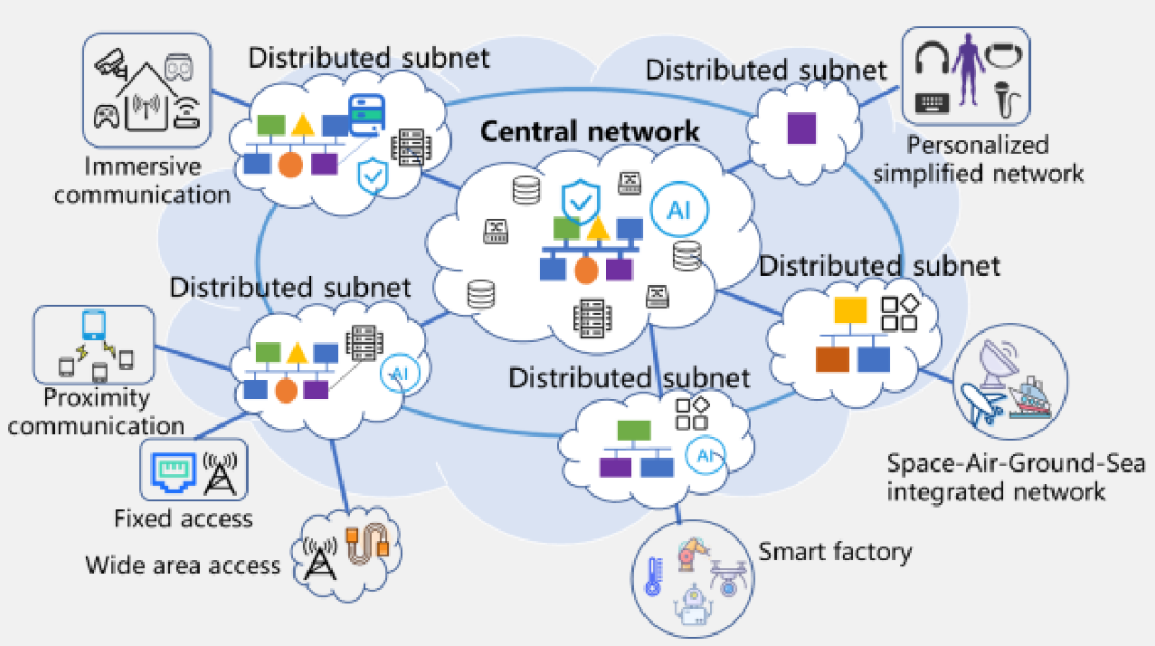



*Source: 6GWS-250176, China Mobile "6G Architecture and Related 3GPP work Consideration"*

**The 6G core network architecture is the foundation and key enabler for facilitating innovative new services beyond communication.**

# 6G CN: Central and Distributed Core Network

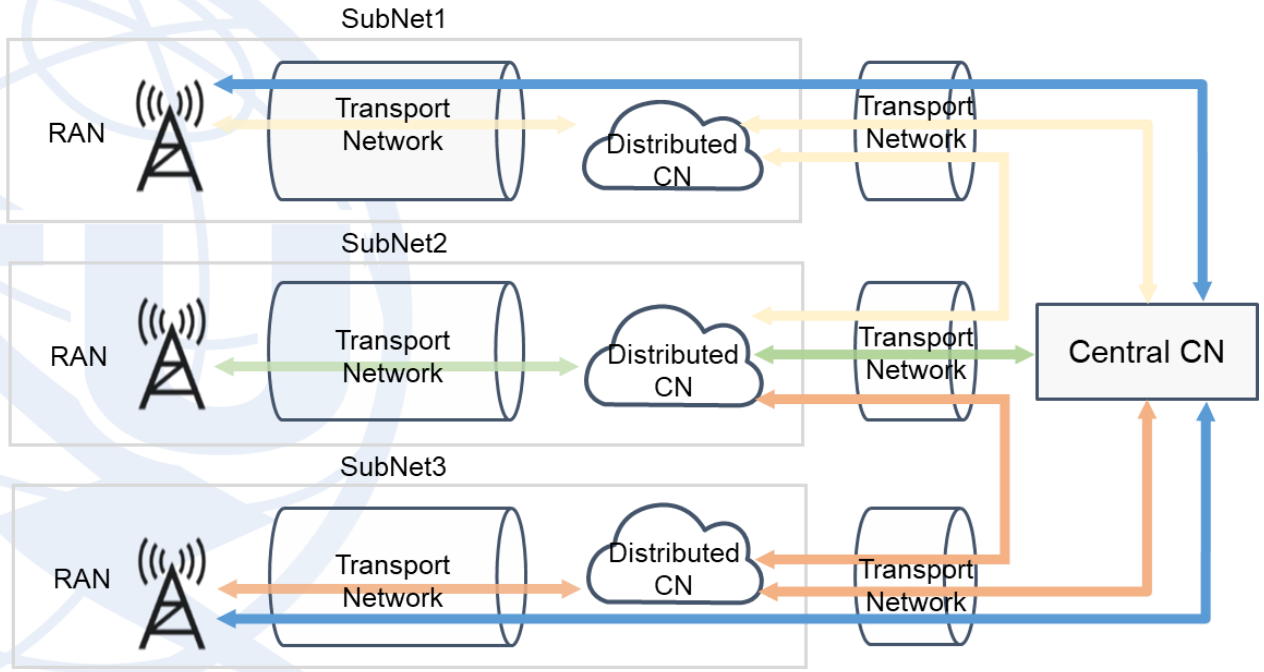
## One Central Network and Multiple Customized Subnets




*Sources: 6GWS-250115, China telecome*

- A centralized network with multiple customized distributed networks providing differentiated services.
- Multi-network collaboration should be supported to improve resource utilization efficiency.

## The Connection will be More Dynamically

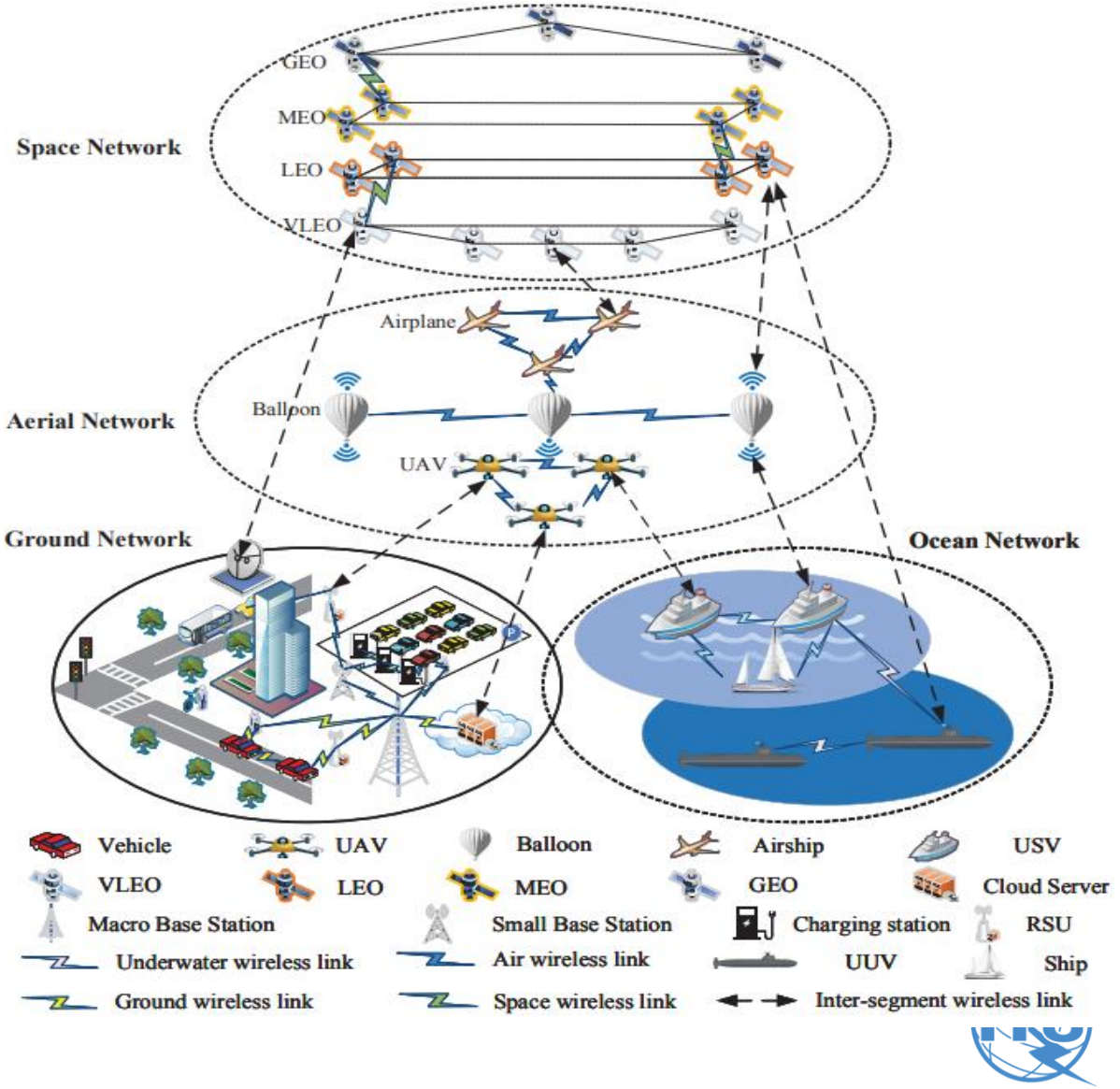



*ITU-T Y.3144；6GWS-250176；6GWS-250117；6GWS-250179*

- The connection of 6G base stations with central and distributed core network will be dynamically changed for different services.

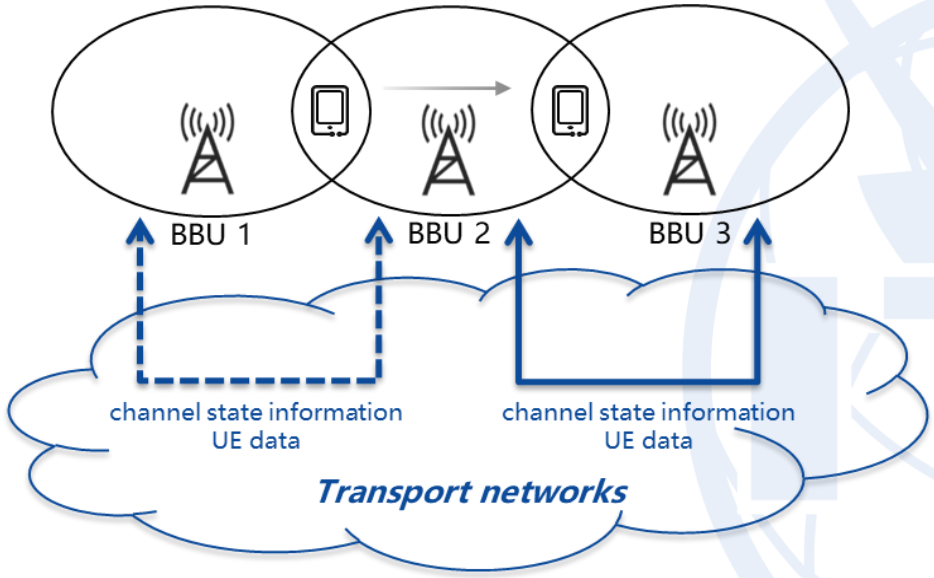
# 6G NTN： Supporting Ubiquitous Communication

- **Ubiquitous communication:** Satellites and low altitude aircrafts provide communications and internet access across ground, aerial, space and oceans.
- **Integrated sensing, communication and computing services:** supporting multi-dimensional perception capabilities in space and time, and etc.
- **High precision positioning and navigation services:** providing users with real-time and high-precision integrated positioning services for people, vehicles, and objects.



# 6G RAN: Cell-free MIMO, AI-RAN and Open-RAN

## Cell-free MIMO: Air interface collaboration

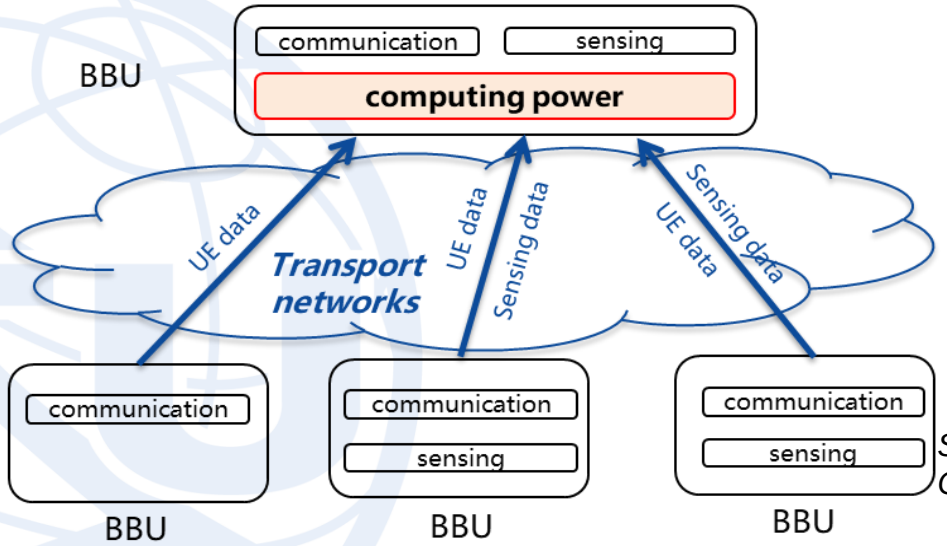



6GWS-250052； 6GWS-250004

**Multi cell collaborative MIMO**, on-demand dynamic clustering

- ✓ **New traffic:** Collaborative BBUs share channel status information and user data
- ✓ **Traffic characteristics:** User mobility, demand changes → Dynamic adjustment of BBU cluster range

## AI-RAN: Services and AI Collaboration




Source: WD1214-61, China Mobile

6GWS-250143； 6GWS-250003

Add intelligent boards to some BBUs (master) to share computing power with other BBUs

- ✓ **New traffic:** User data traffic and perception data traffic from BBU to main BBU
- ✓ **Traffic characteristics:** Services and network load changes → Dynamic adjustment of BBU connection relationship

# 6G+AI: Providing AI Model Training and Agent Services


Source: Meta, 6GWS-250182

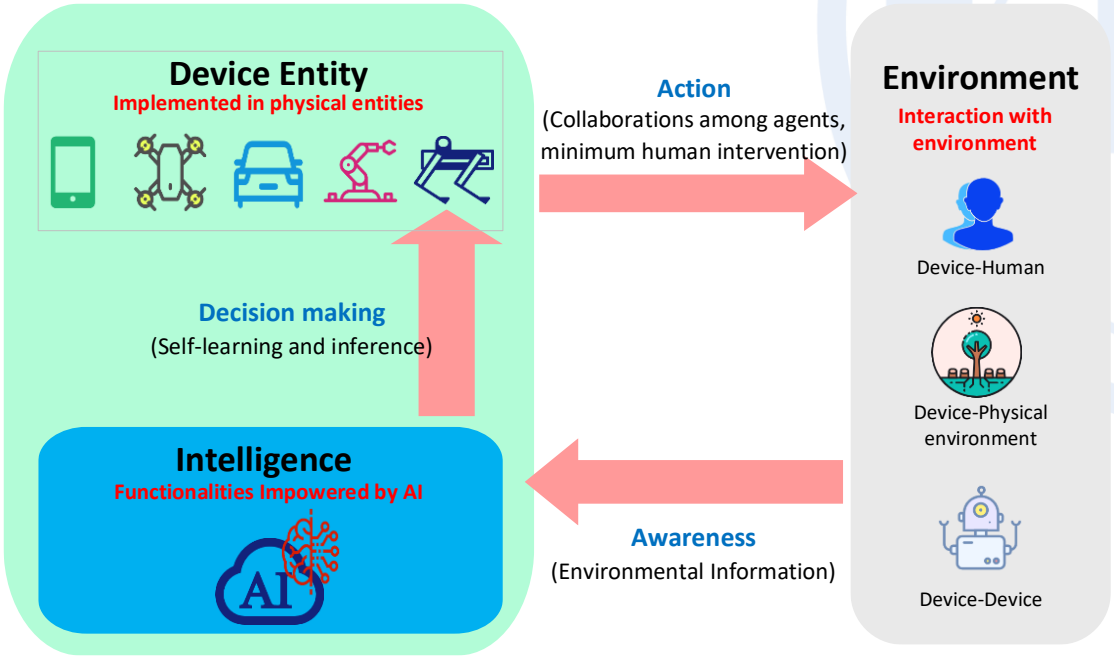
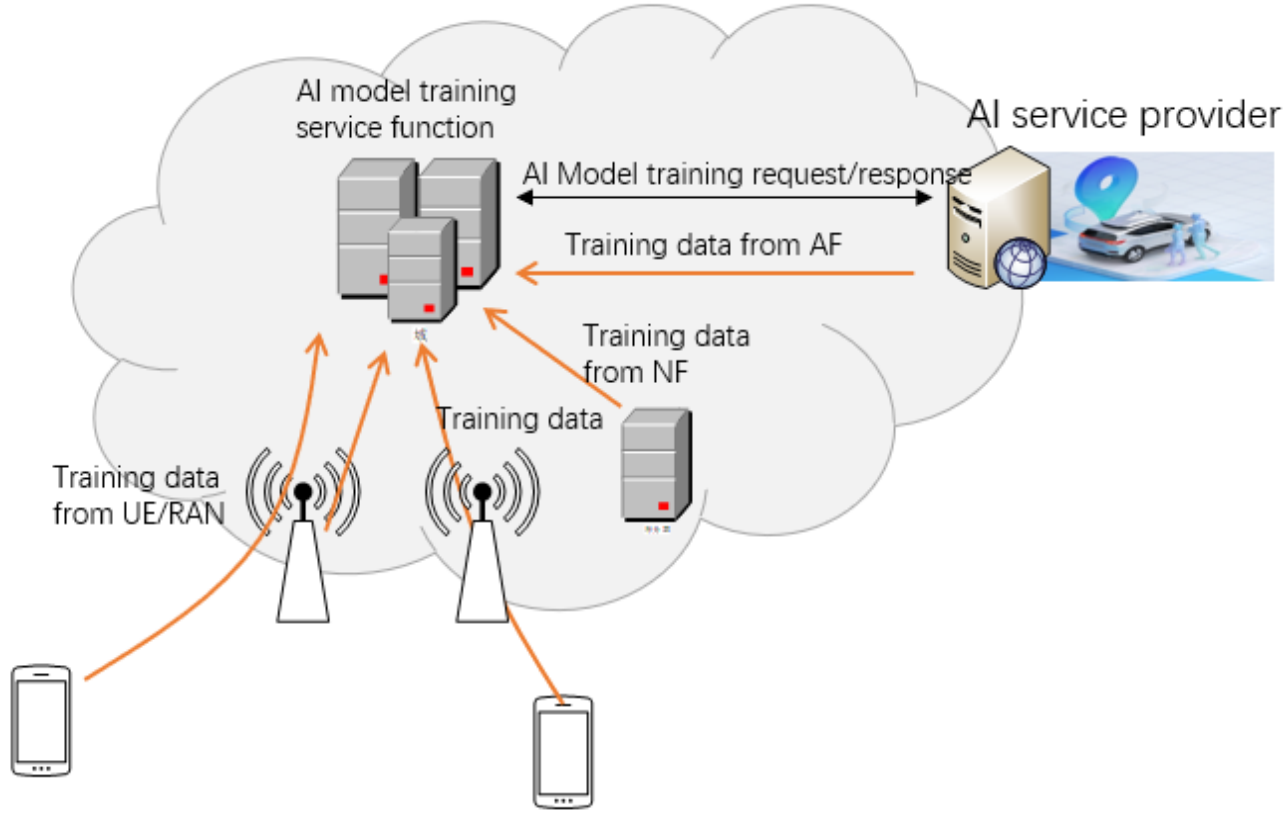



Figure 6.7.1-1. Closed-loop operation for AI agent service

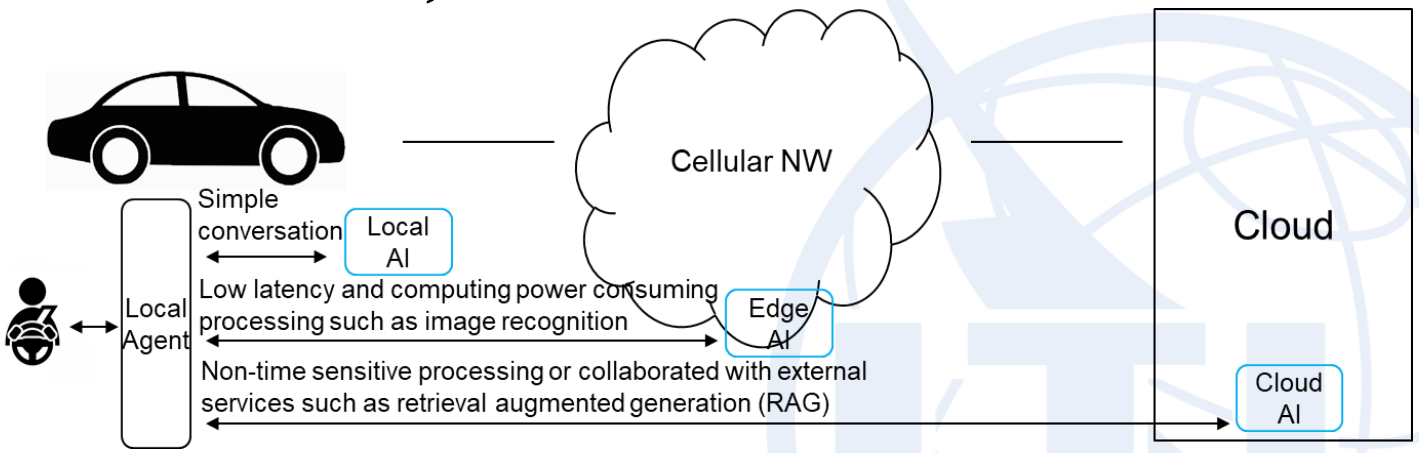
## Service Flows of 6G system supports AI model training service for 3rd party




Source: 3GPP TR 22.870 V0.2.1 (2025-03) **Clause 6 AI** Study on 6G Use Cases and Service Requirements; Stage 1 (Release 20)

# 6G+AI: End-to-End AI Framework for Connected Cars

## Collaborative, end-to-end AI framework

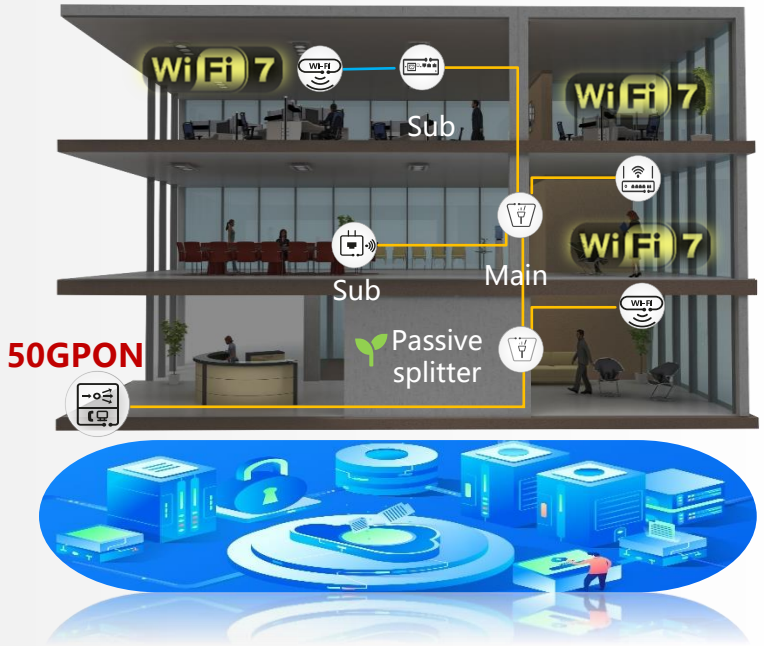



**In-vehicle AI, edge AI, and cloud AI are orchestrated to operate in harmony, adapting dynamically to user requests, network connectivity, network congestion, latency conditions and etc.**

Source: 3GPP TR 22.870 V0.2.1 (2025-03) Clause 6.2 Study on 6G Use Cases and Service Requirements; Stage 1 (Release 20)

- **In-vehicle AI:** Deployed directly within the vehicle, in-vehicle AI systems are designed to manage essential operations and simple conversations and interactions concerning driving or vehicle settings. This localized AI operates independently of network connectivity, ensuring zero latency and real-time responsiveness for basic user requests.
- **Edge AI:** AI servers deployed in 3GPP operator's edge data networks such as Service Hosting Environment offer to AI systems more substantial computational capabilities. These systems are suitable for deploying more powerful models, such as multi-modal LLMs, which require greater processing power and can deliver advanced features with minimal latency. Edge AI serves as an intermediary by balancing resource availability and minimizing latency while handling more complex AI tasks than in-vehicle AI systems.
- **Cloud AI:** Cloud AI systems has vast computing resources, enabling them to execute highly sophisticated and resource-intensive tasks. Although cloud AI is subject to higher communication latency, it is ideal for providing non-real-time services and executing collaborative functions within a retrieval augmented generation (RAG) architecture, thereby expanding the scope and depth of available services.

# Broadband: Collaborative to Improve Services Experience




**Based on 50G PON 、FTTR、Wi-Fi,**
**Ultra high bandwidth, excessive concurrency, ultra-low latency, seamless roaming, Provide high-quality broadband user experience**

## Industry

**High density office and business applications**

FTTR-B：Access**>5Gb/s**
Gigabit and above capability to connect end users

## Office Building

**Cloud Computer (rendering)**

One 4K@60fps:**400Mbps**
Interactive response **< 30ms**

## Home & Comunity

**Cloud Computer (Office)**

20*1080P@60fps:**1Gbps**
Interactive response **< 30ms**

## Hospital

**Real time 3D CT image reading**
**>2Gbps | <20ms**

## Sports Halls

**Live Streaming**
60 channels of 4K free viewing angle **3Gbps**

## XR Education

**XR Holographic Education >4.5Gbps**

# AI Trend: From AI-for-Everything to AI-in-Everything

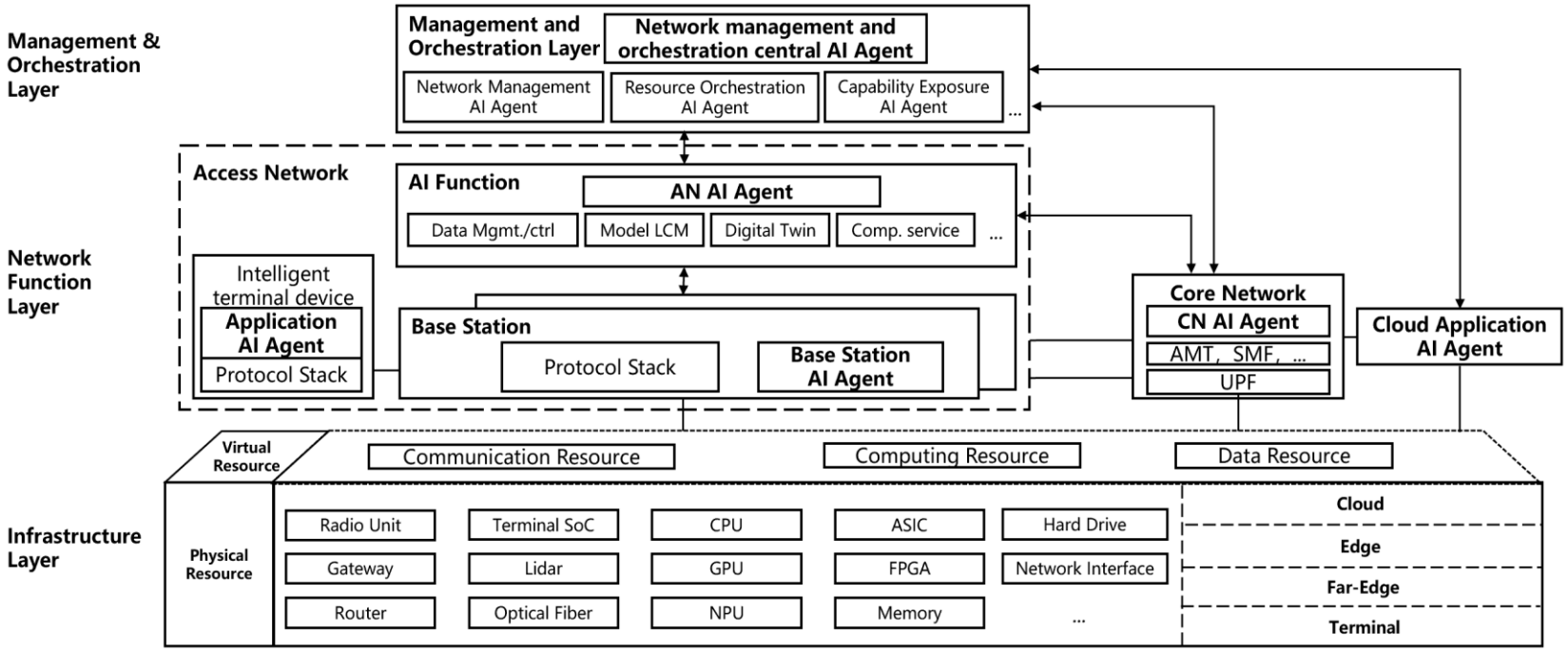
## AI related FGs in ITU-T SGs

- ✓ **AI for Health in SG16**
- ✓ AI and Internet of Things (IoT) for Digital Agriculture in SG20
- ✓ AI for Natural Disaster Management in SG5
- ✓ AI for autonomous and assisted driving (FG-AI4AD) in SG16
- ✓ Environmental Efficiency for AI and other Emerging Technologies (FG-AI4EE) in SG5

## WTSA-24 appoved AI Res.101

Standardization activities of the ITU Telecommunication Standardization Sector **on artificial intelligence technologies in support of telecommunications/information and communication technologies**

## Proposed architecture of AI-Native Network in FG-AINN




Source: ITU-T FG-AINN-I-116,Layered AI-native network architecture with unified AI-related frameworks

**Future networks face three fundamental challenges from AI trends**

- Isolated intelligence in subnetworks impedes global optimization
- Growing demands from end-user intelligence (AI Agents) require dynamic coordination of computing and communication resources
- Broad AI algorithm integration risks network instability

# Content

1. What's new for optical network?
2. Why we need to work on ION-2030?
3. How to promote ION-2030?

# Why We Need to Work Together on ION-2030

- **SG15 Standardization Planning:** **Promoting the collaborative development of end to end Optical Network International Standards workplan within ITU-T SG15, and collaborate effectively with other SDOs.**

## ION-2030: AI enhanced MCS

**Services operations** | **Resources collaborative Orchestrating** | **Service Experience Guarantee** | **Customized Services**

### 6G CN+Cloud & AI DCN

Optical & electrical mixed networking, OCS switching,...

- AI computing clusters' very high performance for ON

### Optical Network

High Bandwidth, Lower delay IP+ Optical converged for QoS, lower cost & energy

- Very high performance for ON
- L4+ Automation and Intelligence

### Edge AI & DCA

multi-Services Optical Gateway Services awareness and QOS

- End to end services experience
- L4+ Automation and Intelligence

### Smart Terminals

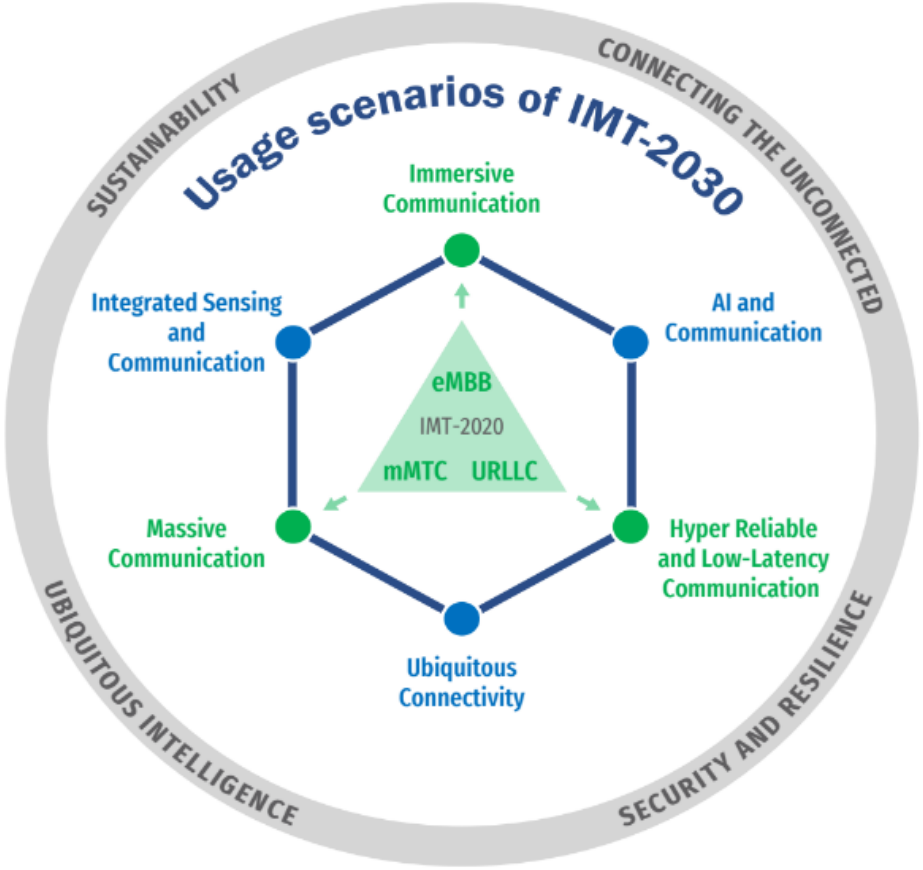
Ubiquitous & converged wireless+optical communication

- Optical and wireless hitless switch and Ubiquitous access
- AI agents' internet

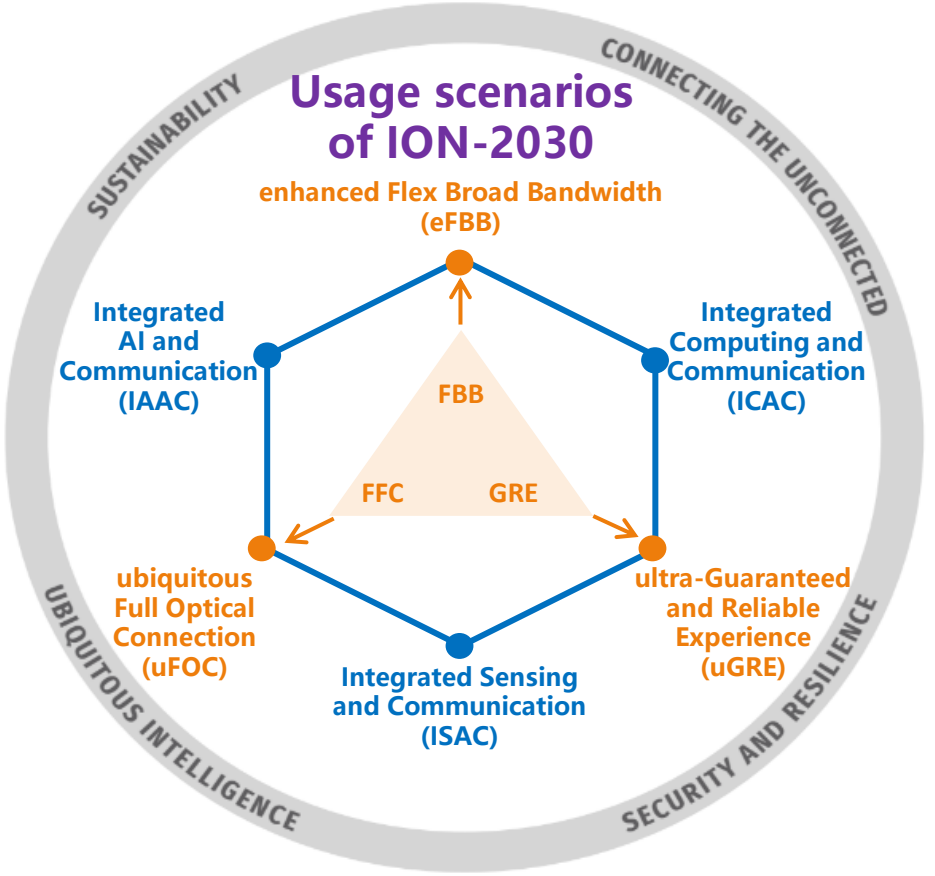
- **SG15 Branding:** **taking ION-2030 as the new brand of ITU-T SG15, let's work together to continuously promote and enhance the international standards and industry influence of ITU-T SG15 on Global Optical Network.**

# Building Common Vision for ION-2030 Use Scenarios

**ITU-R M.2160: IMT-2030**




**GSTR. ION-2030 (Drafting, from WD1214-56 )**




- **Overall design priciples (outer circle):** derived from the United Nations Development Programme
- **Enhanced Scenarios (orange):** large capacity, ubiquitous connectivity, and determined quality
- **New Scenarios (blue):** Add intelligence, optical and computing collaboration, and multi-dimensional sensing, expanding new development space for the optical communication industry

# Enhanced and Expanded Capabilities of ION-2030

## Enhanced Scenarios and Capabilites

### eFBB: enhanced Flex Broad Bandwidth

- **Transport:** B1T OTN/800GE &1.6T FlexE+fgOTN or fgMTN
- **Access:** 50G PON→ VHSP、WIFI7→WIFI8
- **Flexible adjustment:** Optical and electronic switch, coherent subcarrier

### uFOC: ubiquitous Full Optical Connection

- Ground、Satalite，Submarine Optical Conections
- Vertical industry: Industrial PON, FSO
- FTTR/FTTO, WIFI7/8 and other global connections

### uGRE: ultra Guaranteed and Reliable Experience

- **Reliability:** hitless protection, 50ms 1+R
- **Agility:** Task based connection Building in Seconds
- **Differentiation:** End to end application level slicing/SLA differentiated carrier

## New Expanded Scenarios and Capabilites

### ISAC: Intergrated Sensing and Communication

- **Services feature awareness**: Five tuple/DFI/SLA requirements
- **Connection experience perception**: SLA maintenance, poor quality, optimization, channel
- **Infrastructure Perception**: ODN Sensing, Fiber Optic&Spectral Sensing

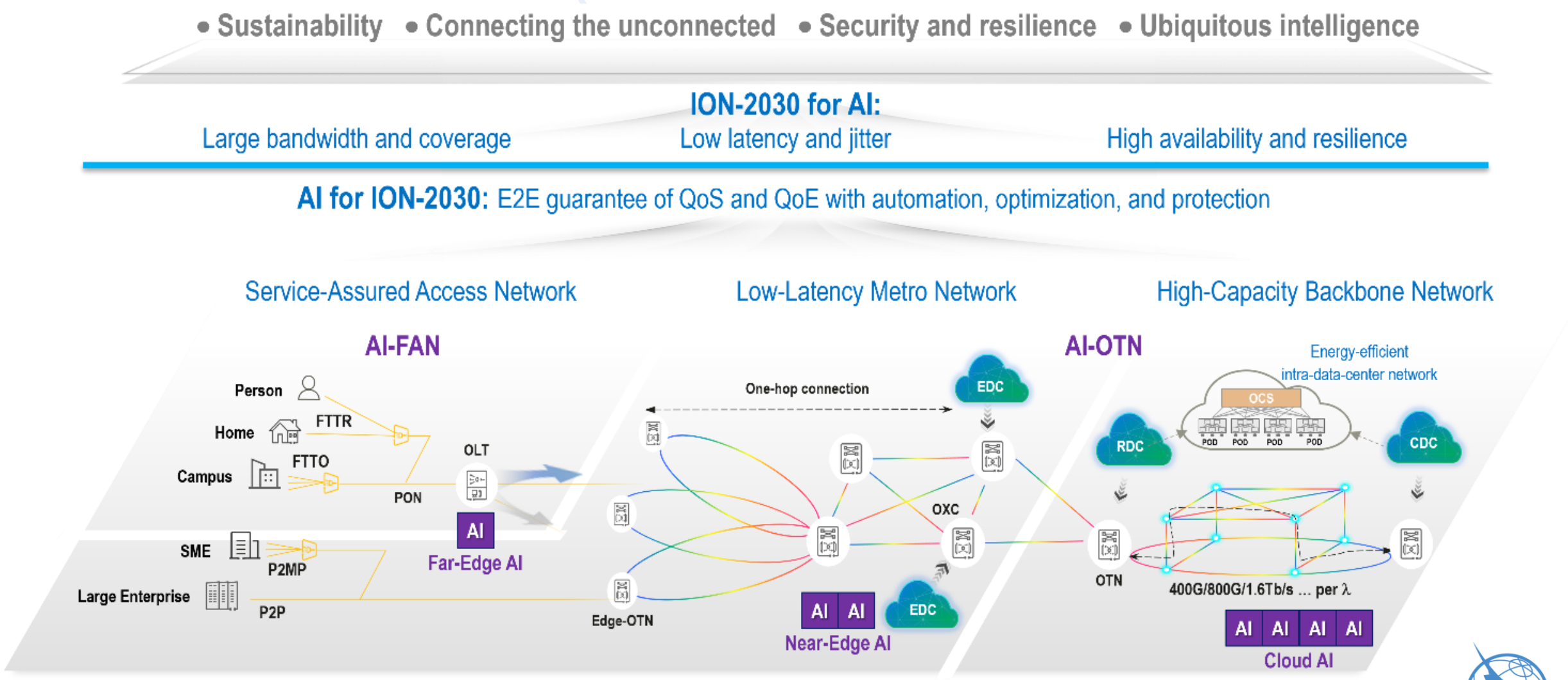
### IAAC: Integrated AI and Communication

- **AI enables network**+services management
- **AI agents:** Fault AI agents, Performance AI agents, Experience assurance AI agents
- **Digital Twin/Big Model**: Improving Operations Efficiency

### ICAC: Integrated Computing and Communication

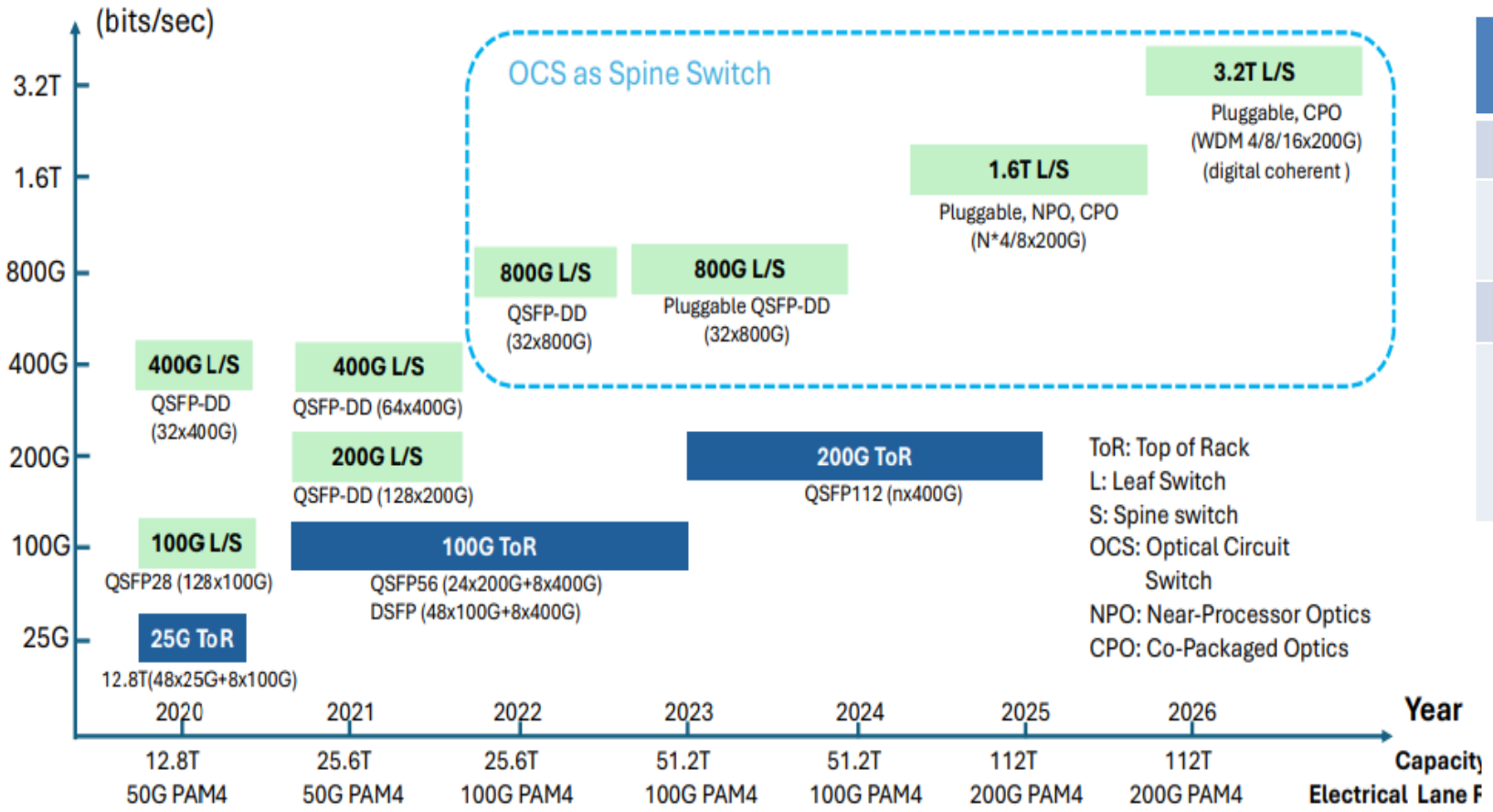
- Collaborative resource scheduling for computing networks
- Lossless transmission ensures computational efficiency
- DCN & DCI & DCA

# Promote the Mutual Empowerment of AI and ON (AI-ON)




Source: wd1214-56, Multi-company

# DCN Optical Modules： 1.6T is Coming, 3.2T under R&D

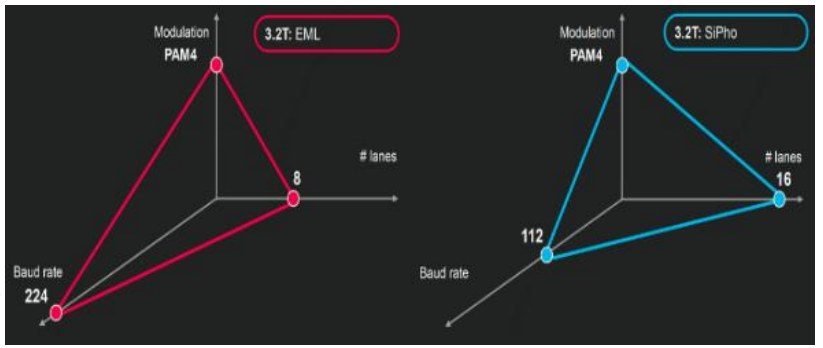



*Source：JSTQE-INV-AIMLIO2025-09994-2024.R1*

| Optical Modules | Electrical interfaces bitrats | Optical interface bitrates |
|---|---|---|
| 400GbE | 50Gbps×8 | 100Gbps×4 |
| 800GbE | 100Gbps×8 | 100Gbps×8<br>**200Gbps×4（Now）** |
| **1.6TbE** | 200Gbps×8 | **200Gbps×8** |
| **3.2TbE** | **Options：**<br>400Gbps×8<br>200Gbps×16 | **Options：**<br>400Gbps×8<br>200Gbps×16<br>Coherent Lite |

*Source：CignalAI 2025*

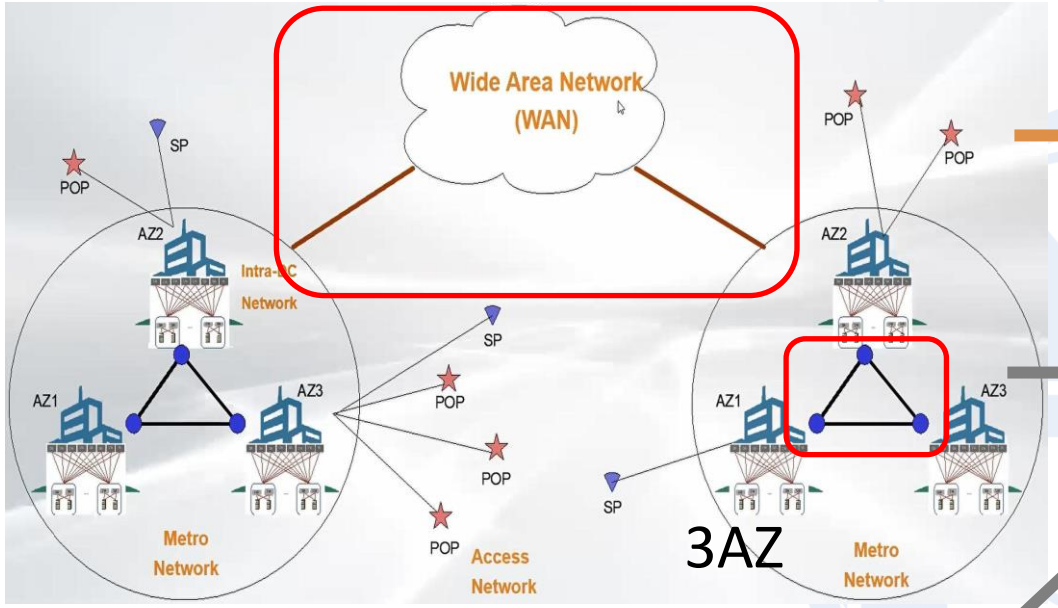
- **Using PAM6 at 150 Gbaud** seems to be an ideal compromise between the simplicity of PAM4 and the signal-to-noise ratio issue of PAM8.
- According to CignalAI's prediction, **single channel 400Gb/s optical devices** will occupy a certain market share around 2028 or 2029.

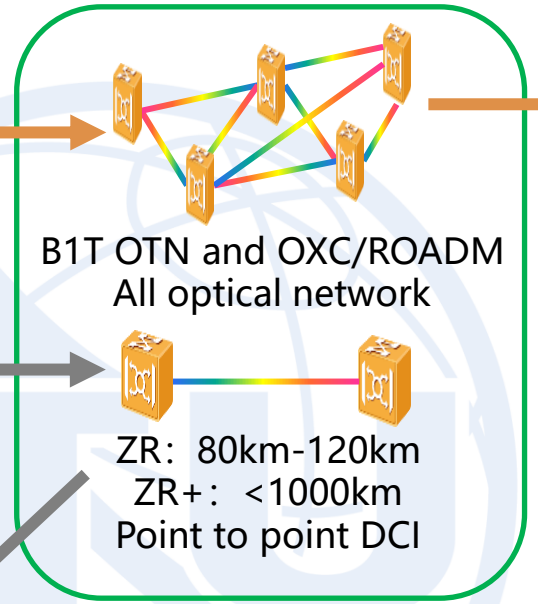



**Marvell：**

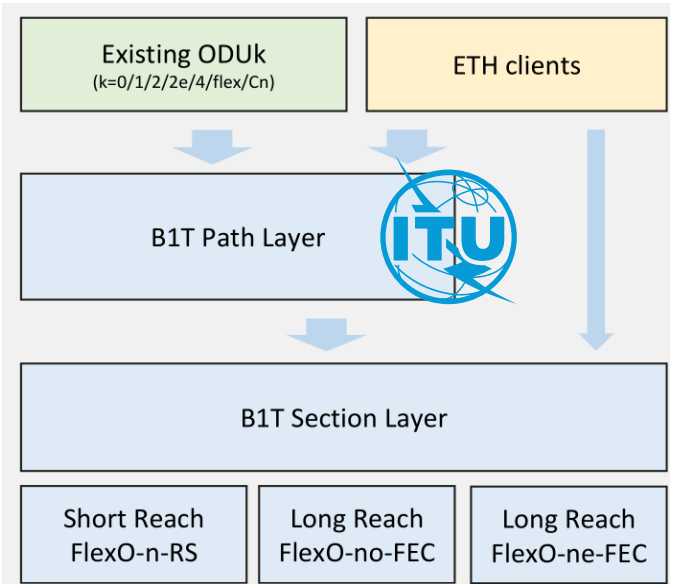
- 8*224GBaud EML
- 16*112GBaud Si-ph， less CW laser used

# DCI: Future ON for distributed AI Computing Clusters



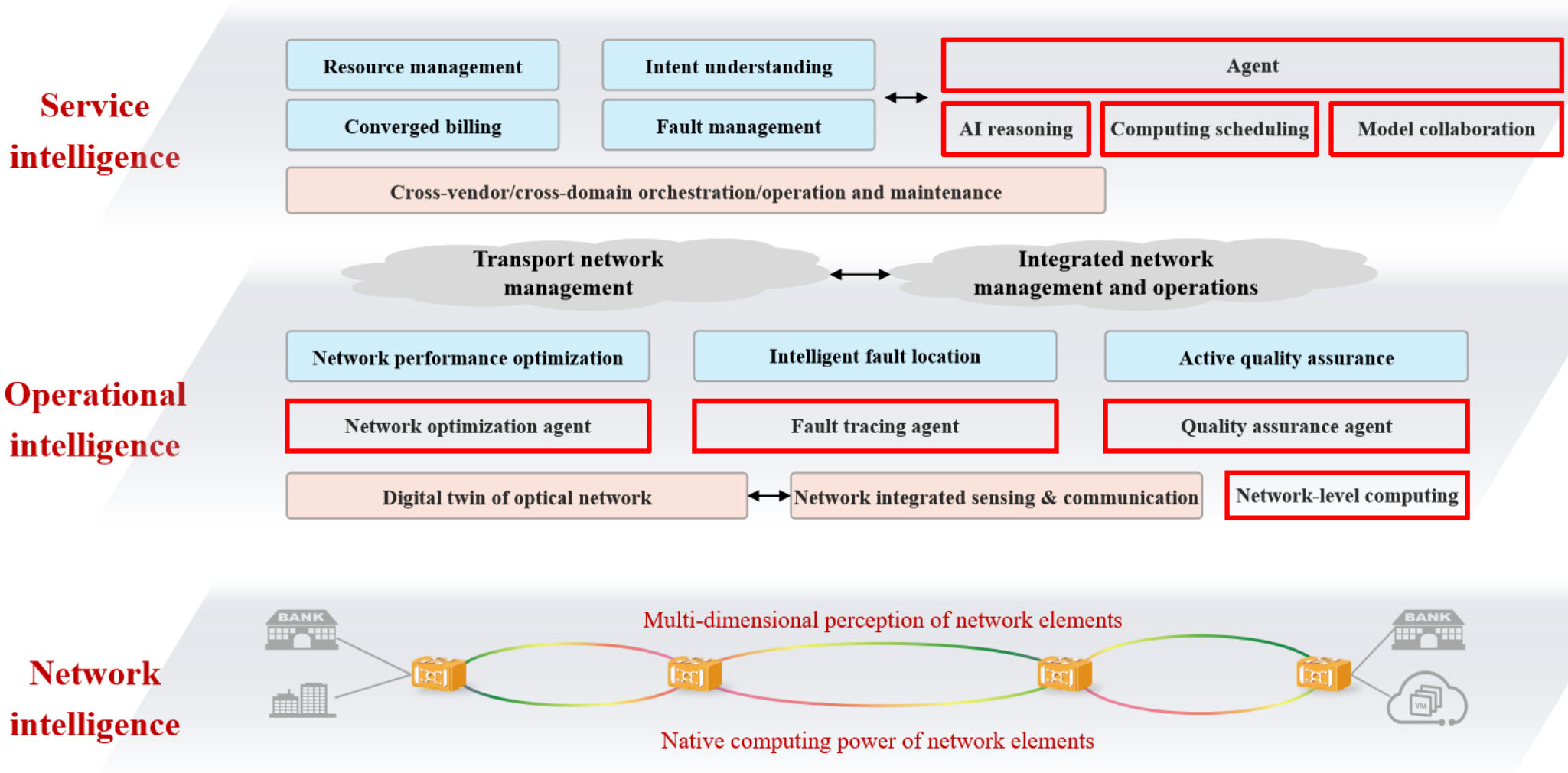

**800G/1.2T/1.6T WDM, OXC/ROADM in Q6/15, B1T OTN in Q11/15**





**What's the 6G+AI+Broadband DC oriented future optical network will be?**
**What's the network architecture and key capabilities that should ON have?**

# The Architecture of AI for Optical Network Intelligence




Source: wd1214-71r1, Multi-company

# Content

1 What's new for optical network?

2 Why we need to work on ION-2030?

3 How to promote ION-2030?

# How to Promote the GSTR.ION-2030 Work Item?

| March. 2025 | June-Augst. 2025 | Sep.-Oct. 2025 | Jan.-July 2026 |
|---|---|---|---|
| **Clearly define the expected output results** | **Refine and drafting the GSTR.ION-2030** | **Review and reach consensus in SG15** | **Joint discussion with other SDOs** |
| ✓ **Target readers:** CXO and CTO<br>✓ **Report content:** Less than 30 pages<br>✓ **Main Scope:** Four key driven scenarios<br>✓ **Output suggestions**: Propose follow-up standardization suggestions and work plans | ✓ **Logically refine outlines**, avoiding duplications<br>✓ **Discussion**: drafting main content and initial version of GSTR.ION-2030<br>✓ Organizing ION-2030 workshop with Questions | ✓ Discuss and reach consensus on technical trends, capabilities, KPIs, & standardization roadmap for ION-2030<br>✓ **Agree on the first release of GSTR.ION-2030 in Oct. 2025** | ✓ Organizing ION-2030 workshops with other SDOs such as ITU-R and IEEE802.3 etc.<br>✓ Update relative contents<br>✓ **Work on new work items based on GSTR.ION-2030** |

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# AI for Good
# Optical Network for a Better Connected World


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# Thank you !