

# Optical Network Challenges and Evolution in the Computing Era

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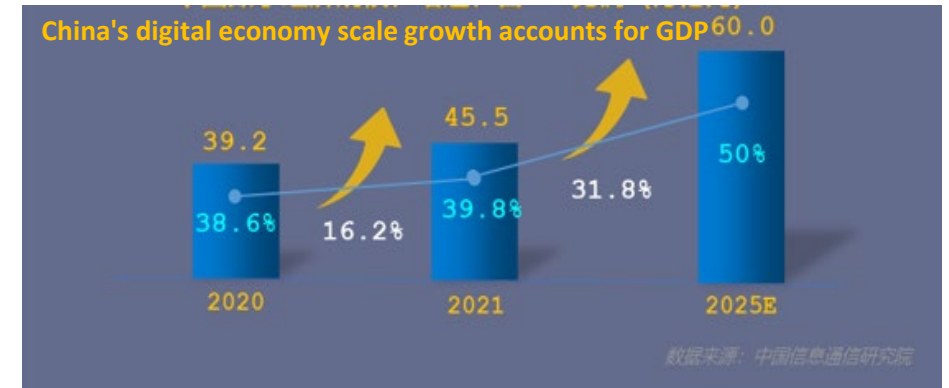
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# Computing power is the new productive force in the digital economy era

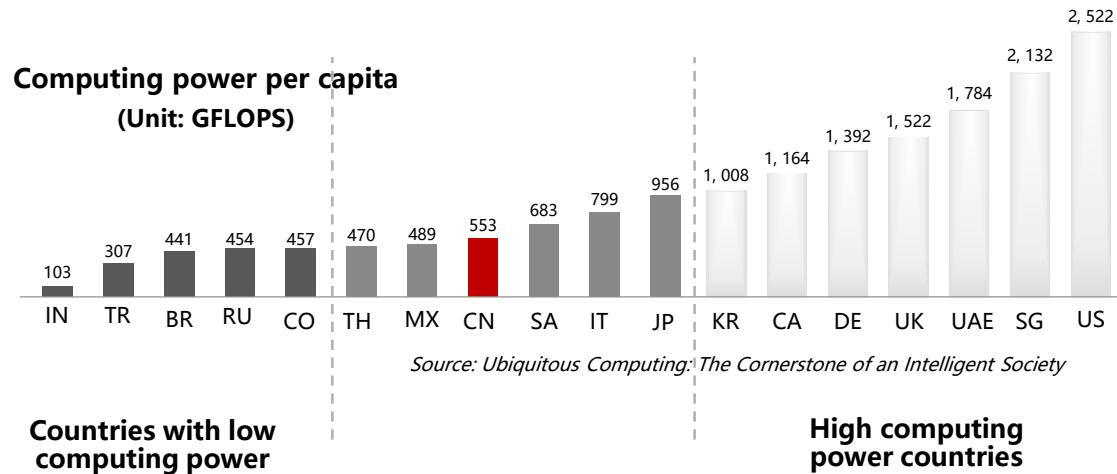
## Core productive force in each era



The growth rate of the China's digital economy is the first in the world and the second in the scale in the world.



## Per capita computing power is positive related to the economic level



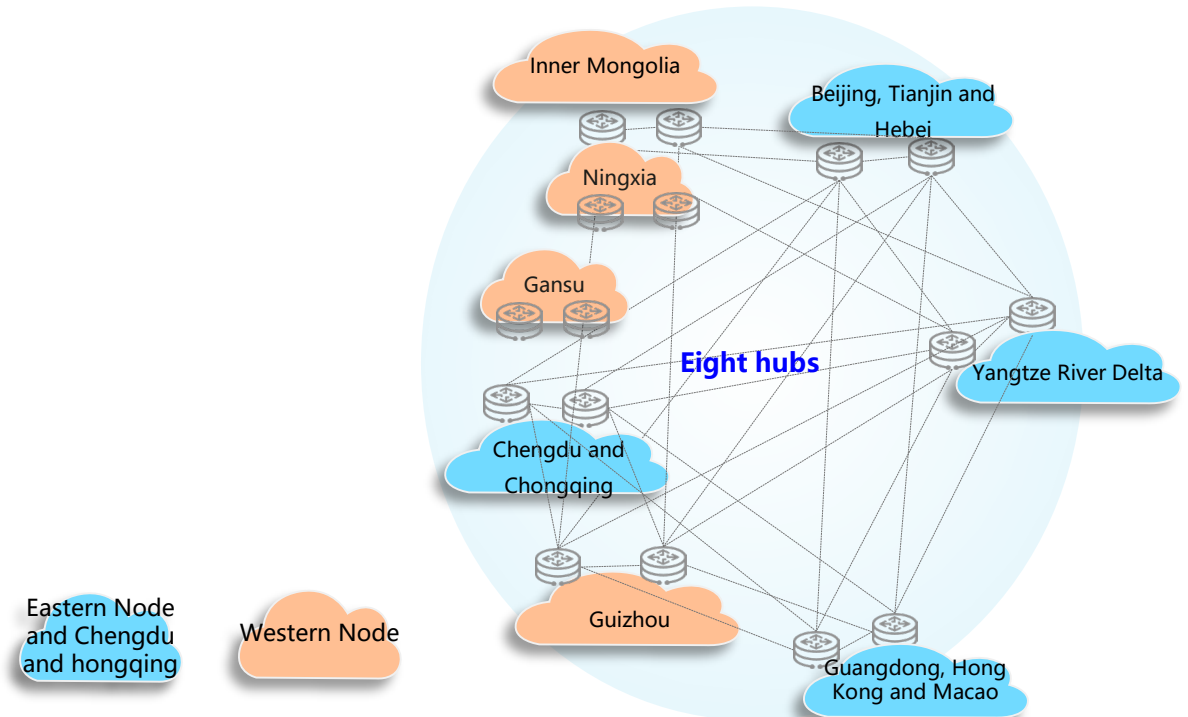
\*GFLOPS: Giga Floating-point Operations Per Second, is a billion floating-point operations per second

- By 2022, China's digital economy will reach 50.2 trillion RMB, worldwide No.2 in terms of total volume, accounting for 41.5% of GDP.
- Every 1% increasing of computing power index will lead to 3.3% digital economy and 1.8% GDP growth respectively.

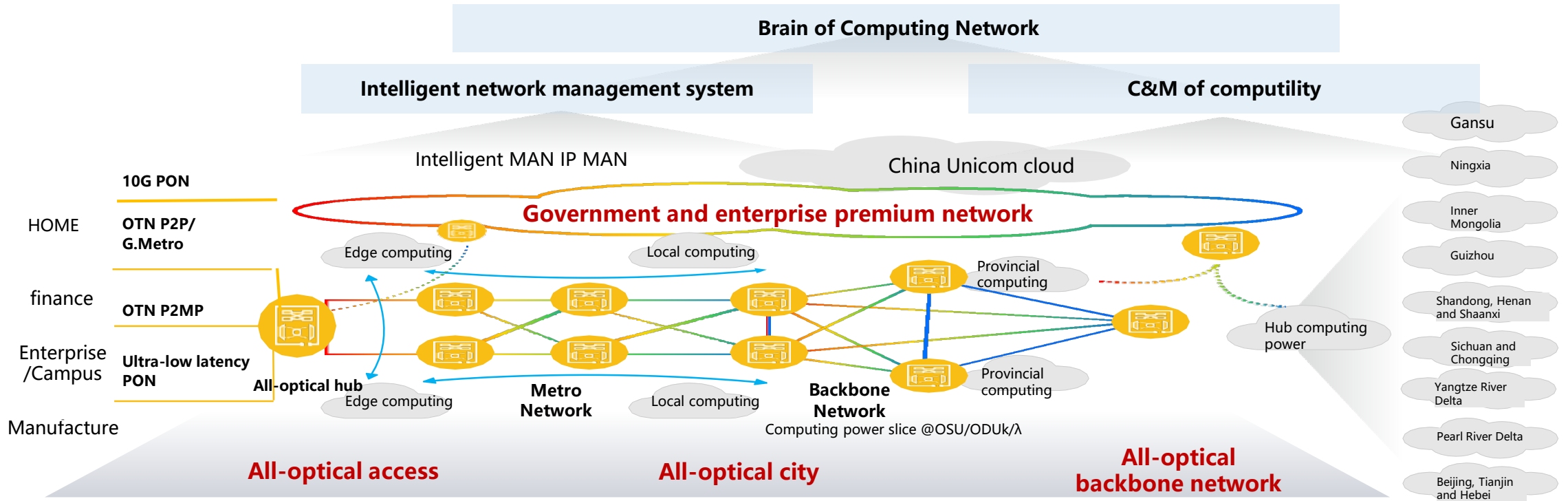
# The country implements the "East Data West Computing" project to improve the computing service capability.

- In May 2021, the National Development and Reform Commission proposed to build national hub nodes of the national integrated computing network and accelerate the implementation of the "East Data West Computing" project.
- In February 2022, the National Development and Reform Commission agreed to build eight national computing hub nodes and planned 10 national data center clusters. The "East Data West Computing" project has entered the stage of full implementation.

- Build a dedicated transport network for data center clusters to increase network bandwidth, improve transmission speed, and reduce transmission costs.
- Build a 1–5–20 ms latency circle. (1ms in a city, 5 ms in a hub, and 20 ms between hubs)



# In May 2022, China Unicom released the all-optical Infrastructure for computing era



### Connections for computing

- Stable architecture
- With computility anchor, 300m to users, experience is optimal.
- Optimal latency: 1ms from the anchor point to the edge, 5 ms to the hub, and 20 ms from the east to the west

### Connections for enterprise

- Reliable connection between large enterprises and flexible connection between small and medium-sized enterprises
- 10M-100G access
- Hard pipe isolation and 99.999% reliability

### Connections for Home

- FTTR Smart Home Networking
- The OLT integrates the edge computility (edge storage, edge computing, and edge acceleration).

# Main technical directions of all-optical network

## High-speed & ubiquitous physical network

- C+L/400G
- G.654E
- New optical fibers

Ultra-high speed transmission



- OXC
- WSS
- Cost-effective metro WDM

Ultra-Broadband Networking



- FTTR, FTTM
- 50G PON

Ubiquitous optical access



## Intelligent and agile service capabilities

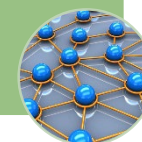
- Autonomous network
- Digital Twin
- Sensing communication integration

Intelligent optical network



- Open network
- Capability openness

Open optical network



- All-optical infrastructure for "East Data West Computing"
- Premium network for government and enterprise customers

All-optical service network



## Development vision of green and low carbon

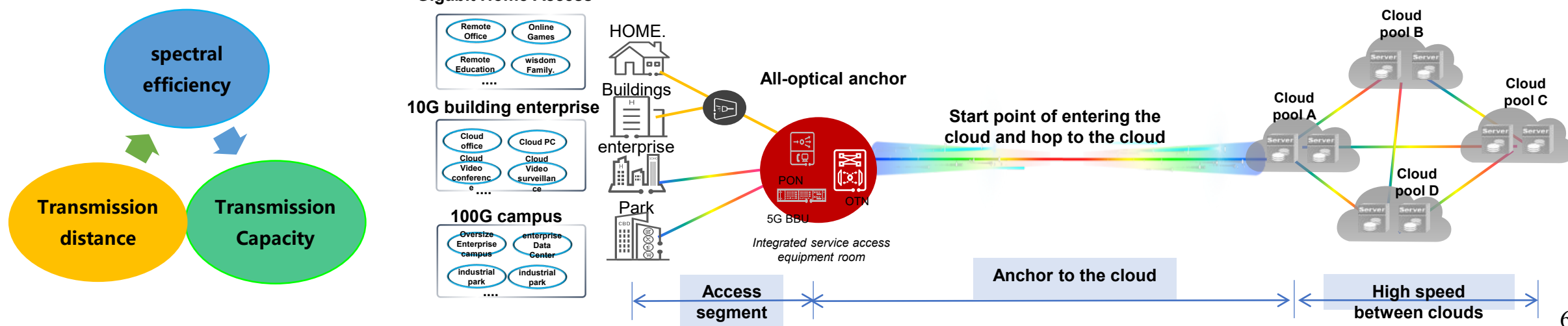
# The all-optical base evolves to F5.5G key technologies

## Ultra-high-speed, large-capacity, long-distance transmission

- **High-speed components:** The baud rate of optoelectronic components evolves from 130 GB to 200GB, achieving high-performance single-wavelength 400G/800G
- **Extended spectrum:** The available bandwidth of optical fibers can be extended to more than 12 THz from the traditional C-band to the C+L-band and S-band.
- **New optical fibers:** G.654.E optical fibers and cables are deployed on a large scale on backbone networks, laying a foundation for 400G and beyond 400G
- **Space division multiplexing:** Based on multi-core and few-mode optical fibers, the transmission capacity is improved. Based on hollow fiber, transmission delay is reduced. Multi-core and hollow fiber are still in the research and test stage.

## Intelligent and Efficient Bearer network and Ubiquitous Optical Connection

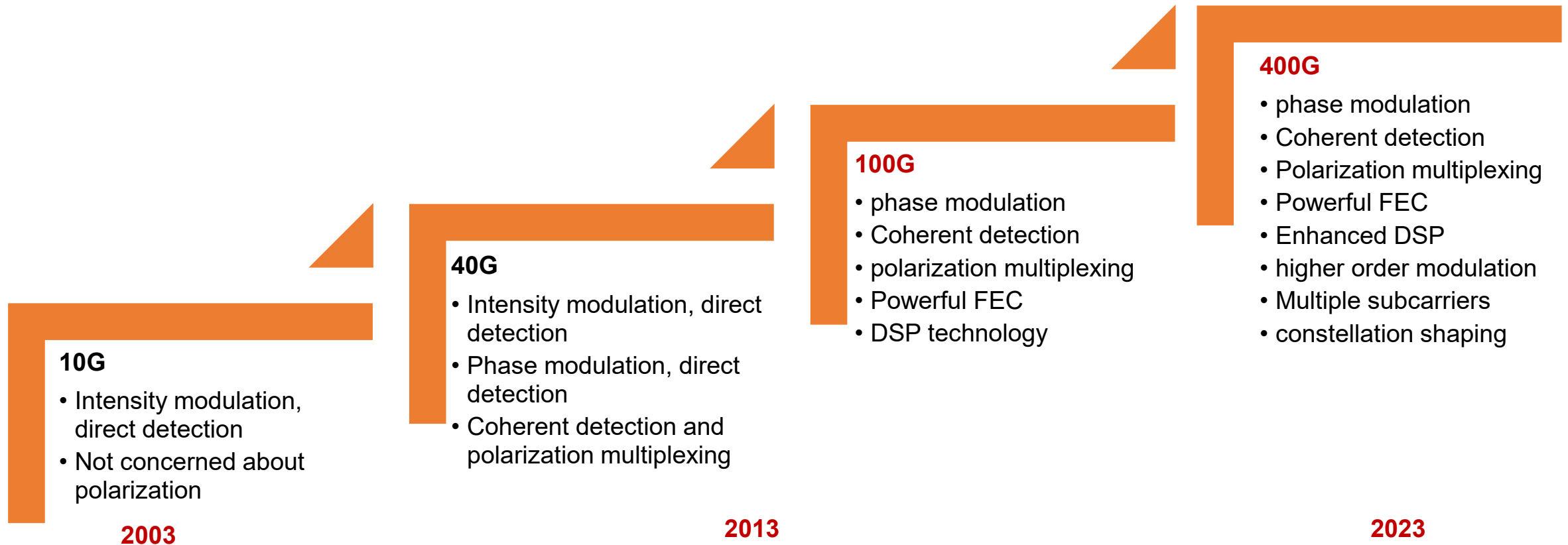
- **Efficient bearer:** The OSU technology is used to efficiently carry multiple services from 10 Mbit/s to 100 Gbit/s.
- **Intelligent networking:** ROADM (OXC) all-optical networking, optical-electrical collaborative C&M, and WSON and ASON make full use of their respective advantages.
- **High-speed access:** 10GPON is the mainstream optical access technology. 50G PON and WDM PON technologies are gradually mature.



# Backbone networks enter the era of single-wavelength 400Gb/s

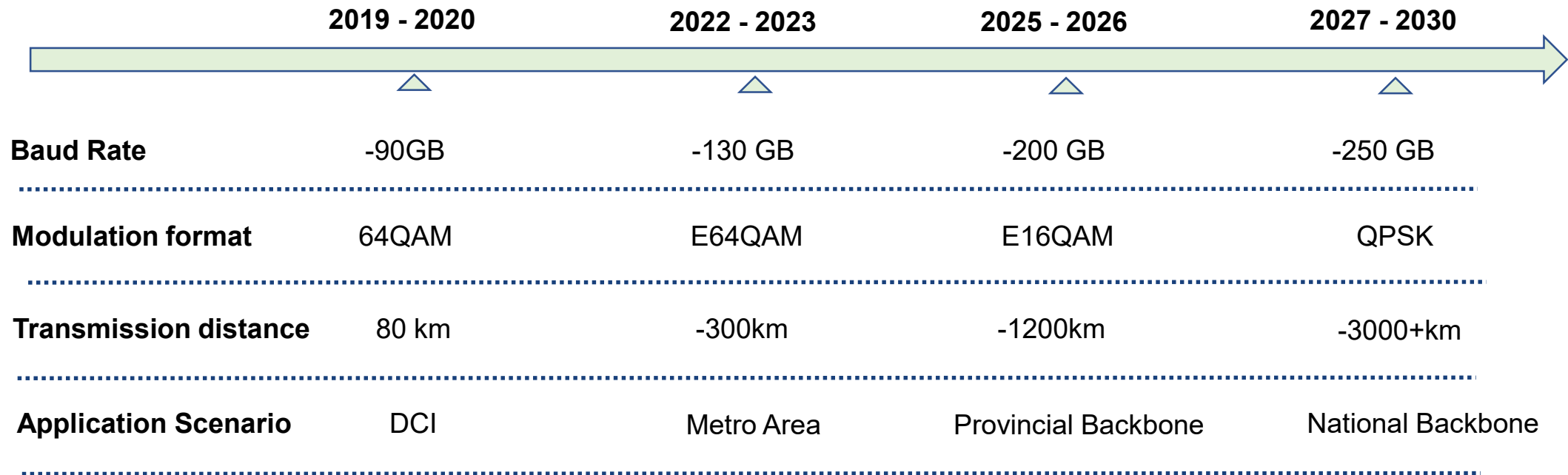
- Coherent optical interfaces are developing in two directions: long-distance backbone network with ultimate performance and MAN with high integration, low power consumption, and pluggable.
- 16QAM modulation can be used for the backbone network with short distances and in the province. QPSK can be used for ultra-long distances.

- In January 2023, China Telecom implemented 400G ultra-long haul real-time transmission on the live network.
- In February 2023, China Mobile released the live network test for the longest-distance 400G transmission.
- In April 2023, China Unicom built the largest 400G OTN experimental network in Zhejiang Province.



# 800G is for short-distance now, it takes 3~5 years for long-haul application 中国联通 China unicom

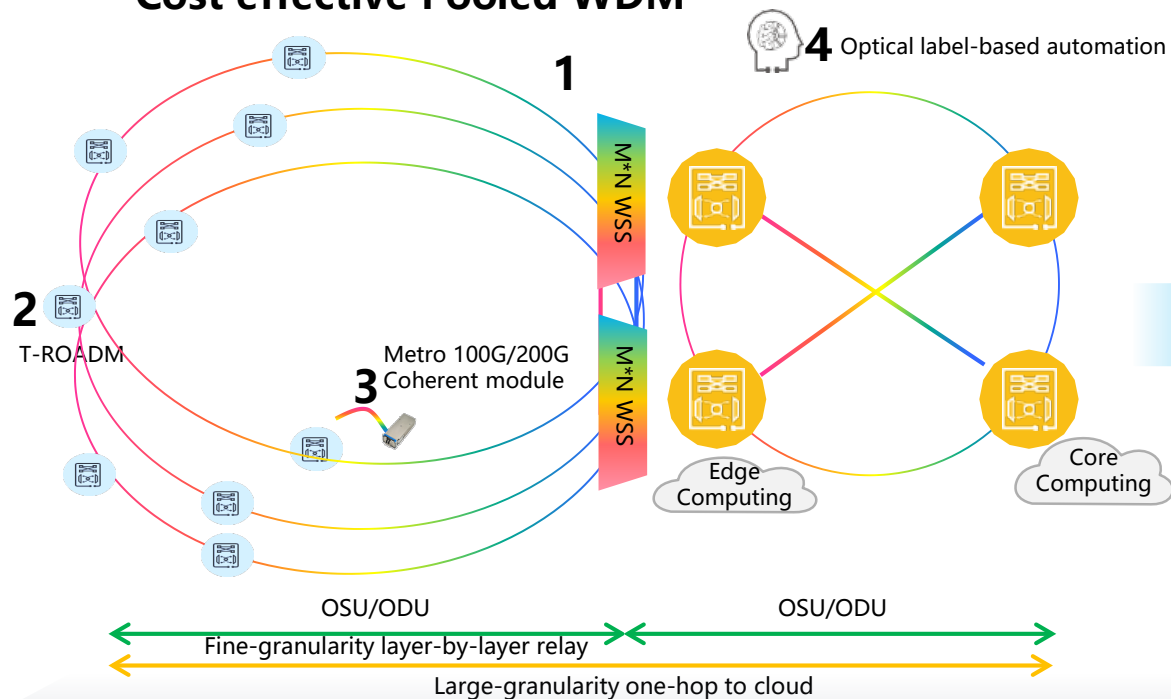
- As the baud rate of components increases, the 800G transmission performance continues to improve. In 2019, the 90GB 64QAM for 80 km DCI, now 130G baud for 300 km metro applications.
- Some mainstream vendors have started to invest on 200 GB high-baud optoelectronic components and chips. It is estimated that the 800 Gbit/s will reach 1000 km in 2025 ~ 2026, meeting the requirements of provincial backbone applications.
- For the long-term, the academic community and industry need to work together to solve the problem of 250G baud-rate components to achieve ultra-long haul transmission on national backbone networks.







## Cost effective Pooled WDM



- MxN ROADM on the Aggregation/ Access Ring enables Wavelength Sharing
- 1x2 ROADM deployed at Edge
- Low-cost Metro 100G/200G systems

## Create the best all-optical metro base

### Enable E2E MAN ROADM+OTN deployment

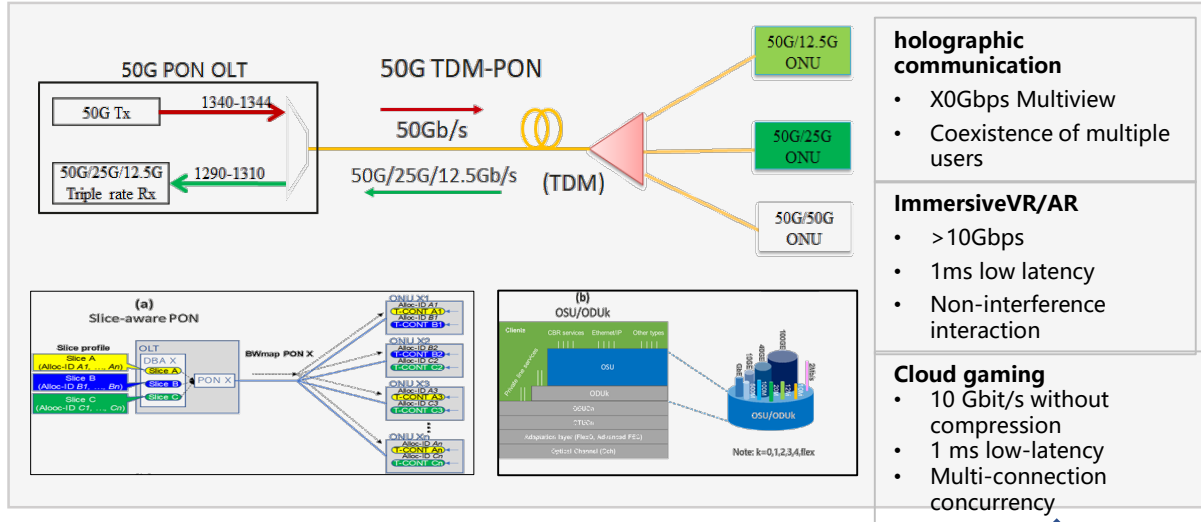
- The MxN ROADM, low-cost 100G OTU technologies enable wavelengths sharing among access rings in the aggregation node and cost effective all-optical metro networks are realized.

### Optimal TCO for metro transport networks

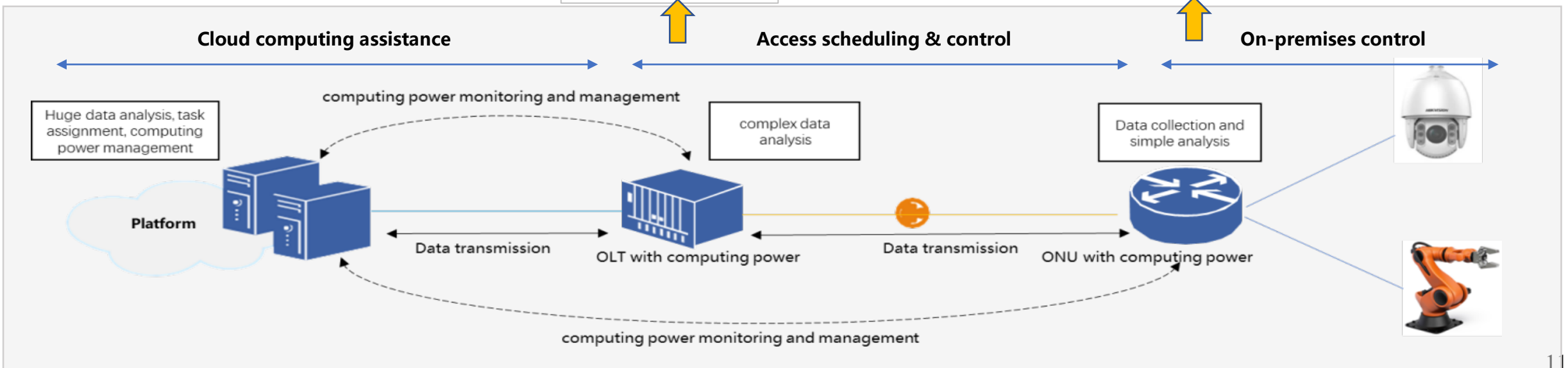
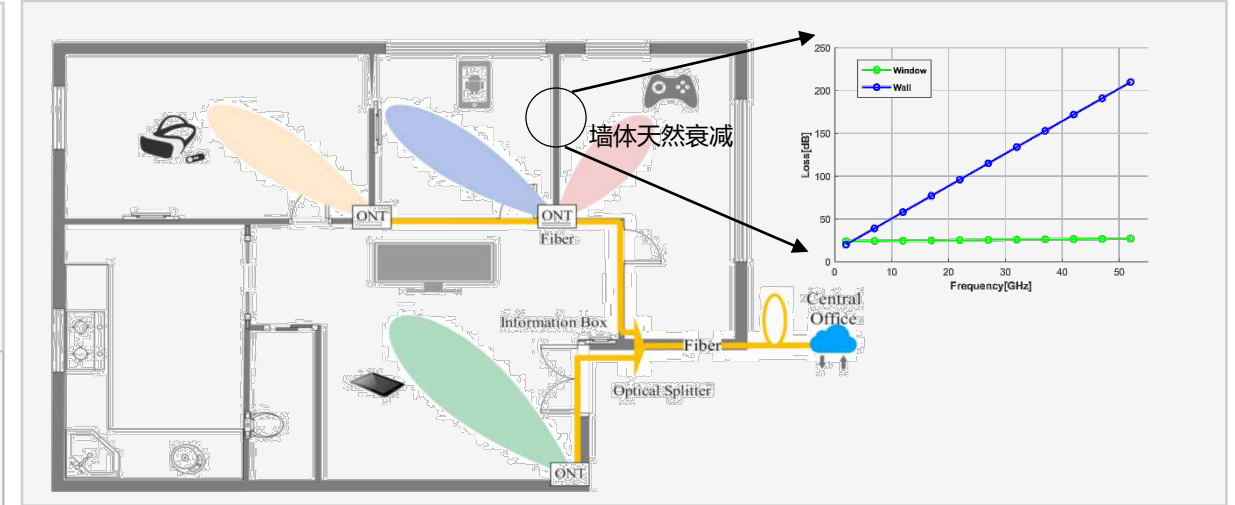
- ROADM boards reduced by 50%
- Space and power consumption reduced by 50%
- ROADM+OTN for metro network: Future proof, Low Cost, Optimal Performance, High service Provisioning Efficiency, and Energy Saving

# All-optical Access evolution: Computing enhancement, 50G PON and FTTR+Q-band WiFi

## 50GPON : Enabling Emerging Digital Services



## FTTR+Q-band mmWave Wi-Fi: high-bandwidth without interference



## **1. All-optical backbone: High capacity all-optical network ensures computing power scheduling (800G).**

Deploy 400G, research and standardize 800G, convey efficient connection and scheduling of computing resources.

## **2. All-optical access: Ubiquitous high speed optical access enables all-optical cloud/computing access.**

Build a stable architecture and full-coverage integrated service area as well as all-optical computing anchor points, provide high-speed ubiquitous optical access with multiple technologies, cultivate 50G PON, and implement flexible and convenient all-optical cloud/computing access.

## **3. Optical network and computing synergy: enhances awareness of computing power and application in transport and access network, and realizes efficient collaboration of network and computing resources.**

Innovation in computing & application awareness, lossless transmission to achieve collaboration between optical network and computing & storage resources and provide efficient and deterministic all-optical computing power networks for AI/ML development.

Thanks !