Xiang Liu, Chief Scientist of Optical Standards, Hong Kong Research Center of Huawei, Hong Kong, China

Dr. Xiang Liu is Chief Scientist of Optical Standards at Huawei Technologies. He has been actively contributing to international standards in ITU-T SG15, IEEE 802.3, ETSI ISG-F5G, BBF and OIF. He had been the Vice President for Optical Transport and Access at Futurewei Technologies.

He received the Ph.D. degree in applied physics from Cornell University in 2000. He has authored/co-authored more than 350 journal and conference papers and holds over 100 patents.

He has served as a Technical Program Co-Chair of OFC 2016 and a General Co-Chair of OFC 2018. He is a Fellow of IEEE and OSA

ITU Workshop on “Evolution of Optical Networks for IMT2030 and Beyond”

Charles K. Kao Auditorium, Hong Kong Science and Technology Park (HKSTP)

20 November 2024, 15:00 - 18:00

Key Requirements and Enabling Technologies of Optical Networks towards 2030

Xiang Liu

Huawei Hong Kong Research Center, Hong Kong, China

ITU-T SG15's Sustained Contributions on Optical Technologies

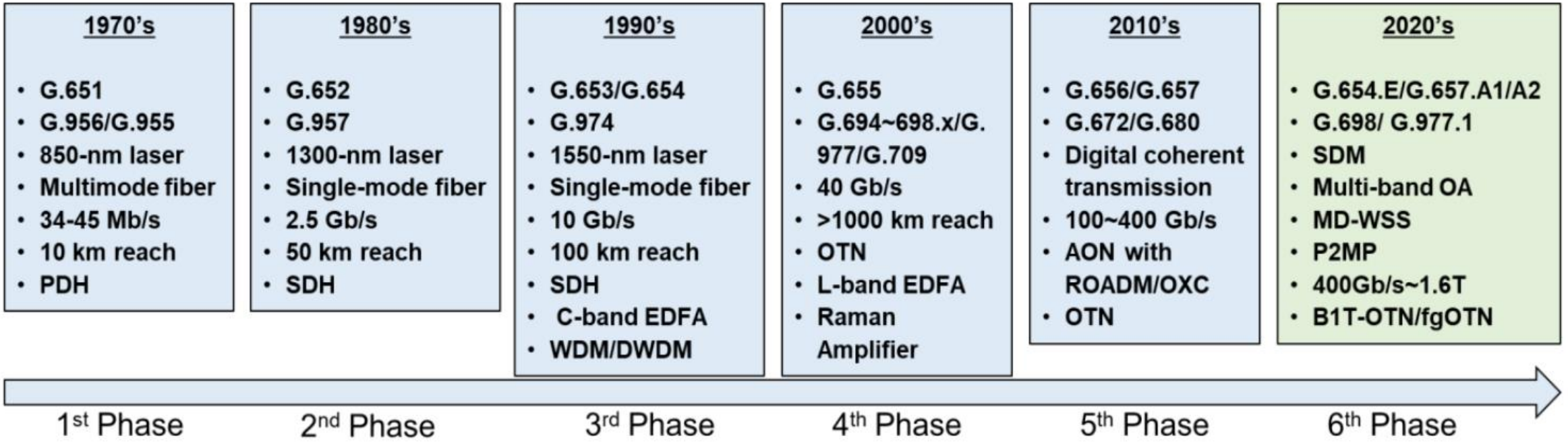


Figure 1 Phases and timeline of fibre-optic communication systems evolution

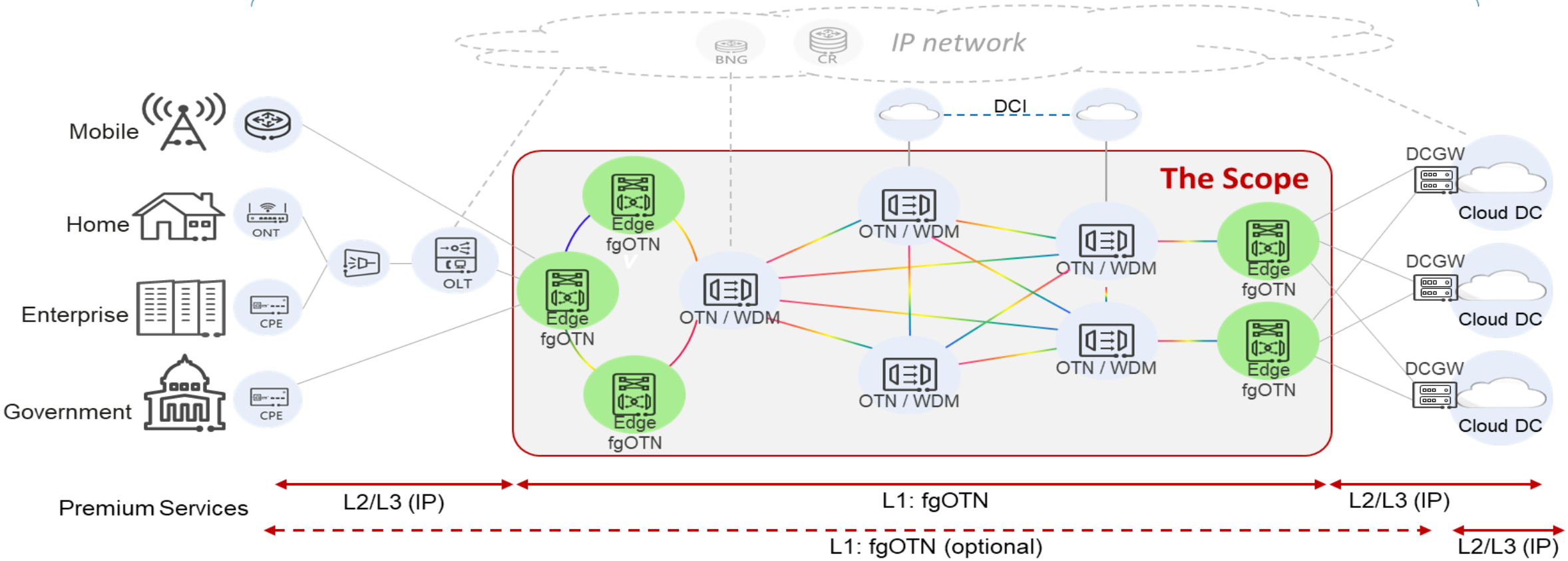
- Communication capacity per fiber has remarkably increased by >10,000 times over the last 40 years!
- Evolution from single-span transmission to intelligent networks with high throughput and fine granularity.

Reference: Technical Report on Optical Fibers, Cables and Systems (TR-OFCS).

Evolving towards Service-Oriented Optical Network (SOON)

End-to-end (E2E) network slicing for guaranteed quality of service (QoS)

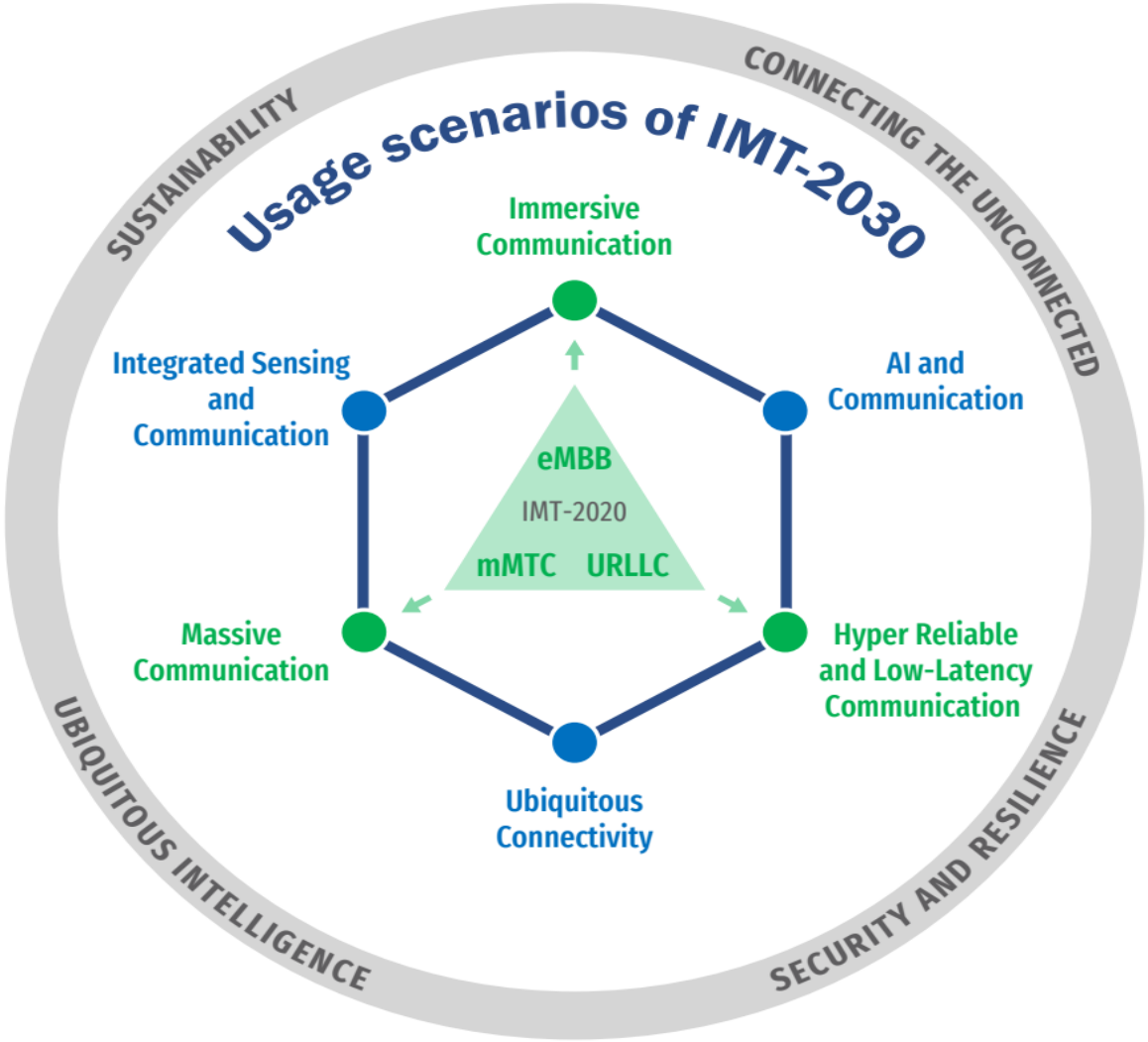
Multi-Layer and Multi-Domain Management & Control (M&C)



Advantages in Agility, Capacity, Coverage, Energy Efficiency, Flexibility, Latency, Reliability, Synchronization, and TCO.

[1] The “SOON” concept was also discussed at the ITU-T Q11/15 Interim Meeting in Zurich, 29 June 2023.
[2] wd1214-52,“Considerations on the management and control of cloud-service-oriented optical networks”, ITU-T SG15 Q12&Q14, Hong Kong, 18-22 Sep., 2023
[3] Y. Zhao et al., "Multi-layer resource scheduling architecture and algorithm for a service-oriented optical network based on a fine grain OTN," in Journal of Optical Communications and Networking, vol. 16, no. 10, pp. F13-F25, October 2024.

Design Principles and Use Cases of IMT-2030

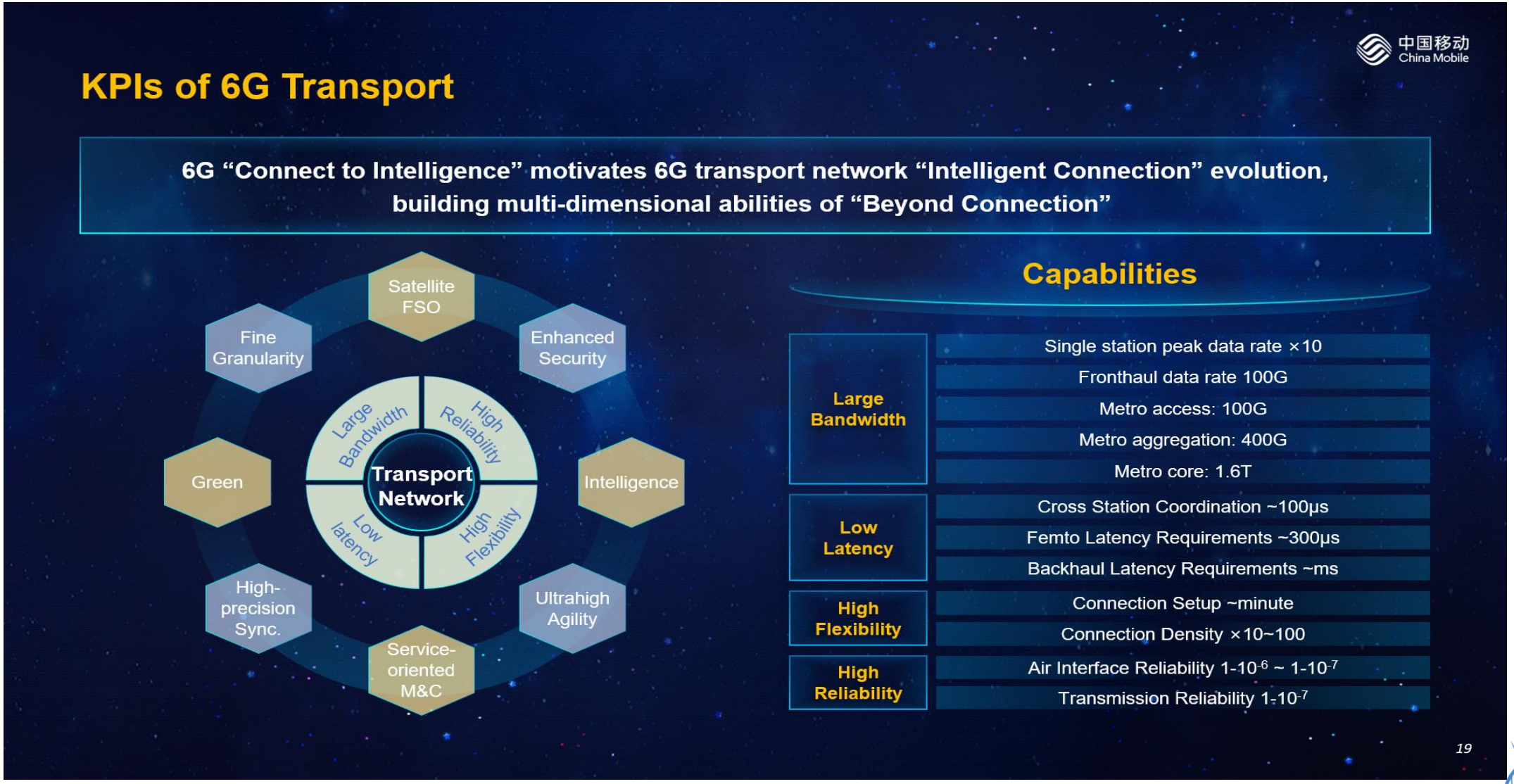


Four overarching design principles commonly applicable to all usage scenarios:

1) **Sustainability**
   - e.g., via better efficiency in cost, resource and energy
2) **Connecting the unconnected** (for providing universal and affordable access to all users independent of the location)
   - e.g., via wider coverage & improved efficiency
3) **Security and resilience**
   - e.g., via end-to-end (E2E) protection and monitoring
4) **Ubiquitous intelligence** (for improving overall system performance)
   - e.g., via cloud and edge computing and E2E C&M

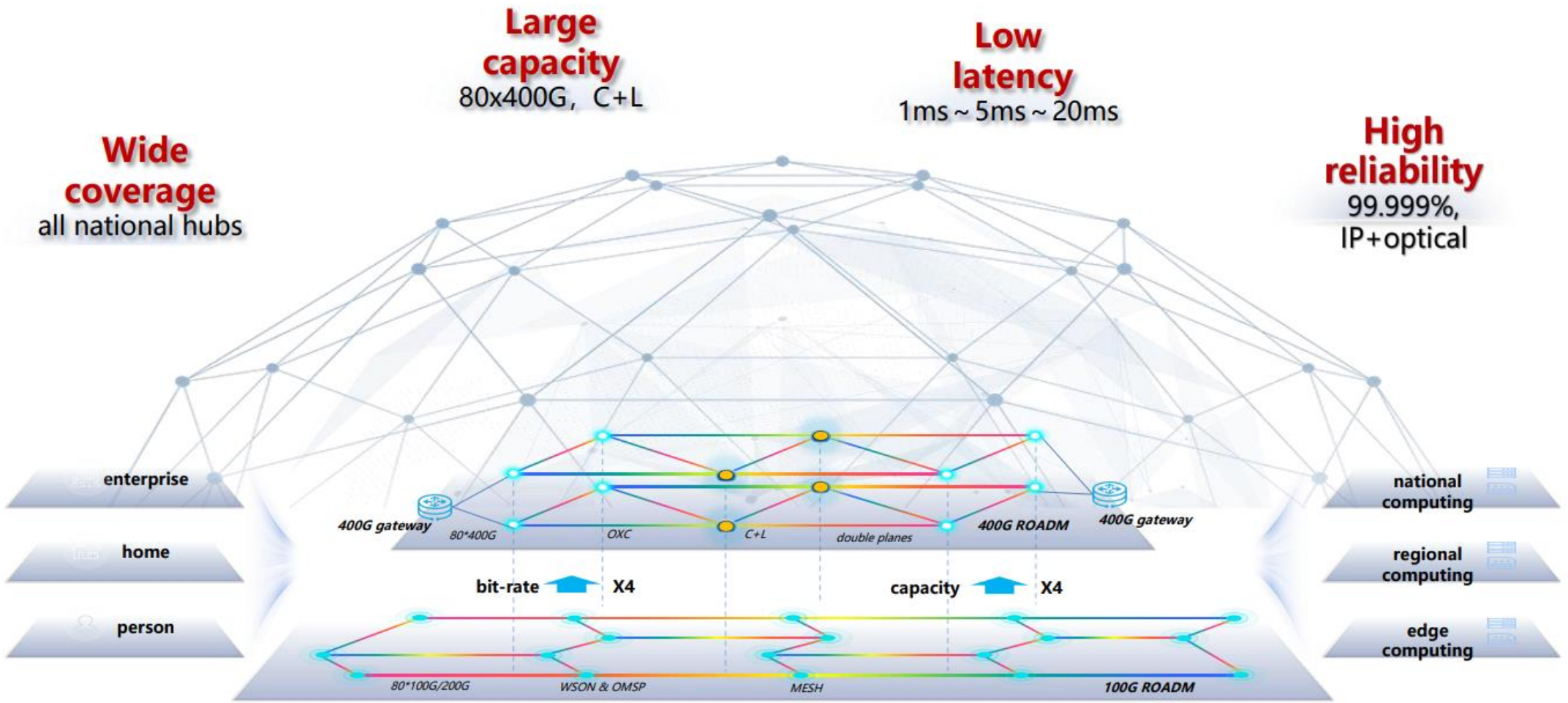
Reference: ITU-R M.2160: Framework and overall objectives of the future development of IMT for 2030 and beyond

China Mobile's View on Optical Networks for IMT-2030



Reference: Keynote speech by Dr. Han Li of China Mobile at the ITU workshop on "The Evolution of Transport and Access Networks to Support IMT 2030/6G" , 7 July, 2024

China Unicom's View on Optical Networks for AI (AiNet)



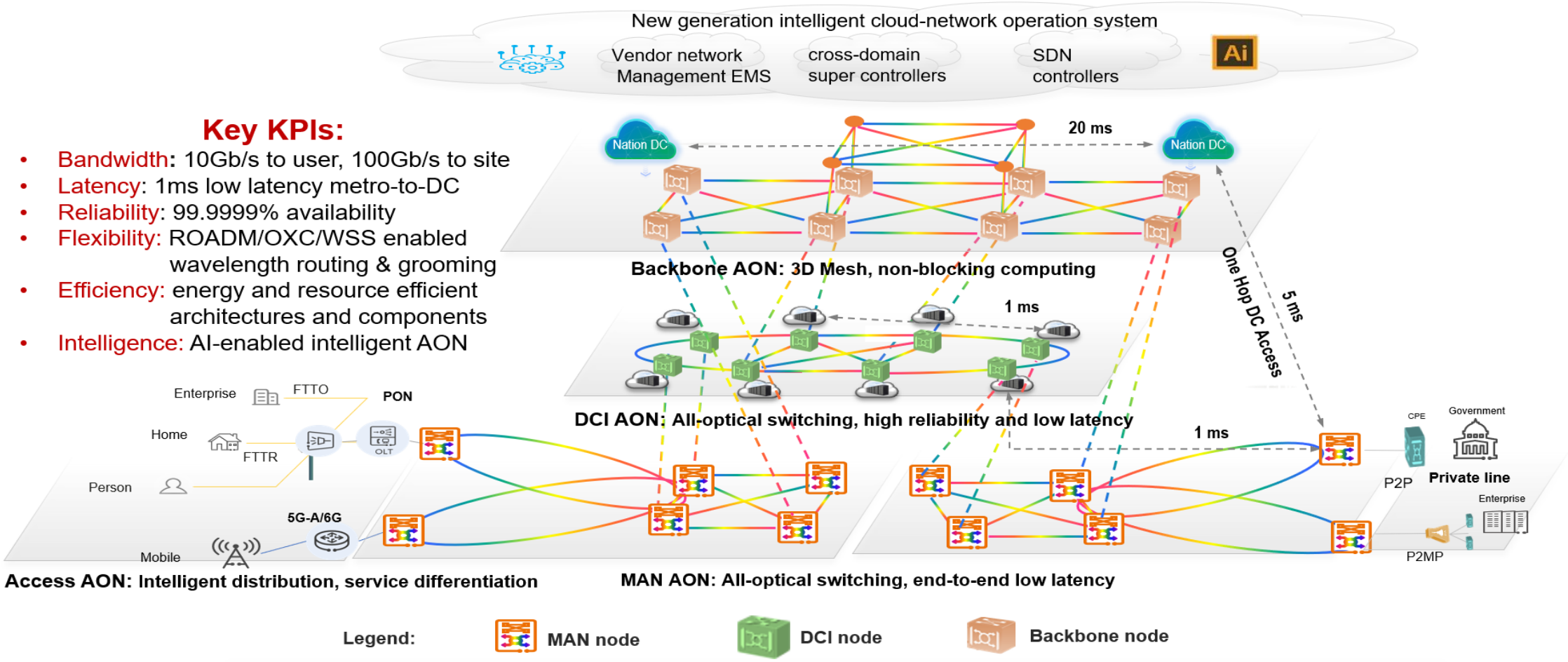
New G.654.E fibres and cables are deployed for AiNet

References: ACP2024 Plenary Talk by Dr. Xiongyan Tang of CUC, 3 November, 2024; Keynote speech by Dr. Shikui Shen of China Mobile at the ITU workshop on "The Evolution of Transport and Access Networks to Support IMT 2030/6G", 7 July, 2024.

China Telecom's View on Optical Networks towards 2030

Key KPIs:

- Bandwidth: 10Gb/s to user, 100Gb/s to site
- Latency: 1ms low latency metro-to-DC
- Reliability: 99.9999% availability
- Flexibility: ROADM/OXC/WSS enabled wavelength routing & grooming
- Efficiency: energy and resource efficient architectures and components
- Intelligence: AI-enabled intelligent AON

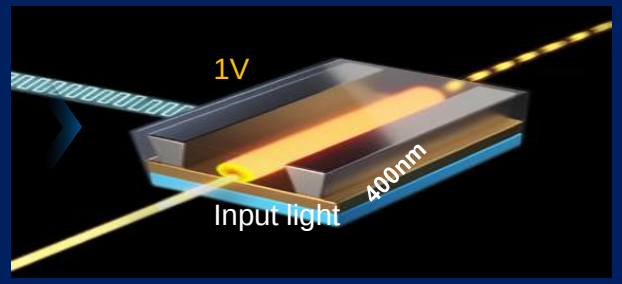


Enables high-speed data transfer between clouds, and bring value to optical networks and connections

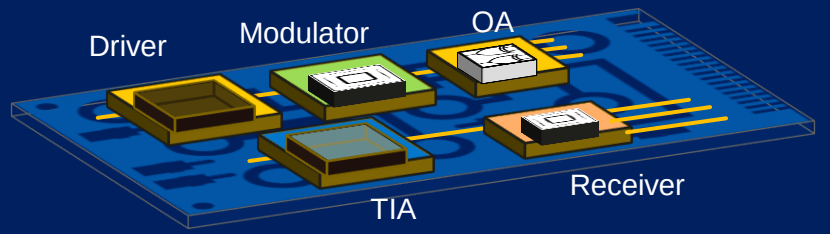
Reference: F5G contribution F5G(24)020029r2 by Drs. Yuyang Liu, Anxu Zhang, Chengliang Zhang, Tao Guo and Yi Lin, 14 November, 2024.

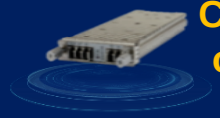
Enabling Optical Components and Devices

High-speed 250Gbaud Thin-Film Lithium Niobate (TFLN) Modulator

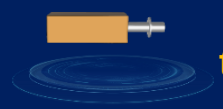


Low power, high integration coherent optical sub-assembly (COSA) 5 in 1



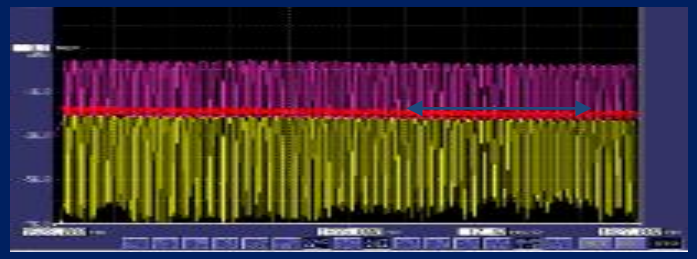


C6T+L6T (12 THz) optical amplifier



C6T+L6T tunable laser

C6T+L6T wavelength-selective switch (WSS)



Reference: Xiang Liu, “Optical transport technology innovation in the intelligent era”, Keynote talk at Network X 2024, Paris, October 9, 2024.

Energy-and-Resource-Efficient Low-Latency Metro Network

Analysis on the compatibility of metro aggregation network based on the new G.672 MD-ROADM example with the G.807 functional architectures

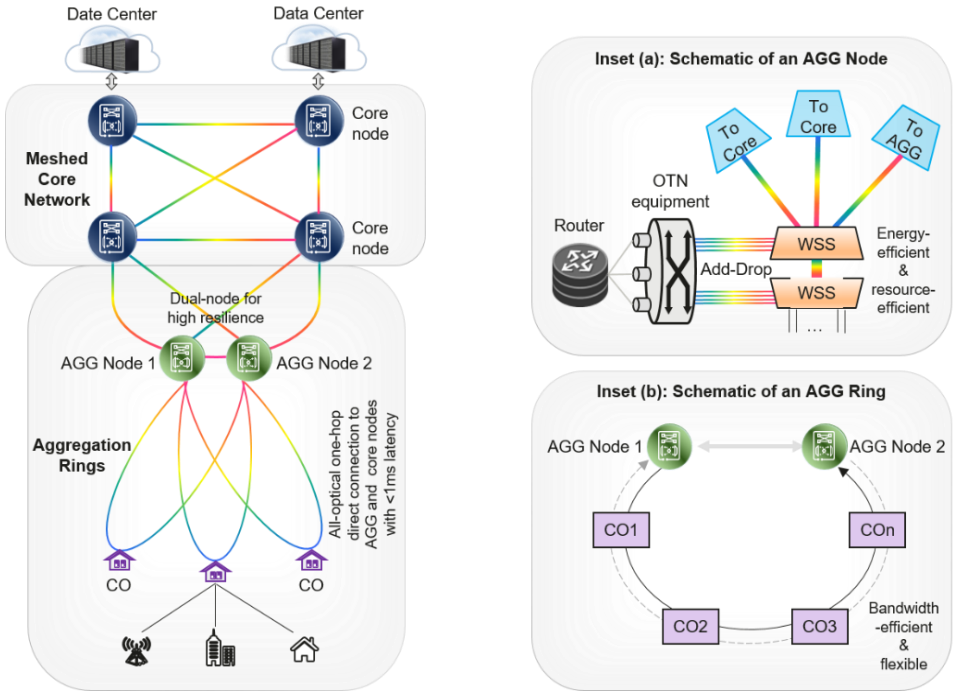


Figure 1 – The overall architecture of the energy-and-resource-efficient low-latency metro network.
Inset (a): Schematic of an AGG node.
Inset (b): Schematic of an access ring.

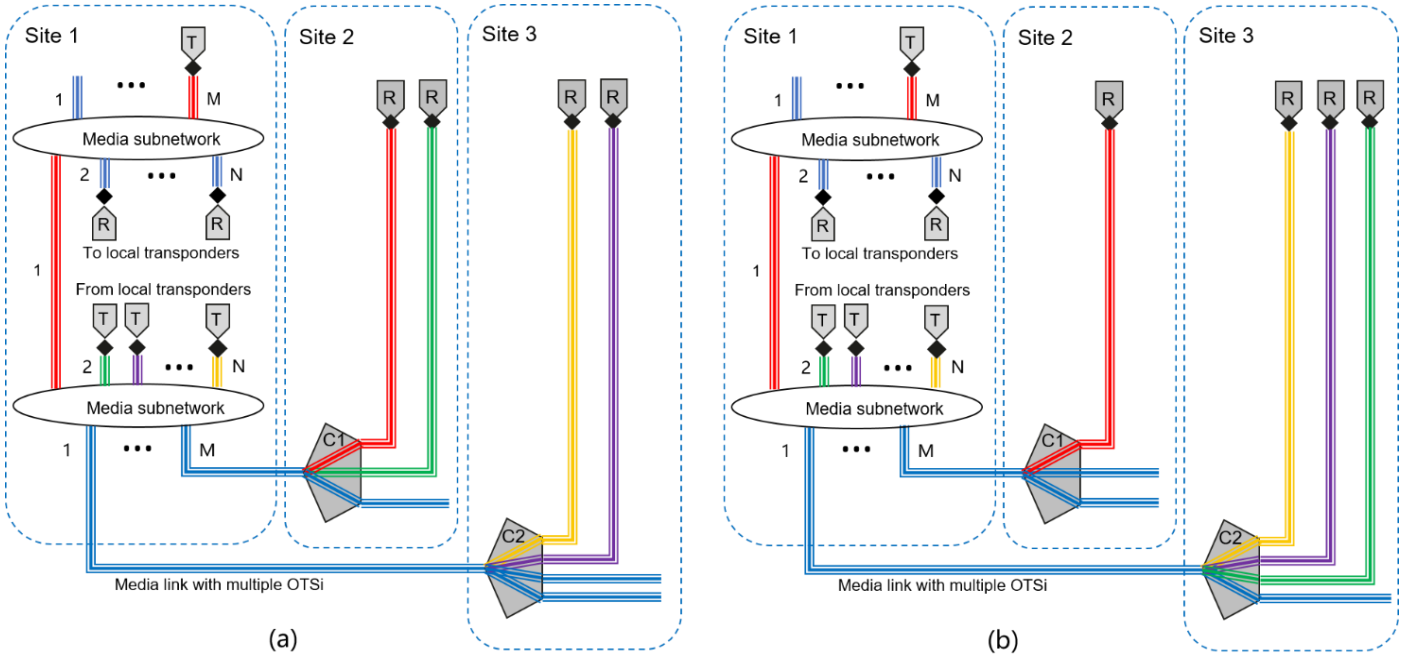


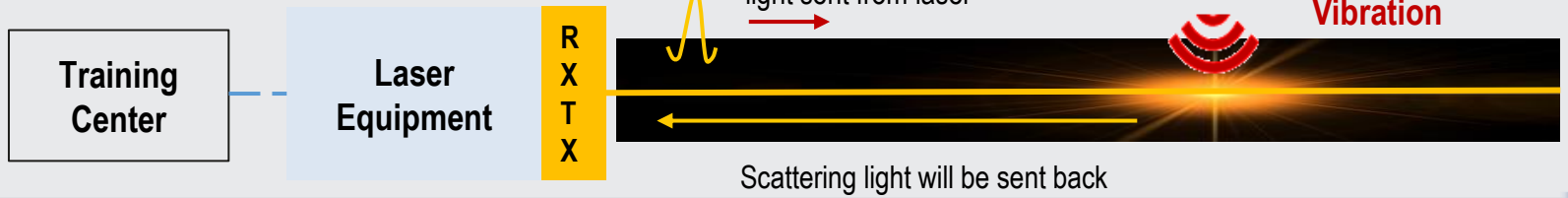
Figure 4 – Optical signals allocated to different rings in a ROADM-based network example with reconfigurable and shared wavelength resource allocations based on (a) 2:2 allocation and (b) 1:3 allocation and represented by the existing G.807 constructs.

Reference: ITU-T Q6 Interregnum Meeting contribution WD06-06 (CMCC & Huawei), Hong Kong, 18-22 November 2024.

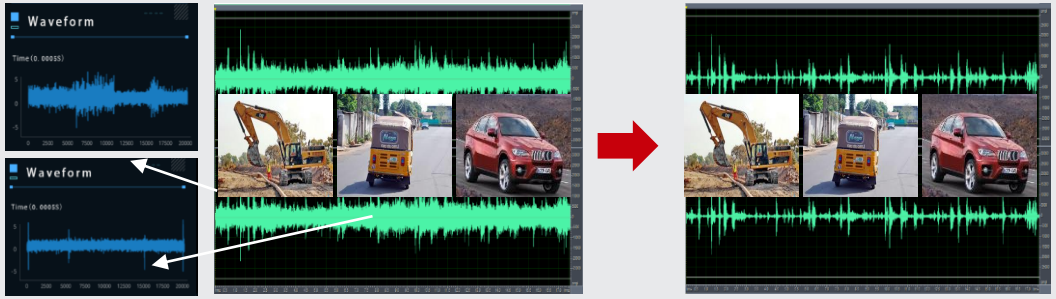
Optical Sensing for Network Monitoring & Protection

Principle

- Distributed acoustic sensing relies on light which is Rayleigh backscattered from small variations in the refractive index of the fiber.

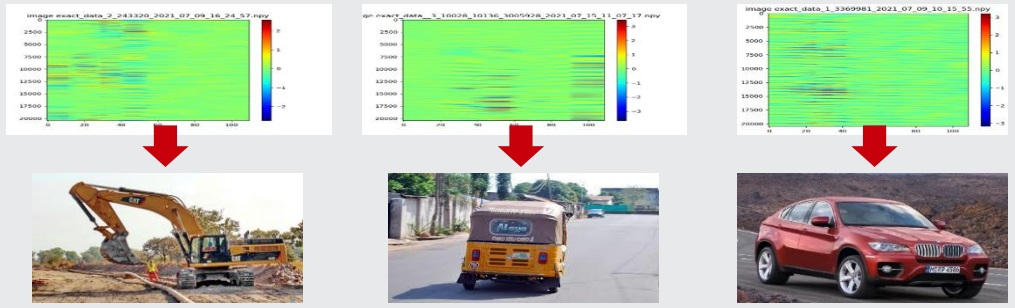


AI-Based Noise Reduction



- Reduce interference noise, while maintaining >99.9% of the signal

AI-Based Intrusion Recognition

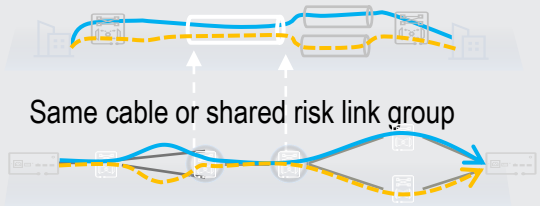


- Recognition accuracy > 97% , AI-Based Deep Self-Learning

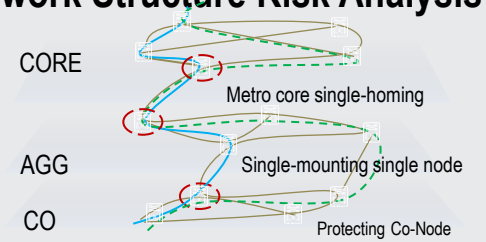
Many contributions on this subject at the ITU-T Q6 Interregnum Meeting, Hong Kong, 18-22 November 2024.

Assurance of Service-Level Agreement, Availability & Performance

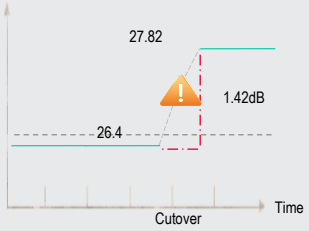
Service Co-routing Detection



Network Structure Risk Analysis



Fiber Deterioration Analysis



Attenuation

before	26.4dB
after	27.82dB
Standard	< 0.1dB
status	unqualified

Service SLA Assurance

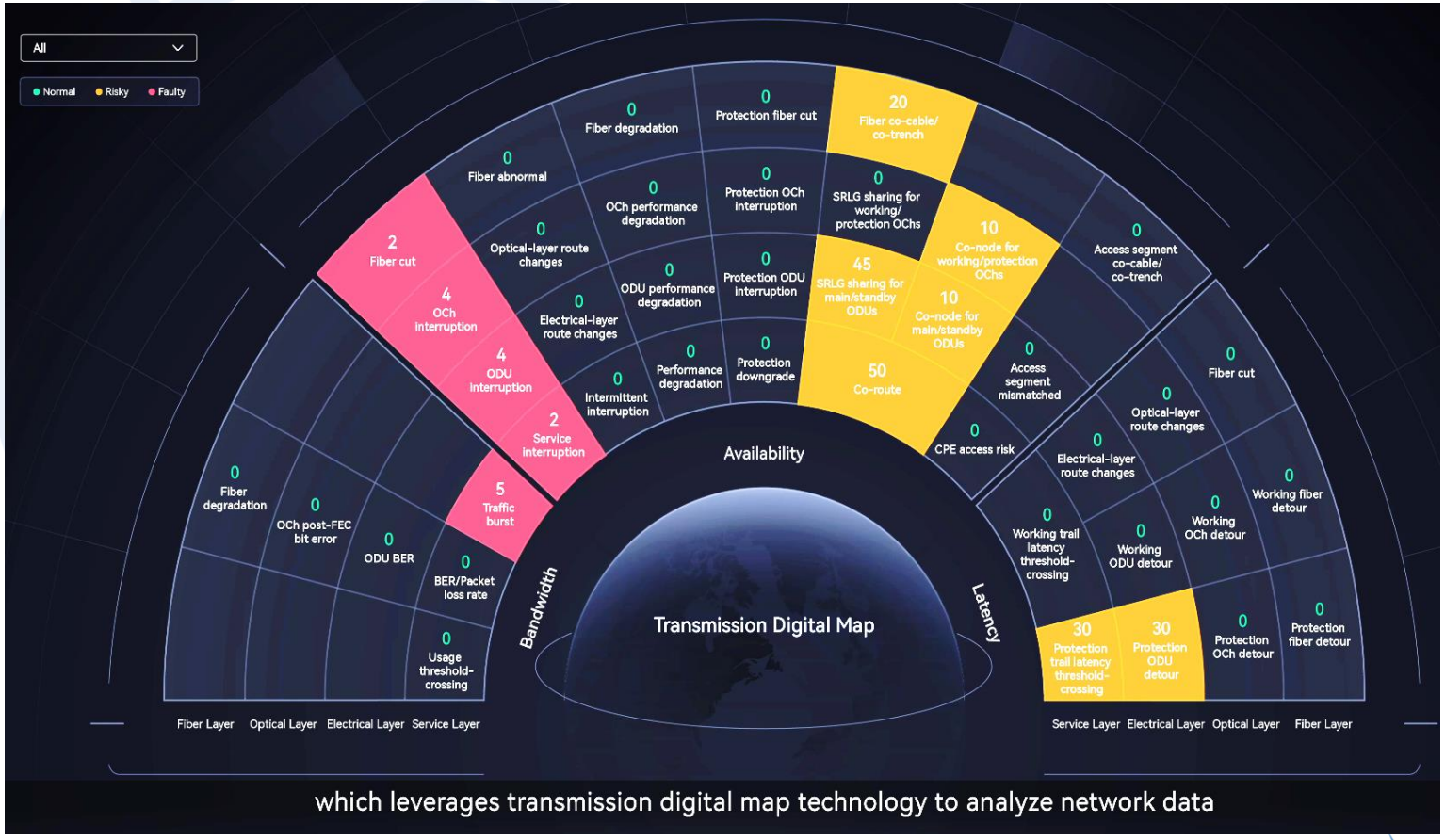
Proactive risk identification

Availability Assurance

Avoidance of co-node/co-cable

Performance Assurance

Deterioration mitigation



which leverages transmission digital map technology to analyze network data

Meaningful & Valuable Evolution of Optical Networks towards 2030

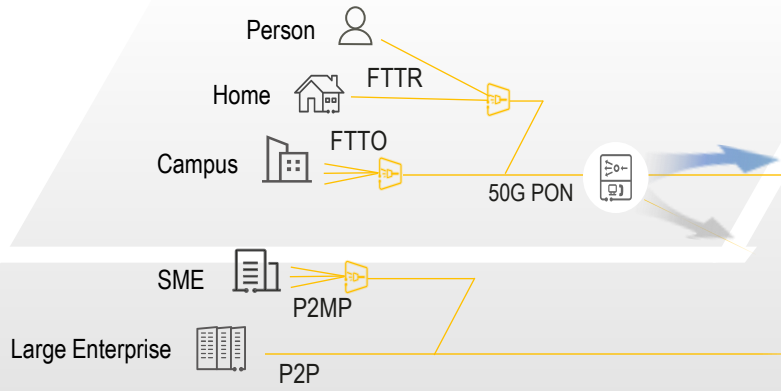
● Sustainability ● Connecting the unconnected ● Security and resilience ● Ubiquitous intelligence

Network for AI:

10Gbps user experience | 1 ms latency | 99.9999% availability

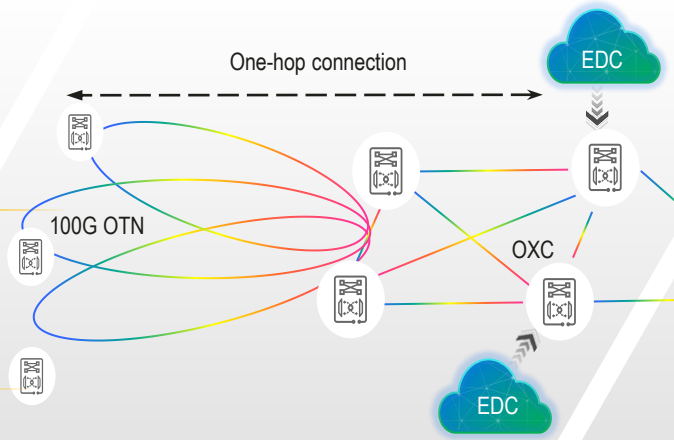
AI for Network: E2E Guarantee of QoS with Automation, Optimization, and Protection

10Gbps Intelligent Access Network



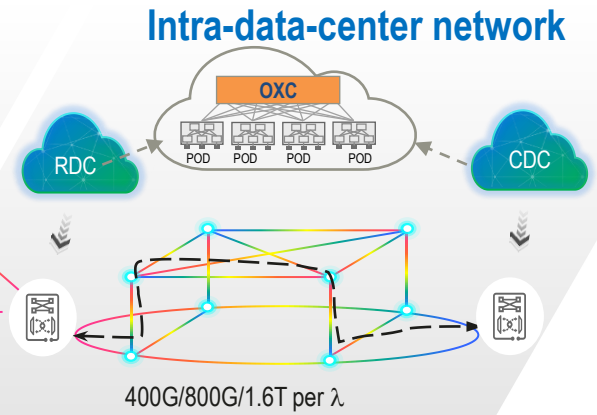
Intelligent distribution, service differentiation

One-hop Metro FMEC Network



All-optical switching, end-to-end low latency

3D-Mesh Backbone Network



3D Mesh， reliable non-blocking computing

Thank you !