



北京 2022 年冬奥会官方合作伙伴

China Unicom Collaboration Research on Quantum Transport Technology

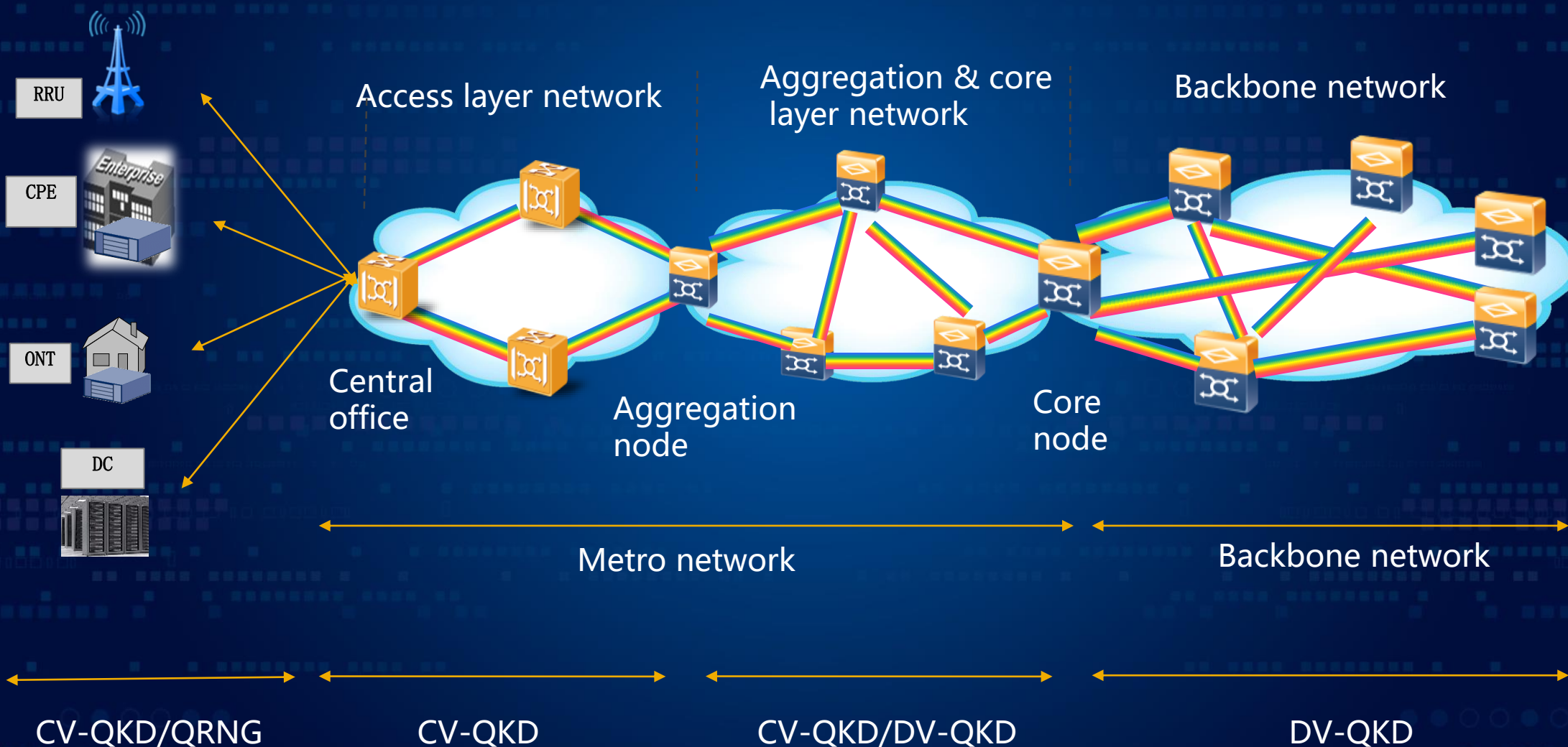
Chunxu Zhao, China Unicom

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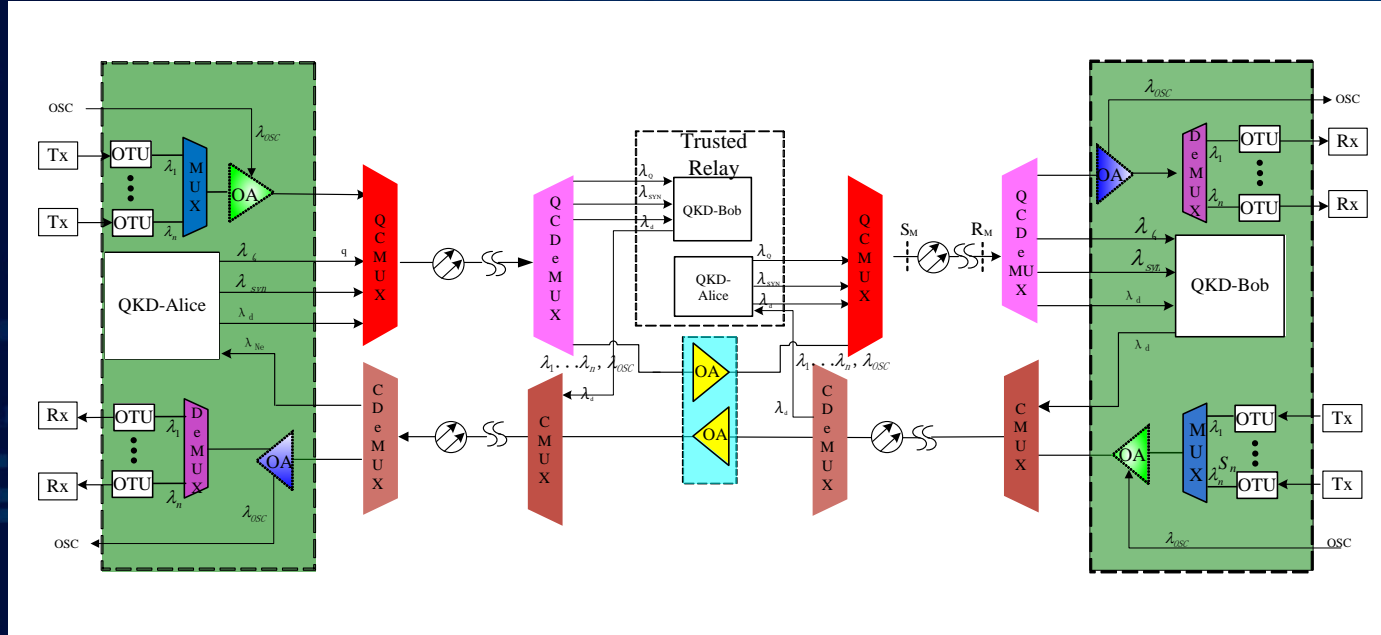
1. China Unicom Collaboration Research on Quantum Transport Technology

2. Future work plan

China Unicom optical network architecture + QKD



Co-propagation between DV-QKD and WDM systems



the reference configuration of co-propagation between QKD and WDM systems

QCMUX & QCDeMUX parameters to be defined

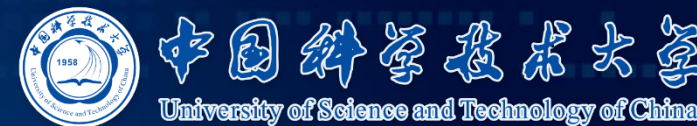
Table 1. QCMUX/CMUX parameter requirement

Parameters	unit	QCMUX	CMUX
O/E-band insertion loss	dB	≤ 1.5	-
S-band insertion loss	dB	≤ 2.5	≤ 2.5
C-band insertion loss	dB	≤ 2.5	≤ 2.5
L-band insertion loss	dB	TBD	TBD
Reflectance	dB	≤ -30	≤ -30
Wavelength range	nm	1260-1625	1260-1625
Other ports to O/E-band port isolation	dB	≥ 120	-
O/E-band port to other ports isolation	dB	≥ 22	-
Other ports isolation	dB	≥ 22	≥ 22
Insertion loss flatness	dB	≤ 1.5	≤ 1.5
Polarization dependent loss (PDL)	dB	≤ 0.2	≤ 0.2
Polarization mode dispersion (PMD)	ps	≤ 0.5	≤ 0.5

China Telecom & QuantumCTek verify the feasibility of co-propagation in lab

China Unicom & USTC co-propagation field trial

USTC: University of Science and Technology of China



Motivation:

to verify QKD performance of co-fiber transmission with high power WDM system in backbone network.

Experiment setup:

200Gb/s WDM system with 20 channels over 12 spans;

QKD signal co-propagation with WDM over 1 span of 66km;

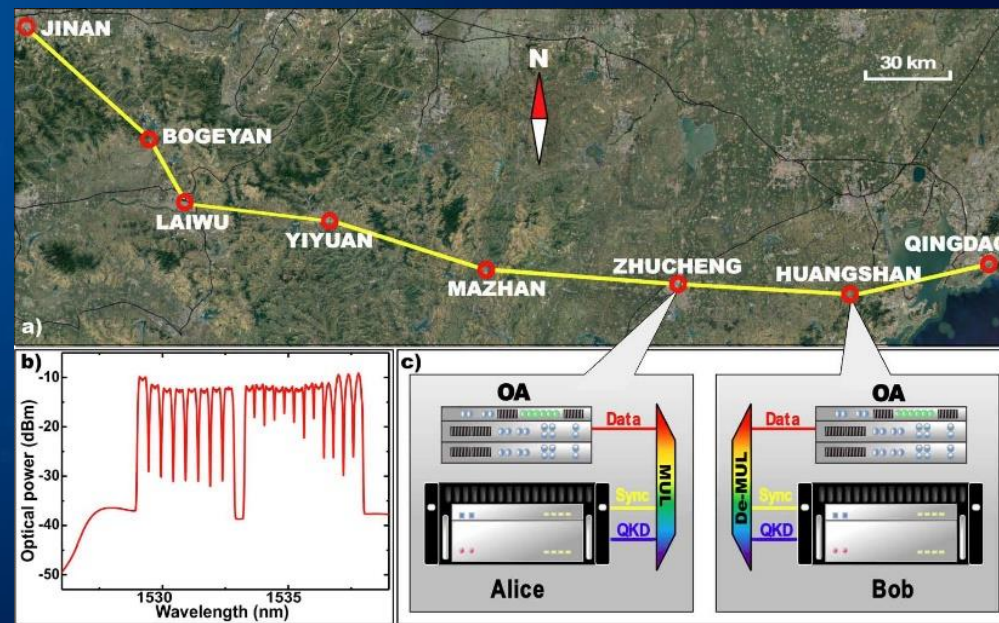
Co-propagation & counter-propagation;

G.652 & 2 G.654E fibers with different loss

and effective core area are compared.

Quantum signal: 1310nm (O-band)

Classical communication WDM system: 1550nm (C-band)

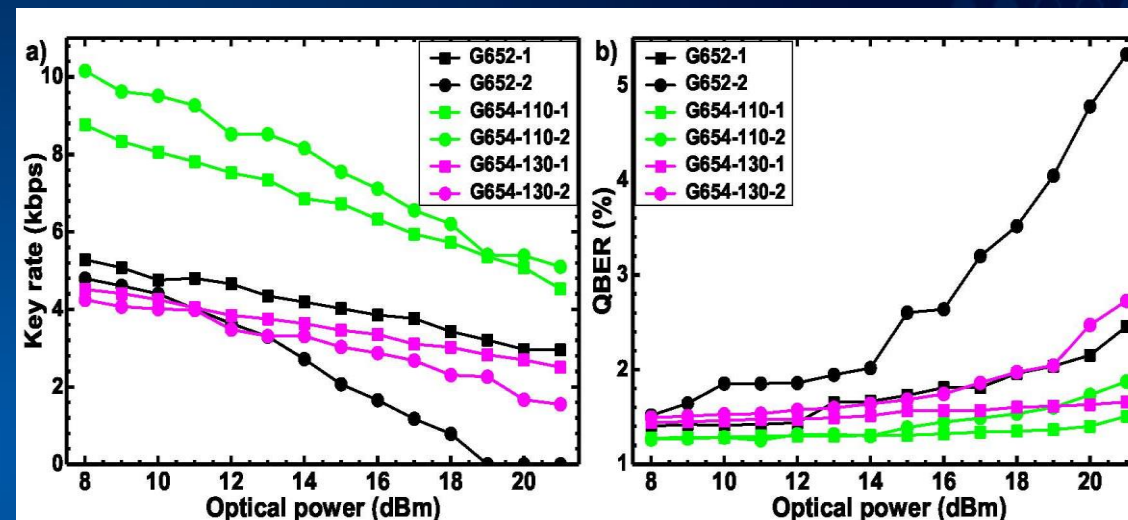


China Unicom & USTC co-propagation field trial

Conclusion:

With 20 GHz pass-band filter and large effective core area fibers, the secure key rates can reach 4.5kb/s and 5.1kb/s for co-propagation and counter-propagation at 21 dBm launched power, respectively.

This demonstrates the feasibility of co-fiber transmission in backbone network with high power WDM system.



Secure key rate (a) and QBER (b) of QKD vs. WDM signal power

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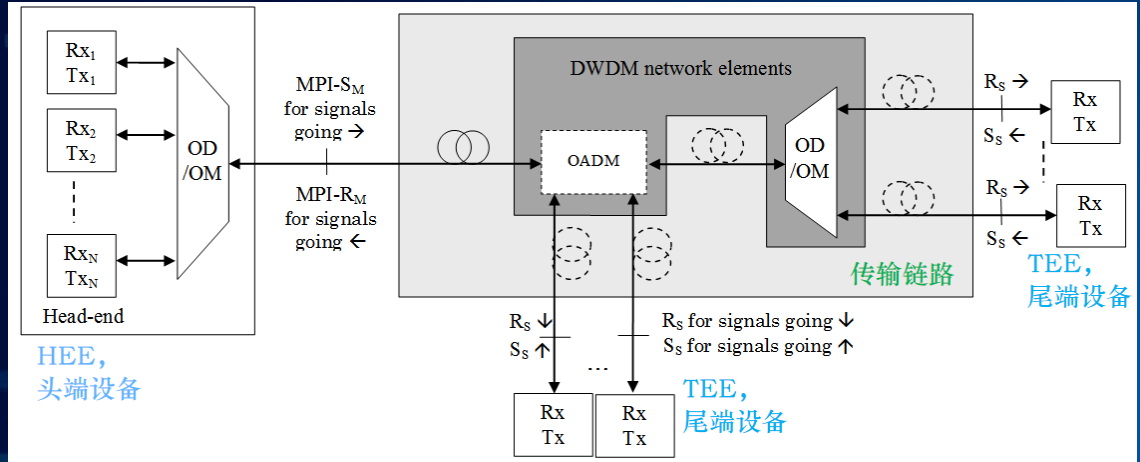
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Integrating quantum key distribution with classical communications in backbone fiber network

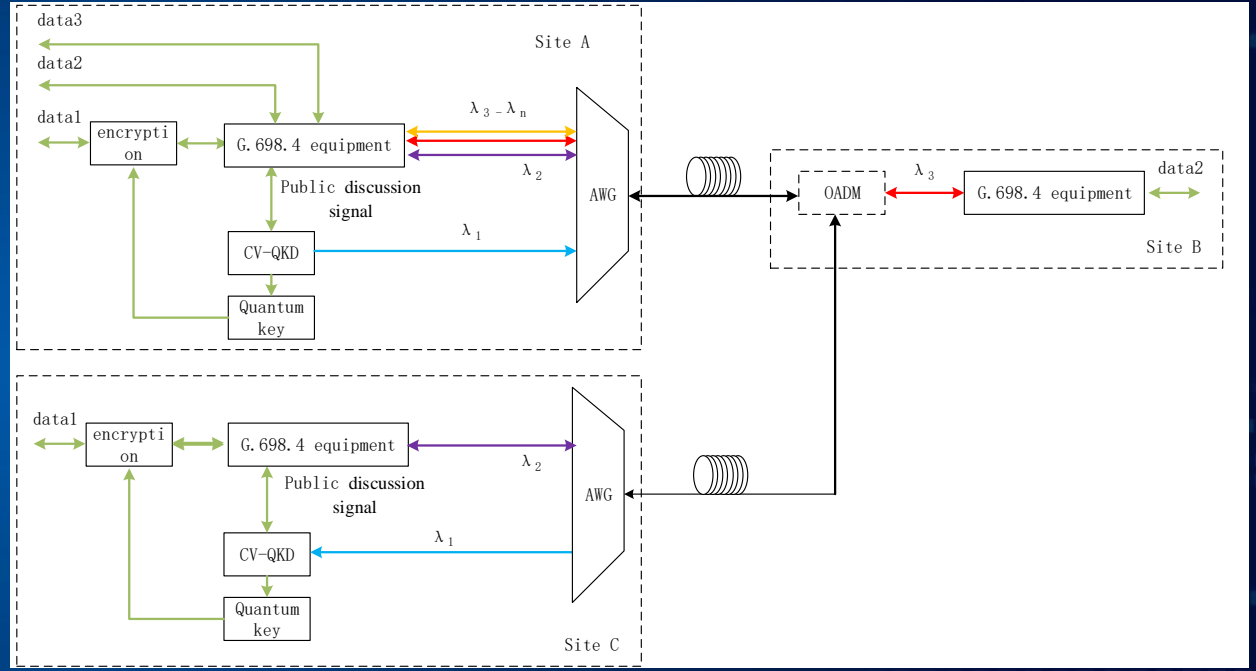
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China Unicom & XT Quantech co-propagation experiment



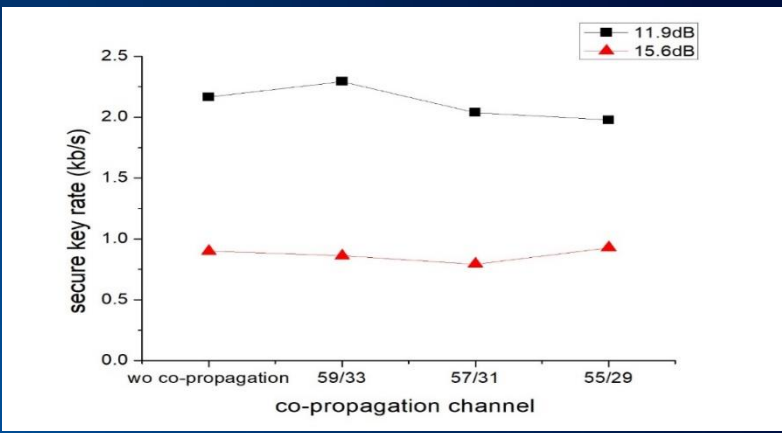
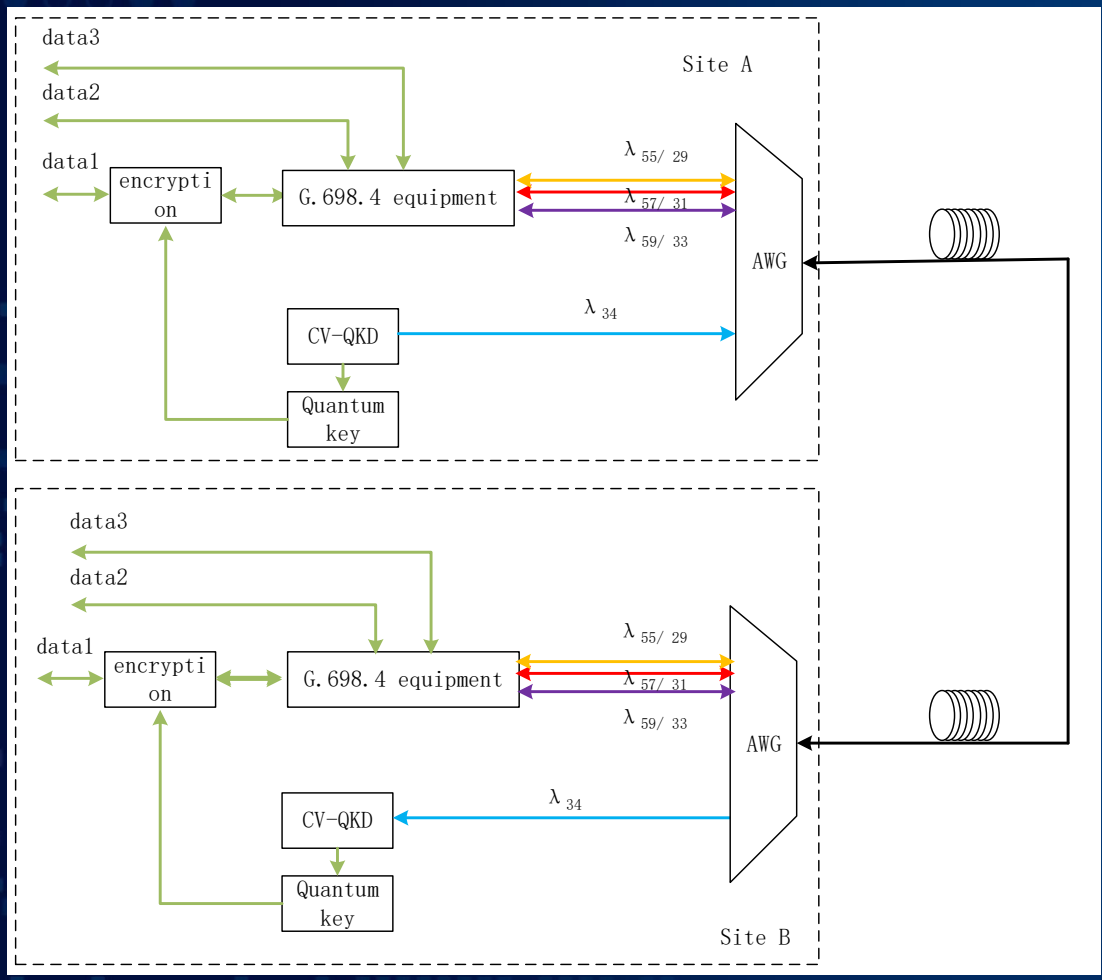
scheme of G.698.4 system



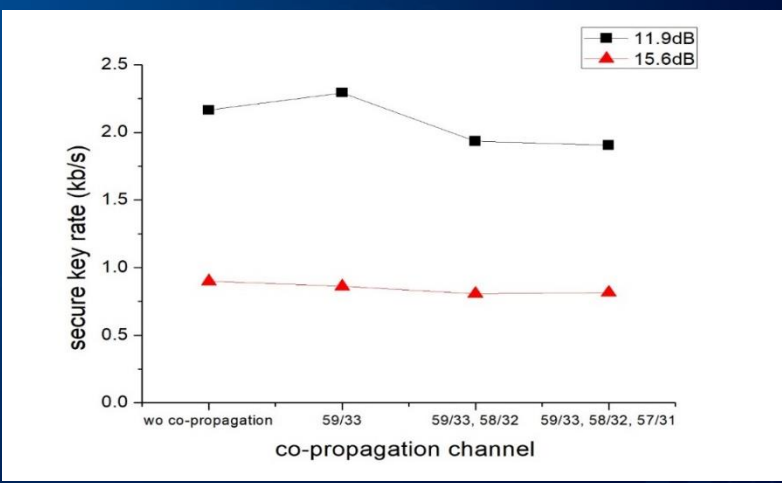
Integration of CV-QKD with G.698.4 system

The G.698.4 system is a multichannel bi-directional DWDM system, which can be used in 5G front-haul network, metro access network.

China Unicom & XT Quantech co-propagation experiment



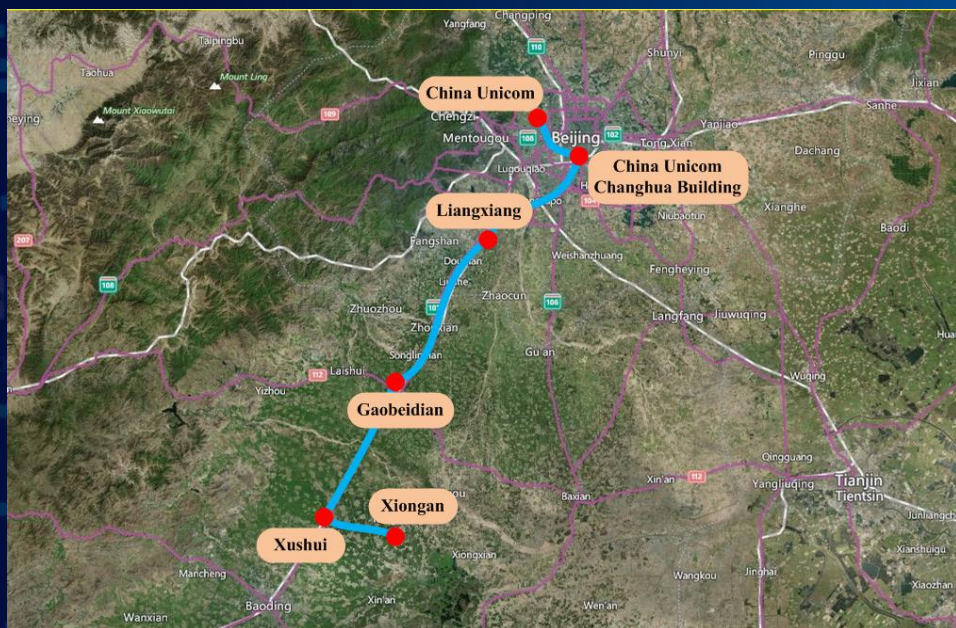
secure secret key rate over different channel space between CV-QKD and classical signal



secure key rate over different channel amount of classical signal

China Unicom & Hengtong Optic-Electric Collaboration on Beijing-Xiong' an Quantum Encryption Trunk Line

China Unicom & Hengtong Optic-Electric collaborated to build Beijing-Xiong'an QKD encryption communication trunk line trial project in 2018. Based on the F-M phase encoding QKD device with independent intellectual property rights, the project length is about 200km and 6 quantum encryption nodes have been built.



- ◆ The project was constructed by the quantum secure communication solution provider and telecommunication operator together.
- ◆ Overcoming the predicament of large link loss between relay nodes. It took only one month to complete installation and commissioning of quantum equipment based on existing fiber, machine room and power supply.

China Unicom & Hengtong Optic-Electric Collaboration on Beijing-Xiong' an Quantum Encryption Trunk Line

The Project won the ITU 2019 WSIS C5 category winner prize.



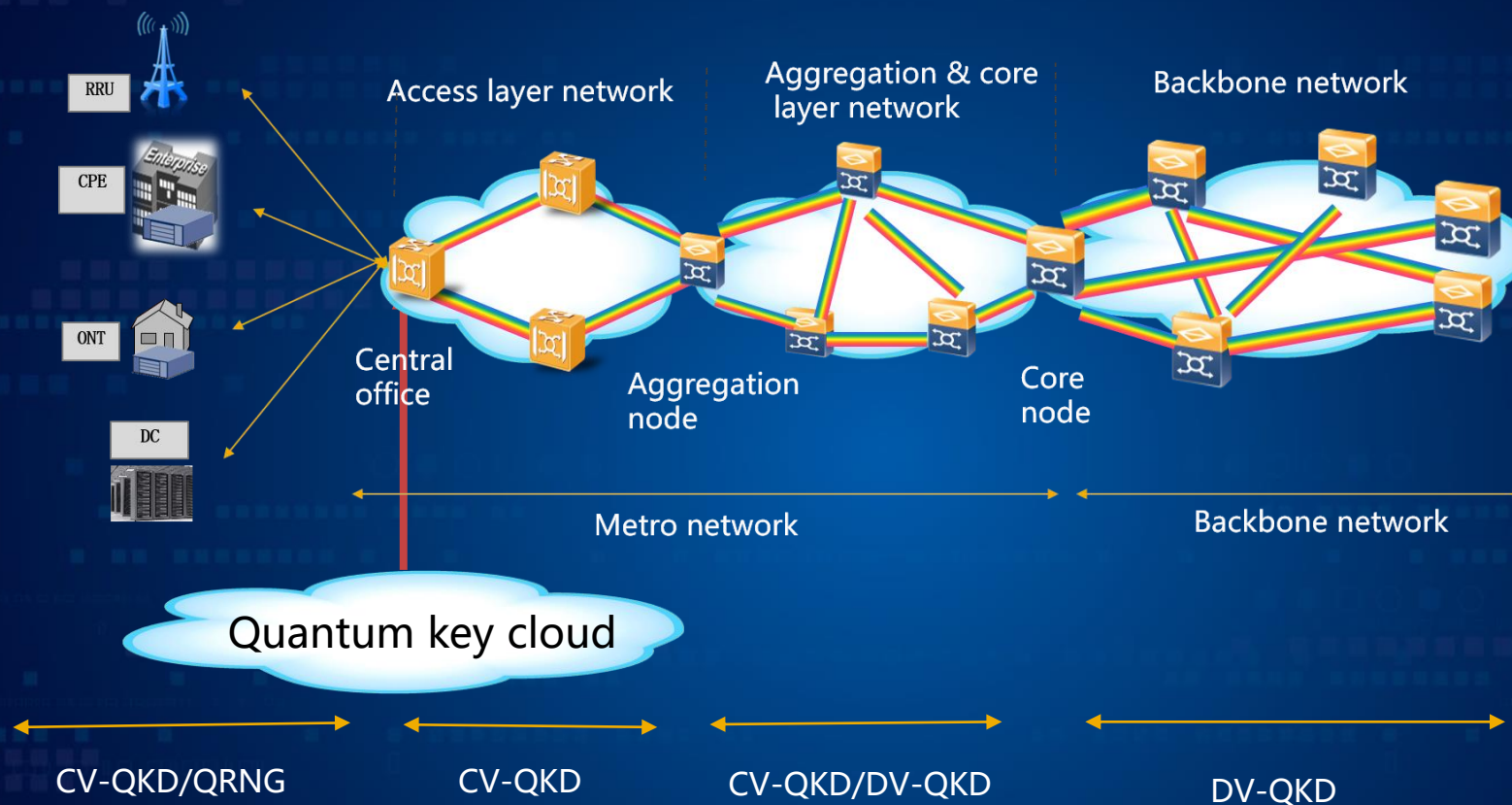
Deployed typical services:

1. Quantum encryption video conference
2. Quantum encryption fixed-line telephone
3. Quantum encryption VPN
4. Quantum encryption database

1. China Unicom Collaboration Research on Quantum Transport Technology

2. Future work plan

Improve End-to-End Quantum Encryption Solution



1. Interchange of CV-QKD & DV-QKD key management layer, deploy 3rd party management platform, develop the interface specification
2. Deploy **quantum key cloud** based on QRNG to decrease the cost and realize large volume access
3. Various topology of network scheme utilizing QKD to be researched

Developing classical communication equipment integrating QKD

1. Develop G.698.4 DWDM system integrating CV-QKD

- 1) interface specification of QKD to G.698.4 system
- 2) Public discuss channel co-propagation scheme

2. Develop OTN system integrating QKD

- 1) interface specification of QKD to OTN system
- 2) public discuss channel co-propagation scheme
- 3) OTN payload encryption, OTNsec

3. Expectation of QKD development

- 1) higher quantum key rate (1kb/s vs. 1Gb/s, 10Gb/s, 100Gb/s, ...)
- 2) longer transmission reach (typical 80km/100km in backbone network)



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