QKD Application:
Coexistence QKD **Network** and Optical Network in the same optical fiber network

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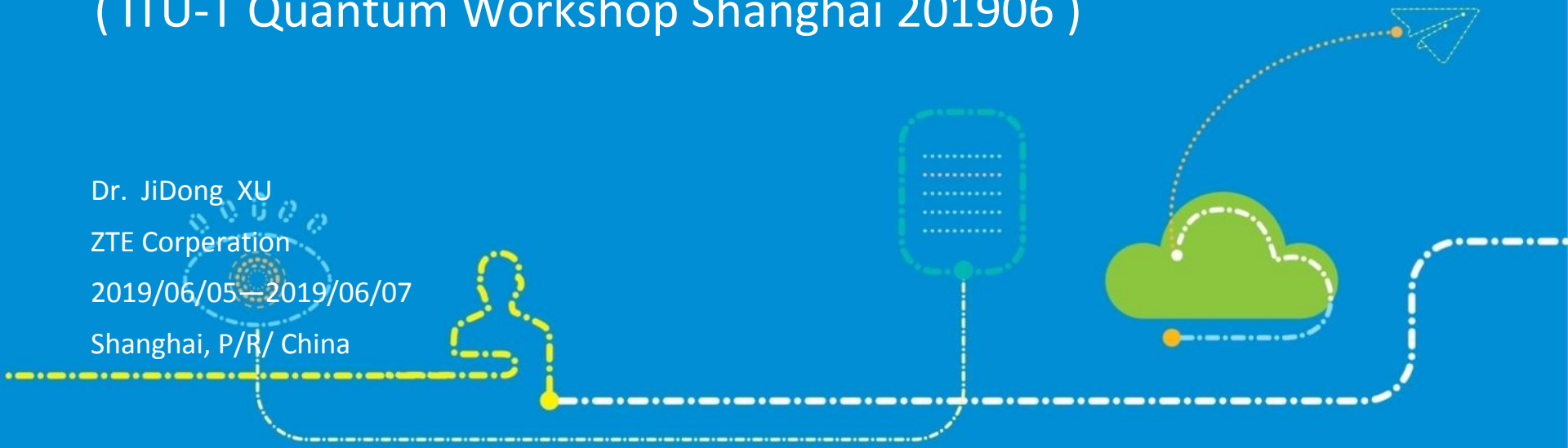

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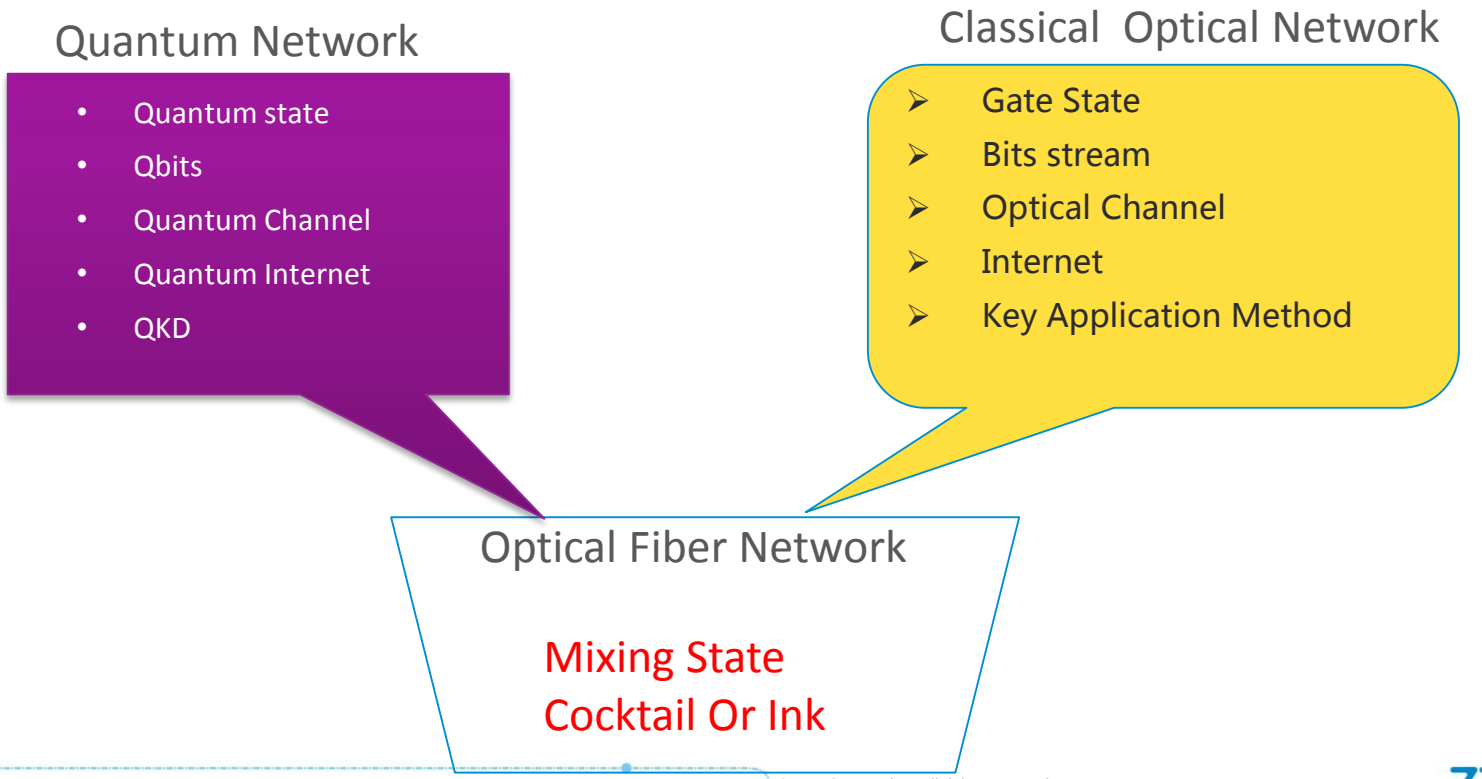
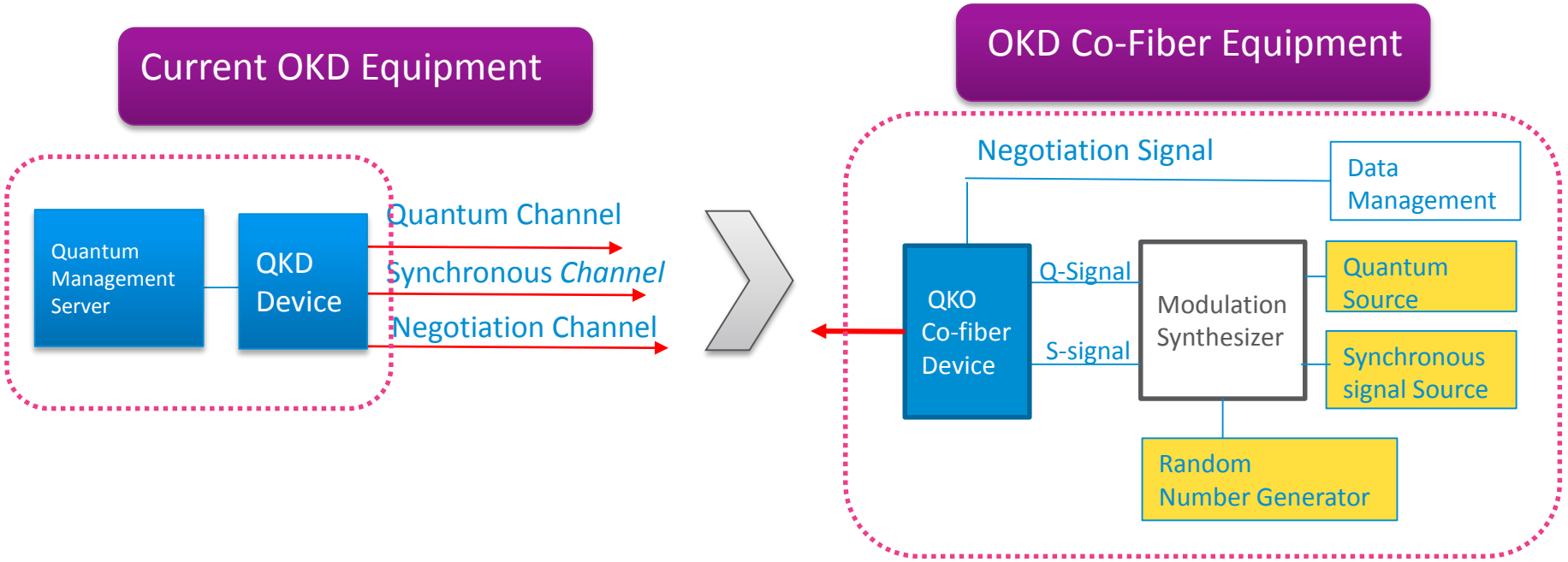
Backguand

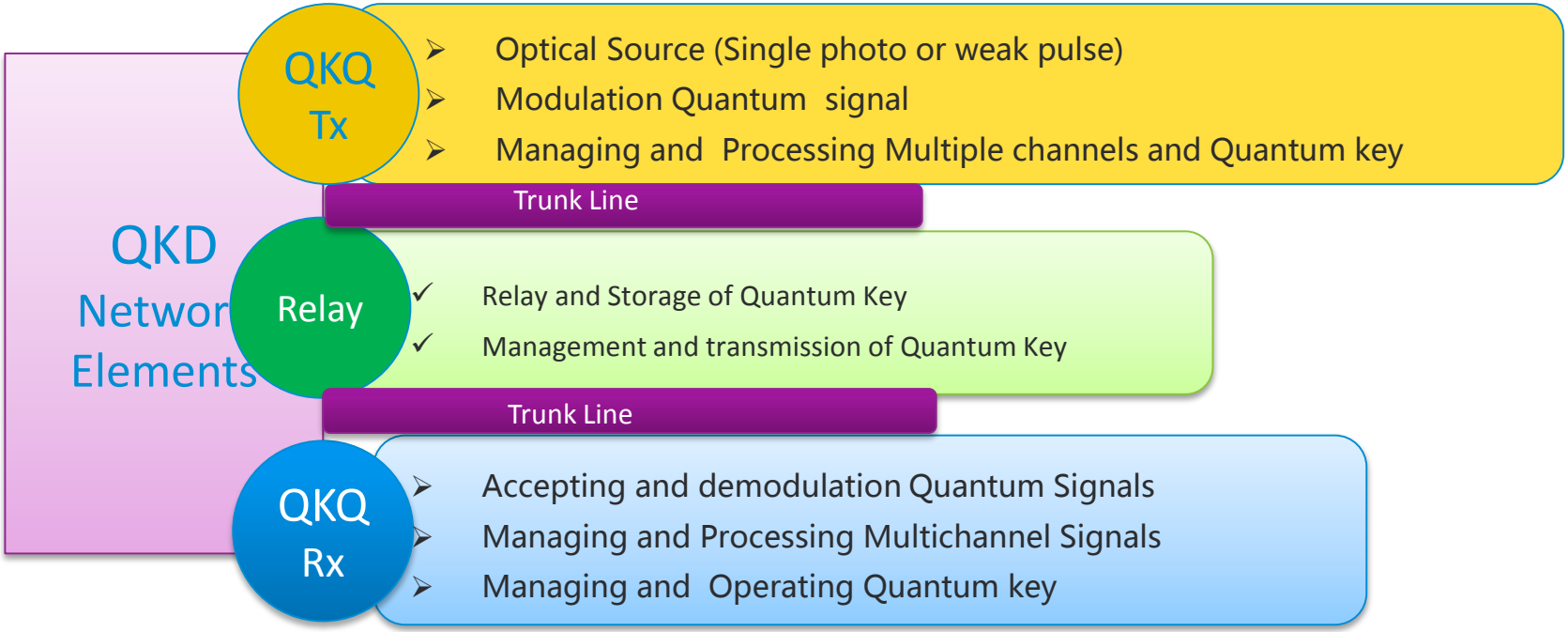


QKD channels

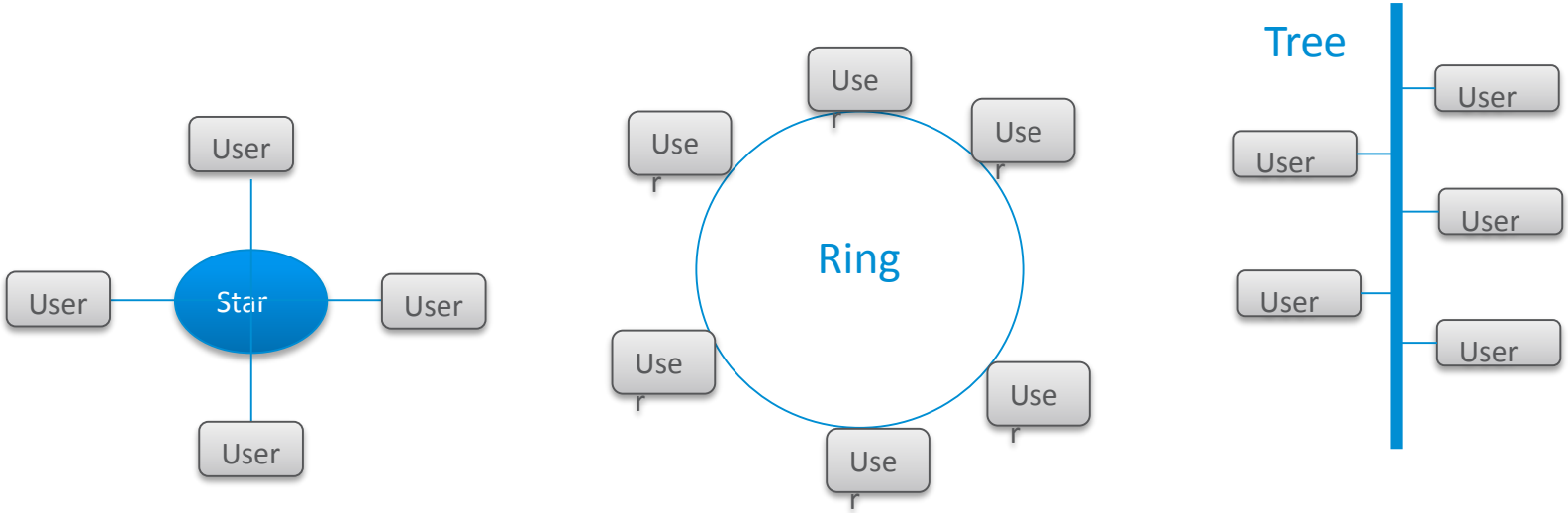


- Basic Framework of QKD device which have many channels（Quantum Channel、Synchronous Channel、Negotiation Channel，Key Data Channel）, and require optical fiber
- Co-fiber QKD device require to combine the channels together in one fiber.

Basic Elements of QKD Network



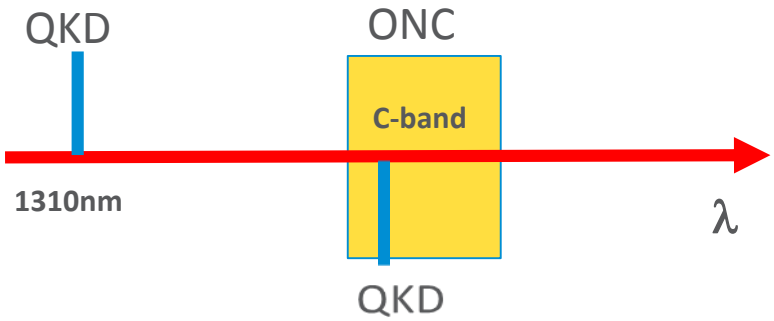
Basic Architecture Types of Optical Networks



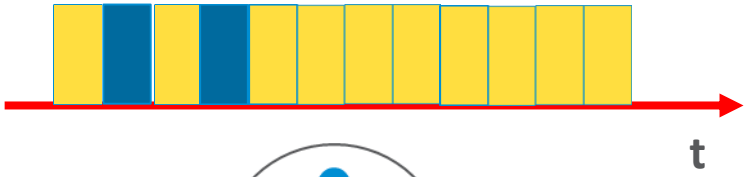
- **Network application:** Optical network can be divided into access network、 bearer network and core network According to its application,.
- **Network architecture:** Optical network can be di vided into star network, ring network and tree network According to its architecture type.

Co-Fiber network Schemes

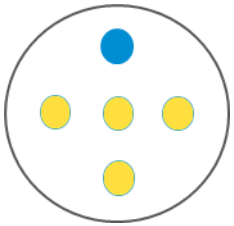
- WDM scheme
  - DWDW : QKD at 1310 nm
  - CWDM : QKD at 1550 nm Band



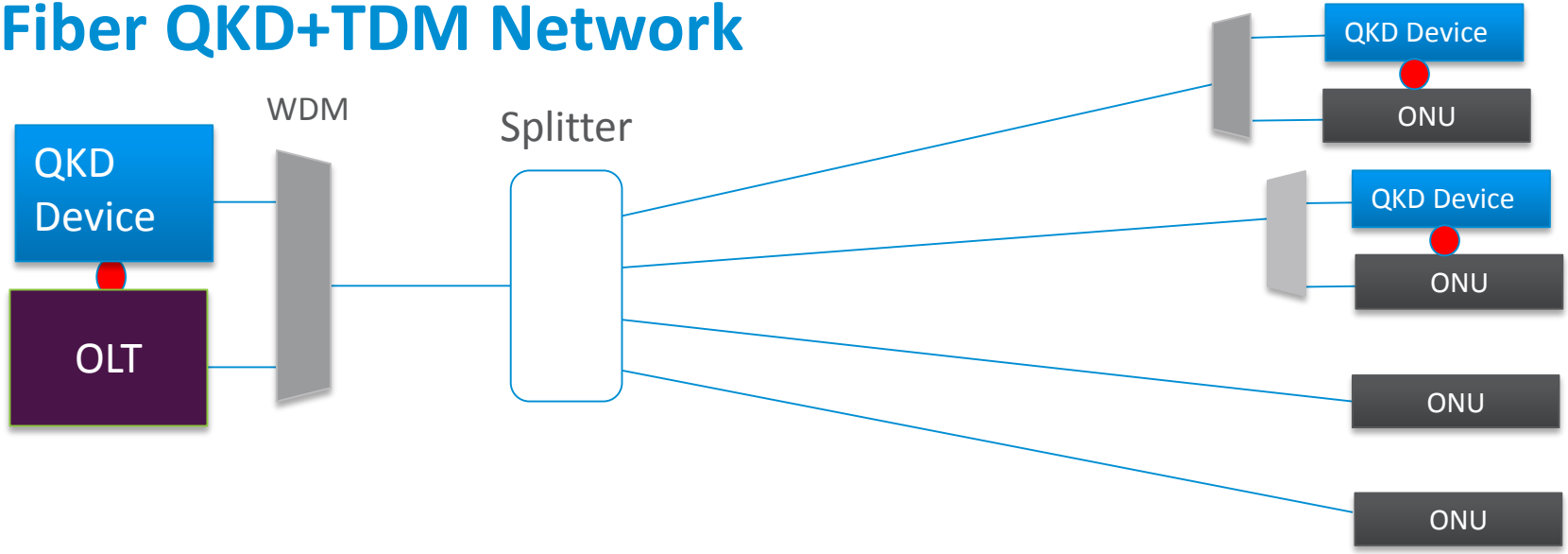
- TDM scheme
  - QKD Occupied time slot



- SDM Scheme
  - OKD occupied one fiber Space in MCF.

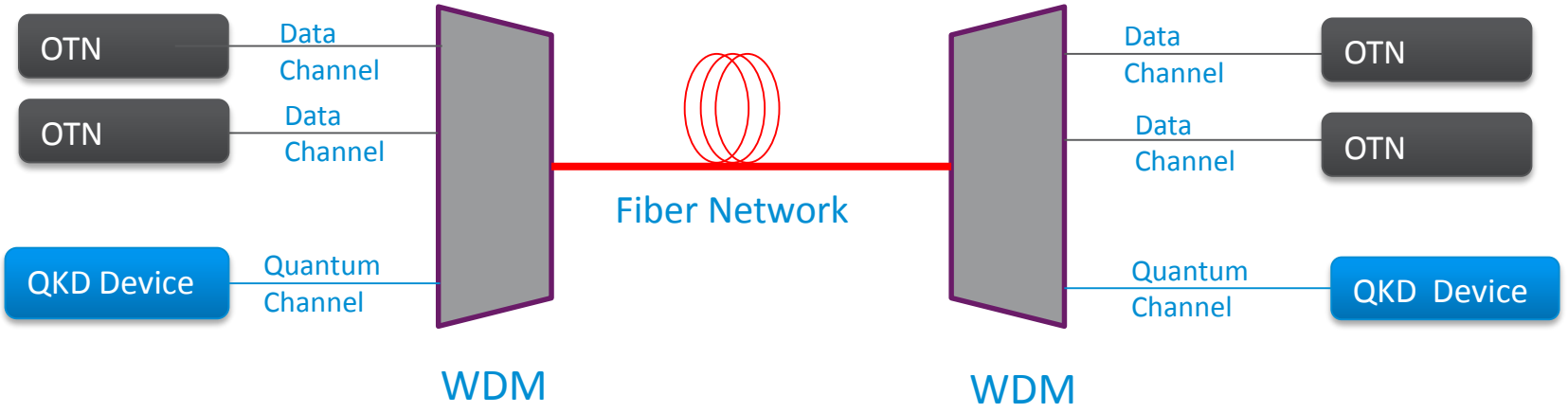


Co-Fiber QKD+TDM Network



- **QKD PON:** QKD has its own upstream and downstream working wavelength, downstream broadcasting, upstream triggering, and constitutes its own PON system.
- **Sharing ODN:** The PON of QKD operates in the same ODN as the original PON system through WDM
- **Data Encryption:** QKD device transfers the quantum key to neighboring PON(OLT or ONU) devices so that it can encrypt the data and transmit them

Co-Fiber QKD+WDM Network

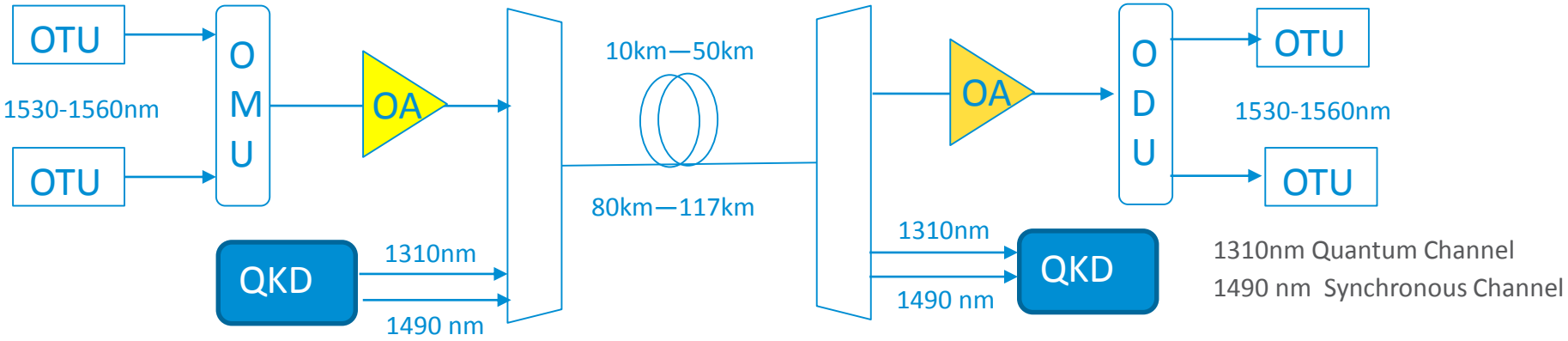


- **OKD network**: Co-fibre QKD devices have their own point to point network
- **Shared P2P network:** QKD devices share point to point network with OTN dada through WDM
- **Data Encryption:** QKD device transfers the quantum key to its side OTN devices so that it can encrypt the data and transmit them

History of Co-Fiber QKD+WDM network Experiments

Date	State /Company	Distance (km)	Rate(G/s)/ Wavelength(nm)	Quantum Wavelength(nm	Code rate (b/s)
1997	UK/BT	28	1.2 /1550	1300	
2009	SW/G Univ.	50	/1550	1550	11
2012	UK/Univ	50	1/1571-1611	1550	507k
2016	UK/Univ	50	100/1547	1529	1.2M
2017	Chna/CTC	80-117	80x100/1550	1310	16K-1k
2018	China/CU	66	3600/1550	1310	4.5

Co-Fiber Experiment in China Telecom Laboratory



Experiment 1

- High coding rate in co-directional fibers
- Classical optical power reduce the coding rate, so we need control their power to increase coding rate.

Experiment 2

- Huge large Capacity Service Datas 8T（80x100G）
- Ultra-long transmission distance（80km-117km）
- Highj QKD code rate（16kbps-1kbps）
- Smooth upgrade, service can be real-time quantum encryption

The challenge of Co-Fiber QKD network

TDM

WDM

Challenge

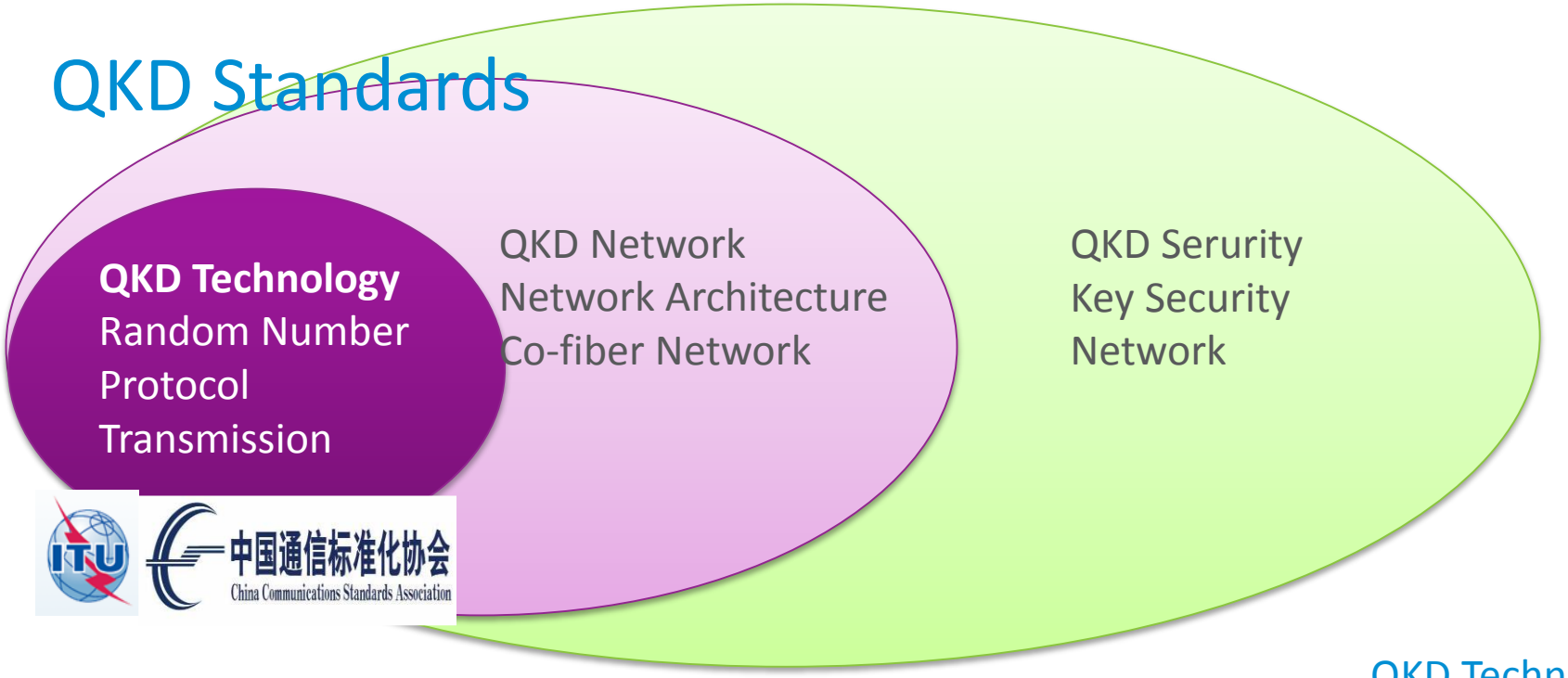
Non linear effects

- Power Fluctuation
- High power level（Over 20dBM）
- SRS
- SBS
- FWX
- Co-direction Transmission
- Anti-direction Transmission

Methods

- ✓ Control Power balance level
- ✓ Band Separation
- ✓ Using Narrow Filter
- ✓ Using deceptive State protocol

The Progress and Future of QKD Standard



Conclusions

- QKD equipment have multi-channel (Quantum、 Synchronous、 Negotiation) , and it must be co-fibrillated.
- The Co-fiber networks is that QKD network and optical network run simultaneously in the same optical fiber network architecture through wavelength division multiplexing.
- There are many co-fiber schemes, such as : WDM、 TDM and SDM. WDM is the key scheme for the merger of network and current optical network.
- Many WDM scheme are being tested and standardization is under way.

谢谢！

5G 先锋