

Coexistence Strategies for CV-QKD and Classical C-band Traffic

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Integrating Quantum Key Distribution (QKD) with existing optical networks via wavelength-division multiplexing (WDM) offers a practical, cost-efficient solution. However, it introduces interference between quantum and high-power classical data channels. The primary noise sources are spontaneous Raman scattering (SpRS), which generates broadband noise that cannot be filtered with conventional optical methods, and four-wave mixing (FWM), which can be mitigated by employing guard bands between the quantum and classical regimes. Discrete-variable QKD (DV-QKD) uses single-photon detectors that cannot distinguish between signal and noise photons, making it sensitive to in-band noise. Continuous-variable QKD (CV-QKD), which employs coherent detection with a local oscillator, provides narrow spectral filtering and better tolerance to co-propagating noise, making it more suitable for dense WDM environments.

We perform numerical simulations to characterize the impact of coexistence between CV-QKD and classical channels in WDM systems on the secure key rate (SKR) by quantifying excess noise from spontaneous Raman scattering. We systematically study the impact of launch power, channel spacing, and channel bandwidth on quantum signal and secure key rate. Our results demonstrate that placing the quantum channel at higher

frequencies than the classical channels significantly reduces noise and interference. We develop a framework for predicting secure key rates under realistic WDM conditions, with particular attention to the C-band, where most classical communication operates, and technology is well developed.

Figures

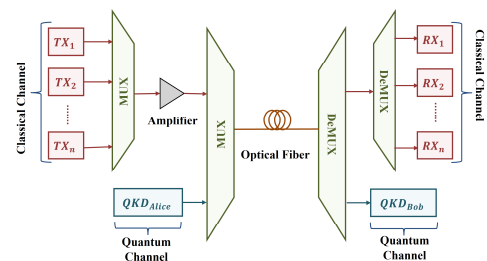


Figure 1: Scheme for multiplexing quantum Channels with the classical channels. MUX: multiplexer; DeMUX: de-multiplexer; TX: transmitter; RX: receiver.

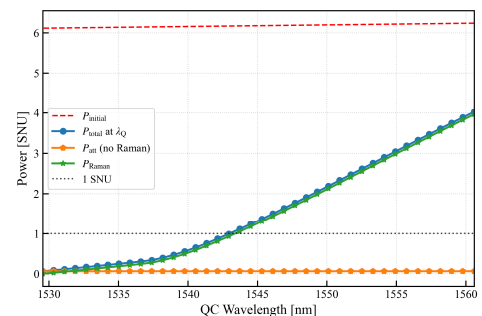


Figure 2: Power in shot noise unit (SNU) as a function of placement of quantum wavelength in a WDM channel with 39 classical signals at 0dBm power and 50 GHz channel spacing.

References

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