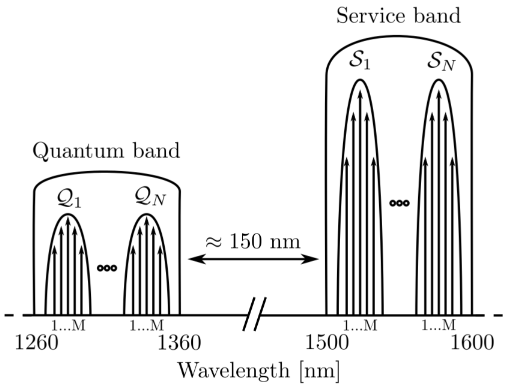
A Proposal for a Wavelength Multiplexed Quantum Metropolitan Area Network

A. Ciurana[1], J. Martínez-Mateo[1], N. Walenta[2], H. Zbinden[2], M. Peev[3], A. Poppe[3], V. Martín[1]

In this communication we present a scheme for fully addressable metropolitan area networks [1] in which quantum and conventional signals are wavelength multiplexed and transmitted simultaneously over different channels. In the present (initial) design, the network can accommodate one-way QKD systems able to withstand at least 30 dB of losses. As Fig. 1 shows, the channel plan places the quantum channels in a quantum band (1300 nm) and the conventional channels in a service band (1500 nm), the latter used for e.g., interferometer stabilization, key distillation communication or (encrypted) data transmission. This spectrum separation allows for an easy filtering of the conventional signals and reduces their noise contribution [2]. A corresponding pair of quantum and conventional service channels has to be routed to the same QKD device that might be situated in any access network. To this end we take advantage of the periodicity of the arrayed waveguide gratings (AWG). This property enables the use of not only one channel per port, but also its periodic "harmonics". Therefore, we slice the quantum and service bands in subbands that match the periods of the AWG, such that each QKD pair can use such periodically matching channels from both bands to communicate. The scheme is easily implemented using standard commercial components. A test bed network of three access networks and a span of 16 km has been deployed in order to test this scheme.



Forward and backward noise measurements were carried out to estimate the maximum number of simultaneous QKD devices. Results are presented in Fig. 2 using 1 ns detector gates. Alongside with the network noise, the figure also shows an estimate of the quantum signal detection probability and the dark count rate of the single photon detector. Using these values, we can calculate the QBER (framed boxes in the figure). In this test bed, the QBER is below the 11% threshold even with a total power of +2 dBm for the service band. This power allows for 32 simultaneous conventional service channels of -13 dBm which is enough to achieve a transmission rate of 1.25 Gbps [3] in the highest loss path of the network (23 dB). More service channels or higher data rates are expected with shorter detector gates (e.g., 100 ps).

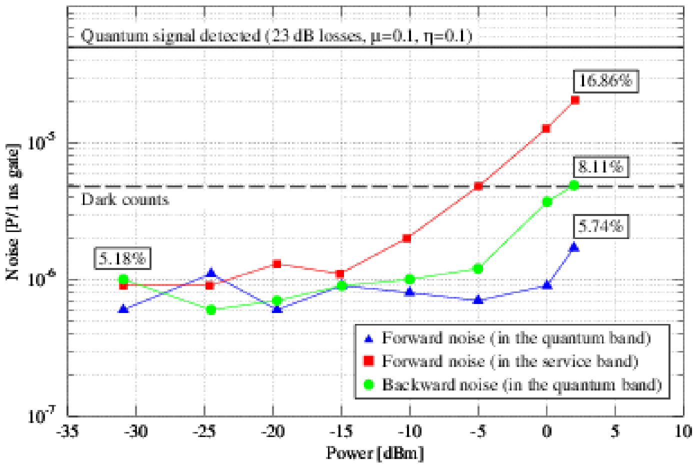


Figure 2. Forward and backward noise measurements.

References:

[1] Ramaswami R, Sivarajan K and Sasaki G 2009 *Optical Networks: A practical Perspective, 3rd Edition* (Morgan Kaufmann Publishers Inc.)

[2] Subacius D, Zayriyev A and Trifonov V A 2005 *Appl. Phys. Lett.* **86** 011103

[3] Patel K A *et al.* 2012 *Phys. Rev. X* **2** 041010

[1] Research Group on Quantum Information and Computation, Universidad Politécnica de Madrid, Spain, {aciurana, vicente, jmartinez}@fi.upm.es; [2] Group of Applied Physics, Université de Genève, Switzerland, {nino.walenta, hugo.zbinden}@unige.ch; [3] Optical Quantum Technology, Austrian Institute of Technology, Austria, {momtchil.peev, andreas.poppe}@ait.ac.at;