In order to deploy QKD in a cost effective and scalable way, its integration with already installed optical networks is a logical step. If, for the sake of security, we require that no intermediate trusted nodes would be needed, the maximum distance/absorptions allowed by QKD systems limit themselves to metropolitan area networks. Current metro networks are mostly all optical and passive, hence a transparent link can be established among any two points and this link can be used to transport the quantum channel. In this poster we report on our findings studying the problems arising when integrating QKD systems in standard telecommunication networks.

1 Network Testbed

The testbed setup is depicted in Fig. 1. The core has a ring topology and the access has a tree topology. The access currently uses the GPON standard, although DWDM-PON studies are under way. QKD equipments are id Quantique Clavis 3000 and 3100 two way systems using BB84. Mean photon number was set to simulate a decoy state protocol with signal plus one decoy. The optimal mean number for our setup was 0.79. A full protocol stack, including specifically designed LDPC error correction codes with 1.05 efficiency[1][2] and privacy amplification was used.

The core testbed uses CWDM technology and is composed of three standard ROADM nodes. Two wavelengths, 1510 and 1470 nm are used for classical signals, while 1550 nm is reserved for the quantum channel. Beyond power management, extra filtering to further isolate the quantum channel was needed and standard DWDM 50 GHz (0.4 nm) filters were used. Losses in this scenario, without the fibers are 8 dB. The setup is depicted in Fig. 3.

2 Results

The results of the core network are shown in Fig. 4. Extrapolated data to a 5.6 GHz filtering scheme are included. QBER (left scale) and key rate (right) are presented as a function of the fiber length connecting ROADM nodes 1 and 2, an almost worst case configuration for QKD. The net key throughput is greatly enhanced using the narrower filter, more markedly at the higher distances because the Raman scattering reaching the detectors is still increasing with distance for that fiber length.

In Fig. 5, we present the results for the access network. QBER and key rate is shown as a function of fiber length connecting the OLT with the splitter, again an almost worst case configuration for QKD. In this scenario, the narrower filter is more important because of the unattenuated upstream classical channel. In both scenarios a secure key throughput of over 100 bit/s is achievable at the longest distances. This is able to sustain an AES256 key exchange rate higher than is usual today and supports the view that the integration of QKD in modern optical networks, although not free from problems, is a real possibility.

3 Conclusions

We have shown that QKD in Standard Optical Networks is a real possibility, although it is limited to a short range and therefore to metropolitan area networks. We believe that switched networks, whether sharing the fibers with other classical, quantum or both channels is the next logical step and a need to deploy QKD in a cost-effective way. In future experiments we plan to measure the capabilities and limits of different setups of PON networks and new standards being deployed (WDM-PON) with QKD.

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References