Multinode subcarrier wave quantum communication network

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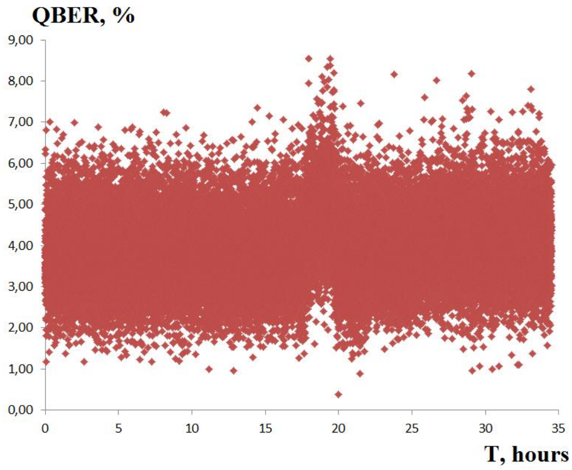
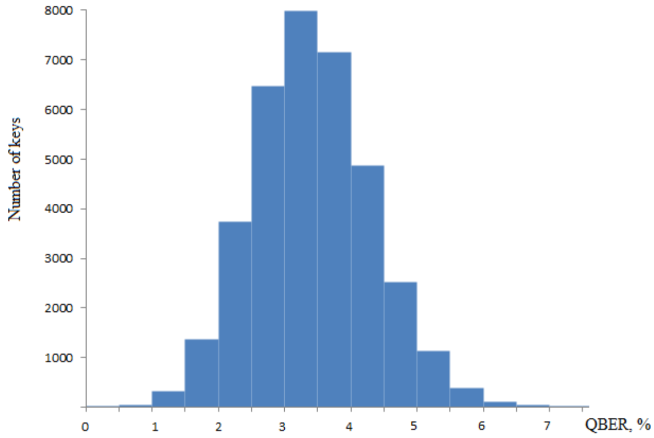
Until recently subcarrier wave quant um communication (SCWQC) systems, which are robust against external conditions and possess unmatched potential for quantum channel multiplexing [1] have only been tested in point-to-point setups, mainly due to relative complexity of SCWQC architecture. In this work we report construction of the first multiuser quantum network fully based on SCWQC method. The experiment allowed to demonstrate long-term stability of several SCW devices intercommunicating in metropolitan infrastructure.

This work is a result of collaboration between KNRTU-KAI and ITMO universities and telecommunication operator PJSC Tattelecom. The network connects four nodes in Kazan city (Russia): two buildings of KNRTU-KAI campus (Nodes 1 and 2) and two Tattelecom offices (Nodes 3 and 4). It implements star topology and thrusted repeater paradigm. Three receiver modules are located in the central Node 1. The transmitters in Nodes 2, 3, 4 are connected to Node 1 through existing metropolitan area telecommunication infrastructure provided by Tattelecom. We have used subcarrier wave QC devices developed earlier in [1]. Network operation is fully automatized and does not require any active compensation of quantum signal distortions in the fiber. State preparation frequency is 100 MHz, losses in Bob modules are 6.4 dB. We use a four-state phase protocol similar to BB84. Mean photon number was chosen to be 0.3 in order to counter modelled collective attacks. Commercially available idQuantique id210 detectors were used for single photon registration.

Quantum channels were implemented using conventional Corning SMF-28 dark fibers in underground cables in all experiments. The distances (losses) between Node 1 and Nodes 2-4 are 0.73 m (0.6 dB), 12,4 km (6.8 dB) and 9.4 km (7.0 dB), respectively. Secure key rates through the channels were 11.1 kbit/s, 19.6 kbit/s and 19.4 kbit/s. Registered mean QBER values were 3.7%, 3.9% and 4%. Fig. demonstrates typical QBER measurements for 9.4 km (Nodes 1-4) link during 34 hours of continuous network operation.





In order to demonstrate security applications, the generated quantum keys were used for real-time encryption of the digital audio signal transmitted through open optical channel.

The obtained results mark another important step to efficient multiuser quantum network development. For the first time several subcarrier wave QC systems have been connected in a unified metropolitan area infrastructure. Different segments of the network have been tested since August 2016 with some maintenance periods, its operation and the main parameters were found to be stable.

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References

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