Physical Layer for Polarization Encoded Qubits

Mariana F. Ramos, Andoni C. Santos, Nuno A. Silva, Nelson J. Muga, and Armando N. Pinto *Senior Member, IEEE, Member, OSA*

***Abstract*—The abstract goes here.**

***Index Terms*—Communications Society, IEEE, IEEEtran, journal, LaTeX, paper, template.**

I. Introduction

~~QUANTUM communications provide unconditional security in every communication.~~ ~~Nowadays, the~~ feasibility of quantum protocols implementations using single-photons polarization-encoded have experimentally been demonstrated [1][2]. In order to meet the requirements for any secure quantum communication protocol, a service able to generate some set of quantum states of polarization (SOP), and delivered them through a given distance, at certain rate with a given quantum bit error channel should be provided. However, polarization-encoded information practical implementation in optical fiber networks raises issues regarding polarization random drift, and symbol and mode synchronism. Moreover, optical imperfections also impacts quantum protocols performance due single-photon detectors efficiency and dark-counts. Last but certainly not least, a low overhead should be used to compensate the physical layer imperfections, and the average number of photons per pulse should fit security requirements.

~~In this work,~~ we propose a physical layer that comprises the transmission of a set of SOPs with a quantum bit error rate (QBER) below a user-defined threshold, which is guaranteed by a QBER-based algorithm that actively compensates the polarization random drift in optical fiber networks. This physical layer takes into account the optical devices imperfections impact on the transmission, and provides to an upper-layer protocol the symbol and operation mode synchronism, the QBER upper-bound, and unconditional secure encryption quantum keys delivery between two parties. This paper contains six sections. Section II the physical layer architecture is described in detail. In section III the synchronization method is detailed taken into account optical imperfections but with no polarization compensation method applied. In section IV we will analyze the full physical layer implementation with optical devices imperfections, synchronism, and polarization compensation method applied. In section V we present the performance assessment of the physical layer. Finally, in section VI the main conclusions of this work are presented.

This work is supported by Fundação para a Ciência e a Tecnologia (FCT) through national funds, by the European Regional Development Fund (FEDER), through the Competitiveness and Internationalization Operational Programme (COMPETE 2020), and by Regional Operational Program of Lisbon, under the projects QuantumMining reference: POCI-01-0145-FEDER-031826 and DSPMetroNet reference: POCI-01-0145-FEDER-029405, by FCT/MEC through national funds and when applicable co-funded by FEDER-PT2020 partnership agreement under the project UID/EEA/50008/2013 (actions QuantPrivNet, and COHERENTINUOUS), and by the FCT, through the Post-Doc Grant SFRH/BPD/96457/2013.

M. F. Ramos, N. A. Silva, and A. N. Pinto are with the Department of Electronics, Telecommunications and Informatics, University of Aveiro, Portugal, and Instituto de Telecomunicações, Aveiro, Portugal (Emails: marianaferreiraramos@ua.pt, nasilva@av.it.pt, anp@ua.pt).

N. J. Muga is with the Instituto de Telecomunicações, Aveiro, Portugal, and i3N, University of Aveiro, Campus UniversitÃąrio de Santiago, Aveiro, Portugal (Email: muga@av.it.pt).

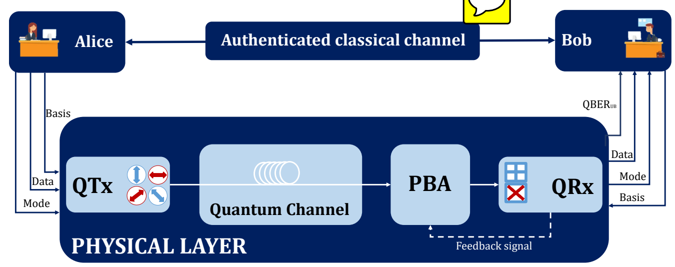

Fig. 1. System architecture

II. Physical Layer Architecture

III. ~~Symbol and Mode Synchronism~~

o-clicks e as dark counts, atenuation (without polarization drift)

IV. Polarization random drift

Algoritmo de compensacao com os no-clicks, dark counts, attenuation, sincronismo

~~V. Performance assessment~~

~~(qber, transmission window, BB84?)~~

VI. Conclusion

The conclusion goes here.

References

[1] J. Wang, X. Qin, Y. Jiang, X. Wang, L. Chen, F. Zhao, Z. Wei, and Z. Zhang, "Experimental demonstration of polarization encoding quantum key distribution system based on intrinsically stable polarization-modulated units," *Optics express*, vol. 24, no. 8, pp. 8302–8309, 2016.

[2] A. Duplinskiy, V. Ustimchik, A. Kanapin, V. Kurochkin, and Y. Kurochkin, "Low loss qkd optical scheme for fast polarization encoding," *Optics Express*, vol. 25, no. 23, pp. 28 886–28 897, 2017.

Mariana F. Ramos Biography text here.