

Flattened Flexible Non-blocking Switching Node with Quantum and Classic Optic Coexistence

Author name(s)

State Key Laboratory of Information Photonics and Optical Communications, School of Information and Telecommunication Engineering, BUPT Beijing, China, 100876
ymsun@bupt.edu.cn

Abstract: Quantum key distribution provides an unconditional physical layer for secure communication. Study on switching and large-scale Networking problems in Quantum Communication could promote QKD communication to industrialization and practical. The current quantum switching nodes can only handle the wavelength of a specific bandwidth and have a strong constraint on the path of the transmission. And the spectrum reuse rate is very low. So it can't meet the demands of build large-scale network. This paper will present a WSS-based flattened flexible and non-blocking switching node that could support quantum communication and classic optical communication at the same time with multi-granularity.

OCIS codes: 000.0000, 999.9999.

1. Introduction

QKD uses non-orthogonal coded single photon states, such as single photon polarization, phase or angular momentum, to provide secure information exchange for two remote users. These all can be transmitted and switched same as classic optic signal in the fiber. So far, the study on point-to-point QKD communication based on fiber-optic links has been quite mature. More and more researchers have turned to large-scale and multi-user QKD communication network systems based on existing optical devices, and strive to make QKD communication network and existing optical network one integration. In 2003, Paul Tolver experimented with the optical switching system of the QKD communication based on the 4x4-based 2-D MEMS switch array under the B92 protocol and reached a transmission distance of more than 10 km at the time of the device attenuation of 5.9 dB. But this system can not achieve the signals with the existence of multiple wavelengths in one fiber are transmitted and switched, only can provide signal switching services for the fiber that only contains one signal. In 2010, Shuang Wang et al. of China University of Science and Technology proposed a wavelength-saving quantum signal switching device composed of a three-port loop and wavelength division multiplexer, and this scheme has lower power loss and higher stability than using active device. However this scheme also adopted the real-time full connection, increased the complexity of the network, and is difficult to expand. Although the wavelength can be reused, but the reuse rate is relatively low. The scheme above two have a certain routing path compared with the using of beam splitter, but neither considered to integrate the quantum network with the existing classical optical network. This paper presents a quantum switching node scheme supporting the coexistence of quantum signals and classical optical signals based on WSS and coupler and providing more flexible spectrum allocation and non-blocking switching for any wavelength with any bandwidth in any input port.

2. Difference between quantum communication and classical optical communication

To integrate quantum communication with classical optical communication, we should consider the same point and difference between quantum communication and classical optical communication. The quantum signal can't be amplified, it needs the transmission link loss to be extremely low, while the classic optical signal is not sensitive to the link loss due to the signal power is very large. The quantum signal will show in one branch of the beam splitter at a specific probability when passing through the beam splitter, while the classical optical signal is transmitted to the branch of the beam splitter at a specific ratio of the input optical power. In the process of quantum communication, the delay time between quantum signal and synchronization signal has an important effect on secret key generate rate. The synchronization signal is needed to transport in the same way with quantum signal on the link layer to keep the signal synchronized. However, the classical optical signal doesn't require additional synchronization signal. Meanwhile, quantum signal is extremely weak and is very easy to be disturbed by the classic optical signals of

other channels, so it is very important to consider the effects of classical signals on quantum signals when this two kind of signals are transported at the same time in the same fiber or switching node.

3. Flattened switching node based on WSS

This article makes full use of the characteristics of WSS: (a)Flexgrid Dynamic Channel Width Control; (b)Flexgrid Dynamic Attenuation Control; (c)Channel plans are configurable 'on-the-fly'. These three features simultaneously meet the needs of quantum signal switching and classical optical signal switching, Which can be used to simultaneously transmit quantum signal and classical signal. the switching node scheme is show as figure 1. The

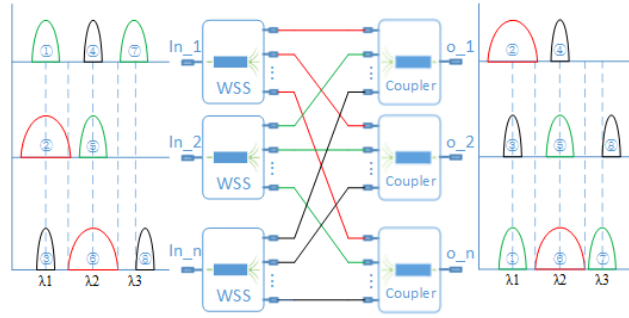


Fig. 1. Switching Node Structure.

switch node only have two kinds of optical devices, WSS and coupler and have the characteristics of flexible grid, multi-granularity, low loss, non-blocking.

3.0.1. Math Notation

Equations should use standard L^AT_EX or AMSL^AT_EX commands (sample from Krishnan *et al.* [1]).

$$\begin{aligned}\bar{\varepsilon} &= \frac{\int_0^\infty \varepsilon \exp(-\beta \varepsilon) d\varepsilon}{\int_0^\infty \exp(-\beta \varepsilon) d\varepsilon} \\ &= -\frac{d}{d\beta} \log \left[\int_0^\infty \exp(-\beta \varepsilon) d\varepsilon \right] = \frac{1}{\beta} = kT.\end{aligned}\tag{1}$$

4. Tables and Figures

Figures and illustrations should be incorporated directly into the manuscript, and the size of a figure should be commensurate with the amount and value of the information conveyed by the figure.

Fig. 2. Sample figure with preferred style for labeling parts.

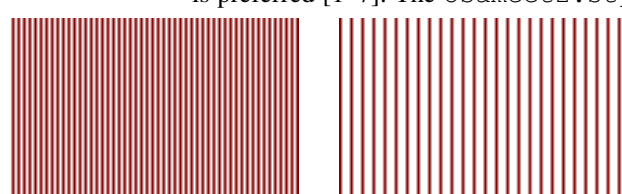
Table 1. Sample Table

One	Two	Three
Eins	Zwei	Drei
Un	Deux	Trois
Jeden	Dvě	Tři

No more than three figures should generally be included in the paper. Place figures as close as possible to where they are mentioned in the text. No part of a figure should extend beyond text width, and text should not wrap around figures.

5. References

References should be cited with the `\cite{}` command. Bracketed citation style, as opposed to superscript, is preferred [1–7]. The `osameet2.sty` style file references `cite.sty`. Comprehensive journal abbreviations are



available on the CrossRef web site: <http://www.crossref.org/titleList/>.

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