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Implementation of Asynchronous Amplitude and Phase Shift Keying for Optical Data in SDN-Intra-Data Centre Network

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Abstract: An intra-data centre design employs a cost effective multi level transmission scheme which analyse the alternative approach for Amplitude Shift Keying (ASK) for low power sensor applications is presented. This scheme enables the optical multiplexing of two asynchronous and independent optical streams into amplitude phase-shift keying signal design and developing suitable hardware platform to study the performance. Incorporating of adequate elements and analyzing various performance factors is carried over in this proposed scheme to guarantee adequate bandwidth flexibility. The transmitter successfully multiplexes two data streams, namely a 40 Gb/s differential quadrature phase-shift keying signal and a 10 Gb/s on–off keying one, coming from two separate apparatus. The design of an intra-data centre switch architecture encompassing the proposed transmission scheme is then presented with help of LDR optical signal inputs which are multiplexed is transmitted and received in intra data centre under open flow principles.

Key words: Amplitude-shift keying(ASK) · Datacenter · Open Flow (OF) · Optical multiplexing · Phase-shift keying (PSK) · Software defined networks (SDN)

INTRODUCTION

New age group of data centre networks provides higher bandwidth efficiency, lower latency, increased flexibility and lesser cost. Several optical interconnect solutions also proposed to guarantee high bandwidth efficiency, flexibility and re-configurability. Many important plans have introduced advanced transmission techniques based on composite multi-level modulation formats and exploiting higher coherent detection techniques. These solutions cannot with stand the cost requirements as the need for expensive and power-starving electronic digital processing executed at the coherent receiver. The other multi-level signalling solutions are based on non coherent receiving techniques, in picky makes use of separate receivers to detect amplitude-shift keying (ASK) and phase-shift keying (PSK) transmissions multiplexed on the same optical carrier. A cost-effective transmission scheme for rate adaptable intra-data centre communication is implemented. This is enabled by the transmission of a multi-level signal obtained through the multiplexing of two asynchronous and independent optical streams. If the two independent streams are operated with nearly the same baud-rate, interest the same spectrum resources. The multi-level signal is implemented is to overcome the errors like truncation, quantization error, power consumption and speed by using level converter. Possible intra-data centre architecture with Point-to-point communication between pairs of top of racks (ToR).Each ToR is equipped with aggregation switches which utilize the proposed transmission solution.

Literature Review: The proposed scheme of control for the shift keying is possible with software defined network (SDN). Originally SDN designed for Ethernet-based networks, is rising as a contender technology to control different application and networking scenarios, including optical networks and intra-data centre solutions. State of the art of data enter architectures and enabling technologies is shown in survey reports of SDN[1-3] they emphasize the appropriate challenges to progress current data centre solutions, including the need to provide better management flexibility, lower costs and enhanced resource deployment. Pandey[4]supports the common acceptance of SDN representing the need for synergy between photonics and SDN contained by data centres. The studies in data centre networks, [5]–[7]offer architectures and implementations mainly relying on Open Flow (OF) effecting to traditional data plane technologies.

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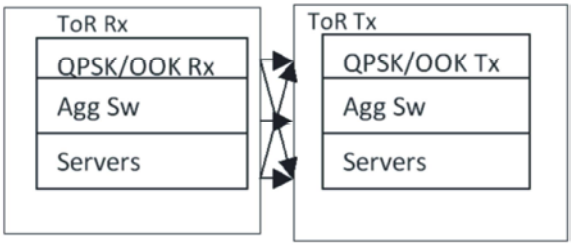

Fig. 1: Intra Data centre

For example, in [5], OF is used to enable optical bypass through the configuration of conventional fiber-based optical cross-connects. In [6] and [7], SDN is applied to control data plane solutions based on reconfigurable optical add-drop multiplexers (ROADM) and flexible grid technology. In [8], a multilevel signalling technique for low-cost short reach applications is considered. Though, the considered technology requires synchronous tributaries, but not available when multiple aggregation switches are considered. Moreover, this scheme is not included in widespread intra-data centre architecture and no related SDN operation is actually presented. In [9], experiment on SDN-controlled data centre advanced optical solutions is reported. However, the architecture relies on complex and expensive technologies (e.g OFDM with burst switching). An OF-based node architecture is launched to support multi-level signalling technology in the circumstance of a reconfigurable intra-data centre networking situation. To control the proposed asynchronous technology and the launch of the multi-level transmission OF architecture is useful and implemented. The architecture wires together a reactive and a pro-active mode, thus permit the managing of listed and non-listed event.

ToR in Intra Data Centre: The intra-data centre architecture is Point-to-point communication [10] between pairs of top of racks (ToR) is shown in fig 1. Each ToR consists of aggregation switches which exploit the proposed transmission solution. The main component of the architecture is the cost-efficient transmission scheme which includes a DQPSK modulator followed by a Mach–Zehnder modulator (MZM) focused by the electrical signal detected from the OOK transmitter. Receiver end is simple 90/10 splitter used to send the multiplexed multi-level signal to both the DQPSK and OOK receivers, to receive the needed streams.

The ToR architecture is considered as a single OF switch, controlled by an OF agent in contact with an OF controller.The OF controller and the OF switch run on a

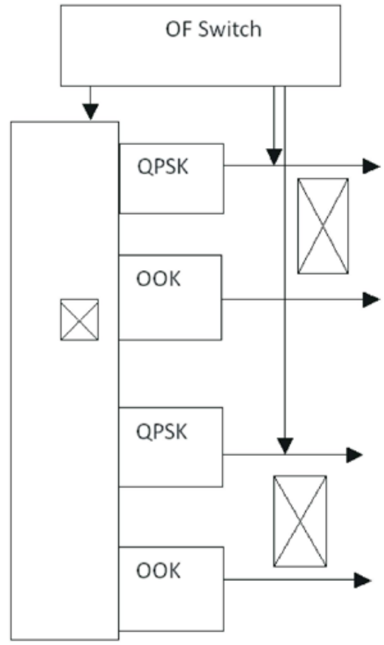

Fig. 2: ToR Node Architecture with OF switch

Linux box with Gigabit Ethernet interfaces. The N input ports of type IN_x are associated to the DQPSK transmitters. Constant flow entries are fitted in the switch for each IN_x and OUT_x port, so that a single DQPSK transmitter is changed to one of the N output port connected to the intra-data centre full-mesh network..The planned transmission scheme involves the configuration of just the transmitter to afford the multiplexing of asynchronous and independent ASK and PSK signals. The receiver is able to adaptively identify either signal without requiring the configuration of optical components at the receiver. This enables the SDN controller to just function on the transmitter element, shorten control architecture. In particular, the controller stores and manages 1) the status of the OOK transmitter (active/inactive), 2) the association between active transmitter and DPSK transmitter (obtained by matching the common OUT_x port towards the same destination ToR) and 3)the intra-ToR architectural limitations (e.g., an OOK transmitter can or cannot be switched to any OUT_x port). Fig. 2 shows a ToR node architecture in which OOK transmitter can be associated to only two adjacent DQPSK transmitters through the configuration of an optical switch introduced between the OOK transmitter and the PR. Moreover, the central DQPSK can be served by two OOK transmitters. In this case the related MZM block (including the optical-electronic conversion) is connected to the switches output through a coupler.

This partially shareable configuration is communicated by the of switch to the controller during the initial switch registration. Two activation methods have been considered, the reactive method and the pro-active method. The figure 1 shows capture of OF messages between ToR switch and controller. The previous reactive method is likely to be triggered locally by the OF switch agent, upon the tx/rx port statistics report a bandwidth notice. This notice is raised when the scrutinized average tx bandwidth raises, becoming close to the nominal rate of the installed flow entry, in this case 40 Gb/s of the DPQSK transmission. The latter pro-active method is likely to be triggered directly by the controller based on forecast traffic patterns or intra-data centre maintenance operations scheduled by the integrated computational /network resource manager like for example a new server or CPU with storage capacity, virtual machine relocation. In the reactive method, when the 40 Gb/s bit-rate of the DQPSK transmission has to be raised due to extra traffic requests, a OFPT_PACKET_IN message is created by the agent to the OF controller. The message is extended to appeal additional 10Gb/s OOK transmission on the similar spectrum resources. The OF controller replies with a specifically designed OFPT_FLOW_MOD message enabling the configuration of the switch at the transmitter. Under this transmission scheme, no operations are essential at the receiver, which receives OOK traffic without any specific signalling or extra configuration. With the pro-active method, the configuration is even more faster since the OF controller directly notify OF switch with a OFPT_FLOW_MOD message.

ToR with Shift Keying Setup: The DQPSK transmitter includes a continuous-wave (CW) distributed feedback laser, with two cascaded 40 GHz phase modulators (PM).Each modulator is driven by an electrical 20 Gb/s binary signal produced by a bit pattern generator. In particular, the signal applied to the first PM has a peak-to-peak voltage (~7 V) configured to obtain a phase shift. The Fig. 3. shows experimental setup of the optical carrier of ±ð/2, but the voltage applied to the second PM (~3.5 V) is configured to induce a phase shift of ±ð/4. The two driving signals are synchronized through an electrical delay line. The resulting 40 Gb/s (20 GBaud) DQPSK signal passes through a 12GHz-MZM for multiplexing the DQPSK modulation with an OOK intensity one. Contrasting the case of using an IQ modulator, the DQPSK signal acquired by pure phase modulation does not reveal intensity transitions, thus allowing the

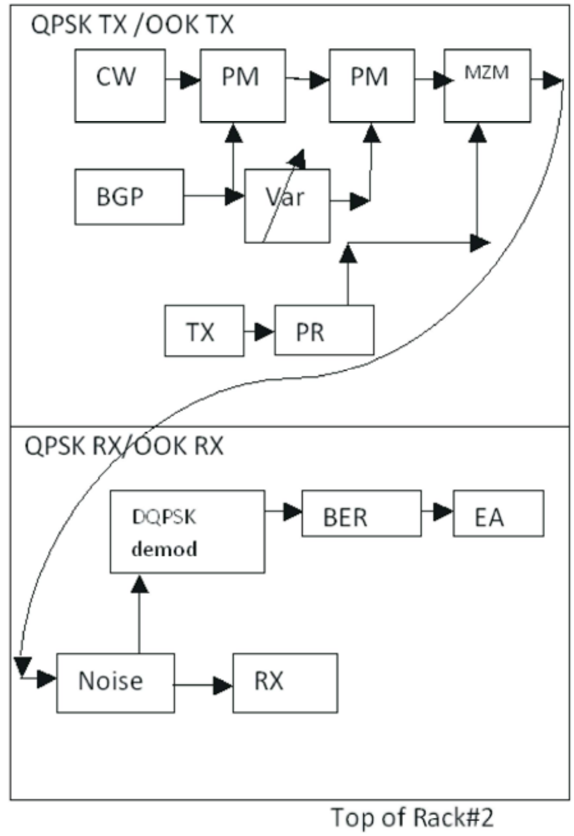

Fig. 3: Experimental Setup

superimposition of an OOK modulation absolutely asynchronous and free with respect to the DQPSK one. The transmitter is capable of handling either Ethernet frames or pseudo-random bit sequences (PRBSs). To perform the multiplexing operation, the OOK signal undergoes opto-electronic conversion via a 20 GHz-photo-receiver (PR), whose output drives the MZM. After the addition of optical noise limited to the optical spectral content of the original signal by an optical band-pass filter, 90% of the signal power reaches the DQPSK receiver, consisting of a 20 GBaud DQPSK demodulator followed by a 32.5 GHz-balanced photo-receiver (BPR), whose output is finally received by an error analyzer (EA) so as to detect a DQPSK component (I and Q) at a time. The remaining 10% of the signal power is used at the OOK receiver where as available OOK transceiver is of 10 Gb Ethernet traffic and PRBS sequences.

Simulation Analysis: To calculate the transmission system behaviour and performance, the setup is shown as in Fig. 4 is analyzed through simulation.

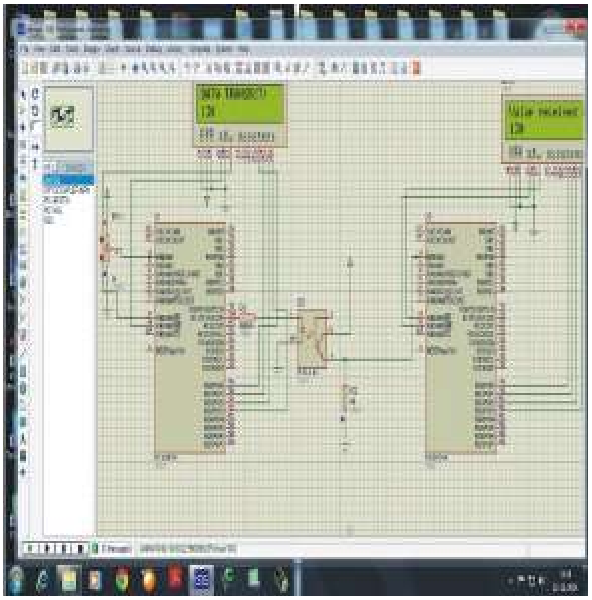

Fig. 4: Simulation setup

The CW contained in the DQPSK transmitter is believed to have a 100 KHz-linewidth. A SNR is 22dB is believed for the electrical signals driving every modulator. The simulation is presented considering two 2^{21}–1-long uncorrelated RBS for the I and Q elements of the20 GBaud DQPSK modulation and a RBS string for the 10 Gb/s OOK modulation of more or less half of that length. The two modulations are jointly asynchronous and uncorrelated. Each DQPSK symbol time is described by 21 points (roughly a twice number of points describes each OOK bit time). At each receiver input, a Gaussian filter with full width half maximum equal to the base-band of the detected modulation is considered (10 GHz for the OOK, 20 GHz for the DQPSK). Optical noise is added within the whole eight APSK signal bandwidth in order to carry out BER curves at distinct functional ER values. The ER is fortunately varied by changing the peak-to-peak voltage applied to the MZM. A 0.1 dB of penalty at BER = 10^{-9} is observed at ER = 1 dB, finally reaching 6.1 dB for ER = 5 dB. The electrical noise input of each receiver is not considered in the simulation. Capture of the OF messages at the OF switch with IP address is done. The extended OFPT_PACKET_IN message (frame 1256) is extended with the indication of the requested output port (ToR output port) such information is used by the controller to identify the most suitable OOK transmitter and its related AUX_x port and to configure the flow entry. Controller replies with a FLOW_MOD message (frame 1257). The message exchange from OF agent to OF controller is successfully completed in around 1 ms.

RESULT

The pictorial represents fig 5,6 a successful multiplexing operation of a 40 Gb/s DQPSK transmission with a 10 Gb/s OOK modulation. The two multiplexed data streams come from two different procedures and are asynchronous each other. The transmission of the multiplexed signal is demonstrated over a 1km-long. BER measurements reveal correct functionality and EF operation (BER = 10^{-9}) guaranteed for both the transmissions for an OSNR = 31 dB, considering an ER of the applied OOK modulation in the range 1-2 dB. OSNR can be improved, by including a FEC strategy for the DQPSK transmission. The output is shown by using LDR for data transmission happening on tx/rx modules. The changes in amplitude and phase parameters are seen by variation in motor speed.

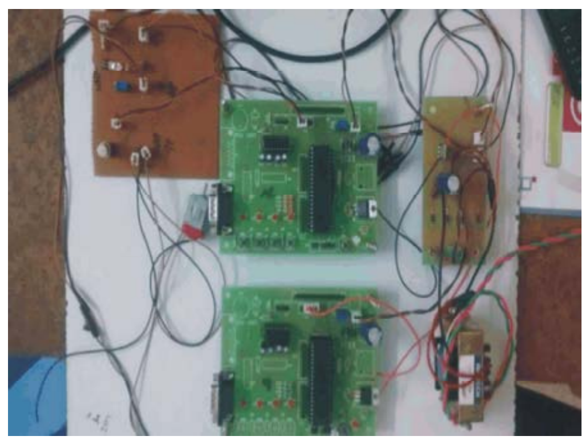

Fig. 5: ASK/QPSK TX/RX modules

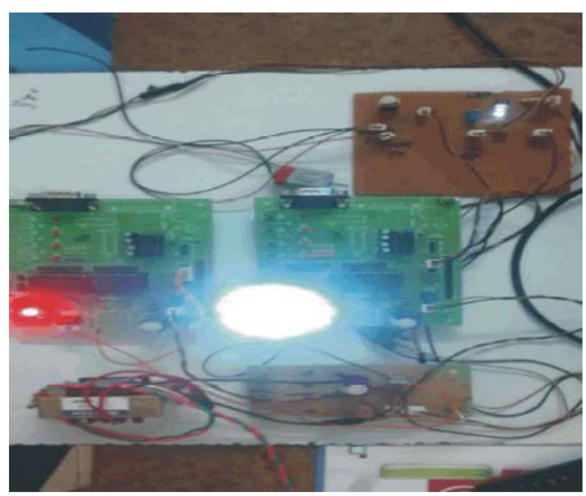

Fig. 6: Data transfer with optical signals

CONCLUSION

A cost-effective multi-level transmission scheme enables the multiplexing of two asynchronous and autonomous traffic streams utilizing OOK and DQPSK transmission. The performance of the transmission scheme has been widely estimated through both simulative and experimental studies. In particular, switch architecture has been considered to enable bandwidth flexibility through the sharing of OOK transmissions among different and independent DQPSK-based communications. A multiplexing transmission scheme has been controlled through a SDN architecture with OF solutions have been proposed and implemented. The multidimensional M-ary shift keying scheme to support low power sensor is used as applications is proposed. The scheme can be implemented on a dedicated hardware platform to study its performance under varying data transfer rates.

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