Implementation of an OBS access node supporting multiple services

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ABSTRACT

Network operators want to deliver multiple services to the end customers. This leads to the need of efficient transport of data using optical network technologies. OBS is a promising technology for metro networks, where the operator can locate their servers to provide services such as video, backup or PC virtualization. These services are competing for shared network bandwidth when running in parallel.

This work develops an FPGA-based access edge node, which operates with multiple QoS applications. This paper describes the architecture of the design as well as the behaviour of the implemented solution.

Keywords: OBS node architecture, assembler, scheduling, QoS.

1. INTRODUCTION

Many operators are interested in developing new business opportunities through the implementation of Network Centric Services (NCS), where the operator combines both network resources (raw connectivity) and IT resources (content storage and computing). Some examples of NCS include: PC virtualization, VoD, 3D Internet gaming, Software as a Service (SaaS) and Storage Area Networks (SAN). These types of services and the expected continuous growth in Internet traffic (mainly driven by video) will imply a huge impact in the metro network. The network costs of current metro architectures depend significantly on traffic growth; the higher the traffic the higher the network costs. Consequently, any cost increase will impact on the ISP's margins. The network architectures of the last 20 years were never designed to cope with these new types of service demands. Therefore, new architectural solutions are needed to deliver the huge expected increase in traffic in a cost-effective way, and ensure low cost broadband Internet access. Authors in [1] show that sub-wavelength solutions reduce the CAPEX investment in metropolitan networks while supporting NCS traffic.

OBS technology is recently under a critical analysis like the work done in [2]. The authors consider "classical" OBS, but not TSON architectures [3] or fast wavelength switching used in OPST [1], which are the technologies analysed in MAINS project [4] (where this work is supported). Technologies used in MAINS provide the lack of blocking end-to-end is achieved by means of slot reservation.

This work is focus on the development of an OBS access node, which support multiple services based on VLAN information. Authors in previous work [5] developed an edge node with support of multiple services based on IP and TCP features. This paper reports on a platform to support multiple services based on Layer 2 (VLAN tagging) over OBS.

2. MAINS REFERENCE ARCHITECTURE

The MAINS project is focused on a new multiservice metro network architecture that allows the application/service layer to access subwavelength optical layer resources on-demand and at the granularity of optical packets and/or optical bursts. The use of subwavelength switching technologies (i.e. OPST, TSON) provides a cost effective metro transport solution, which guarantees high QoS performances and optimizes resource utilization. Moreover, the direct interfacing of these optical technologies with the service layer enables a new "network-centric" approach to Cloud Computing, by allowing the dynamic distribution of applications among multiple servers across the metro network, and overcoming the limitations of the current centralized server architectures [4]. The MAINS reference network is shown in Figure 1.

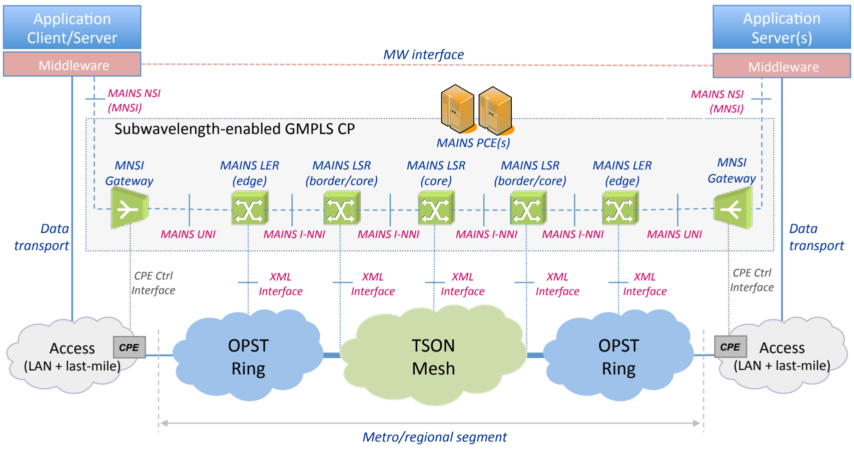

Figure 1: MAINS Reference Network Architecture

In MAINS, the layering model adopted between the service layer (i.e. the distributed application and its middleware) and the subwavelength-enabled control plane is overlay-style. The middleware has full knowledge of the remote server locations, the distributed IT resources capabilities and availabilities. It processes application workflows according to internal brokering and scheduling policies and requests network connections across the subwavelength metro network through the MAINS Network Service Interface (MNSI). The GMPLS control plane is responsible for the end-to-end network connection setup and management, with a scope ranging from the MNSI head-end (calling party) up to the MNSI far-end (called party).

Network services are required by the middleware by specifying the connection end-points and the bandwidth and QoS profiles needed for the specific application. In such metropolitan network, sub-wavelength nodes support multiple services at the same time.

3. PROTOTYPE IMPLEMENTATION ARCHITECTURE

The multi-service OBS access node is develop in a Virtex 5 – SX95T2C for the design. All modules developed are shown in Figure 2. On the upper part of the figure the burst transmitter is depicted, while the burst receiver is in the bottom part.

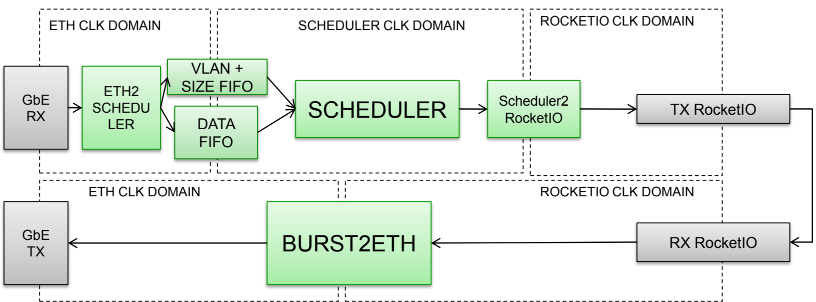

Figure 2: Modules of the developed access node

3.1 Multi-service burst transmitter modules

First, the modules of the transmitter are described. *GbE TX/RX modules* are generated using the Virtex5 embedded Tri-mode Ethernet MAC Wrapper. These modules enable the transmission and reception of Ethernet frames. Once an Ethernet frame is received in the board, it is sent to the *Ethernet2Scheduler module*. This module reads Ethernet frame and extracts the size and VLAN information, while storing the incoming frame in a FIFO. The *Scheduler module* reads the VLAN of the incoming Ethernet packets and maps the traffic to the QoS queue in this module. Moreover, Scheduler module reads the packet size, which is used in the burst generation. For the burst generation, a burst-size threshold is defined for each VLAN. In the bit file generation, a default value is given for each VLAN. However, it is possible to modify such value from the PC via PCIe. Using the PCIe, the VLAN ids and burst generation parameters can be modified online. Once there is a burst for a VLAN, scheduler asserts a signal to say that there is a burst ready to the *Scheduler2RocketIO module*. The Scheduler2RocketIO module starts the transmission of the burst through the RocketIO interface. The *RocketIO modules* are created using the coregen.

3.2 Burst structure

RocketIO uses K-Characters to carry out signalling process in the PtP connection. K-Characters are possible in the link because there is an 8B/10B codification. This K-Characters can be used to send in band signalling with the burst structure. Each Ethernet frame is stored in the Scheduler module and a Flag 1 (K-Character) is inserted between each frame. This flag is a Start of Packet flag, which allows delimiting each packet in the burst. To detect the burst end a Flag 2 is included. The burst structure is defined in the Figure 3.

	Flag 1	Packet ETH1	Flag 1	Packet ETH2	Flag 1	Packet ETH3	Flag 2	

Figure 3: Burst Format

3.3 Burst receiver modules

The burst receiver is composed by the *GbE TX* and *RX RocketIO modules*, which are interconnected by a *Burst2Ethernet module*. This module is in charge of decodifying the burst and sending the Ethernet packets to the GbE interface. Based on the burst structure (Figure 3), the receiver can decode the burst.

4. PROTOTYPE BEHAVIOURAL VALIDATION

4.1 Burst size threshold validation

For this experiment, the application server 1 sends traffic to the application server 2 with a fixed packet size of 128 bytes (Figure 4).

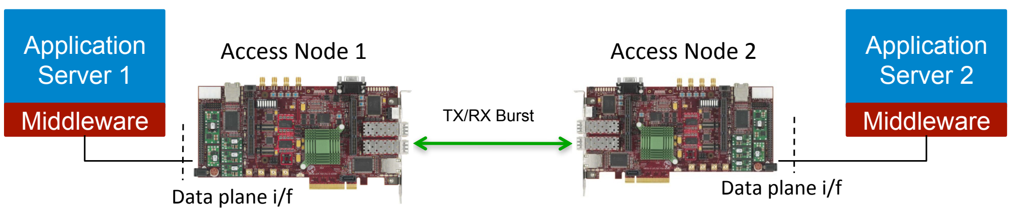

Figure 4: Test validation scenario

The traffic is captured in the application server 2 using Wireshark to check the burst size and the delay between bursts. Figure 5 shows the number of packets per second received when the maximum burst size is set to 6400 bytes. As the packet size is fixed to 128 bytes, each burst contains 50 packets as depicted in Figure 5. For this experiment, the timer threshold is set high enough to avoid exceeding it.

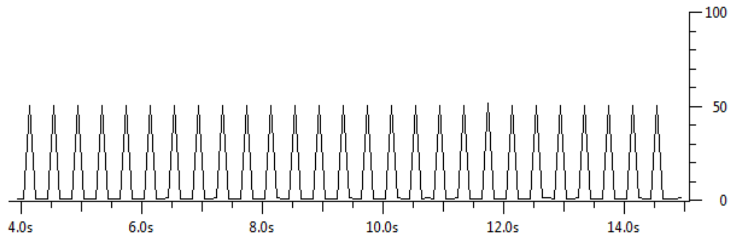

Figure 5: Packets per second when transmitting bursts with size threshold of 50 packets

4.2 Support to multiple services

In the second experiment, traffic with two VLAN tags is transmitted. To have a Wireshark capture, the Access Node 1 (Figure 4) is connected in loopback so the burst is created and received in Access Node 1. For VLAN 10 and VLAN 7 the timer threshold is set to 0.5s and 0.25s accordingly. Figure 6 shows the capture and the difference from the first packet arrival to the first packet reception for VLAN 10 is around 0.5s, while for VLAN 7 the difference is 0.25s. This validates that the access node is able to provide different delay based on the VLAN tag.

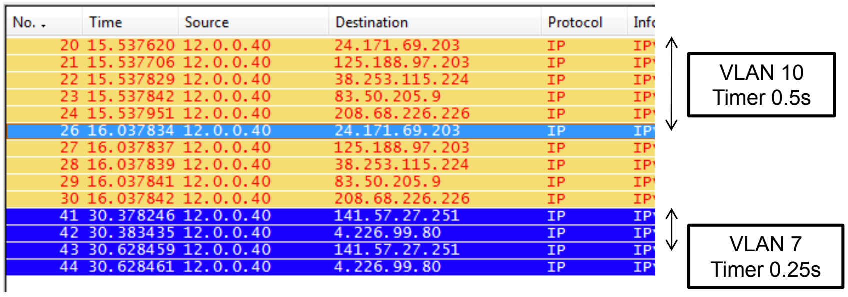

Figure 6: QoS variation based on VLAN tag

5. CONCLUSIONS

This article describes in detail the architecture for a multi-service OBS access node based on a Virtex 5 FPGA. The modules of the access node are described and their functionality to support multiple services on an access node. The paper shows a behavioural validation of the prototype under traffic from two different services.

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