Modeling an OBS Network in OMNeT + + and the Impact of Processing Speed of Control Packets in Such Network

F. LOUKDACHE, S. EL HAJJI, S. KRIT, and A. EL GHAZI

***Abstract* – In this paper the architecture of the optical burst switching network has been implemented in OMNeT. This experiment aims at determining the burst-loss probability depending on the increase of processing speed of control packets. In future studies a new approach will be then suggested in order to reduce the losses in OBS networks.**

***Index Terms* – TCP/IP, offset-time, NED language; core node, control packet.**

I. Introduction

THE need for a bandwidth and the explosion of IP traffic are general factors driving research towards the development of new network architectures and techniques for an effective switching. The adoption of all-optical switching networks is to meet this need. But, unfortunately, despite the progress and improvement that this type of network has known in order to meet the users' needs, losses remain present in all these architectures.

There are three types of OBS network architecture, conventional OBS (C-OBS), emulated OBS (E-OBS), and labeled OBS (L-OBS), by which the sending and the treatment of the BCP (burst control packet) differs from one architecture to another [1].

The modeling is performed based on a C-OBS architecture, in which the time between the burst control packet will be fixed at each input node. This offset-time (OT) has to be quite sufficient to allow the processing of the BCP and the configuration of the burst switch matrix.

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On the other hand, it was necessary to define and implement a set of mechanisms and techniques using C++, and also to implement the architecture of our network using the NED language. The architecture under consideration is composed of two edge nodes and two core nodes that will serve as information processing and routing of data that is received from the edge nodes. In this paper, we present the architecture of the OBS network, the architecture of each component, and then we conclude by raising the question of the following research.

II. OBS network architecture

OBS network or "optical burst switching" is composed of two types of nodes: the edge node and the core node connected by optical fibers (Figure 1). These optical fibers are made of a number of data and control channels.

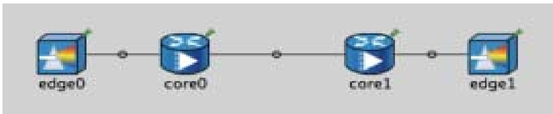

Fig. 1. Overall architecture of an OBS network

A. *The Edge Node*

The edge node is divided into two types: "ingress edge node" and "egress edge node". In the ingress edge node, all TCP / IP packets are assembled into large packets or bursts. This assembly is done by taking into considering some parameters; in particular, destinations and service quality criteria.

Then, bursts are transmitted inside the network in the form of optical signals. In the egress edge node, the received bursts will be disassembled into packets [2].

The edge node is generally composed of the following elements (Figure 2):

- **A dispatcher:** it is responsible for the reception and the classification of IP packets according to predefined criteria. IP packets which belong to the same class will be sent to the same assembler.
- **The assembler:** it is responsible for the gathering of IP packets and burst creation. The gathering of

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bursts can be realized according to different mechanisms based on:

• Size: it is predetermined; once the size is reached, the burst will be transmitted directly into the network.

• Time: time interval is preset; once the timer expires, the burst will be transmitted directly into the network.

• Size and time (hybrid mechanism): the burst will be transmitted into the network either when the timer expires or when the maximum size is reached.

o **The scheduler:** given a specific algorithm, the scheduler selects a queue to serve and triggers the control packet generator by a signal.

o **The control packet generator:** it is responsible for determining the output port, the wavelength, and the time of burst transmission based on information received from the scheduler.

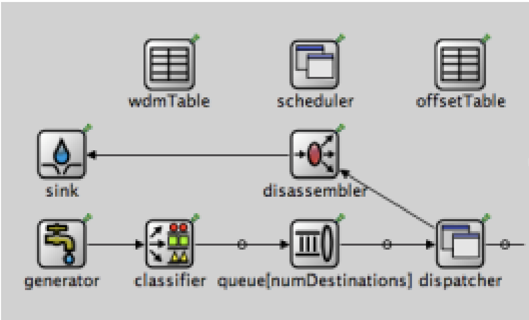

Fig. 2. Architecture of edge node

B. The Core Node

An OBS core node is the part which is responsible for the following tasks [3]:

• Processing of control packets.

• Reserving resources to transmit bursts and control packets.

• Routing control packets and bursts.

A core node is generally composed of the following units (Figure 3):

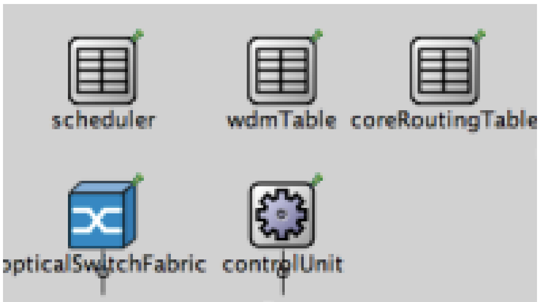

Fig. 3. Architecture of core node.

o **Unit of control packet processing:** it includes dedicated ports to control packets. Each received control packet will be converted into electronic format to get the information about its burst. This information will allow updating the routing table. Finally, the same control packets will be converted back in optical signal and then sent to the next hop.

o **Unit of routing and signaling:** it is responsible for the creation and maintenance of the routing table using information from control packets.

C. The Signaling in OBS Network

Signaling is the mechanism which allocates resources and configures the switch matrix. There are several signaling techniques:

o **JIT (just in time):** using this technique, the control packet is immediately sent for treatment to reserve the burst's path. The burst will be then sent after an offset-time. This mechanism eliminates the need to store the bursts in the fiber delay line (FDL).

o **JET (just enough time):** using this technique, the control packet is sent for treatment to reserve the bandwidth. This reservation starts from the arrival of the initial bit to the final bit of the burst. The resource will be released immediately after the transmission of the last bit of the burst.

D. The Scheduling in OBS Networks

The scheduling algorithms allocate wavelengths to bursts. For each burst, the scheduler chooses the wavelength that has enough space to accommodate the burst itself. The used algorithm is the LAUC (Latest-Available-Unscheduled Channel) [4]. This algorithm chooses for a new burst an available wavelength which has the nearest and reserved time.

III. OMNET++ SIMULATOR

The simulation is performed using OMNeT++ simulator. The advantage of OMNeT++ is its ease of learning, integration of new modules, and changing those already implemented. We introduce the following architecture of the OMNeT++ simulator, Mobility Framework and Libraries, and INET [5].

A. OMNet++ Abbreviations

OMNeT++ is an extensible, modular, component-based C++ simulation library and framework, primarily for building network simulators. "Network" is meant in a broader sense that includes wired and wireless communication networks, on-chip networks, queuing networks, and so on. Domain-specific functionality such as support for sensor networks, wireless ad-hoc networks, internet protocols, performance modeling, photonic networks, etc., is provided by model frameworks, developed as independent projects.

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OMNeT++ offers an eclipse-based IDE, a graphical runtime environment, and a host of other tools. There are extensions for real-time simulation, network emulation, alternative programming languages (Java, C#), database integration, and several other functions.

B. *Inet Framework*

The INET framework is an open-source communication networks simulation package for the OMNeT++ simulation environment.

The INET framework contains models for several wired and wireless networking protocols; including UDP, TCP, SCTP, IP, IPv6, Ethernet, PPP, 802.11, MPLS, OSPF, and many others.

C. *Impact of Processing Speed of Control Packets in OBS Network*

Our network consists of two edge nodes: an ingress edge node and an egress edge node. The obtained results of such experiment will be shown. These nodes are connected to two core nodes responsible for processing BCP and the configuration of the burst routing matrix.

The simulation environment is based on the following data:

- TCP packet size fixed at 1500 bytes.
- Maximum size is fixed at 6000 bytes.
- Scheduling algorithm is the LAUC.
- The wavelengths have the same bandwidth: 10Gbps.
- It is assumed that entrance charge will remain unchangeable during the experiments.
- Delay of experience 60s.
- Conversion opto-electronic delay 1µs.
- Number of data channels is 1.

At each node within the network, where a control packet transits, this one undergoes an opto-electronic conversion and is stored in an electronic buffer.

The packet is subsequently processed to reserve the data channel through which the burst with which it is associated will be routed.

After a period called «*offset-time*» separating the burst from the control packet, this is transmitted from the input device node and routes through reserved channels [6].

An untreated control packet may result in the problem of traffic congestion in the control channels; in other words, overloading them.

At each intermediary node within OBS networks lies in a processing unit (PU) of control packets.

The processing unit has electronic buffers which allow it to store the control packets that are converted to electronic format and that are still waiting to be processed.

The experience has shown that out of 60 seconds we have received 26 packets. Only 19 packets were treated, the other 7 packets were stored, on hold to be processed.

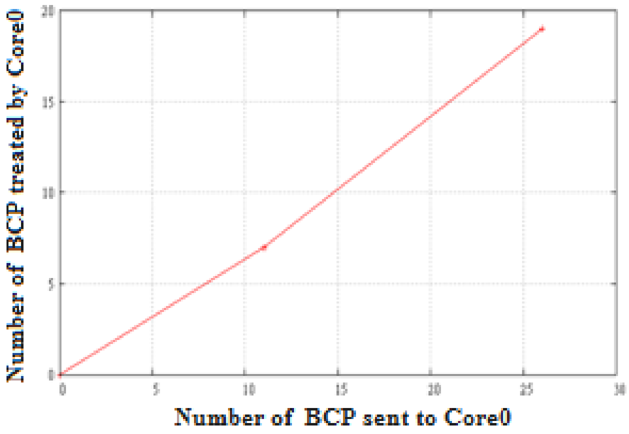

Fig. 4. Report of the number of BCP sent to and treated by Core0

The time spent by a control packet depends on the processing speed of the PU.

Like any system with a buffer, an overload of control channels can cause congestion problem.

We have scheduled an OT based on the BCP processing delay in order to avoid having a time set by the control packet in the PU above the "offset time" [7]; i.e., to avoid that a burst reaches the node in question before its control packet is processed. This is known as an "early arrival problem" or the problem of premature arrival.

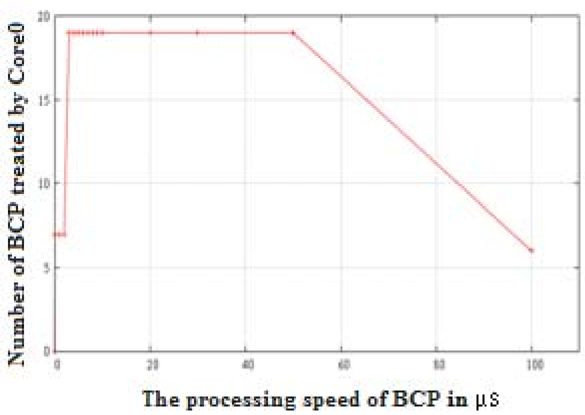

Fig. 5 Report of the processing speed of BCP and the number of BCP treated by Core0

Figure 5 clearly shows that the increase in BCP processing delay may be responsible for the increase in the number of processed control packets, but this can cause an overload of control channels.

We can also deduce that the greater the BCP processing delay is, the more bursts are delayed as the number of treated BCP decreases, causing not only a high-delay of data but also an underuse of data channels.

IV. CONCLUSION

In this paper, we present the general architecture of a burst switching network. This type of network has established itself as a prominent technique; but, the main persisting challenge of OBS network is the loss reduction. We will soon explore the different techniques for the attempt to estimate a probability of the loss according to a processing speed control packets.

On the basis of the obtained results, we will suggest a new approach to reduce losses in these networks.

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