QoS Forwarding On The Optical Internet Backbone Area Using R-IWDMTC Protocol

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***Abstract*- This article describes the study of improving the proposed protocol called Receiver-initiated WDM Tree Construction (R-IWDMTC) protocol. The protocol has been introduced by Salvador *et al.* (Extended via Multi-protocol Label Switching (MPLS)) provides connection-oriented set-up and multicast tree construction control for Optical Internet data forwarding in the network backbone area. The study has done several analysis and research to improve R-IWDMTC protocol to support quality and services (QoS) (differentiation and integration services). Several algorithms, schemes and techniques have been suggested in this study including several analyses. The study has focused on RTA link set-up and data forwarding. Discrete event simulator called OMNeT++ is used for modelling and analysis purposes and model of optical internet backbone area has been developed. The analysis were referred from the average access delay, percentage of loses, jitters and throughput of data (video, voice and text) that has been transferred between two end point via optical internet backbone area. The results were proved that the differentiation and integration technique could be applied in Optical Internet and gateway system by using R-IWDMTC protocol.**

Keywords: Quality of services, Label switching, multicasting

I. INTRODUCTION

Recently, topics on Optical Internet, also called Internet Protocol (IP) over WDM network, have received a lot of attention from researchers around the world especially in the areas of developing next generation protocol and switching technologies. WDM has been investigated extensively over the last 10 to 12 years [1]. This is because this technology has the potential to provide networks with abundant bandwidth and features that will enhance future broadband communications. Therefore, Salvador *et al.* introduced a protocol called Receiver-initiated WDM Tree Construction (R-IWDMTC) protocol as an alternative solution for multicasting set-up and forwarding over the Optical Internet. R-IWDMTC protocol focuses on the lambda switching and receiver-initiated WDM multicast tree constructions. R-IWMDTC protocol is a multicast protocol which multiplexing MPLS with IP multicast dense mode protocol. This protocol has been proposed to overcome one of the physical optical switches problems that is, the optical switches have limited functionalities such as wavelength conversion incapability. R-IWDMTC protocol has introduced light tapping set-up by providing add/drop capability control in its signalling process [1]. Research and development on R-IWDMTC protocol has been concentrated on solving the aforementioned problem by introducing add/drop and tapping set-up method mechanisms. Realising its potential benefits, this study aims to enhance R-IWDMTC protocol to allow support for RTA data transmission link set-up and forwarding. The main issues of RTA data on network layer are on multicast control (bridging control), QoS and optimum bandwidth consumption [6].

As far as improvement is concerned, this study has added two schemes in R-IWDMTC protocol for per-flow and per-queue threshold control. Those schemes are called Bandwidth Assignment Scheme (BandAS) and Buffer Assignment Scheme (BuffAS) to provide Differentiated Services (DiffServ) and Integrated Services (IntServ) over the Optical Internet. In addition, modifications modification also be done on signalling messages of R-IWDMTC protocol include the MPLS label stack entry and error detection techniques for proper multicast and QoS set-up in Optical Internet backbone area. They are Wavelength Splitting Control (WSC) and Bandwidth Assignment Compliant Control (BACC). WSC was introduced to prevent unbalanced set-up by using add/drop provided by R-IWDMTC protocol and BACC is used to control bandwidth set-up for each requested lambda to provide service level agreement (SLA) admission control in BandAS and BuffAS. For evaluation purposes, this study has developed the Optical Internet backbone model to simulate the modified R-IWDMTC protocol on data forwarding level. Objective Modular Network simulator based on C++ (OMNeT++) was used for that purpose. Analysis (via simulation) was focused on the effectiveness of BandAS, BuffAS and FRM-SA on providing the DiffServ and IntServ for each forwarded

RTA data (video, voice and data) in the Optical Internet backbone area.

II. ANALYSIS METHODOLOGY

As mentioned in section I, Optical Internet Backbone network discrete model has been developed using OMNeT++ discrete simulator software [2].

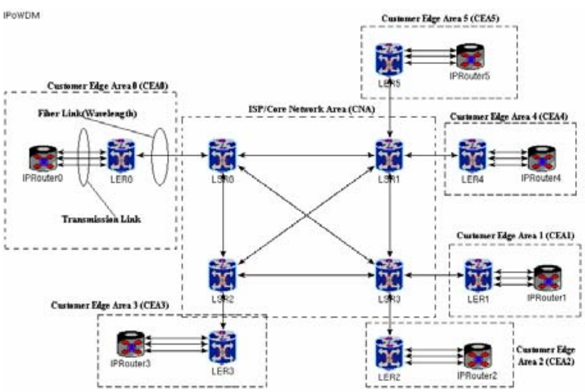

Fig.1 Optical Internet Backbone Network Model

Several assumptions have been made on modelling process;

- Optical Internet model were completely set-up by modified R-IWDMTC protocol signalling process.
- Forwarding information table (FIT) was provided for each LSR/LER model.
- Each gateway routers (IP Routers) acted as a source and destination for each packet message.
- Detail about O/E and E/O conversion process was ignored.
- Wavelength channels were assumed as logical channel (no physical hardware precisions are considered).
- Service level agreement (SLA) was assumed to be set between each node of routers before each CoS setting for each simulation.

The assumption is made for the evaluation flow of performances at the forwarding level on each forwarded RTA data in the Optical Internet backbone. As shown in Figure 4.4, the model consist of six IP Routers (gateway routers), six LERs and four LSRs. LER and LSR model are the main elements of the model. These models were developed to simulate data forwarding of the modified R-IWDMTC protocol on each RTA data. Optical Internet backbone model was developed for two ways forwarding operations, which are request state and reply state forwarding (see Figure 1).

Optical Internet backbone model's traffics are programmed according to the operation as shown in Figure 4.12. Four traffics were set between each end-to-end gateway (IP Router). As seen in Figure 4.12, IP Router 0 is the source of Traffic 1 (T1) and 2 (T2), and IP Router 3 is the source of Traffic 3 (T3) and 4 (T4). Those traffics are point to multipoint for west-to-east forwarding and multipoint to point for east-to-west forwarding. A part of that, Optical Internet backbone model was programmed to execute in two ways forwarding state which are request state (point-to-multipoint) and reply state (multipoint-to-point) forwarding (see Figure 2).

For analysis purpose, the model was programmed according to the following policies;

- All IP Routers at the west side will send out the same total of message in one simulation.
- All IP Routers at the east side will send out the same size of packets as it received in one simulation.
- All LER/LSR will select the same CoS in one simulation (SLA admission setting).
- All peer-to-peer connection between LSR/LER used the same number of channels in one simulation.

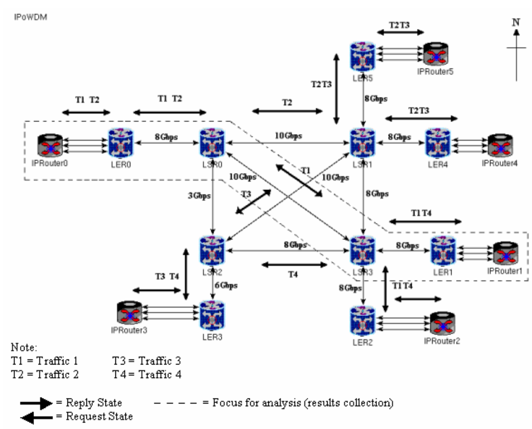

Fig. 2 Programmed traffics and link rates for simulation

The purpose of the policies is to get the precise results in the analysis progress. Furthermore, the policies are done to apply the SLA admission control in modified R-IWDMTC protocol by selecting the same CoS for each IP Routers and LER/LSR (proposed policy on using BandAS and BuffAS is followed).

The overall simulation setting is tabulated as Table I (A, B and C) and Table II. Table I shows the CoS configuration setting of the simulation for video, voice and data forwarding simulation. For data size effect, setting will be done as tabulated in Table II.

TABEL I.
CoS CONFIGURATIONS FORWARDING ANALYSIS

A. Video Forwarding Configuration

Configuration	Video Channel	Voice Channel	Data Channel
1	**Premium**	Gold	Best Effort
2	**Gold**	Premium	Best Effort
3	**Silver**	Premium	Best Effort
4	**Bronze**	Premium	Best Effort
5	**Best Effort**	Premium	Gold

B. Voice Forwarding Configuration

Configuration	Video Channel	Voice Channel	Data Channel
1	Gold	**Premium**	Best Effort
2	Premium	**Gold**	Best Effort
3	Premium	**Silver**	Best Effort
4	Premium	**Bronze**	Best Effort
5	Premium	**Best Effort**	Gold

C. Data Forwarding Configuration

Configuration	Video Channel	Voice Channel	Data Channel
1	Gold	Best Effort	**Premium**
2	Premium	Best Effort	**Gold**
3	Premium	Best Effort	**Silver**
4	Premium	Best Effort	**Bronze**
5	Premium	Gold	**Best Effort**

TABLE II
SIZE OF PACKET AND ARRIVAL RATE CONFIGURATION

Type of Data	Traffic 1 (T1) Packet Size (Bytes)		Other Traffics (T3/T4) Packet Size (Bytes)		Bit Rate/Arrival Rate (Kbps)
	Section 1	Section 2	Section 1	Section 2	
Video	1500	800	800 to 1500 (random)	800 to 1500 (random)	380
Voice	480	350	350 to 480 (random)	350 to 480 (random)	64
Data (Text)	250	250	80 to 250 (random)	80 to 250 (random)	1 to 60 (random)

III. RESULTS AND DISCUSSIONS

Analysis is focused on the results of traffic parameters such as average access delay, jitters, throughputs and percentage of losses versus the total of message of each RTA data (video, voice and data) in both state of forwarding. The overall performance of DiffServ provided by BandAS and BuffAS technique was tabulated in Table III. Referring to the Table III, it shows that Premium and Gold CoS forwarding is suitable high sensitivity data such as video and voice streaming. However, due to the SLA policy [2], only one CoS forwarding could be chose by each data either Premium CoS or Gold CoS forwarding. Therefore, the enterprises of network administrator must define which one of those CoS forwarding is suitable for video and voice streaming in the Optical Internet backbone (if the proposed modified R-IWDMTC protocol is implemented and deployed). In addition, Gold CoS forwarding is also practical for broadband services use, which is required high capacity of bandwidth and assured forwarding guaranteed for various application requirements.

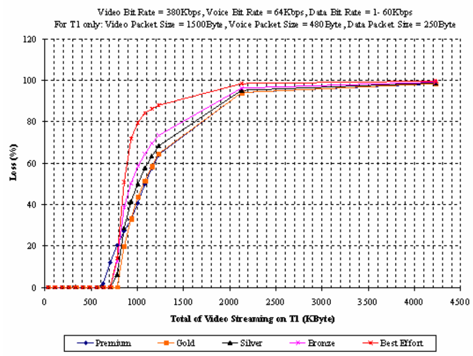

Fig. 3 Loss Percentage vs. total of video streaming sample

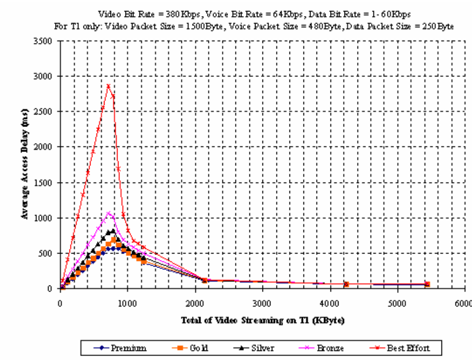

Fig. 4 Average access delay vs. total of video streaming sample

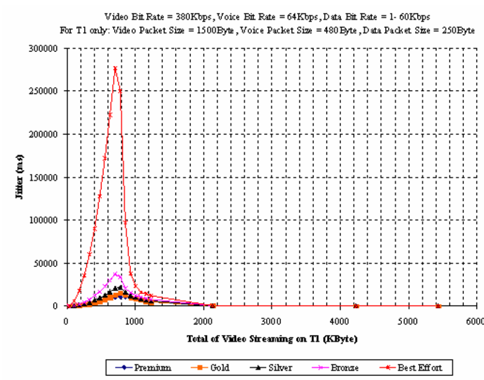

Fig. 5 Jitter vs. total of video streaming sample

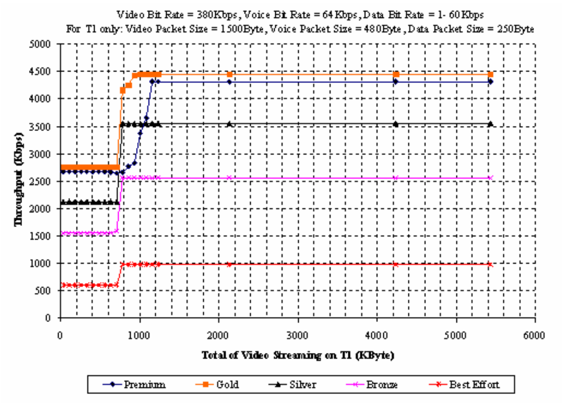

Fig. 6 Throughput vs. total of video streaming sample

As simulation result sample (video forwarding only) as shown from Figure 3 to 6 [2], it shows that the performance getting unstable after several amount of data lost after amount of data in traffic of the Optical Internet Backbone network reached more than 700Kbyte. However the Premium CoS is the best in terms of latency control (fast forwarding) and jittering among the entire CoS. The conclusion of the overall simulation is tabulated in Table III[2].

Table III: Conclusion of DiffServ simulation performance

Class of Service	Low Latency	Low Jitter	Control Load	Probability of packet lost
Premium	Yes	Yes	No	Low/Moderate
Gold	Yes (not guarantee)	Yes (not guarantee)	Yes	Low/Moderate
Silver	No	No	Yes	Moderate
Bronze	No	No	Yes	Moderate
Best Effort	No	No	No	Low

IV. CONCLUSION

According to the conclusion results of the simulations, it shows that modified R-IWDMTC protocol has the potential to be used for QoS on RTA data forwarding. This protocol has capable of provide high priority for video and voice data to be forwarded in high speed, low jerky and low or no losses [2]. The protocol will be more reliable and practical (implementation point of view) is the device or system router/switching has high speed processing unit and high capacity.

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