The Implementation of UNI signaling based on Overlay Model

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ABSTRACT: With the development of Wavelength Division Multiplexing (WDM) and Optical Cross-Connect (OXC) systems, an efficient integration of IP and WDM has been focused. The Optical Internetworking Forum (OIF) proposes a new model that is called Overlay model for the integration of IP and WDM. In the Overlay model, UNI 1.0 signaling is adopted to establish signaling interface between Optical and IP network. UNI 1.0 signaling consists of a lot of functions; especially, reliability, light traffic, and etc. For that reason, Srefresh and ACK messages in UNI signaling support reliable messaging and reduce the amount of information that must be transmitted and processed in order to maintain RSVP states and processing time. This paper focuses on an implementation of Srefresh and ACK messages based on UNI 1.0 signaling and comparison between before and after implementing. The results show that Srefresh and ACK messages improve intelligence in the control plane of the optical network, which will make them more survivable, flexible, reliable, and controllable.

1. Introduction

Trials presented by the increasing need for inter-communication have resulted in the great demand for broadband services in the Internet. Basing optical networks on WDM techniques and OXC systems is clearly the best way to support the intense demand anticipated. With the recent developments in WDM technology, all-optical networks provide an unlimited potential for bandwidth. Challenge is continuing to introduce more intelligence in the control plane of the optical transport systems. The trials are focusing on the efficient unity of IP and WDM.

GMPLS (Generalized Multi-Protocol Label Switching) is believed to be the best approach for the integrated architecture between IP and WDM. GMPLS clearly separates control plane from data plane. Besides it suits normally WDM when wavelengths are used as labels [3].

As stated above, the optimal unification between IP and WDM has been studied by lots of groups. Especially, the OIF has suggested a model that is called Overlay model. In OIF, the network is divided into optical network (server) and user network (client) based on the server-client model. IP domain of user network is independent with optical network in Overlay model.

This paper addresses the implementation based on UNI 1.0 signaling proposed by the OIF. Especially, the focus of the study is to realize Srefresh and ACK messages and to compare between before and after the extension. This paper, with realization of Srefresh and ACK messages, presents what is improved [1].

This paper is organized as follows. The following section deals with UNI 1.0 signaling suggested by the OIF and the Resource reSerVation Protocol (RSVP) for UNI 1.0 signaling is discussed in Section 3. Section 4 describes Srefresh and ACK messages. The implementation and experimental results are explained in Section 5. The last section gives the conclusion of the study.

2. UNI 1.0

2.1 Configuration

UNI 1.0 signaling specified by the OIF is signaling interface between the transport network and the equipment in user's network called client. Overlay model consists of the client network such as IP router (or ATM switch, etc) and the optical network organized by optical equipment such as OXC in separating control plane from data plane (Figure 1). Signaling over the UNI is used to invoke services that the transport network offers to clients. The OIF's focus is to develop implementation agreements that result in interoperability between manufactures [1].

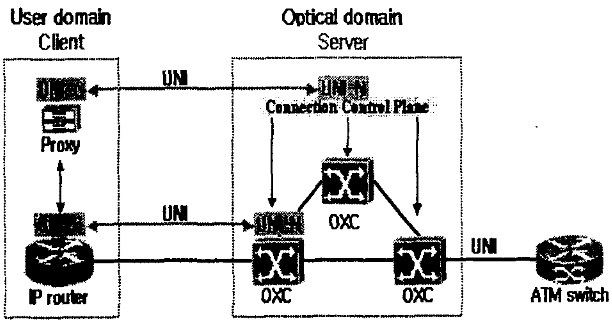

Figure 1: UNI 1.0

2.2 Procedure of signaling

UNI 1.0 signaling uses the newly extended RSVP for signaling, which defines a few new objects for supporting connection attributes that are unique. The network is assumed to provide coordination of signaling information between the initiating and the terminating side of the connection. RSVP messages are exchanged over the UNI signaling channel. Figure 2 describes the timing diagram and message flow during successful connection creation. To avoid loss of data, the source client should not start data transmission before the Resv message is received by the corresponding UNI-C and the destination client should not start data transmission before the ResvConf message is received by the corresponding UNI-C [1].

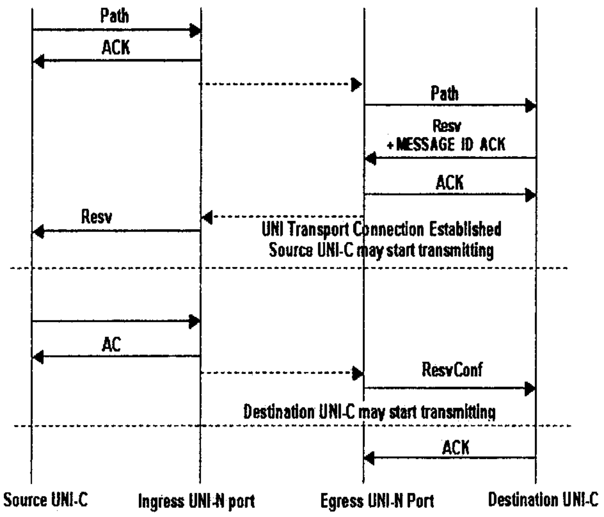

Figure 2: Initial connection establishment

3. RSVP for UNI 1.0 signaling

The transition of the RSVP from the original to RSVP-TE for UNI 1.0 signaling is described in Figure 3. The RSVP was a protocol for establishing network resources for IP sessions [6]. RSVP with Traffic Engineering extensions is defined for establishing connections subject to routing constraints in an MPLS network [7].

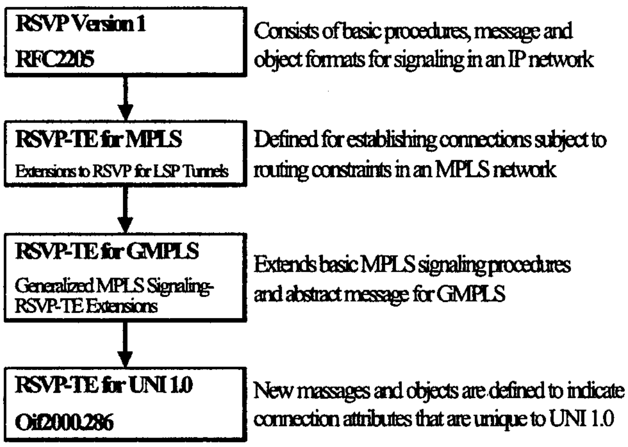

Figure 3: The transition of RSVP

The RSVP-TE for GMPLS extends RSVP-TE signaling procedures and objects to cover different types of switching applications such as switching, wavelength switching, and etc [1][4][5]. RSVP-TE for UNI 1.0 signaling adds new massages such as ACK, Srefresh message, and unique objects to previous RSVPs (RSVP [6], RSVP-TE for MPLS, and RSVP-TE for GMPLS). Besides, it must support the RSVP Refresh Reduction Extensions for assisting reliable messaging across the UNI [2]. In case of connection state maintenance, RSVP-TE for UNI 1.0 takes a "soft state" approach like previous RSVP, but requires explicit Tear-down messages from the user [1][2].

4. Srefresh and ACK messages

4.1 The Srefresh message

As stated above, all kinds of RSVPs adopt "soft state" to refresh previously advertised states. In the previous RSVP, the Refresh message that contains the same objects and information as a previously transmitted message is used to refresh. But, in UNI 1.0 signaling, the Srefresh message enables the refreshing of the RSVP state without the transmission of standard Path or Resv messages. The benefit of the Srefresh message is to reduce the amount of information that must be transmitted and processed in order to maintain the RSVP state [1][2]. The Srefresh message is organized as new objects such as the MESSAGE_ID, the MESSAGE_ID_LIST, and etc.

The MESSAGE_ID object must be included in most RSVP messages. Message identification and acknowledgment are done on a per-hop basis. Each MESSAGE_ID object contains a message identifier. This identifier must uniquely identify a message at each node [1].

The MESSAGE_ID_LIST object is used to refresh all previously advertised states. It is made up of a list of Message_Identifier fields that were originally advertised in the MESSAGE_ID objects [1][2].

4.2 The ACK message

In the previous RSVP, the process of Path creation is not being ACK processing. In the Overlay model, to support reliable messaging across the UNI 1.0, the ACK message is included. The purpose of ACK message is to respond to the request of Path creation and to query the status of the connection with its peers [1][2].

5. The Implementation and Experimental results

5.1 The Implementation

In this paper, the experimental environment is designed with a view to implement OXC emulation and UNI 1.0 signaling (Figure 4). The label allocation of MPLS network is adopted as a substitute for the wavelength (Lambda) in the optical network. The emulated OXC (Optix) and UNI-Cs are organized under the foundation of FreeBSD 3.3 and

ALTQ (ALTernative Queuing). Besides, the NIST Switch program is used to realize RSVP-TE for UNI 1.0 signaling. In the NIST Switch program, a basic label handling module creates, interprets, and processes the labels for all incoming and outgoing packets as a substitute for Lambda.

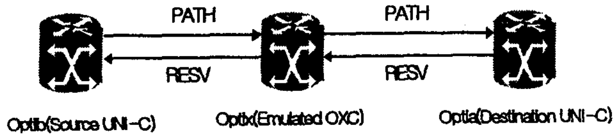

Figure 4: The experimental environment for implementation of UNI 1.0 signaling

The scope of our implementation by using the NIST Switch program is to add only Srefresh and ACK messages to the NIST Switch program.

5.2 Experimental results

The operation of signaling within the scope of our implementation is described in Figure 5.

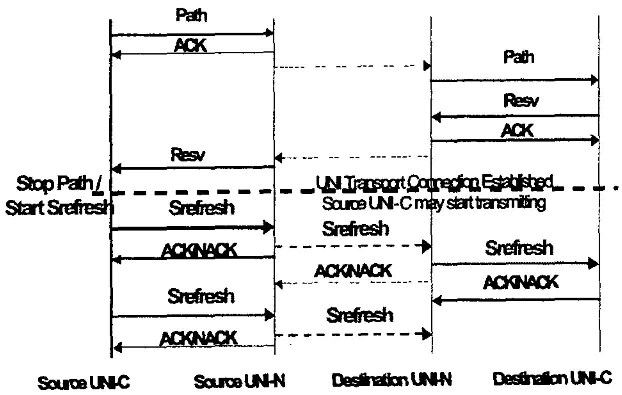

Figure 5: The operation of signaling within the scope of our proposal (In the Path message)

In the Source UNI-C node, it's possible to request the connection by using the Path message. We type a command of "rtest" to send the Path message from the Source UNI-C to the Destination UNI-C. After receiving the Path message, the Destination UNI-C responds to the Source UNI-C with the Resv message, if we type a command of "rapirecv". As we add the MESSAGE_ID to RSVP messages, each node can know what kind of message arrives. After Path message is only used to complete the initial connection establishment, we adopt the Srefresh message instead in maintenance of RSVP states. With TCP_DUMP values that are the same as in the Source UNI-C, the receipt of Path and Srefresh messages in UNI-N is verified. What is more, the size of the Srefresh message is smaller than that of the existing RSVP's Path message, which means a reduction of the amount of information that must be transmitted and processed in order to maintain RSVP states and processing time. If we try to implement it in larger circumstances, we are sure that we can find a definite reduction of traffic for signaling.

6. Conclusion

This paper described an implementation of Srefresh and ACK messages based on UNI 1.0 signaling proposed by the OIF and results of comparison between before and after the extension. With the realization of Srefresh and ACK messages, it was shown that problems which should support reliable messaging and reduce the amount of information that must be transmitted and processed in order to maintain RSVP states could be solved. The results confirm more intelligence in the control plane of the optical network, which will make them more survivable, flexible, reliable, and controllable.

Future study is required to measure the performance of Srefresh and ACK messages in more extended experimental circumstances such as using real OXCs and a lot of nodes and to implement the rest of UNI 1.0 signal except Srefresh and ACK messages.

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