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RSVP-TE Extensions in Support of Distributed Impairment Validation with Feedback Control

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Abstract

The impairment validation of the light path in a Wavelength Switched Optical Network (WSON) can be implemented with a distributed hop by hop process by signaling protocol. This memo proposes feedback control of some parameters related to impairment evaluation results with the extensions to the Resource Reservation Traffic Engineering (RSVP-TE) signaling protocol in order to establish an optical path with a higher probability.

Status of this Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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1. Introduction

WSON technology was deployed to provide an end to end optical path that can be used to carry client signals transparently. From the perspective of control plane, the light path provision needs to resolve the problems including routing, wavelength assignment (WA) and impairment validation (IV). As detailed in [I-D.ietf-ccamp-wson-impairments], there are three main frameworks to resolve these problems: 1 Combined Routing, WA and IV; 2 Separated routing, WA or IV; 3 Distributed WA and/or IV. Among the three processes, distributed WA and/or IV can eliminate the need to distributed wavelength availability and impairment characteristics of network elements and links via routing protocols or other means. The approach of distributed process can be accomplished by extending to the RSVP-TE signaling protocol of [RFC3471] and [RFC3473] to collect the accumulated impairment parameters hop by hop and validated the available wavelgnth at the egress node. The examples of such an approach can be found in [I-D.martinelli-ccamp-optical-imp-signaling] and [I-D.agraz-ccamp-wson-impairment-rsvp].

However, in these scenarios, the ingress and transit nodes do not know the detailed impairment parameters of other nodes at first, so the establishment of the LSP by such an approach may suffer a much higher blocking probability.

In this memo we propose feedback control of some parameters related to impairment evaluation results so as to provide a relatively higher probability in setting up a LSP.

2. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

3. Motivation

According to ITU-T recommendation [G.680]and [I-D.bernstein-wson-impairment-info], the performance of an optical network is subjected to several parameters including optical signal noise ratio (OSNR), chromatic dispersion (CD), polarization mode dispersion (PMD), cross talk (XT) (considering the approximated impairment estimation situation). Besides, the impairment tolerance has a close connection with the signal bit-rate, modulation format and Forwarding Error Code (FEC) used in the path.

For a point to point lambda connection in WSON, the channel power, modulation format, FEC, dispersion compensation (electronic dispersion compensate technology) may be configured in the ingress and egress nodes. And in the passive transit nodes without 3R or wavelength conversion, the channel power may be adjusted, while in the active transit nodes, the parameters mentioned above as in the ingress or egress ends may also be configured. According to [G.680], adjusting the optical channel power will contribute to significant change of OSNR. It is demonstrated that the channel (corresponding to a wavelength) power of the transmitter can be configured by adjusting the laser's current of the ingress node and the channel attenuation at the others. Then adjusting the channel pre/post electronic dispersion compensation of the transmitter or receiver respectively will change the total dispersion tolerance. While, in the 100G and above or future ultra-wideband network, per channel CD, PMD passive compensation on all nodes may be able to be deployed to further solve the dispersion tolerance. The selection of all the parameters mentioned above spread in the network elements will have a direct impact on the impairment validation results.

However, in the existing distributed WA and IV schemes, these parameters are not mentioned to be configured in signaling which have an implication of system-default value. As the situation of every LSP's setup can be so different that these system-default or previous defined parameters may lead to a relative higher blocking probability in impairment validation. Hence, a new signaling procedure is introduced to record the parameters that is configurable in the Path message and carry out feedback control in the Resv message leading to a higher probability in establishing the LSP.

4. RSVP-TE extensions

In order to realize feedback control of the parameters, a variable impairment sub-TLV and a Configuration Route Object (CRO) are defined in the Path and Resv message respectively. In the signaling procedure, the egress node needs to know which nodes among the path to be configured after collecting all the impairment information, so the configurable node and interface addresses MUST be known. [RFC3209] has defined the Record Route Object (RRO) to record the attribute of the node and corresponding interface when establishing a new LSP. This document extended the application of this object by including a variable impairment sub-TLV to carry the configurable parameters along the path. The format of the variable impairment sub TLV is illustrated in figure 1:

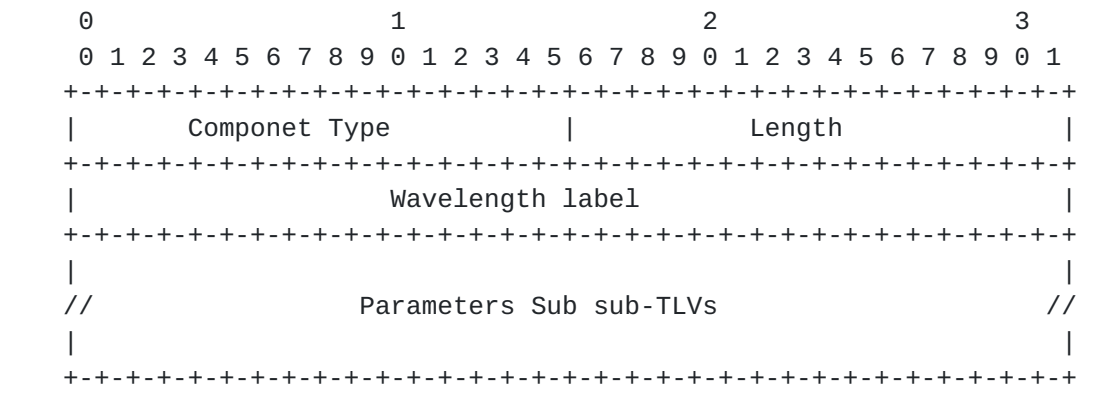

figure 1: variable impairment sub-TLV

The newly defined variable impairment sub-TLV SHOULD be nested in the RRO object after the corresponding node and interface address. More than one variable impairment sub-TLV is allowed if there are multiple components can be configured at the node.

Component type: indicated the type of network element in the node, such as transmitter, receiver amplifier, attenuator, dispersion compensator or else.

Length: the Length contains the total length of the subobject in bytes. The length MUST be at least 4, and MUST be a multiple of 4.

Wavelength Label: this field indicated which channel the signal was about to be carried on. The carried impairment related parameters SHOULD be configured in the single channel or single wavelength to avoid impact on other tunnels/LSP.

Parameter sub-sub tlv:

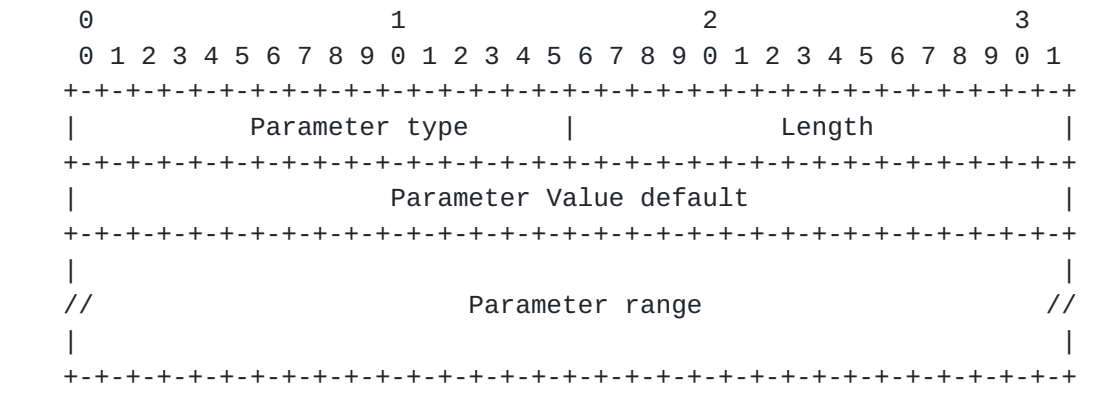

figure 2: Parameters sub-sub-TLV

Parameter type: this field defines the configurable impairment

parameter type. Including power, modulation format, FEC, amount of attenuation , amount of dispersion compensation (including CD and PMD), etc.

Default parameter: this field defines the system-default or pevious defined values of the impairment related parameters. This filed might be OPTIONAL with the parameter type of modulation format and FEC.

Parameter value range: defines the available capacity of the parameter type. For signal, this filed SHOULD be a category of supported modulation format and FEC type, Whiel for powerGBP[not]attenuation, CD or PMD this filed SHOULD contain two elements: the lower and the upper limit of the parameters.

Once the egress node has collected all the impairment information, it MUST decide whether to configure the involved nodes along the path to establish the LSP after calculation. The calculation procedure can be referred to [G.680] and [G.sup39]. The egress node finds that only if some parameters have been configured, the selected wavelength label can satisfy the impairment requirement. A reliable message MUST be used to configure the parameter to the specified nodes. So, a newly defined object named Configuration Route Object (CRO) is introduced in the Resv message to configure the involved nodes in the path. This object MUST include the specified node address and calculated parameter values. The process procedure of the CRO object is the same as the Label object that the Resv message MUST not be passed to the next hop unless the configuration is done. The format of the CRO object is illustrated in figure 3.

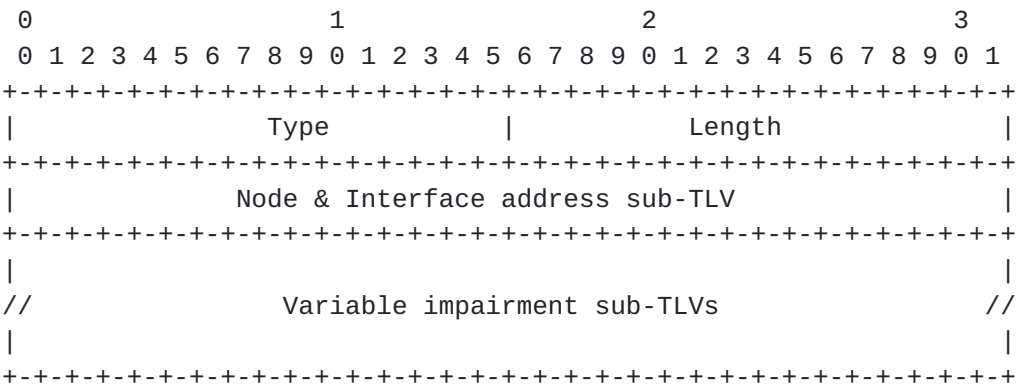

figure 3: Paramete sub-sub-TLV

The structure of the CRO object is similar to the extended RRO object including the node & interface address and Variable impairment congigure sub-TLV (shown in figure 1 which alse contains the parameter sub-sub TLVs). However, the specified feedback parameter

value replaces the system default value in the parameter sub-sub TLV, while the paramter range SHOULD be omitted.

5. Procedure for distributed impairment validation

This section details the distributed wavelength assignment and impairment validation with the extended RSVP-TE signaling mentioned in this doucoment by the following procedure:

- The ingress node first checks out the wavelength usage information on the outgoing interface, and fills the available wavelength in the Label set object in the path message. Then it records the configurable parameters in the extended RRO object including (modulation format ,FEC, power, attenuation, etc.). The accumulated four approximated impairment parameters (OSNR, CD, PMD, XT) with the default parameters can be carried in the LSP required attribute object as described in [I-D.martinelli-ccamp-optical-imp-signaling].
- The transit nodes check their own available wavelength on the outgoing interfaces and prune the Label set object. Then update the four accumulated impairment parameters with the default parameters respectively. The control plane will inspect that if these nodes have any configurable parameters, if they do (For example, the channel attenuation can be adjusted), the parameters will be recorded to the RRO object as mentioned in section.
- Once the egress node has received the path message, it will firstly check if there are any available labels that satisfy the wavelength continuity constraints. If there exist available wavelengths and the corresponding optical impairment is acceptable, the process procedure of the Resv message is the similar to [I-D.martinelli-ccamp-optical-imp-signaling]. The egress node SHOULD select the local transponders of the node and choose the wavelength in the label object, and signal type (modulation, FEC) in the CRO object respectively in the Resv message. If the egress node finds that there are available wavelengths only when some impairment parameters are adjusted among certain nodes, the calculated parameters to satisfy the impairment validation requirment were put in the CRO object carried by Resv message to configure the involved network element among the path. It is worth to note that which nodes and parameters are going to be configured is due to the egress's local policy, that is to say, not every configurable node MUST be configured.
- Once received the Resv message, the transit nodes will check the CRO object if they need some parameter configuration. If they need, the Resv message MUST not be transferred to the next hop unless the selected wavelength cross-connection and parameter

configuration have been finished.

- o The ingress node finally choose the selected wavelength, and signal type to the local transponder and checks if there are any parameters need to be configured according to the CRO Object. Once the wavelength cross-connection and the parameter configuration process are done, the LSP has been successfully established.

Note that in the path message, any node that cannot recognize the extended variable sub object MUST ignore it and transfer the RRO object transparently. While in the Resv message, if the specify node cannot recognize the CRO object or a failure in configuration MUST reject the setup of the LSP and sent a ResvError message with Error code "unknown object" or "CRO configuration failure".

6. Acknowledgements

7. IANA Considerations

A future revision of this document will present requests to IANA for codepoint allocation.

8. Security Considerations

This document has no requirement for a change to the security models within MPLS and GMPLS associated signaling protocols. For details of the specific security measures refer to the documents that define the protocols ([RFC3209], [RFC3471], [RFC3473],). [RFC5920] provides an overview of security vulnerabilities and protection mechanisms for the GMPLS control plane.

9. References

9.1. Normative references

[G.680] International Telecommunications Union, "Physical transfer functions of optical network elements", Recommendation G.680, December 2007 .

[G.sup39] International Telecommunications Union, "Optical system design and engineering considerations", Recommendation G.sup39, December 2007 .

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate

Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC3209] Awduche, D., Berger, L., Gan, D., Li, T., Srinivasan, V., and G. Swallow, "RSVP-TE: Extensions to RSVP for LSP Tunnels", RFC 3209, December 2001.

[RFC3471] Berger, L., "Generalized Multi-Protocol Label Switching (GMPLS) Signaling Functional Description", RFC 3471, January 2003.

[RFC3473] Berger, L., "Generalized Multi-Protocol Label Switching (GMPLS) Signaling Resource ReserVation Protocol-Traffic Engineering (RSVP-TE) Extensions", RFC 3473, January 2003.

[RFC5920] Fang, L., "Security Framework for MPLS and GMPLS Networks", RFC 5920, July 2010.

9.2. Informative References

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Lee, Y., Bernstein, G., Systems, C., Martinelli, G., and A. Zanardi, "Information Model for Impaired Optical Path Validation", draft-bernstein-wson-impairment-info-03 (work in progress), October 2010.

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[I-D.martinelli-ccamp-optical-imp-signaling]
Martinelli, G. and A. Zanardi, "GMPLS Signaling Extensions for Optical Impairment Aware Lightpath Setup", draft-martinelli-ccamp-optical-imp-signaling-03 (work in progress), October 2010.

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