

Internet Engineering Task Force
Internet-Draft
Intended status: Standards Track
Expires: August 25, 2008

G. Martinelli, Ed.
Cisco Systems
A. Zanardi, Ed.
CREATE-NET
February 22, 2008

GMPLS Signaling Extensions for Optical Impairment Aware Lightpath Setup
draft-martinelli-ccamp-optical-imp-signaling-01.txt

Status of this Memo

By submitting this Internet-Draft, each author represents that any applicable patent or other IPR claims of which he or she is aware have been or will be disclosed, and any of which he or she becomes aware will be disclosed, in accordance with Section 6 of BCP 79.

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF), its areas, and its working groups. Note that other groups may also distribute working documents as Internet-Drafts.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

The list of current Internet-Drafts can be accessed at
<http://www.ietf.org/ietf/lid-abstracts.txt>.

The list of Internet-Draft Shadow Directories can be accessed at
<http://www.ietf.org/shadow.html>.

This Internet-Draft will expire on August 25, 2008.

Copyright Notice

Copyright (C) The IETF Trust (2008).

Abstract

The problem of provisioning a lightpath in a transparent dense wavelength division multiplexing (DWDM) optical island requires the evaluation of the optical impairments along the selected route. In this draft we propose a GMPLS signaling protocol (RSVP/RSVP-TE) extension to collect and provide the egress node the optical impairment parameters needed to validate a lightpath setup request feasibility.

Table of Contents

1. Introduction	3
2. Conventions Used in This Document	4
3. Optical Path Validation Procedure	4
4. Physical Parameter Classification and top level TLV	5
5. Optical Service Parameters sub-TLV	7
5.1. Forward Error Correction (FEC)	8
5.2. Modulation Format	9
6. Optical Path Parameters sub-TLV(s)	9
6.1. Optical Parameter sub-TLV overview	10
6.2. Mandatory Linear Optical Parameters sub-TLVs	10
6.2.1. Optical Power	11
6.2.2. Optical Signal to Noise Ratio	11
6.3. Optional Linear Optical Parameters sub-TLVs	11
6.3.1. Chromatic Dispersion (CD)	11
6.3.2. Polarization Mode Dispersion (PMD)	11
6.3.3. Cross-Talk (XT)	11
7. Message Fragmentation	11
8. Backward Compatibility	14
9. Error management	14
10. Acknowledgments	14
11. Contributing Authors	14
12. IANA Considerations	15
13. Security Considerations	16
14. References	16
14.1. Normative References	16
14.2. Informative References	17
Authors' Addresses	17
Intellectual Property and Copyright Statements	19

1. Introduction

The current Generalized Multi-Protocol Label Switching (GMPLS) specification [RFC3945] and the signaling related documents ([RFC3471], [RFC3473], [RFC4328]) support optical interfaces with different switching capability to setup a lightpath while [RFC4054] defines the impairments to be considered in optical routing. [I-D.bernstein-ccamp-wavelength-switched], defines a framework identifying the key components and issues pertaining to wavelength switched optical networks (WSO). [I-D.otani-ccamp-gmpls-lambda-labels] proposes a global semantic for wavelength generalized labels taking into account lightpath specific needs.

In transparent optical networks, physical impairments incurred by non-ideal optical transmission medium accumulate along an optical path. Because of these impairments even if there is physical connectivity (fibers, wavelengths, and nodes) between the ingress and egress nodes, there is no guarantee that the optical signal (light) reaches the Egress node with acceptable signal quality, for example in terms of BER/OSNR/Q-factor limit. For a successful lightpath provisioning in a WSON, the set up process must be aware of a set of physical impairments that has effect on the lightpath. A complete set of physical impairments will include linear and non-linear impairments. This preliminary draft proposes a way to collect the optical path linear impairments in the signaling phase by providing suitable extensions to signaling protocol (RSVP/RSVP-TE) assuming that non-linear impairments effects are handled in the network design phase considering a bounded OSNR margin [RFC4054].

The management of physical impairments is done only in the signaling process and it does not require any extension to the traffic engineering database and IGP routing protocols.

The set of parameters carried by the signaling protocol is divided into optical service parameters and optical path parameters:

- o The optical service parameters describe the requested signal type, are related to the characteristics of the transponder at ingress node and hence are not changed at transit nodes.
- o The optical path parameters describe the signal characteristics evolution along the path from ingress node to egress node, are related to the characteristics of the various links/subsystems and are updated at each transit node. They are divided into mandatory and optional parameters. The mandatory parameters are related to feasibility constraints such as power and OSNR, whereas the optional parameters are expandable linear impairments such as

chromatic dispersion (CD), polarization mode dispersion (PMD), crosstalk, etc. The optional parameters can be used to evaluate the feasibility of a lightpath more accurately as an alternate solution to the bounded OSNR margin evaluation. Parameter update methods might use appropriate physical models and are out of scope of this document.

2. Conventions Used in This Document

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].

In additions this document will use terminology from [RFC2205], [RFC3209], [RFC4054], and [I-D.bernstein-ccamp-wavelength-switched].

3. Optical Path Validation Procedure

The signaling based validation of an optical path in downstream direction in a transparent network (lambda switched LSP) is implemented by the following procedure:

- o The ingress node signals in the Path message the supported signal types (FEC and modulation format) and wavelength set (encoded in the LABEL_SET Object) depending on available local transponders.
- o Transit nodes update the Path message pruning non cross-connectable wavelengths (LABEL_SET Object) and computing or measuring the path optical characteristics up to the outgoing interface (optical impairments).
- o The egress node selects the wavelength and the signal type based on the signaled optical impairments and the available local transponders (supported wavelengths, sensitivity to optical impairments) and signals the selection in the Resv message.
- o Transit nodes process the Resv message cross-connecting the selected wavelength in incoming and outgoing interfaces (wavelength continuity constraint).
- o The ingress node cross-connects the selected wavelength to a local transponder supporting the selected signal type (FEC and modulation format).

This procedure forces the meeting of the wavelength continuity constraint: the final effect of pruning wavelengths (e.g. removing

labels from the LABEL_SET object) in transit nodes is the implementation of a wavelength selection process in the signaling phase. The wavelength assignment will be done at the egress node among all available wavelength for the LSP. The criteria used by the egress node to assign the wavelength is out of the scope of this document.

In the Path message processing, the unavailability of cross-connectable wavelength in transit nodes or of transponders supporting the signal in the egress node causes the request failure (PathErr message).

In the Resv message processing, the unavailability of the selected wavelength in transit nodes or of transponders supporting the signal in the ingress node (race condition in allocating resources) causes the request failure (ResvErr message).

In this document, only the encoding in the RSVP messages of the optical information needed to support the described procedure is defined. The specific policies used to select the resources (wavelength and transponders), the models to compute the optical impairments and the procedure to validate the signal with respect to the transponder sensitivity are not in the scope of this document.

4. Physical Parameter Classification and top level TLV

RSVP/RSVP-TE requires the following additional information in order to be aware of optical impairments and setup optically feasible lightpaths:

- o Optical Service Parameters.
The standard GENERALIZED_LABEL_REQUEST and TSPEC/FLOW_SPEC objects support the encoding of the information related to service type and service QoS. However for DWDM networks the egress node of an LSP has to know a certain set of specific optical parameters related to the transmitting interface. Section 5 reports details of these parameters and their encoding.
- o Optical Path Parameters.
These attributes are required to support transmission of physical impairment parameters for the optical path feasibility evaluation. Details are presented in Section 6.

This document defines how to encode the above information through new TLVs according to [RFC4420].

The proposed encoding scheme for the optical parameters defines a TLV

(channel optical physical information) associated to a wavelength containing a sub-TLV for each service and path parameter.

Additional set of parameters can be added without affecting the already defined encoding.

A TLV sub-object for each available wavelength (Path message) or selected wavelength (Resv message) is encoded in an LSP_REQUIRED_ATTRIBUTES Object.

The TLV sub-object encoding is defined in the next picture.

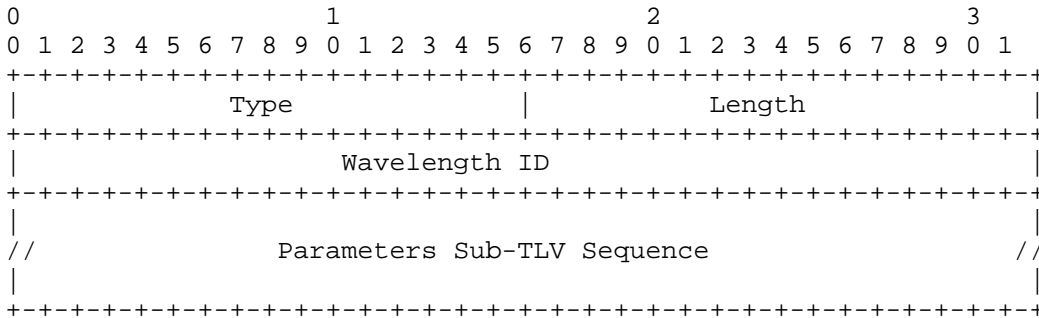


Figure 1

- o Type: optical channel physical parameters info TLV type (TBA).
- o Length: length of the TLV object in bytes without the 4 byte header.
- o Wavelength ID: wavelength label identifier according to [I-D.otani-ccamp-gmpls-lambda-labels].
- o Parameters Sub-TLV Sequence: service and path parameters values.

The TLVs wavelength ID value must be consistent with the presence of LABEL_SET objects and its actions as defined within [RFC3471] and [RFC3473].

The Sub-TLV format is defined in the next picture

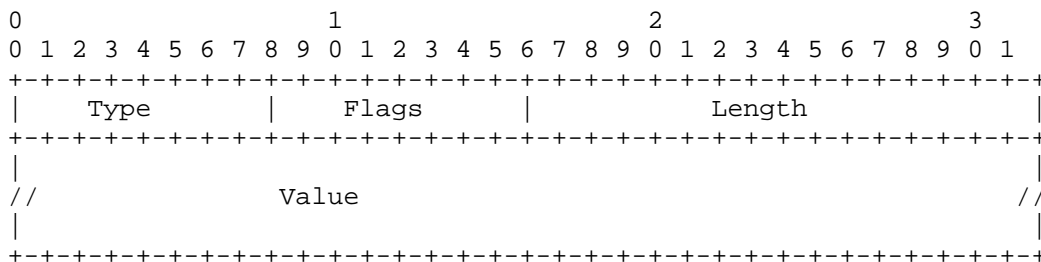


Figure 2

Type: Sub-TLV type

Flags: bit-mask defining the management of the Sub-TLV

bit 0: if set the parameter is mandatory, otherwise it is optional.

bit 1: if set the parameter is variable and MUST be updated with the local value, otherwise it is a constant value set by the ingress node.

bit 2-7: not used.

Length: Value field length in bytes

Value: variable length Sub-TLV content

The Flags field defines how transit nodes manage the Sub-TLV:

- o Constant sub-TLVs are forwarded as-is.
- o Mandatory non constant sub-TLVs MUST be updated with the local parameter value, if the parameter is not managed by the node, it MUST reject the request with a failure.
- o Optional non constant sub-TLVs MUST be updated with the local parameter value, if the parameter is not managed by the node, it MUST silently drop it from the TLV (the value would be inaccurate).

5. Optical Service Parameters sub-TLV

The Optical Service Parameters define the signal transmissions characteristics at the ingress node. This type of information is required at the egress node to verify the optical signal

compatibility.

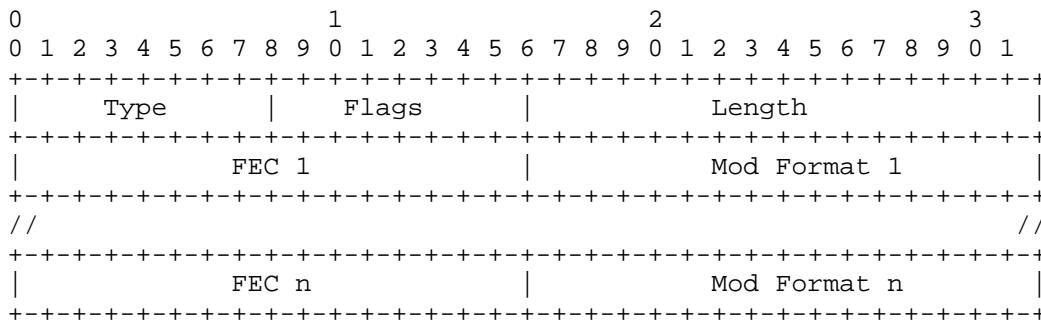


Figure 3

Type: sub-TLV type (=1)

Flags: Mandatory, Constant

Length: length of the sub-TLV value in bytes

FEC: supported Forward Error Correction Modes (see Section 5.1)

Mod Format: supported modulation formats (see Section 5.2) associated with the FEC.

This sub-TLV is used in the PATH message to signal the full list of optical parameters associated with the interface (signal types and wavelengths) available at the ingress node. A DWDM interface might have several sets of optical parameters available, for example a tunable interface has a set of possible wavelengths, together with a set of possible FEC encoding or modulation formats. In the RESV message this information is associated to the selected receiving interface at the egress node. In the RESV message only one tuple (FEC, Mod Format) will be specified.

5.1. Forward Error Correction (FEC)

FEC (16 bits) field is the Forward Error Correction and has the following values:

0: no FEC

1: standard FEC (according to [ITU.G709])

2-9: super-FEC according to sub clauses from I.2 to I.9 of [ITU.G975.1]

Values with the format 1bbbbbbbbbbbbbbb are left to represent vendor specific or proprietary FEC encoding.

5.2. Modulation Format

Mod Format (16 bits) is the modulation and has the following values:

0: NRZ

1: Duo Binary

2: DPSK

Other values might be defined in the future as technology advance. Values with the format 1bbbbbbbbbbbbbbb are left to represent vendor specific or proprietary modulation formats.

6. Optical Path Parameters sub-TLV(s)

This set of parameters is carried in the PATH message for each available wavelength to allow the optical feasibility evaluation. At each hop, the optical node MUST update these values according to information locally available at the node (say internal amplifiers, wavelength cross connect, etc.).

The way an optical node gets knowledge of this required information (e.g. through NMS, auto-discovery etc.) is out of the scope of this document and highly depends on specific equipment implementation.

This document defines two groups of linear optical parameters.

Mandatory Linear Optical Parameters

This set includes Optical Signal Power and the OSNR with associated variances. It represents the minimum set to assess the feasibility of an optical path. This set will be encoded using mandatory sub-TLVs.

Optional Linear Optical Parameters

This set includes CD, PMD, XT with associated variances. These parameters represent an additional set to allow a more accurate optical feasibility evaluation. This set will be encoded using optional sub-TLVs.

Separation between mandatory and optional parameters allows a rough

optical feasibility evaluation where network elements support at least the mandatory set. Depending on how a WSON is designed, the usage of the mandatory set could be an operational choice not to overwhelm the control plane while maintaining reliable feasibility estimation. Moreover it might happens that not all nodes in a networks support the full set of optical path parameters. With this classification, the lightpath signaling still continues to work although with a less accurate evaluation.

The choice of the optional set of parameters depends on several considerations. They are among those reported by the [RFC4054] and provide sufficient accuracy for the linear impairments evaluation.

6.1. Optical Parameter sub-TLV overview

Each optical parameter will be encoded using the following format:

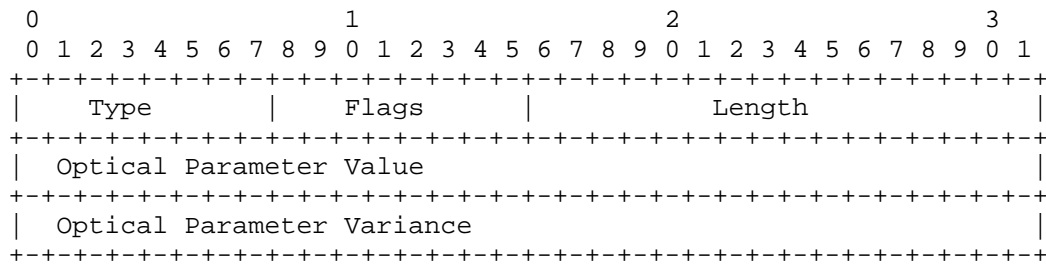


Figure 4

Type: sub_TLV type > 1.

Flags: mandatory or optional according to each parameter classification, variable.

Length: 4 octets or 8 octets depending if the optical parameter has the variance value associated.

Value associated with the optical parameter.

Variance: the error estimation for optical parameter value calculation. Depending on the length value may not be present.

6.2. Mandatory Linear Optical Parameters sub-TLVs

The Sub-TLVs encode the following optical parameters of a channel (wavelength) measured at the node egress interface. Flags are: mandatory, variable.

6.2.1. Optical Power

Type = 2.

Value: 32bit IEEE floating point number. Measurement Unit: dBm.

6.2.2. Optical Signal to Noise Ratio

Type = 3.

Value: 32bit IEEE floating point number. Measurement Unit: dB.

6.3. Optional Linear Optical Parameters sub-TLVs

The Sub-TLVs encode the following optical parameters of a channel (wavelength) measured at the node egress interface. Flags are: optional, variable.

6.3.1. Chromatic Dispersion (CD)

Type = 4.

Value: 32bit IEEE floating point number. Measurement Unit: ps/nm.

6.3.2. Polarization Mode Dispersion (PMD)

Type = 5.

Value: 32bit IEEE floating point number. Measurement Unit: ps.

6.3.3. Cross-Talk (XT)

Type = 6.

Value: 32bit IEEE floating point number. Measurement Unit: dB.

7. Message Fragmentation

In certain cases, the state information carried by the Path message can be quite large. Size estimation for a physical Optical Channel TLV (see Figure 1) can be the following: 8 bytes for type, length and wavelength ID plus, 16 bytes for the Optical Service Parameters sub-TLV considering 3 FEC/modulation format combinations plus, 24 bytes for the Mandatory Linear Optical Path parameters plus 36 bytes for the Optional Linear Optical Parameter sub-TLV. Total is 48 bytes for each wavelength by just considering mandatory sub-TLVs and 84 bytes by considering also the optional part. Given the number of

wavelengths today available in DWDM networks, the size of the path message end up in large values. For example to signal just 32 wavelengths the size required for the physical optical parameters ranges at least from 1536 to 2688 bytes.

A possible option is to let the application layer requesting the lightpath setup to decide how many wavelengths to signal according to the MTU available. For example, having an MTU of 1500 bytes the application layer might signal only 10 wavelengths with the full set of parameters taking up 840 bytes, or it might decide to signal 20 wavelengths with just the mandatory parameters. Note that, according to procedure described within Section 3, the message size may decrease as long as the Path message pass through transit nodes.

A second solution proposed here implements the semantic fragmentation as suggested by RSVP [RFC2205]. The proposed encoding extends the SENDER_TEMPLATE Object with a new Class Type (derived from the LSP_TUNNEL_IPv4 and LSP_TUNNEL_IPv6 RSVP-TE [RFC3209]). The Object includes the additional information on the "fragment id" and on the requested policy for the channel selection at the egress node

Class = SENDER_TEMPLATE, FRAGREQ_LSP_TUNNEL_IPv4 C-Type = TBA

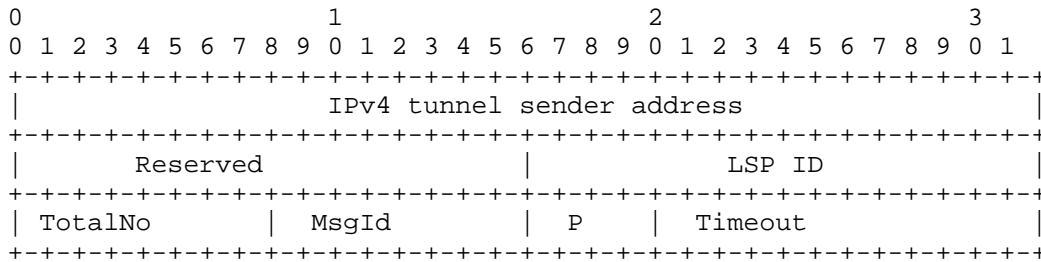


Figure 5

Class = SENDER_TEMPLATE, FRAGREQ_LSP_TUNNEL_IPv6 C-Type = TBA

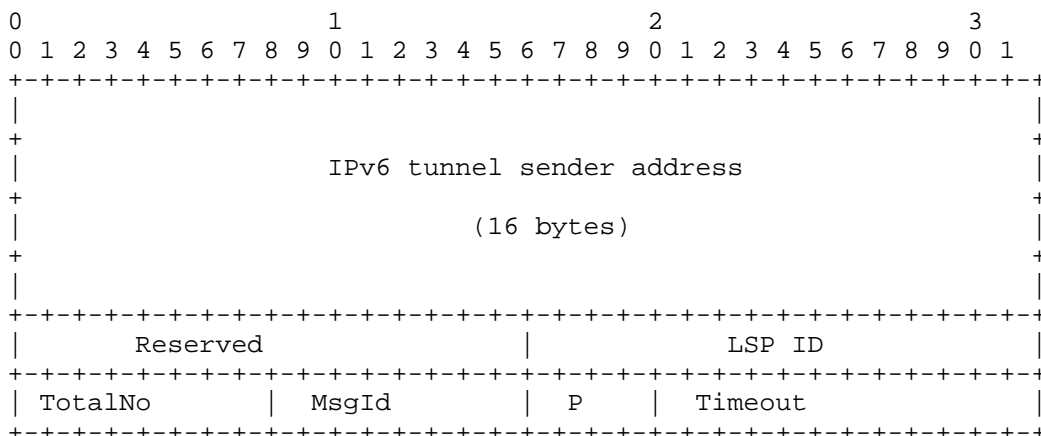


Figure 6

Besides the fields already defined in the SENDER_TEMPLATE, the following fields are defined:

- o TotalNo: 8 bit integer representing the total number of Path messages issued by the ingress node to setup a single lightpath. When this values is equals to 1 all the other fields MUST be ignored.
- o MsgId: 8 bit integer representing the sequential number of a single Path request. Its value must be between 1 and TotalNo, both inclusive.
- o P: Policy the egress node must apply upon receiving a fragmented path request:
 - 1: Take the first message arrived and ignore the following ones.
 - 2: After the first message arrives, wait for any message within the specified Timeout.
 - 3: After the first message arrives, waits for all messages. Fail, if the timeout expires, and there's at least one message missing

The egress node should "reject" (PathErr) all the requests except for the selected one, even if it could rely on the RSVP timeout to clear the unselected requests status in upstream nodes.

- o Timeout: 12 bits integer number representing the timeout value used by the policy. The value is in s/100 (hundreds of seconds) All messages MUST have the same value.

This type of encoding is a generic solution to manage the semantic fragmentation and its not strictly related to optical parameters encoding.

8. Backward Compatibility

The TLV usage as defined by [RFC4420] will guarantee the co-existence of nodes supporting normal RSVP-TE operations and node with optical impairment signaling capability.

A service with the new feature (optical feasibility evaluation) can be setup only if all the nodes in the path support the extensions. Optical Path Parameters are updated hop-by-hop and evaluated at egress node. If a transit node does not support the extensions the collected information is unreliable and the Path request MUST be rejected.

9. Error management

No additional error code is introduced to manage requests failures; the behavior defined in [RFC4420] applies to the management of the LSP_REQUIRED_ATTRIBUTES Object.

10. Acknowledgments

11. Contributing Authors

This document was the collective work of several authors. The text and content of this document was contributed by the editors and the co-authors listed below (the contact information for the editors appears in appropriate section and is not repeated below):

Gabriele Maria Galimberti
Cisco Systems
via Philips 12
Monza 20052
Italy

Email: ggalimbe@cisco.com

Domenico La Fauci
Cisco Systems
via Philips 12
Monza 20052
Italy

Email: dlafauci@cisco.com

Alberto Tanzi
Cisco Systems
via Philips 12
Monza 20052
Italy

Email: atanzi@cisco.com

Stefano Piciaccia
Cisco Systems
via Philips 12
Monza 20052
Italy

Email: spiciacc@cisco.com

Elio Salvadori
CREATE-NET
via alla Cascata 56 C, Povo
Trento 38100
Italy

Email: elio.salvadori@create-net.org

Yabin Ye
CREATE-NET
via alla Cascata 56 C, Povo
Trento 38100
Italy

Email: yabin.ye@create-net.org

Chava Vijaya Saradhi
CREATE-NET
via alla Cascata 56 C, Povo
Trento 38100
Italy

Email: saradhi.chava@create-net.org

12. IANA Considerations

This memo needs the following request to IANA

TLV (see Figure 1 in Section 4)

New class type for sender template (see Section 7)

All drafts are required to have an IANA considerations section (see the update of RFC 2434 [I-D.narten-iana-considerations-rfc2434bis])

for a guide). If the draft does not require IANA to do anything, the section contains an explicit statement that this is the case (as above). If there are no requirements for IANA, the section will be removed during conversion into an RFC by the RFC Editor.

13. Security Considerations

This document introduces no new security considerations to [RFC3473]. GMPLS security is described in section 11 of [RFC3471] and refers to [RFC3209] for RSVP-TE.

14. References

14.1. Normative References

- [ITU.G709] International Telecommunications Union, "Interface for the Optical Transport Network (OTN)", ITU-T Recommendation G.709, March 2003.
- [ITU.G975.1] International Telecommunications Union, "Forward Error Correction for high bit rate DWDM Submarine Systems", ITU-T Recommendation G.975, February 2004.
- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.
- [RFC2205] Braden, B., Zhang, L., Berson, S., Herzog, S., and S. Jamin, "Resource ReSerVation Protocol (RSVP) -- Version 1 Functional Specification", RFC 2205, September 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.
- [RFC4328] Papadimitriou, D., "Generalized Multi-Protocol Label Switching (GMPLS) Signaling Extensions for G.709 Optical

Transport Networks Control", RFC 4328, January 2006.

- [RFC4420] Farrel, A., Papadimitriou, D., Vasseur, J., and A. Ayyangar, "Encoding of Attributes for Multiprotocol Label Switching (MPLS) Label Switched Path (LSP) Establishment Using Resource ReserVation Protocol-Traffic Engineering (RSVP-TE)", RFC 4420, February 2006.

14.2. Informative References

- [I-D.bernstein-ccamp-wavelength-switched]
Bernstein, G., "Framework for GMPLS and PCE Control of Wavelength Switched Optical Networks", draft-bernstein-ccamp-wavelength-switched-03 (work in progress), February 2008.
- [I-D.narten-iana-considerations-rfc2434bis]
Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", draft-narten-iana-considerations-rfc2434bis-08 (work in progress), October 2007.
- [I-D.otani-ccamp-gmpls-lambda-labels]
Otani, T., Guo, H., Miyazaki, K., Caviglia, D., and Z. Ali, "Document: draft-otani-ccamp-gmpls-lambda-labels-01.txt", draft-otani-ccamp-gmpls-lambda-labels-01 (work in progress), November 2007.
- [RFC3945] Mannie, E., "Generalized Multi-Protocol Label Switching (GMPLS) Architecture", RFC 3945, October 2004.
- [RFC4054] Strand, J. and A. Chiu, "Impairments and Other Constraints on Optical Layer Routing", RFC 4054, May 2005.

Authors' Addresses

Giovanni Martinelli (editor)
Cisco Systems
via Philips 12
Monza 20052
Italy

Email: giomarti@cisco.com

Andrea Zanardi (editor)
CREATE-NET
via alla Cascata 56 C, Povo
Trento 38100
Italy

Email: andrea.zanardi@create-net.org

Full Copyright Statement

Copyright (C) The IETF Trust (2008).

This document is subject to the rights, licenses and restrictions contained in BCP 78, and except as set forth therein, the authors retain all their rights.

This document and the information contained herein are provided on an "AS IS" basis and THE CONTRIBUTOR, THE ORGANIZATION HE/SHE REPRESENTS OR IS SPONSORED BY (IF ANY), THE INTERNET SOCIETY, THE IETF TRUST AND THE INTERNET ENGINEERING TASK FORCE DISCLAIM ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Intellectual Property

The IETF takes no position regarding the validity or scope of any Intellectual Property Rights or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; nor does it represent that it has made any independent effort to identify any such rights. Information on the procedures with respect to rights in RFC documents can be found in BCP 78 and BCP 79.

Copies of IPR disclosures made to the IETF Secretariat and any assurances of licenses to be made available, or the result of an attempt made to obtain a general license or permission for the use of such proprietary rights by implementers or users of this specification can be obtained from the IETF on-line IPR repository at <http://www.ietf.org/ipr>.

The IETF invites any interested party to bring to its attention any copyrights, patents or patent applications, or other proprietary rights that may cover technology that may be required to implement this standard. Please address the information to the IETF at ietf-ipr@ietf.org.

Acknowledgment

Funding for the RFC Editor function is provided by the IETF Administrative Support Activity (IASA).

