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RSVP-TE Signaling Extensions in support of Flexible Grid

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Status of this Memo

Abstract

This memo describes the signaling extensions of GMPLS control of flexible grid network.

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].

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1. Introduction

[G.694.1v1] defines the DWDM frequency grids for WDM applications. A frequency grid is a reference set of frequencies used to denote allowed nominal central frequencies that may be used for defining applications. The channel spacing, i.e. the frequency spacing between two allowed nominal central frequencies can be 12.5 GHz, 25 GHz, 50 GHz, 100 GHz and integer multiples of 100 GHz as defined in [G.694.1v1]. All of the wavelengths on a fiber SHALL use different central frequencies and occupy a fixed bandwidth of frequency.

[G.FLEXIGRID], an updated version of [G.694.1v1] will be consented in December 2011 in support of flexible grids. The terms "frequency slot (i.e. the frequency range allocated to a specific channel and unavailable to other channels within a flexible grid)" and "slot width" (i.e. the full width of a frequency slot in a flexible grid) are introduced to define flexible grid. A channel is represented as an LSC (Lambda Switching Capable) LSP in the control plane and SHOULD occupy a frequency slot on each fiber it traverses. In the case of flexible grid, the different LSC LSPs may have different slot width on a fiber, i.e. the slot width is flexible on a fiber.

[WSON-SIG] describes the requirements and extensions for WSON signaling. It focuses on the fixed grids control. This document describes the additional requirements and extensions for signaling control brought by flexible grids.

2. Requirements for Flexible Grid Signaling

An LSC LSP SHOULD occupy a frequency slot, i.e. a range of frequency. The route computation and frequency slot assignment could be called RSA (Routing and Spectrum Assignment).

[FLEXIGRID-REQ] describes three types of architecture approaches to RSA, which are: combined RSA, separated RSA and distributed SA. In the case of combined RSA and separated RSA, both the routing and the spectrum (frequency slot) are provided by the RSA algorithm before the signaling procedure. It could be called "centralized SA". In the case of distributed SA, only the route is provided before the signaling procedure and the spectrum assignment is done during the signaling procedure.

In the case of centralized SA, the frequency slot SHOULD be specified in the Path message. In the case of distributed SA, the slot width of the LSC LSP SHOULD be specified in the Path message for the purpose of frequency slot assignment.

Similar to fixed grid network, if there is no wavelength converter in an optical network, there is "wavelength continuity constraint" of a LSC LSP which is described as section 4 of [RFC 6163].

2.1. Slot Width

The slot width is an end-to-end parameter representing how much spectrum resource is requested for a LSC LSP. Since different LSPs may request different amounts of spectrum portion in flexible grid networks, the slot width SHOULD be carried in the signaling message, so that all the nodes along the LSP can know how much spectrum portion will be allocated for the LSP.

2.2. Frequency Slot

The frequency slot information represents which part of the spectrum portion is allocated on each link for an LSC LSP. This information SHOULD be carried hop-by-hop in signaling message so that each node can indicate its neighbor the resource reservation on the link between them.

The frequency slot can be represented by the two parameters: central frequency and slot width, as follows:

```
   Frequency slot = [(central frequency) - (slot width)/2] ~
                    [(central frequency) + (slot width)/2]
```

Since the slot width information is carried in the signaling message (as described in Section 2.1), also the central frequency parameter SHOULD be carried in the signaling message for frequency slot determination.

Figure 1 shows an example of two LSC LSPs traversing a link and illustrates how to determine the frequency slot based on the central frequency and slot width information.

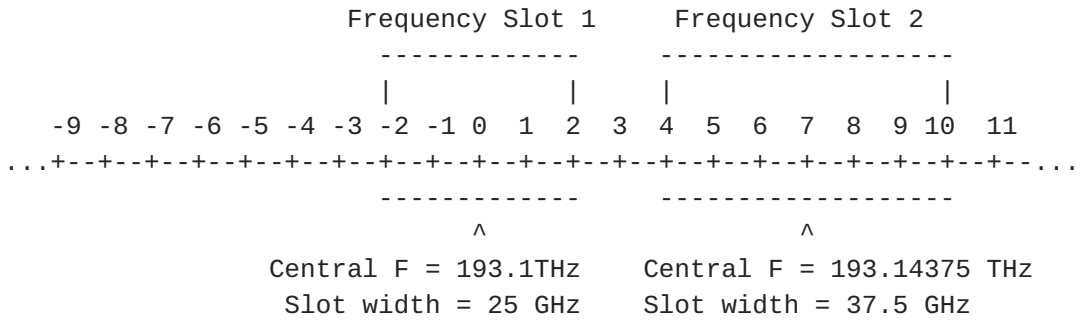


Figure 1 - Two LSC LSPs traverse a Link

The two wavelengths shown in figure 1 have the following meaning:

LSC LSP 1: central frequency = 193.1 THz, slot width = 25 GHz. It means the frequency slot [193.0875 THz, 193.1125 THz] is assigned to this LSC LSP.

LSC LSP 2: central frequency = 193.14375 THz, slot width = 37.5 GHz. It means the frequency slot [193.125 THz, 193.1625 THz] is assigned to this LSC LSP.

Note that the frequency slots of two LSC LSPs on a fiber MUST NOT overlap with each other.

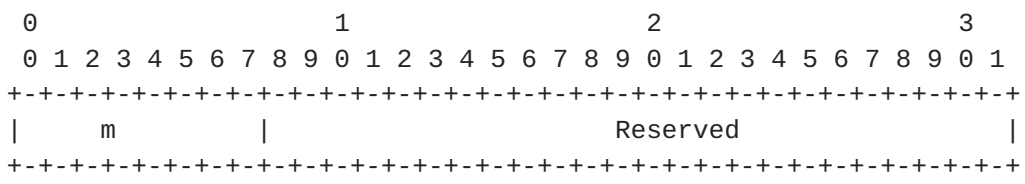
3. Extensions

This section defines the extensions of signaling for flexible grid.

3.1. WSON Traffic Parameters

As described in Section 2, the slot width represents how much spectrum resource is requested for an LSC LSP, i.e., it describes the end-to-end traffic profile of the LSP. Therefore, the slot width SHOULD be regarded as a traffic parameter for an LSC LSP.

The WSON traffic parameters are organized as follows:



m (8 bits): the slot width is specified by m*12.5 GHz.

Note that the slot width of fixed grid defined in [G.694.1v1] can be also specified by m because the defined channel spacing (12.5 GHz, 25 GHz, 50 GHz, 100 GHz and integer multiples of 100 GHz) are also the multiple of 12.5 GHz. Therefore, the traffic parameters are general for WSON including both fixed grid and flexible grid.

The WSON traffic parameters SHOULD be carried in SENDER_TSPEC or FLOWSPEC objects:

WSON SENDER_TSPEC: Class = 12, C-Type = to be assigned by IANA, preferred 8.

WSON FLOWSPEC: Class = 9, C-Type = to be assigned by IANA, preferred 8.

3.2. Generalized Label

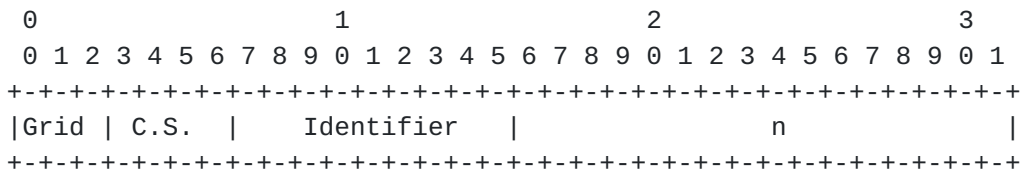
In the case of flexible grid, the allowed central frequency is calculated as follows:

Central Frequency = (193.1 + n * 0.00625) THz

Where n is a two's-complement integer (positive, negative, or 0).

The Label object is used to indicate the resource reserved on a link. In Flexible Grid networks, it is used to indicate which frequency slot is allocated on a link for the given LSC LSP.

Since the frequency slot assigned to an LSC LSP can be determined by the combination of [central frequency, slot width], while the slot width of an LSC LSP is specified in the traffic parameters, the Label object just needs to carry the assigned central frequency. Therefore, the wavelength label format defined in [RFC6205] can be reused to specify the central frequency of an LSC LSP, without any change on the label format.



The meaning of Grid, Identifier and n fields are not changed. The usage of the label format is also not changed.

According to [G.FLEXIGRID], flexible grid still belongs to DWDM, so there is no need to introduce a new type of Grid, i.e., Grid=1 (ITU-T DWDM) SHOULD be used for flexible grid.

In case of Grid=1 (ITU-T DWDM), a new value of C.S. is defined for flexible 6.25 GHz grid. The C.S.(Channel Spacing) field is defined as follows:

C.S. (GHz)	Value
Reserved	0
100	1
50	2
25	3
12.5	4
6.25	5 (TBA)
Future use	6 ~ 15

The value for flexible 6.25 GHz is to be assigned by IANA, preferred 5.

3.3. Signaling Procedures

This section describes the signaling procedures for distributed SA and centralized SA (See [FLEXIGRID-REQ]).

3.3.1. Distributed SA

In this case, only the route is provided by a PCE or ingress node before the signaling procedure. The available central frequencies will be collected hop by hop and the egress node SHOULD select a proper central frequency for the LSP.

After the route is computed, the ingress node SHOULD find out the available central frequencies for the LSP on the next link of the route. If the frequency slot which is determined by a central frequency and slot width of the LSC LSP (See section 2.2) does not overlap with the existing LSC LSPs, the central frequency is considered to be available for the requesting LSC LSP.

Then a Path message is sent to the next node on the route. The Path message MUST contain a Flexible Grid SENDER_TSPEC object to specify the slot width of the LSC LSP. A LABEL_SET object SHALL be added to the Path message, which contains the available central frequencies for the LSP on the next link.

When an intermediate node receives a Path message, it can get the slot width from the Flexible Grid SENDER_TSPEC object. Then it SHOULD find the available central frequencies for the LSP on the next link of the route similar to the ingress node. The common part of the two available central frequency sets, i.e. the set received from the Path message and the set of the next link, SHALL be selected as the new available central frequency set for the LSP. If the new set is null, the Path message SHALL be rejected by a PathErr message. Otherwise, the LABEL SET object in the Path message SHALL be updated according to the new set and the Path message is forwarded to the next node on the route.

When an egress node receives a Path message, it SHOULD select an available central frequency from the LABEL SET object based on local policy and determine the frequency slot based on the slot width and the selected central frequency (See section 2.2). Then a Resv message is responded so that the nodes along the LSP can establish the optical cross-connect based on the frequency slot determined by

the slot width in the traffic parameters and the central frequency in the label.

3.3.2. Centralized SA

In this case, both of the routing and frequency slot are provided by PCE or ingress node. When signaling the LSP, the slot width is carried in the traffic parameters, and the assigned central frequency is carried in the Label ERO. When the nodes along the LSP receive the Path message carrying these information, they can determine the frequency slot by the slot width and the central frequency and then establish the optical cross-connect based on the central frequency. The procedures of ERO and Label ERO are the same as described in [RFC3209] and [RFC3473].

4. IANA Considerations

TBD.

5. Security Considerations

TBD.

6. References

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