

Network Working Group

Iftekhar Hussain

Rajan Rao

Marco Sosa

Infinera

Internet Draft

Abinder Dhillon

Fujitsu

Intended status: Standard Track

March 5, 2014

Expires: Sept 04, 2014

TE extensions to OSPF for GMPLS control of Flex-Grid Networks
draft-dhillon-ccamp-flexgrid-ospfte-ext-00.txt

Abstract

This document specifies the extension to TELINK LSA of OSPF routing protocol [[RFC4203](#)] [[3](#)] in support of GMPLS [[1](#)] for flex-grid networks [[2](#)].

This draft is a renamed version of "'[draft-dhillon-ccamp-super-channel-ospfte-ext-06.txt](#)'" [[11](#)]. To align with ITU terminology, references to super-channel have been removed in the title & other parts of the document.

Status of this Memo

This Internet-Draft is submitted in full conformance with the provisions of [BCP 78](#) and [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 Sept 45, 2014.

Internet-Draft [draft-dhillon-ccamp-flexgrid-ospfte-ext](#)

May 2013

Copyright Notice

Copyright (c) 2012 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to [BCP 78](#) and the IETF Trust's Legal Provisions Relating to IETF Documents (<http://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Simplified BSD License text as described in Section 4.e of the [Trust Legal Provisions](#) and are provided without warranty as described in the Simplified BSD License.

Table of Contents

1.	Introduction.....	2
2.	Terminology.....	3
3.	Interface Switching Capability Descriptor.....	3
3.1.	Switch Capability Specific Information	5
3.2.	BW sub TLV: Bit Map format.....	5
3.2.1.	Meaning of sub TLV fields.....	5
3.3.	BW sub TLV: List and Rage format.....	7
3.3.1.	Meaning of sub TLV fields.....	7
3.4.	BW advertisement procedure.....	8
4.	Examples.....	8
4.1.	Example: BW advertisement without any service present.....	8
4.2.	Example: How to use advertise Bandwidth.....	9
5.	Security Considerations.....	10
6.	IANA Considerations.....	10
7.	References.....	10
7.1.	Normative References.....	10
7.2.	Informative References.....	10
8.	Acknowledgments.....	11

1. Introduction

To enable scaling of existing transport systems to ultra-high data rates of 1 Tbps and beyond, next generation systems providing ultra-

high capacity optical switching capability are currently being developed. To allow efficient allocation of optical spectral bandwidth for such high bit rate systems, International Telecommunication Union Telecommunication Standardization Sector

Dhillon

Expires Sept 4, 2014

[Page 2]

Internet-Draft [draft-dhillon-ccamp-flexgrid-ospfte-ext](#)

May 2013

(ITU-T) is extending the G.694.1 grid standard (termed 'Fixed-Grid') to include flexible grid (termed 'Flex-Grid') support [10].

This document defines OSPF-TE extensions in support of flex-grid networks.

Figure-1 shows a network capable of switching in Flexible-Grid[10]. The physical media/Fiber is modeled as a TE-Link to advertise spectrum (bandwidth) availability. This information is used during Flex-grid LSP[10] creation([2]). This draft defines extensions to ISCD in support of Flexible-Grid.

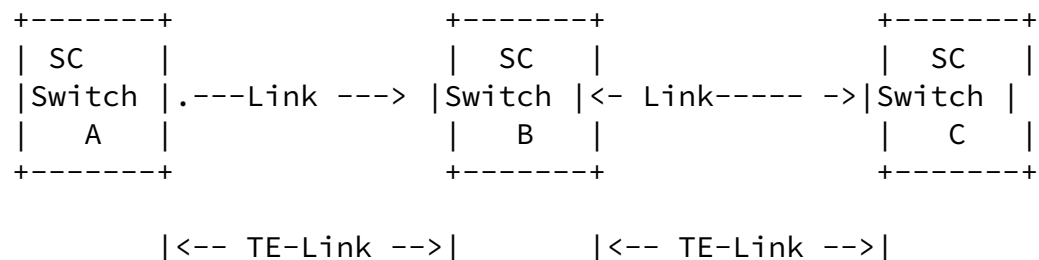


Figure 1: TE-Links

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. Interface Switching Capability Descriptor

The Interface Switching Capability Descriptor describes switching capability of an interface [RFC 4203]. This document defines a new Switching Capability value for Flex Grid [FLEX-GRID] as follows:

Value -----	Type -----
102 (TBA by IANA)	Spectrum-Switch-Capable (SSC)

Switching Capability and Encoding values MUST be used as follows:

Switching Capability = SSC

Dhillon

Expires Sept 4, 2014

[Page 3]

Internet-Draft [draft-dhillon-ccamp-flexgrid-ospfte-ext](#)

May 2013

Encoding Type = Lambda [as defined in [RFC3471](#)]

The Interface Switching Capability Descriptor is a sub-TLV (of type 15) of the Link TLV. The length is the length of value field in Octets. The format of the value field is as shown below:

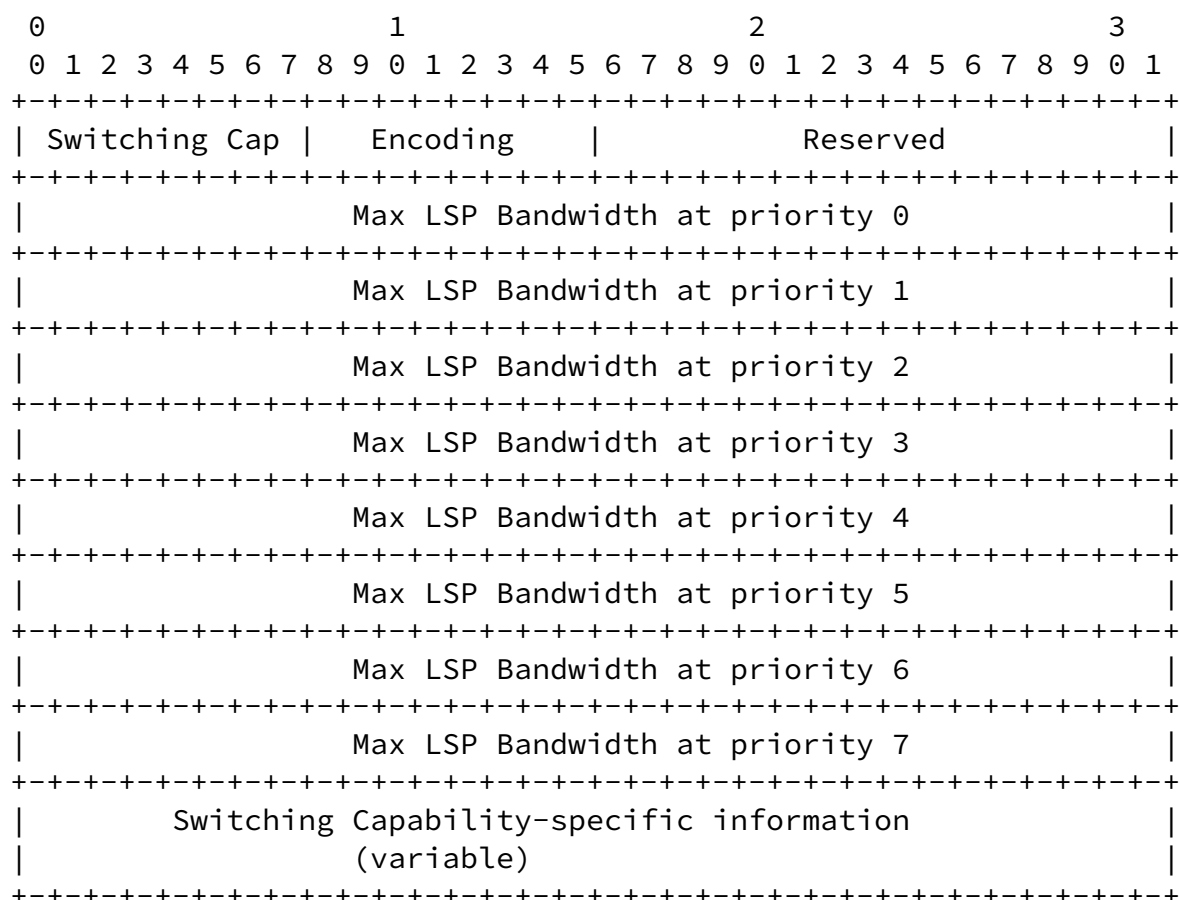


Figure 2: ISCD & SCSI

Max LSP Bandwidth will be based on Max Slot Width field in BW-sub-TLV (Ref to [section 3.1](#) for details on BW sub-TLV) and the modulation format used.

[3.1.](#) Switch Capability Specific Information

The technology specific part of the ISCD can include a variable number of sub-TLVs. We propose to encode Slice Information in Bandwidth sub-TLVs under SCSI field. The format of BW sub-TLVs is as shown below.

[Editor's note: To provide options similar to Label set field defined in [\[9\]](#), we have included 2 variants to advertise slice level information. These are bit-format and list/range format].

[3.2.](#) BW sub TLV: Bit Map format

The figure below shows format of Type=1 sub-TLV for encoding slice information in bit-map format. This sub-TLV must be repeated for each priority that is supported on the Te-link.

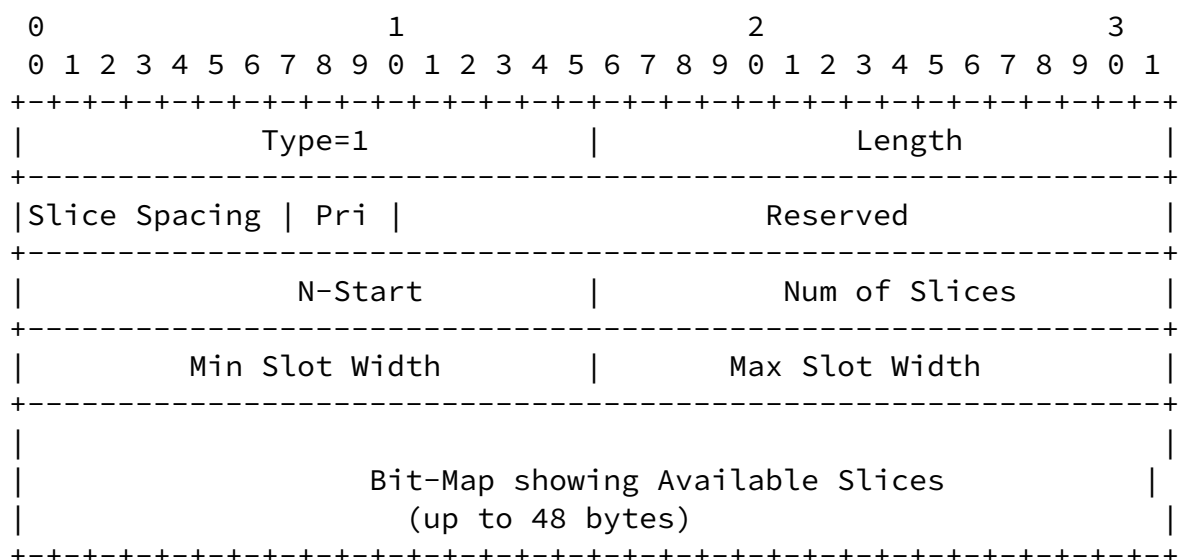


Figure 3: Type=1 BW sub TLV in Bit-Map format

3.2.1. Meaning of sub TLV fields

- o Slice Spacing: 8-bit field (S.S) which can take one of the values as shown in table below.
 - o For e.g., the 12.5GHz spacing is specified by setting this field to value 4.

Dhillon

Expires Sept 4, 2014

[Page 5]

Internet-Draft

[draft-dhillon-ccamp-flexgrid-ospfte-ext](#)

May 2013

+-----+-----+
S.S. (GHz) Value
+-----+-----+
Reserved 0
+-----+-----+
100 1
+-----+-----+
50 2
+-----+-----+
25 3
+-----+-----+
12.5 4
+-----+-----+
Future use 5 - 15
+-----+-----+

Table 1: Slice Spacing Values

- o Priority: 3-bit field
 - o 3-bit field to identify one of the 8 priorities for which Slice information (BW) is advertised.
- o N-Start: 16-bit field
 - o Is a two's complement integer to specify start of the grid
 - o Use center freq formula to determine start of spectrum
- o Number of slices: 16-bit field
 - o Total number of slices advertised for the link. This includes (available plus consumed).
- o Minimum Slot Width: 16-bit field
 - o This is a positive integer value
 - o This field is similar to Min LSP BW field. The value in this field is used to determine the smallest frequency slot width that the advertising node can allocate for an LSP. This is defined by the following equation:
Smallest Frequency slot width = Slice Spacing * integer value

- in 'Minimum Slot Width' field
- o Maximum Slot Width: 16-bit field
 - o This is a positive integer value
 - o This field is used to determine the Maximum contiguous frequency slot width that the advertising node can allocate for an LSP. This is defined by the following equation:

$$\text{Largest Contiguous Frequency slot width} = \text{Slice Spacing} * \text{integer value in 'Maximum Slot Width' field}$$
- o Available slices encoded as bit-map
 - o Each bit represents availability of one slice of width identified by S.S field
 - o Zero: Available ; One: occupied
 - o Padding MUST be used to align with 32 bit boundary.

3.3. BW sub TLV: List and Range format

The figure below shows format of Type=2 sub-TLV for encoding slice information in list/range format. This sub-TLV must be repeated for each priority that is supported on the Te-Link.

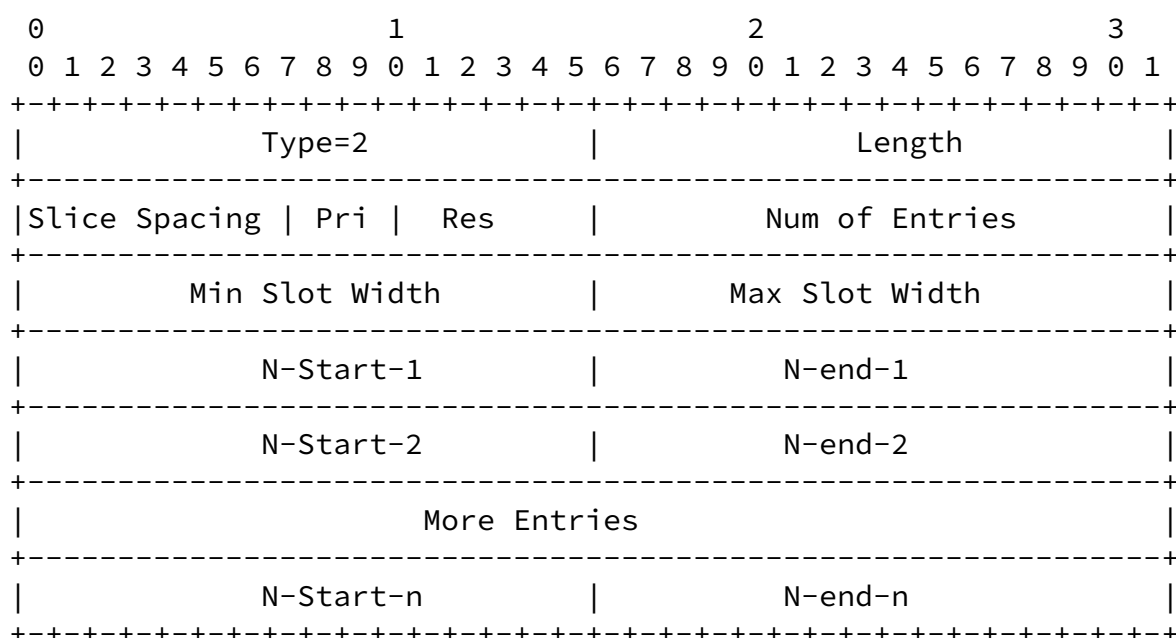


Figure 4: Type=2 BW sub TLV in List/Range format

3.3.1. Meaning of sub TLV fields

- o The meaning of above fields is same as in Type=1 BW-sub-TLV. For details refer to [section 3.2.1](#).
 - o Slice Spacing,
 - o Priority,
 - o Maximum Slot Width &
 - o Minimum Slot Width
- o Number of Entries: 16-bit field
 - o Is a positive integer value.
 - o Total number of N-start & N-End rows advertised for the link.
- o N-Start-x: 16-bit field
 - o Is a two's complement integer value (+ve, -ve or zero) to specify start of the grid.

Dhillon

Expires Sept 4, 2014

[Page 7]

Internet-Draft [draft-dhillon-ccamp-flexgrid-ospfte-ext](#)

May 2013

- o Use center freq formula to determine start of spectrum
- o N-end-x: 16-bit field
 - o Is a two's complement integer value (+ve, -ve or zero) to specify end of the list/range.
 - o Use center freq formula to determine end of spectrum

[3.4.](#) BW advertisement procedure

This section describes bandwidth advertisement for Te-Links capable SSC.

- o Optical nodes capable of Spectrum Switching advertise slices of certain width available based on the frequency spectrum supported by the node (e.g. C band, extended C-band). For example, node(s) supporting extended C-band will advertise 384 slices.
- o The BW advertisement involves an ISCD containing
 - o Slice information in bit-map format (Type=1 BW-sub-TLV) where each bit corresponds to a single slice of width as identified by S.S field. OR
 - o Slice information in list/range format (Type=2 BW-sub-TLV) where each 32-bit entry represents an individual slice or list or range.
- o The slice position/numbering in Type=1 sub-TLV is identified based on N-start field. The N-start field is derived based on ITU

- o The advertising node MUST also set Number of Slices field.
- o Minimum & Maximum slot width fields are included to allow for any restrictions on the link for carrying Flex Grid LSPs.
- o The BW advertisement is priority based and up to 8 priority levels are allowed.
- o The node capable of supporting one or more priorities MUST set the priority field and include BW-sub TLV for each of the priority supported.

4.1. Example: BW advertisement without any service present

Dhillon Expires Sept 4, 2014 [Page 8]

Internet-Draft [draft-dhillon-ccamp-flexgrid-ospfte-ext](#) May 2013

- o N-start=-142 for extended C-band (2's complement should be included in this field)
- o Total number of slices available on the link = 384 (based on Slice spacing = 12.5GHz)
- o Min SW field shows min consumption of 4 Slices per LSP (=50GHz)
- o Max SW field shows up to 400GHz BW allowed per LSP (32x12.5GHz)
- o 48 bytes showing that all 384 slices are available.

0										1										2										3																			
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1																		
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+																		
										Type=1																				Length																			
+-----																																																	

```

|                               Bit-Map showing info for 384 slice                               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Figure 5: Type=1 BW sub-TLV without any service present

4.2. Example: How to use advertise Bandwidth

Assume user wants to setup Flex Grid LSP over a single Flex-Grid link with BW requirement = 200GHz and transponder fully tunable.

- o The path computing node performs the following:
 - o Determine the number of slices required for the LSP ($200/S.S = 16$)
 - o Look for contiguous spectrum availability on each link from BW advertisement (both dir)
 - o Look for 16 contiguous bits in the BW advertisement TLV
 - o If available select the link for LSP creation.
 - o Signal for LSP creation. Once LSP is created, update BW available via new advertisement using the same Bandwidth sub-TLV.

Dhillon

Expires Sept 4, 2014

[Page 9]

Internet-Draft [draft-dhillon-ccamp-flexgrid-ospfte-ext](#)

May 2013

5. Security Considerations

<Add any security considerations>

6. IANA Considerations

IANA needs to assign a new Grid field value to represent ITU-T Flex-Grid.

7. References

7.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), March 1997.

7.2. Informative References

- [1] Berger, L., Ed., "Generalized Multi-Protocol Label Switching (GMPLS) Signaling Functional Description", [RFC 3471](#), January 2003
- [2] Iftekhar H, Abinder, Zhong , Marco , "'Generalized Label for Optical-Channel Assignment on Flexible Grid'", [draft-hussain-ccamp-flexgrid-label-0o.txt](#), March 2014.
- [3] K. Kompella, Y., " OSPF Extensions in Support of Generalized Multi-Protocol Label Switching (GMPLS)", [RFC 4203](#), Oct 2005
- [4] Lee, Y., Ed., "Framework for GMPLS and Path Computation Element (PCE) Control of Wavelength Switched Optical Networks (WSONs)", [RFC 6163](#), April 2011
- [5] M. Jinno et. al., "'Spectrum-Efficient and Scalable Elastic Optical Path Network: Architecture, Benefits and Enabling Technologies'", IEEE Comm. Mag., Nov. 2009, pp. 66-73.
- [6] S. Chandrasekhar and X. Liu, "'Terabit Super-Channels for High Spectral Efficiency Transmission '",in Proc. ECOC 2010, paper Tu.3.C.5, Torino (Italy), September 2010.
- [7] ITU-T Recommendation G.694.1, "Spectral grids for WDM applications: DWDM frequency grid", June 2002

Dhillon

Expires Sept 4, 2014

[Page 10]

Internet-Draft [draft-dhillon-ccamp-flexgrid-ospfte-ext](#)

May 2013

- [8] Oscar G, et al., "'Framework and Requirements for GMPLS based control of Flexi-grid DWDM networks'", [draft-ietf-ccamp-flexi-grid-fwk-00](#), work in progress.
- [9] G. Bernstein, Y. Lee, D. Li, W. Imajuku, " General Network Element Constraint Encoding for GMPLS Controlled Networks", work in progress: [draft-ietf-ccamp-general-constraint-encode-05](#), May 2011
- [10] [FLEX-GRID] "ITU-T Recommendation G.694.1, Spectral grids for WDM applications: DWDM frequency grid", November 2012.
- [11] Previous version of this draft: OSPFTE extension to support GMPLS for Flex Grid: [draft-dhillon-ccamp-super-channel-ospfte-ext-06.txt](#)

8. Acknowledgments

The authors would like to thank Ashok Kunjidhapatham & Mohit Misra for their valuable comments.

Dhillon Expires Sept 4, 2014 [Page 11]

Internet-Draft [draft-dhillon-ccamp-flexgrid-ospfte-ext](#) May 2013

Authors' Addresses

Rajan Rao
Infinera
140 Caspian Ct., Sunnyvale, CA 94089
Email: rrao@infinera.com

Iftekhar Hussain
Infinera
140 Caspian Ct., Sunnyvale, CA 94089

Email: ihussain@infinera.com

Marco Sosa
Infinera
140 Caspian Ct., Sunnyvale, CA 94089
Email: msosa@infinera.com

Abinder Dhillon
Fujitsu
Richardson, TX
Email: Abinder.Dhillon@us.fujitsu.com

Contributor's Addresses

Biao Lu
Email: blu@infinera.com

Subhendu Chattopadhyay
Email: schattopadhyay@infinera.com

Harpreet Uppal
Email: harpreet.uppal@infinera.com