Network Working Group

Abinder Dhillon
Iftekhar Hussain
Rajan Rao
Marco Sosa
Infinera

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OSPFTE extension to support GMPLS for Flex Grid
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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].

Status of this Memo

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1. Introduction

To enable scaling of existing transport systems to ultra high data rates of 1 Tbps and beyond, next generation systems providing super-channel [11] 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 (ITU-T) is extending the

G.694.1 grid standard (termed ''Fixed-Grid'') to include flexible grid (termed ''Flex-Grid'') support.

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

Figure-1 shows a network consisting of Network Elements (NEs) with super channel switching capability. User can create super-channel [11] connections using GMPLS through these NEs. To create these super-channel connections, system needs to model TELINKs [8][7]for routing which are capable of super channel switching and hence there is a need to extend the switching capability descriptor in TELINK for super channel switched networks.

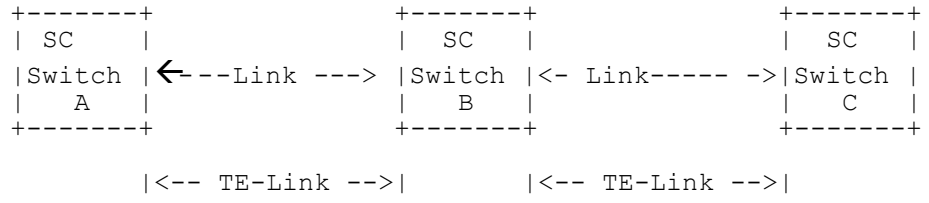

Figure 1: TE-Links

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)	Super-Channel-Switch-Capable(SCSC)

Switching Capability and Encoding values MUST be used as follows:

Switching Capability = SCSC
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:

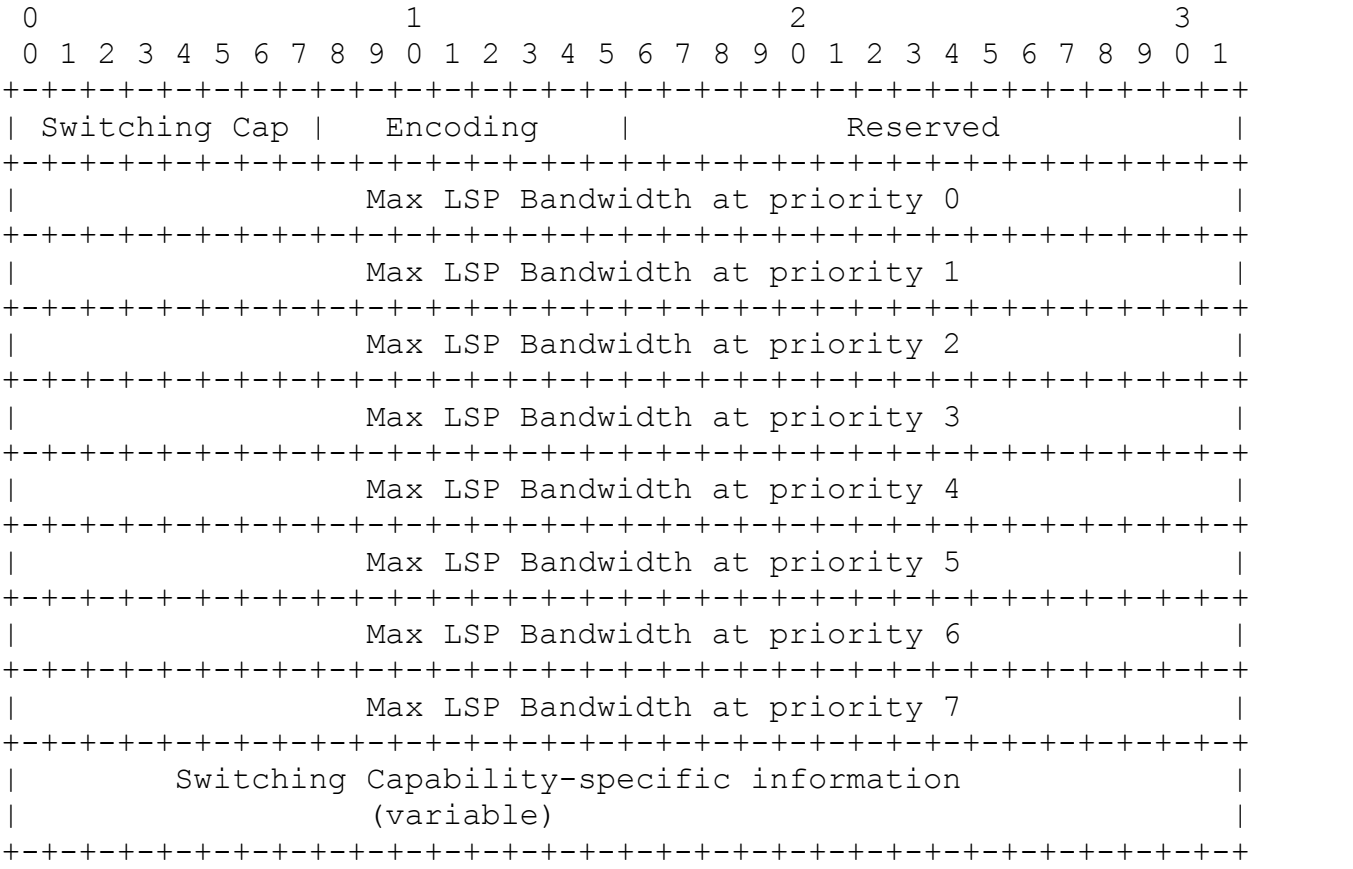

Figure 2: ISCD & SCSI

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.

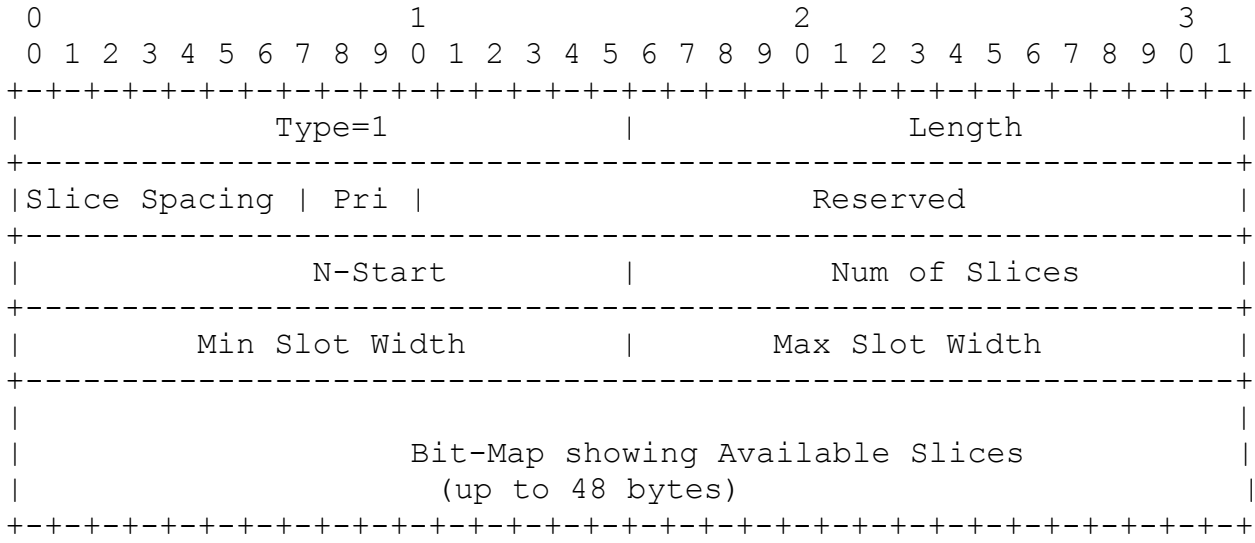

Figure 3: Type=1 BW sub TLV in Bit-Map format

3.2.1. Meaning of sub TLV fields

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

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

Table 1: Slice Spacing Values

- Priority: 3-bit field
  - 3-bit field to identify one of the 8 priorities for which Slice information (BW) is advertised.
- N-Start: 16-bit field
  - Is a two's complement integer to specify start of the grid
  - Use center freq formula to determine start of spectrum
- Number of slices: 16-bit field
  - Total number of slices advertised for the link. This includes (available plus consumed).
- Minimum Slot Width: 16-bit field
  - This is a positive integer value
  - 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
- Maximum Slot Width: 16-bit field
  - This is a positive integer value
  - 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: Largest Contiguous Frequency slot width = Slice Spacing * integer value in 'Maximum Slot Width' field
- Available slices encoded as bit-map
  - Each bit represents availability of one slice of width identified by S.S field
  - Zero: Available ; One: occupied
  - Padding MUST be used to align with 32 bit boundary.

3.3. BW sub TLV: List and Rage 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.

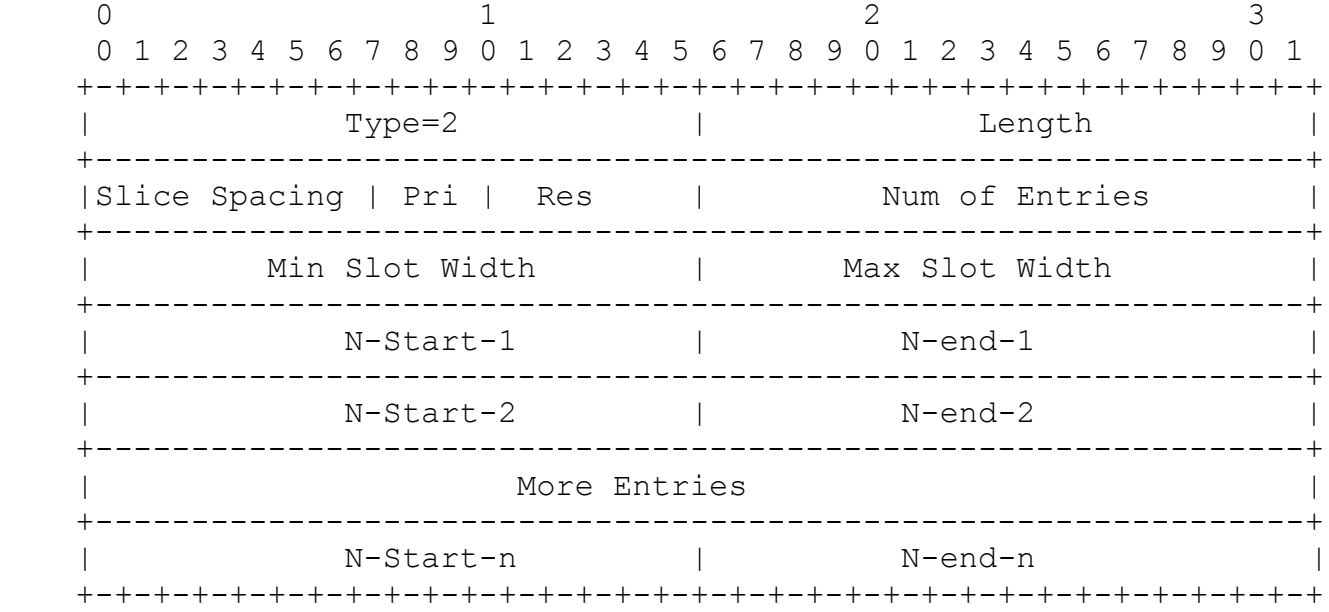

Figure 4: Type=2 BW sub TLV in List/Range format

3.3.1. Meaning of sub TLV fields

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

- Use center freq formula to determine start of spectrum

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

3.4. BW advertisement procedure

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

- Optical nodes capable of Super Channel 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 advertize 384 slices.
- The BW advertisement involves an ISCD containing
  - 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
  - Slice information in list/range format (Type=2 BW-sub-TLV) where each 32-bit entry represents an individual slice or list or range.
- 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 center frequency formula.
- The advertising node MUST also set Number of Slices field.
- Minimum & Maximum slot width fields are included to allow for any restrictions on the link for carrying super channel LSPs.
- The BW advertisement is priority based and up to 8 priority levels are allowed.
- 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. Examples

4.1. Example: BW advertisement without any service present

Figure 5 shows an example of BW sub-TLV for a te-link which has no service established over it yet. Attributes of BW sub-TLV in the te-link are:

- 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.

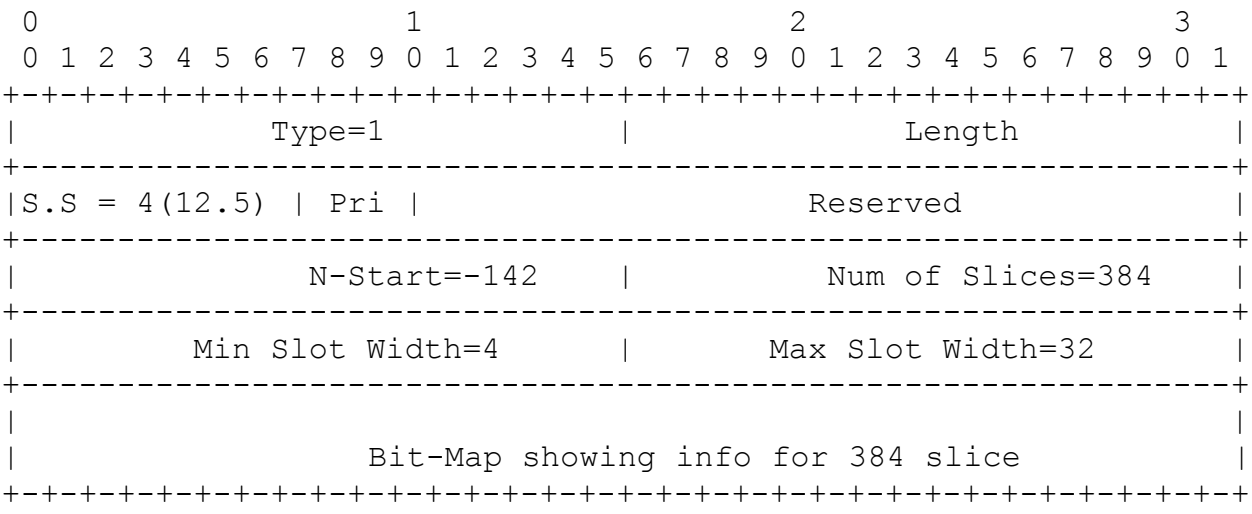

Figure 5: Type=1 BW sub-TLV without any service present

4.2. Example: How to use advertized Bandwidth

Assume user wants to setup Super Channel 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 adv (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.

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

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7.2. Informative References

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Authors' Addresses

Abinder Dhillon
Infinera
140 Caspian Ct., Sunnyvale, CA 94089

Email: adhillon@infinera.com

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

Email: ihussain@infinera.com

Rajan Rao
Infinera
140 Caspian Ct., Sunnyvale, CA 94089

Email: rrao@infinera.com

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

Contributor's Addresses

Biao Lu
Email: blu@infinera.com

Subhendu Chattopadhyay
Email: schattopadhyay@infinera.com

Harpreet Uppal
Email: harpreet.uppal@infinera.com
Infinera
140 Caspian Ct., Sunnyvale, CA 94089