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J.P. Vasseur (Editor)
Cisco Systems, Inc.
J.L. Le Roux (Editor)
France Telecom
S. Yasukawa
NTT
S. Previdi
P. Psenak
Cisco Systems, Inc.
Paul Mabey
Comcast

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Routing extensions for discovery of Traffic Engineering Node Capabilities

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Abstract

It is highly desired in several cases, to take into account Traffic Engineering (TE) node capabilities during TE LSP path selection, such as for instance the capability to act as a branch LSR of a P2MP LSP. This requires advertising these capabilities within the IGP.
For that purpose, this document specifies OSPF and IS-IS traffic engineering extensions for the advertisement of control plane and data plane traffic engineering node capabilities.

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.

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1. Terminology

This document uses terminologies defined in [RFC3031], [RFC3209] and [RFC4461].

2. Introduction

MPLS Traffic Engineering (MPLS-TE) routing ([IS-IS-TE], [OSPF-TE]) relies on extensions to link state IGP routing protocols ([OSPF-v2], [IS-IS]) in order to advertise Traffic Engineering (TE) link information used for constraint based routing. Further Generalized MPLS (GMPLS) related routing extensions are defined in [IS-IS-G] and [OSPF-G].

It is desired to complement these routing extensions in order to advertise TE node capabilities, in addition to TE link information. These TE node capabilities will be taken into account as constraints during path selection.

Indeed, it is useful to advertise data plane TE node capabilities, such as, for instance the capability for an LSR to be a branch LSR or a bud-LSR of a P2MP LSP. These capabilities can then be taken into account as constraints when computing TE LSP paths.

It is also useful to advertise control plane TE node capabilities such as for instance the capability to support GMPLS signaling for a packet LSR, or the capability to support P2MP (Point to Multipoint) TE LSP signaling. This allows selecting a path that avoids nodes that do not support a given signaling feature, or triggering a mechanism to support such nodes. Hence this facilitates backward compatibility.

For that purpose, this document specifies IGP (OSPF and IS-IS) traffic engineering node capability TLVs in order to advertise data plane and control plane capabilities of a node.

A new TLV is defined for ISIS and OSPF: the TE Node Capability Descriptor TLV, to be carried within:

- The ISIS Capability TLV ([ISIS-CAP]) for ISIS
- The Router Information LSA ([OSPF-CAP]) for OSPF.

3. TE Node Capability Descriptor

3.1. Description

LSRs in a network may have distinct control plane and data plane Traffic Engineering capabilities. The TE Node Capability Descriptor information defined in this document describes data and control plane capabilities of an LSR. Such information can be used for instance during path computation so as to avoid nodes that do not support a given TE feature either in the control or data plane or to trigger procedure to handle these nodes along the path (e.g trigger LSP hierarchy to support a legacy transit LSR on a P2MP LSP (see [RSVP-P2MP]). In some cases, this may also be useful to ensure backward compatibility.

3.2. Required Information

The TE Node Capability Descriptor contains two variable length sets of bit flags:

- The Data Plane Capabilities: This a variable length set of bit flags where each bit corresponds to a given TE data plane capability.
- The Control Plane Capabilities: This a variable length set of bit flags where each bit corresponds to a given TE control plane capability.

Two Data Plane Capabilities are currently defined:

- B bit: when set, this flag indicates that the LSR can act as a branch node on a P2MP LSP (see [P2MP-REQ]);
- E bit: when set, this flag indicates that the LSR can act as a bud LSR on a P2MP LSP, i.e. an LSR that is both transit and egress (see [P2MP-REQ]).

Three Control Plane Capabilities are currently defined:

- M bit: when set, this flag indicates that the LSR supports MPLS-TE signaling ([RSVP-TE]);
- G bit: when set this flag indicates that the LSR supports GMPLS signaling ([RSVP-G]);
- P bit: when set, this flag indicates that the LSR supports P2MP MPLS-TE signaling ([RSVP-P2MP]).

Note that new capability bits may be added in the future if required. Also more complex capabilities encoded within sub-TLVs may be added in the future if required.

4. TE Node Capability Descriptor TLV formats

4.1. OSPF TE Node Capability Descriptor TLV format

The OSPF TE Node Capability Descriptor TLV is made of various non-ordered sub-TLVs.

The format of the OSPF TE Node Capability Descriptor TLV and its sub-TLVs is the same as the TLV format used by the Traffic Engineering Extensions to OSPF [OSPF-TE]. That is, the TLV is composed of 2 octets for the type, 2 octets specifying the TLV length and a value field. The TLV is padded to four-octet alignment; padding is not included in the length field (so a three octet value would have a length of three, but the total size of the TLV would be eight octets). Sub-TLVs are also 32-bit aligned. Unrecognized types are ignored. All types between 32768 and 65535 are reserved for vendor-specific extensions. All other undefined type codes are reserved for future assignment by IANA.

The OSPF TE Node Capability Descriptor TLV has the following format:

```
TYPE     To be defined by IANA
LENGHT   Variable
VALUE    This comprises one or more sub-TLVs
```

Currently two sub-TLVs are defined:

Sub-TLV type	Length	Name
1	variable	DATA-PLANE-CAP sub-TLV
2	variable	CONTROL-PLANE-CAP sub-TLV

Any unrecognized sub-TLV MUST be silently ignored.

More sub-TLVs could be added in the future to handle new capabilities.

The OSPF TE Node Capability Descriptor TLV is carried within an OSPF Router Information LSA which is defined in [OSPF-CAP].

4.1.1. The DATA-PLANE-CAP sub-TLV

The DATA-PLANE-CAP sub-TLV is a series of bit flags, where each bit correspond to a data plane TE node capability, and has a variable length.

The format of the DATA-PLANE-CAP sub-TLV is as follows:

TYPE To be assigned by IANA (suggested value =1)
LENGTH It is set to N x 4 octets. N starts

from 1 and can be increased when there is a need.
Each 4 octets are referred to as a capability flag.

VALUE This comprises one or more capability flags.
For each 4 octets, the bits are indexed from the most significant to the least significant, where each bit represents one data plane TE node capability. When the first 32 capabilities are defined, a new capability flag will be used to accommodate the next capability. These bits are under IANA control.

The following bits are defined the first capability flag:

Bit	Capabilities
0	B bit: P2MP Branch Node capability: When set this indicates that the LSR can act as a branch node on a P2MP LSP [P2MP-REQ];
1	E bit: P2MP Bud-LSR capability: When set, this indicates that the LSR can act as a bud LSR on a P2MP LSP, i.e. an LSR that is both transit and egress [P2MP-REQ];

The values for the B and E bits are to be assigned by IANA.

2-31 Reserved for future assignments by IANA.

4.1.2. The CONTROL-PLANE-CAP sub-TLV

The CONTROL-PLANE-CAP sub-TLV is a series of bit flags, where each bit correspond to a control plane TE node capability, and has a variable length.

The format of the CONTROL-PLANE-CAP sub-TLV is as follows:

TYPE To be assigned by IANA (suggested value = 2)
LENGHT It is set to N x 4 octets. N starts from 1 and can be increased when there is a need. Each 4 octets are referred to as a capability flag.
VALUE This comprises one or more capability flags. For each 4 octets, the bits are indexed from the most significant to the least significant, where each bit represents one control plane TE node capability. When the first 32 capabilities are defined, a new

capability flag will be used to accommodate the next capability. These bits are under IANA control.

The following bits are defined in the first capability:

Bit	Capabilities
0	M bit: If set this indicates that the LSR supports MPLS-TE signaling ([RSVP-TE]).
1	G bit: If set this indicates that the LSR supports GMPLS signaling ([RSVP-G]).
2	P bit: If set this indicates that the LSR supports P2MP MPLS-TE signaling ([RSVP-P2MP]).
3-31	Reserved for future assignments by IANA

The values for the M, G and P bits are to be assigned by IANA.

4.2. IS-IS TE Node Capability Descriptor TLV format

The IS-IS TE Node Capability Descriptor TLV is made of various non ordered sub-TLVs.

The format of the IS-IS TE Node Capability TLV and its sub-TLVs is the same as the TLV format used by the Traffic Engineering Extensions to IS-IS [IS-IS-TE]. That is, the TLV is composed of 1 octet for the type, 1 octet specifying the TLV length and a value field.

The IS-IS TE Node Capability Descriptor TLV has the following format:

TYPE: To be assigned by IANA
LENGTH: Variable, from 3 to 255
VALUE: set of one or more sub-TLVs

Currently two sub-TLVs are defined:

Sub-TLV type	Length	Name
1	variable	DATA-PLANE-CAP sub-TLV
2	variable	CONTROL-PLANE-CAP sub-TLV

Any unrecognized sub-TLV MUST be silently ignored. More sub-TLVs could be added in the future to handle new capabilities.

The IS-IS TE Node Capability Descriptor TLV is carried within an IS-

IS CAPABILITY TLV which is defined in [ISIS-CAP].

4.2.1. DATA-PLANE-CAP sub-TLV

The DATA-PLANE-CAP sub-TLV is a series of bit flags, where each bit correspond to a data plane TE node capability, and has a variable length. These bits are under IANA control.

The DATA-PLANE-CAP sub-TLV has the following format:

TYPE: To be assigned by IANA (Suggested value =1)
LENGTH: It is set to N. N starts from 1 and can be increased when there is a need. Each octet is referred to as a capability flag.
VALUE: This comprises one or more data plane TE node capability flags.

The following bits are defined in the first capability flag:

```
0 1 2 3 4 5 6 7
+-+-+-+-+-+-+-+-+
|B|E| Reserved  |
+-+-+-+-+-+-+-+-+
```

B bit: P2MP Branch node capability: When set this indicates that the LSR can act as a branch node on a P2MP LSP ([P2MP-REQ]).
E bit: P2MP bud-LSR capability: When set, this indicates that the LSR can act as a bud LSR on a P2MP LSP, i.e. an LSR that is both transit and egress ([P2MP-REQ]).

Reserved bits are for future assignment by IANA

The values for the B and E bits are to be assigned by IANA.

4.2.2. CONTROL-PLANE-CAP sub-TLV

The CONTROL-PLANE-CAP sub-TLV is a series of bit flags, where each bit correspond to a control plane TE node capability, and has a variable length. These bits are under IANA control.

The CONTROL-PLANE-CAP sub-TLV has the following format:

TYPE: To be assigned by IANA (suggested value = 2)
LENGTH: It is set to N. N starts from 1 and can be increased when there is a need. Each octet is referred to as a capability flag.
VALUE: This comprises one or more control plane TE node capability flags.

The following bits defined in the first capability flag:

```
0 1 2 3 4 5 6 7
+-+-+-+-+-+-+-+-+
|M|G|P|Reserved |
+-+-+-+-+-+-+-+-+
```

-M bit: If set this indicates that the LSR supports MPLS-TE signaling ([RSVP-TE]).

-G bit: If set this indicates that the LSR supports GMPLS signaling ([RSVP-G]).

-P bit: If set this indicates that the LSR supports P2MP MPLS-TE signaling ([RSVP-P2MP]).

Reserved bits are for future assignment by IANA.

The values for the M, G and P bits are to be assigned by IANA.

5. Elements of procedure

5.1. OSPF

The TE Node Capability Descriptor TLV is advertised, within an OSPFv2 Router Information LSA (Opaque type of 4 and Opaque ID of 0) or OSPFv3 Router information LSA (function code of 12) which are defined in [OSPF-CAP]. As such, elements of procedure are inherited from those defined in [OSPF-CAP].

The TE Node Capability Descriptor TLV advertises capabilities that may be taken into account as constraints during path selection. Hence its flooding scope is area-local, and it MUST be carried within OSPFv2 type 10 Router Information LSA (as defined in [RFC2370]) or an OSPFv3 Router Information LSA with the S1 bit set and the S2 bit cleared (as defined in [OSPFv3]).

A router MUST originate a new OSPF router information LSA whenever the content of any of the TE Node Capability Descriptor TLV changes or whenever required by the regular OSPF procedure (LSA refresh (every LSRefreshTime)).

The TE Node Capability Descriptor TLV is OPTIONAL and must at most appear once in an OSPF Router Information LSA or ISIS Router Capability TLV.

When an OSPF LSA or ISIS LSP does not contain any TE Node capability Descriptor TLV, this means that the TE Capabilities of that LSR are unknown.

Note that a change in any of these capabilities MAY trigger CSPF computation, but MUST not trigger normal SPF computation.

Note also that TE node capabilities are expected to be fairly static.

5.2. IS-IS

The TE Node Capability TLV is carried within an IS-IS CAPABILITY TLV defined in [IS-IS-CAP]. As such, elements of procedure are inherited from those defined in [IS-IS-CAP].

The TE Node Capability Descriptor TLV advertises capabilities that may be taken into account as constraints during path selection. Hence its flooding is area-local, and MUST be carried within an IS-IS CAPABILITY TLV having the S flag cleared.

An IS-IS router MUST originate a new IS-IS LSP whenever the content of any of the TE Node Capability TLV changes or whenever required by the regular IS-IS procedure (LSP refresh).

The TE Node Capability Descriptor TLV is OPTIONAL and must at most appear once in an OSPF Router Information LSA or ISIS Router Capability TLV.

When a IS-IS LSP does not contain any TE Node capability Descriptor TLV, this means that the TE Capabilities of that LSR are unknown.

Note that a change in any of these capabilities MAY trigger CSPF computation, but MUST not trigger normal SPF computation.

Note also that TE node capabilities are expected to be fairly static.

6. Backward compatibility

The TE Node Capability Descriptor TLVs defined in this document do not introduce any interoperability issue. For OSPF, a router not supporting the TE Node Capability Descriptor TLV MUST just silently ignore the TLV as specified in [OSPF-CAP]. For IS-IS a router not supporting the TE Node Capability Descriptor TLV MUST just silently ignore the TLV as specified in [IS-IS-CAP].

7. Security Considerations

No new security issues are raised in this document.

8. IANA considerations

8.1. OSPF TLVs

IANA is in charge of the assignment of TLV code points for the Router Information LSA defined in [OSPF-CAP].

IANA will assign a new codepoint for the TE Node Capability Descriptor TLV defined in this document and carried within the Router Information LSA.

IANA will be in charge of the assignment of sub-TLV code points for the TE Node Capability Descriptor TLV defined in this document. Two sub-TLVs types are defined for this TLV and should be assigned by IANA:

-CONTROL-PLANE-CAP sub-TLV (suggested value =1)
-DATA-PLANE-CAP sub-TLV (suggested value =2)

8.2. ISIS TLVs

IANA is in charge of the assignment of sub-TLV code points for the ISIS CAPABILITY TLV defined in [ISIS-CAP].
IANA will assign a new codepoint for the TE Node Capability Descriptor TLV defined in this document, and carried within the ISIS CAPABILITY TLV.

IANA will be in charge of the assignment of sub-TLV code points for the TE Node Capability Descriptor TLV defined in this document. Two sub-TLVs types are defined for this TLV and should be assigned by IANA:

-CONTROL-PLANE-CAP sub-TLV (suggested value =1)
-DATA-PLANE-CAP sub-TLV (suggested value =2)

8.3. Capability bits

IANA is requested to manage the space of control plane and data plane capability bit flags carried within the OSPF and ISIS TE Node Capability Descriptor TLVs, numbering them in the usual IETF notation starting at zero and continuing at least through 31.
New bit numbers may be allocated only by an IETF Consensus action.
Each bit should be tracked with the following qualities:

- Bit number
- Defining RFC
- Name of bit

Currently two capabilies are defined in the data plane capability flags and must be assigned by IANA. Here are the suggested values:

-0x01: P2MP Branch LSR capability
-0x02: P2MP Bud LSR capability

Currently three capabilities are defined in the control plane capability flags and must be assigned by IANA. Here are the suggested values:

-0x01: MPLS-TE support
-0x02: GMPLS support
-0x04: P2MP RSVP-TE support

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11. Editors Address

Jean-Philippe Vasseur
Cisco Systems, Inc.
1414 Massachusetts Avenue
Boxborough , MA - 01719
USA
Email: jpv@cisco.com

Jean-Louis Le Roux
France Telecom
2, avenue Pierre-Marzin
22307 Lannion Cedex
FRANCE
Email: jeanlouis.leroux@francetelecom.com

12. Contributors address

Seisho Yasukawa
NTT
9-11, Midori-Cho 3-Chome
Tokyo, 180-8585
JAPAN
Email: yasukawa.seisho@lab.ntt.co.jp

Stefano Previdi
Cisco Systems, Inc
Via Del Serafico 200
Roma, 00142
Italy
Email: sprevidi@cisco.com

Peter Psenak
Cisco Systems, Inc
Pegasus Park DE Kleetlaan 6A
Diegmen, 1831
BELGIUM
Email: ppsenak@cisco.com

Paul Mabbey
Comcast
USA
Email:

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