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# IGP Routing Protocol Extensions for Discovery of Traffic Engineering Node Capabilities

## Status of This Memo



## Abstract

It is highly desired, in several cases, to take into account Traffic Engineering (TE) node capabilities during Multi Protocol Label Switching (MPLS) and Generalized MPLS (GMPLS) Traffic Engineered Label Switched Path (TE-LSP) selection, such as, for instance, the capability to act as a branch Label Switching Router (LSR) of a Point-To-MultiPoint (P2MP) LSP. This requires advertising these capabilities within the Interior Gateway Protocol (IGP). For that purpose, this document specifies Open Shortest Path First (OSPF) and Intermediate System-Intermediate System (IS-IS) traffic engineering extensions for the advertisement of control plane and data plane traffic engineering node capabilities.

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## 1. Introduction

Multi Protocol Label Switching-Traffic Engineering (MPLS-TE) routing ([RFC3784], [RFC3630], [OSPFv3-TE]) relies on extensions to link state Interior Gateway Protocols (IGP) ([IS-IS], [RFC1195], [RFC2328], [RFC2740]) in order to advertise Traffic Engineering (TE) link information used for constraint-based routing. Further Generalized MPLS (GMPLS) related routing extensions are defined in [RFC4205] and [RFC4203].

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 the capability for a Label Switching Router (LSR) to be a branch LSR or a bud-LSR of a Point-To-MultiPoint (P2MP) Label Switched Path (LSP). These capabilities can then be taken into account as constraints when computing the route of TE LSPs.

It is also useful to advertise control plane TE node capabilities such as 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 control plane feature, or triggering a mechanism to support such nodes on a path. Hence, this facilitates backward compatibility.

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

A new TLV is defined for OSPF, the TE Node Capability Descriptor TLV, to be carried within the Router Information LSA ([RFC4970]). A new sub-TLV is defined for IS-IS, the TE Node Capability Descriptor sub-TLV, to be carried within the IS-IS Capability TLV ([RFC4971]).

## 2. Terminology

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

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. 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 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 procedures to handle these nodes along the path (e.g., trigger LSP hierarchy to support a legacy transit LSR on a P2MP LSP (see [RFC4875])).

### 3.2. Required Information

The TE Node Capability Descriptor contains a variable-length set of bit flags, where each bit corresponds to a given TE node capability.

Five TE Node Capabilities are defined in this document:

- B bit: when set, this flag indicates that the LSR can act as a branch node on a P2MP LSP (see [RFC4461]);
- 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 [RFC4461]);
- M bit: when set, this flag indicates that the LSR supports MPLS-TE signaling ([RFC3209]);
- G bit: when set this flag indicates that the LSR supports GMPLS signaling ([RFC3473]);
- P bit: when set, this flag indicates that the LSR supports P2MP MPLS-TE signaling ([RFC4875]).

Note that new capability bits 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 a variable length TLV that contains a series of bit flags, where each bit correspond to a TE node capability. The bit-field MAY be extended with additional 32-bit words if more bit flags need to be assigned. Any unknown bit flags SHALL be treated as Reserved bits.

The OSPF TE Node Capability Descriptor TLV is carried within an OSPF Router Information LSA, which is defined in [RFC4970].

The format of the OSPF TE Node Capability Descriptor TLV is the same as the TLV format used by the Traffic Engineering Extensions to OSPF [RFC3630]. That is, the TLV is composed of 2 octets for the type, 2 octets specifying the length of the value field, and a value field.

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

TYPE: 5 (see Section 8.1)
LENGTH: Variable (multiple of 4).
VALUE: Array of units of 32 flags numbered from the most significant bit as bit zero, where each bit represents a TE node capability.

The following bits are defined:

| 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 [RFC4461]. |
| 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 [RFC4461]. |
| 2 | M bit: If set, this indicates that the LSR supports MPLS-TE signaling ([RFC3209]). |
| 3 | G bit: If set, this indicates that the LSR supports GMPLS signaling ([RFC3473]). |
| 4 | P bit: If set, this indicates that the LSR supports P2MP MPLS-TE signaling ([RFC4875]). |
| 5-31 | Reserved for future assignments by IANA. |

Reserved bits MUST be set to zero on transmission, and MUST be ignored on reception. If the length field is greater than 4, implying that there are more than 32 bits in the value field, then any additional bits (i.e., not yet assigned) are reserved.

## 4.2. IS-IS TE Node Capability Descriptor sub-TLV format

The IS-IS TE Node Capability Descriptor sub-TLV is a variable length sub-TLV that contains a series of bit flags, where each bit corresponds to a TE node capability. The bit-field MAY be extended with additional bytes if more bit flags need to be assigned. Any unknown bit flags SHALL be treated as Reserved bits.

The IS-IS TE Node Capability Descriptor sub-TLV is carried within an IS-IS CAPABILITY TLV, which is defined in [RFC4971].

The format of the IS-IS TE Node Capability sub-TLV is the same as the sub-TLV format used by the Traffic Engineering Extensions to IS-IS [RFC3784]. That is, the sub-TLV is composed of 1 octet for the type, 1 octet specifying the length of the value field.

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

```
TYPE:   1 (see Section 8.2)
LENGTH: Variable
VALUE:  Array of units of 8 flags numbered from the most
        significant bit as bit zero, where each bit represents
        a TE node capability.
```

The following bits are defined:

| 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 [RFC4461]. |
| 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 [RFC4461]. |
| 2 | M bit: If set, this indicates that the LSR supports MPLS-TE signaling ([RFC3209]). |
| 3 | G bit: If set, this indicates that the LSR supports GMPLS signaling ([RFC3473]). |
| 4 | P bit: If set, this indicates that the LSR supports P2MP MPLS-TE signaling ([RFC4875]). |
| 5-7 | Reserved for future assignments by IANA. |

Reserved bits MUST be set to zero on transmission, and MUST be ignored on reception. If the length field is great than 1, implying that there are more than 8 bits in the value field, then any additional bits (i.e., not yet assigned) are reserved.

## 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 an OSPFv3 Router Information LSA (function code of 12), which are defined in [RFC4970]. As such, elements of procedure are inherited from those defined in [RFC2328], [RFC2740], and [RFC4970].

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 an 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 [RFC2740]).

A router MUST originate a new OSPF Router Information LSA whenever the content 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 NOT appear more than once in an OSPF Router Information LSA. If a TE Node Capability Descriptor TLV appears more than once in an OSPF Router Information LSA, only the first occurrence MUST be processed and others MUST be ignored.

When an OSPF Router Information LSA does not contain any TE Node Capability Descriptor TLV, this means that the TE node capabilities of that LSR are unknown.

Note that a change in any of these capabilities MAY trigger Constrained Shortest Path First (CSPF) computation, but MUST NOT trigger normal SPF computation.

Note also that TE node capabilities are expected to be fairly static. They may change as the result of configuration change or software upgrade. This is expected not to appear more than once a day.

## 5.2. IS-IS

The TE Node Capability sub-TLV is carried within an IS-IS CAPABILITY TLV defined in [RFC4971]. As such, elements of procedure are inherited from those defined in [RFC4971].

The TE Node Capability Descriptor sub-TLV advertises capabilities that may be taken into account as constraints during path selection. Hence, its flooding is area-local, and it 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 sub-TLV changes or whenever required by the regular IS-IS procedure (LSP refresh).

The TE Node Capability Descriptor sub-TLV is OPTIONAL and MUST NOT appear more than once in an ISIS Router Capability TLV.

When an IS-IS LSP does not contain any TE Node Capability Descriptor sub-TLV, this means that the TE node 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. They may change as the result of configuration change, or software upgrade. This is expected not to appear more than once a day.

## 6. Backward Compatibility

The TE Node Capability Descriptor TLVs defined in this document do not introduce any interoperability issues. For OSPF, a router not supporting the TE Node Capability Descriptor TLV will just silently ignore the TLV, as specified in [RFC4970]. For IS-IS, a router not supporting the TE Node Capability Descriptor sub-TLV will just silently ignore the sub-TLV, as specified in [RFC4971].

When the TE Node Capability Descriptor TLV is absent, this means that the TE Capabilities of that LSR are unknown.

The absence of a word of capability flags in OSPF or an octet of capability flags in IS-IS means that these capabilities are unknown.

## 7. Security Considerations

This document specifies the content of the TE Node Capability Descriptor TLV in IS-IS and OSPF to be used for (G)MPLS-TE path computation. As this TLV is not used for SPF computation or normal routing, the extensions specified here have no direct effect on IP routing. Tampering with this TLV may have an effect on Traffic Engineering computation. Mechanisms defined to secure IS-IS Link State PDUs [RFC3567], OSPF LSAs [RFC2154], and their TLVs can be used to secure this TLV as well.

## 8. IANA Considerations

### 8.1. OSPF TLV

[RFC4970] defines a new codepoint registry for TLVs carried in the Router Information LSA defined in [RFC4970].

IANA has made a new codepoint assignment from that registry for the TE Node Capability Descriptor TLV defined in this document and carried within the Router Information LSA. The value is 5. See Section 4.1 of this document.

### 8.2. ISIS sub-TLV

IANA has defined a registry for sub-TLVs of the IS-IS CAPABILITY TLV defined in [RFC4971].

IANA has made a new codepoint assignment from that registry for the TE Node Capability Descriptor sub-TLV defined in this document, and carried within the ISIS CAPABILITY TLV. The value is 1. See Section 4.2 of this document.

### 8.3. Capability Registry

IANA has created a new registry to manage the space of capability bit flags carried within the OSPF and ISIS TE Node Capability Descriptor.

A single registry must be defined for both protocols. A new base registry has been created to cover IGP-TE registries that apply to both OSPF and IS-IS, and the new registry requested by this document is a sub-registry of this new base registry.

Bits in the new registry should be numbered in the usual IETF notation, starting with the most significant bit as bit zero.

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

IANA has made assignments for the five TE node capabilities defined in this document (see Sections 8.1 and 8.2) using the following values:

| Bit No. | Name | Reference |
|---|---|---|
| 0 | B bit: P2MP Branch LSR capability | [RFC5073] |
| 1 | E bit: P2MP Bud LSR capability | [RFC5073] |
| 2 | M bit: MPLS-TE support | [RFC5073] |
| 3 | G bit: GMPLS support | [RFC5073] |
| 4 | P bit: P2MP RSVP-TE support | [RFC5073] |
| 5-7 | Unassigned | [RFC5073] |

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Adrian Farrel prepared the final version of this document for submission to the IESG.

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