Extended Administrative Groups in MPLS Traffic Engineering (MPLS-TE)

Abstract

   MPLS Traffic Engineering (MPLS-TE) advertises 32 administrative
   groups (commonly referred to as "colors" or "link colors") using the
   Administrative Group sub-TLV. This is defined for OSPFv2 (RFC 3630),
   OSPFv3 (RFC 5329) and IS-IS (RFC 5305).

   This document adds a sub-TLV to the IGP TE extensions, "Extended
   Administrative Group". This sub-TLV provides for additional
   administrative groups (link colors) beyond the current limit of 32.

Status of This Memo

   This is an Internet Standards Track document.

   This document is a product of the Internet Engineering Task Force
   (IETF). It represents the consensus of the IETF community. It has
   received public review and has been approved for publication by the
   Internet Engineering Steering Group (IESG). Further information on
   Internet Standards is available in Section 2 of RFC 5741.

   Information about the current status of this document, any errata,
   and how to provide feedback on it may be obtained at
   http://www.rfc-editor.org/info/rfc7308.

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1. Introduction

   Do we need more than 32 bits?

   The IGP extensions to support MPLS-TE (RFCs 3630 [RFC3630] and 5305
   [RFC5305]) define a link TLV known as Administrative Group (AG) with
   a limit of 32 AGs per link. The concept of Administrative Groups
   comes from Section 6.2 of RFC 2702 [RFC2702], which calls them
   Resource Classes. RFCs 3630 [RFC3630] and 5305 [RFC5305] describe
   the mechanics of the TLV and use the term Administrative Groups
   (sometimes abbreviated herein as AGs), as does this document.

   Networks have grown over time, and MPLS-TE has grown right along with
   them. Administrative Groups are advertised as fixed-length 32-bit
   bitmasks. This can be quite constraining, as it is possible to run
   out of values rather quickly. One such use case is #5 in Section 6.2
   of RFC 2702 [RFC2702], using AGs to constrain traffic within specific
   topological regions of the network. A large network may well have
   far more than 32 geographic regions. One particular operator builds
   their network along the lines of this use case, using AGs to flag
   network regions down to the metro scale, e.g., Seattle, San
   Francisco, Dallas, Chicago, St. Louis, etc. MPLS-TE tunnels are then
   specified with affinities to include or exclude specific metro
   regions in their path calculation. Each metro region is given its
   own bit in the AG bitmask. This means that 32 bits can only
   (cleanly) represent 32 metro areas. It should be obvious that 32 may
   not be enough even for a US-based network, never mind a worldwide
   network.

There may be some opportunity for color reuse; that is, bit 0x8 may
mean 'Seattle' or 'Prague' or 'Singapore' depending on the geography
in which it is used. In practice, coordinating this reuse is fraught
with peril and the reuse effectively becomes the limiting factor in
MPLS-TE deployment. With this example, it is not possible to build a
Label Switched Path (LSP) that avoids Seattle while including Prague,
as it is the same AG value.

This document provides Extended Administrative Groups (EAGs). The
number of EAGs has no fixed limit, it is constrained only by
protocol-specific restrictions such as Link State Advertisement (LSA)
or MTU size. While an operator may one day need to go beyond these
protocol-specific restrictions, allowing for an arbitrary number of
EAGs should easily provide the operator with hundreds or thousands of
bit values, thus no longer making the number of AGs an impediment to
network growth.

EAG's intended use case is within a single domain. As such, this
document provides no support for signaling an EAG. It provides no
analog to either the SESSION_ATTRIBUTE of C-Type 1 defined in
[RFC3209] nor the LSP Attributes (LSPA) object of the Path
Computation Element Communication Protocol (PCEP), defined in
[RFC5440]. Since this specification provides no way of signaling an
LSP's path requirements in reference to the EAG, such constraints may
only be applied at the ingress.

1.1. Requirements Language

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].

2. Extended Administrative Groups Sub-TLV

This document defines the Extended Administrative Group (EAG) sub-TLV
for both OSPF [RFC3630] and IS-IS [RFC5305]. The EAG sub-TLV is used
in addition to the Administrative Groups when an operator wants to
make more than 32 colors available for advertisement in a network.
The EAG sub-TLV is optional. Coexistence of EAG and AG TLVs is
covered in Section 2.3.1 of this document.

This document uses the term 'colors' as a shorthand to refer to
particular bits with an AG or EAG. The examples in this document use
'red' to represent the least significant bit in the AG (red == 0x1),
'blue' to represent the second bit (blue == 0x2). To say that a link
has a given color or that the specified color is set on the link is
to say that the corresponding bit or bits in the link's AG are set to
1.

2.1. Packet Format

   The format of the Extended Administrative Groups sub-TLV is the same
   for both OSPF and IS-IS:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Extended Admin Group                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        ..........                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Extended Admin Group                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
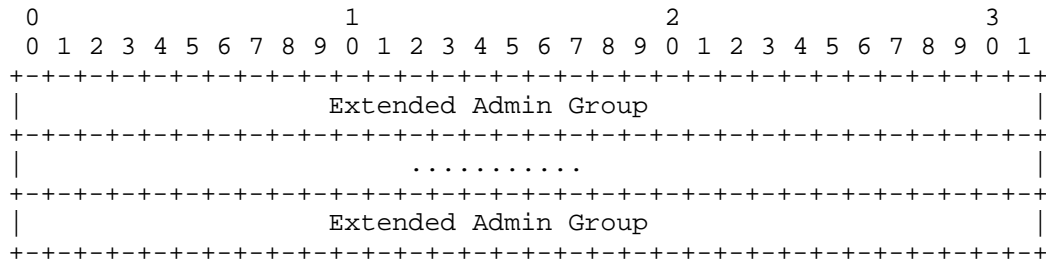
   The Type of the sub-TLV for OSPF is 26 and for IS-IS is 14. The
   Length is the size of the Extended Admin Group (EAG) value in bytes.
   The EAG may be of any non-zero length, but it MUST be a multiple of 4
   bytes. The only limits on EAG size are those that are imposed by
   protocol-specific or media-specific constraints (e.g., max packet
   length).

2.2. Admin Group Numbering

   By convention, the existing Administrative Group sub-TLVs are
   numbered 0 (least significant bit) to 31 (most significant bit). The
   EAG values are a superset of AG. That is, bits 0-31 in the EAG have
   the same meaning and MUST have the same values as an AG flooded for
   the same link. If an EAG's length is more than 4 bytes, numbering
   for these additional bytes picks up where the previous byte left off.
   For example, the least significant bit in the fifth byte of an 8-byte
   EAG is referred to as bit 32.

2.3. Backward Compatibility

   There are two questions to consider for backward compatibility with
   existing AG implementations -- how do AG and EAG coexist, and what
   happens if a node has matching criteria for unadvertised EAG bits?

2.3.1. AG and EAG Coexistence

   If a node advertises EAG, it MAY also advertise AG.

   If a node advertises both AG and EAG, then the first 32 bits of the
   EAG MUST be identical to the advertised AG.

   If both an AG and EAG are present, a receiving node MUST use the AG
   as the first 32 bits (0-31) of administrative color and use the EAG
   for bits 32 and higher, if present.

   A receiving node that notices that the AG differs from the first 32
   bits of the EAG SHOULD report this mismatch to the operator.

   This process allows nodes that do not support EAG to obtain some link
   color information from the network, while also allowing for an
   eventual migration away from AG.

2.3.2. Desire for Unadvertised EAG Bits

   The existing AG sub-TLV is optional; thus a node may be configured
   with a preference to include red or exclude blue and may be faced
   with a link that is not advertising a value for either blue or red.
   What does an implementation do in this case? It shouldn't assume
   that red is set, but it is also arguably incorrect to assume that red
   is NOT set, as a bit must first exist before it can be set to 0.

   Practically speaking, this has not been an issue for deployments, as
   many implementations always advertise the AG bits, often with a
   default value of 0x00000000. However, this issue may be of more
   concern once EAGs are added to the network. EAGs may exist on some
   nodes but not others, and the EAG length may be longer for some links
   than for others.

   To allow for maximum interoperability, an implementation SHOULD treat
   desired but unadvertised EAG bits as if they were set to 0. Consider
   the case where a node wants to only use links where the 127th bit of
   an EAG is set to 1. If a link is only advertising 64 EAG bits, the
   setting of the 127th EAG bit is not known -- that is, it is neither
   explicitly 0 nor 1. The node that wants the 127th EAG bit to be 1
   will not use this link when implementing the recommended behavior, as
   the assumption is than the unadvertised 127th bit is set to 0.

   That said, each implementation makes its own choices based on
   necessary constraints, and there might be reasons to provide other
   strategies for handling this case. A strategy that deviates from the
   behavior this document recommends SHOULD be configurable to use the
   recommended behavior, in order to provide maximum interoperability.

3. Security Considerations

   This extension adds no new security considerations.

4. IANA Considerations

   This document registers a sub-TLV allocation in both OSPF and ISIS.

   For OSPF, the subregistry is the "Types for sub-TLVs of TE Link TLV
   (Value 2)" in the "Open Shortest Path First (OSPF) Traffic
   Engineering TLVs" registry.

   For IS-IS, it is "Sub-TLVs for TLV 22, 141, and 222" subregistry in
   the "IS-IS TLV Codepoints" registry. For IS-IS, the value should be
   marked 'y' for Sub-TLVs 22, 141 and 222; this is identical to the
   allocation for the Administrative Group sub-TLV (value 3 in the same
   subregistry).

   The assigned value from the OSPF registry is 26 and the assigned
   value from the IS-IS registry is 14. The sub-TLV is called "Extended
   Administrative Group".

5. Acknowledgements

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   Robert Sawaya, Andy Malis, Les Ginsberg and Adrian Farrel for their
   review and comments.

6. References

6.1. Normative References

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6.2. Informative References

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