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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.

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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.

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 that 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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6. References

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