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**Extensions to OSPF
for support of Diff-Serv-aware MPLS Traffic Engineering**

Status of this Memo

Abstract

A companion document [DIFF-TE-REQTS] defines the requirements for
support of Diff-Serv-aware MPLS Traffic Engineering on a per-Class-
Type basis, as discussed in the Traffic Engineering Working Group
Framework document [TEWG-FW].

This document proposes corresponding extensions to OSPF for support
of Traffic Engineering on a per-Class-Type basis.

   Two companion documents [DIFF-TE-EXT] [DIFF-TE-ISIS] propose
   corresponding extensions to RSVP and CR-LDP and to ISIS for support
   of Traffic Engineering on a per-Class-Type basis.

1.   Introduction

   As Diffserv becomes prominent in providing scalable multi-class of
   services in IP networks, performing traffic engineering at a per-
   class level instead of an aggregated level is needed in networks
   where fine optimisation of resources is sought in order to further
   enhance performance and efficiency. By mapping a traffic trunk in a
   given class on a separate LSP, it allows the traffic trunk to
   utilize resources available on both shortest path(s) and non-
   shortest paths and follow paths that meet constraints which are
   specific to the given class. It also allows each class to select the
   proper protection/restoration mechanism(s) that satisfy its
   survivability requirements in a cost effective manner.

   Besides the set of parameters defined for the general aggregate TE
   [TE-REQ], a new set of per-class parameters needs to be provided at
   each LSR interface and propagated via extensions to the IGP
   (ISIS/OSPF) [TEWG-FW]. Furthermore, the per-class parameters can be
   aggregated into per-Class-Type parameters. The main motivation for
   grouping a set of classes into a Class-Type is to improve the
   scalability of the IGP link state advertisements by propagating
   information on a per-Class-Type basis instead of on a per-class
   basis. This approach also has the benefit of allowing better
   bandwidth sharing between classes in the same Class-Type.

   A Class-Type [TEWG-FW] is defined as a set of classes that satisfy
   the following two conditions:

     1) Classes in the same Class-Type possess common aggregate maximum
        and minimum bandwidth requirements to guarantee the required
        performance level.

     2) There is no maximum or minimum bandwidth requirement to be
        enforced at the level of an individual class within the Class-
        Type. One can still implement some "priority" policies for
        classes within the same Class-Type in terms of accessing the
        Class-Type bandwidth (e.g. via the use of preemption
        priorities).

   An example of Class-Type comprising multiple Diff-Serv classes is a
   low-loss Class-Type that includes both AF1-based and AF2-based

Ordering Aggregates.

Note that with per Class-Type TE, Constraint-Based Routing is
performed with bandwidth constraints on a per Class-Type basis but
LSPs may carry a single Diff-Serv class (Ordered Aggregate) with
Diff-Serv scheduling (i.e. PHB) performed separately for each class.

In this document, we will only discuss "per Class-Type TE" because
"per Class TE" can be viewed as a special case of per Class-Type TE
(where each Class-Type is degenerated into a single Diff-Serv
class).

This document focuses on intra-domain operations. Inter-domain
operations is for further study.

A companion document [DIFF-TE-REQTS] defines the requirements for
support of MPLS Traffic Engineering on a per-Class-Type basis. The
following sections propose detailed extensions to OSPF that meet
those requirements.

Two companion documents [DIFF-TE-EXT] [DIFF-TE-ISIS] propose
corresponding extensions to RSVP and CR-LDP and to ISIS for support
of Traffic Engineering on a per-Class-Type basis.

2.   OSPF Extensions

In this section we propose extensions to OSPF for support of Diff-
Serv Traffic Engineering on a per-Class-Type basis which meet the
requirements defined in [DIFF-TE-REQTS]. These extensions are in
addition to the extensions already defined for support of
(aggregate) MPLS Traffic Engineering in [OSPF-TE].

2.1.   Existing TE Sub-TLVs

[OSPF-TE] defines a new LSA for support of (aggregate) Traffic
Engineering, which is referred to as the Traffic Engineering LSA.
This LSA contains a Link TLV (Type 2) comprising a number of sub-
TLVs.

In this document we refer to the sub-TLV 7 (maximum reservable
bandwidth) of the Link TLV (as defined in [OSPF-TE]) as the "Maximum
Reservable Aggregate Bandwidth".

We also refer to the sub-TLV 8 (unreserved bandwidth) of the Link
TLV (as defined in [OSPF-TE]) as the "Unreserved Bandwidth for
Class-Type 0".

2.2.   New Sub-TLVs

The following additional sub-TLVs are defined for the Link TLV of
the Traffic Engineering LSA (sub-TLV numbers to be allocated)

   TBD1   - Unreserved Bandwidth for Class-Type 1 (32 octets)
   TBD2 - Unreserved Bandwidth for Class-Type 2 (32 octets)
   TBD3 - Unreserved Bandwidth for Class-Type 3 (32 octets)

Each sub-TLV may occur only once. Unrecognized types are ignored.

Unlike the sub-TLVs defined for the Link TLV in [OSPF-TE], the
additional sub-TLVs defined above are optional.

The Link TLV may include the sub-TLVs for any subset of the three
additional Class-Types. In other words, the Link TLV may contain
none of the three sub-TLVs defined above, any one of those, any two
of those, or the three sub-TLVs.

As discussed in [DIFF-TE-REQTS], where a Class-Type is not
effectively used in a network, it is recommended that the
corresponding sub-TLV is not included in the Link TLV. Therefore,
the Class-Types to be advertised in OSPF should be configurable. For
instance, a Network Administrator may elect to use Diff-Serv Traffic
Engineering in order to compute separate routes for data traffic and
voice traffic (and apply different bandwidth constraints to the
route computation for those). In that case, the IGP would only
advertise the sub-TLV for one additional Class-Type (i.e. the Link
TLV would contain sub-TLV 7 for the Maximum Reservable Aggregate
Bandwidth, sub-TLV 8 for the Unreserved Bandwidth for Class-Type 0
and sub-TLV TBD1 for Unreserved Bandwidth for Class-Type 1).

An LSR which supports Class-Type N and which receives a Link TLV
without the sub-TLV corresponding to Class-Type N, interprets this
as meaning that the corresponding link does not support Class-Type
N. For Constraint Based Routing purposes, the LSR may consider this
equivalent to the case where the Link TLV contains an Unreserved
Bandwidth for Class-Type N sub-TLV set to zero.

An LSR which does not support Class-Type N and which receives a Link
TLV containing the sub-TLV corresponding to Class-Type N, must
ignore this sub-TLV. However, the Link TLV must be flooded
transparently, so that the sub-TLV for Class-Type N is kept in the
Link TLV when reflooded by this LSR.

2.3.   Sub-TLV Details

The Unreserved Bandwidth for Class-Type N (N= 1,2,3) sub-TLV
specifies the amount of bandwidth not yet reserved at each of the
eight preemption priority levels for Class-Type N. Each value will
be less than or equal to the Maximum Reservable Bandwidth for Class-
Type N.

When the bandwidth value for preemption Z (Z > 0) is identical to
the bandwidth value for preemption Z-1, the bandwidth value for
preemption Z is not explicitly repeated in the sub-TLV. Rather, the
fact that it is identical to the value of preemption Z-1, is encoded
in a "repetition octet".

Thus, the sub-TLV comprises:

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      - P (1<=P<=8) bandwidth values. These values correspond to the
  bandwidth that can be reserved with a holding priority of 0 through
  7, arranged in increasing order with priority 0 occurring at the
  start of the sub-TLV, and priority 7 towards the end of the sub-TLV,
  but omitting all repeated values. The units are bytes per second and
  the values are encoded in IEEE floating point format.

      - a "repetition octet" where each bit is referred to as bitZ ,
  0 <= Z < 8, and is defined to have the following meaning:
          * if bitZ = 0 then "Unreserved Bandwidth" for preemption
      level Z is explicitely included in the sub-TLV,
          * if bitZ = 1 then "Unreserved Bandwidth" for preemption
      level Z is not explicitly included in the sub-TLV but is
      defined to be equal to "Unreserved Bandwidth" for preemption
      level Z-1.

Note that the highest preemption level (level 0) is always
advertised and the first bit (Bit0) in the "repetition octet" is
always set to 0.

[Editor's note: should the "repetition octet" be moved before the
bandwidth values?]

The Unreserved Bandwidth for Class-Type N sub-TLV is TLV type
(TBDN). Its length is (P*4 +1), where 1<=P<=8 and where P is the
number of non-equal bandwidth values across all preemption levels
for that Class-Type.

For example, when a link supports LSPs of preemption levels 2 and 4
only (for a particular Class-Type) with "Unreserved Bandwidth" (for
the particular Class-Type) on that link for preemption levels 0, 2,

and 4 currently of 10Mb/s, 5Mb/s and 3Mb/s, respectively, then
"Unreserved Bandwidth" (for the particular Class-Type) for
preemption levels 0, 2, and 4 of 10Mb/s, 5Mb/s and 3Mb/s,
respectively, are explicitly advertised for that link as well as
"repetition octet" of 01010111 in binary form. The sub-TLV length is
13.

3. Security Considerations

This document raises no new security issues for OSPF. The security
mechanisms already proposed for OSPF may be used.

4. Acknowledgments

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