            Spanning Tree Protocol (STP) Application
          of Inter-Chassis Communication Protocol (ICCP)
                  draft-ietf-pwe3-iccp-stp-05.txt

Abstract

   Inter-Chassis Communication Protocol (ICCP) supports an inter-chassis
   redundancy mechanism which is used to support high network
   availability.

   In this document, Provider Edge (PE) devices in a Redundancy Group
   (RG) running ICCP are used to offer multi-homed connectivity to
   Spanning Tree Protocol (STP) networks to improve availability of the
   STP networks. The ICCP TLVs and usage for the ICCP STP application
   are defined.

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1. Introduction

Inter-Chassis Communication Protocol (ICCP [RFC7275]) specifies a multi-chassis redundancy mechanism which enables Provider Edge (PE) devices located in a multi-chassis arrangement to act as a single Redundancy Group (RG).

With the Spanning Tree Protocol (STP), a spanning tree will be formed over connected bridges by blocking some links between these bridges so that forwarding loops are avoided. This document introduces support of STP as a new application of ICCP. This STP application of ICCP supports when a bridged STP network is connected to a RG, the RG members act as a single root bridge participating in the operations of STP protocol.

STP relevant information needs to be exchanged and synchronized among the RG members. New ICCP TLVs for the ICCP STP application are specified for this purpose.

From the point of view of the customer, the Service Provider is providing a Virtual Private LAN Service (VPLS) [RFC4762].

1.1. 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 [RFC2119].

1.2. Terminology

ICCP: Inter-Chassis Communication Protocol
VPLS: Virtual Private LAN Service
STP: Spanning Tree Protocol
MSTP: Multiple Spanning Tree Protocol
MST: Multiple Spanning Trees
CIST: Common and Internal Spanning Tree ([802.1q] Section 3.27)
MSTI: Multiple Spanning Tree Instance ([802.1q] Section 3.138)
BPDU: Bridge Protocol Data Unit

In this document, unless otherwise explicitly noted, the term STP also covers MSTP.

2. Use Case

Customers widely use Ethernet as an access technology [RFC4762]. It's common that one customer's Local Area Network (LAN) has multiple bridges connected to a carrier's network at different locations for reliability purposes. Requirements for this use case are listed as

follows.

o Customers desire to balance the load among their available
   connections to the carrier's network, therefore all the
   connections need to be active.

o When one connection to the carrier network fails, customers
   require a connection in another location to continue to work after
   the re-convergence of the STP rather than compromising the whole
   STP network. The failure of the connection may be due to the
   failure of the PE, the attachment circuit (AC) or even the
   Customer Edge (CE) device itself.

In order to meet these requirements, the 'ICCP-STP' model is
proposed. It introduces STP as a new application of ICCP.

```
         +--------------+       +============+
         |              |       |            |
         |              |       |            |
         |     +---+    |       |   +-----+|<--|--Pseudowire-->|
         |  +---+CE1+<6>-------<5>+ PE1 ||   |               |
         |  <1>  +---+    |       |   +-----+|<--|--Pseudowire-->|
         | +-+-+         |       |     ||    |
         | |CE3|         |       |     ||ICCP  |--> Towards the Core
         | +-+-+         |       |     ||    |
         |  <2>  +---+    |       |   +-----+|<--|--Pseudowire-->|
         |  +---+CE2+<3>-------<4>+ PE2 ||   |               |
         |      +---+    |       |   +-----+|<--|--Pseudowire-->|
         |              |       |            |
         | Multi-homed  |       | Redundancy |
         | STP Network  |       |    Group   |
         +--------------+       +============+
```
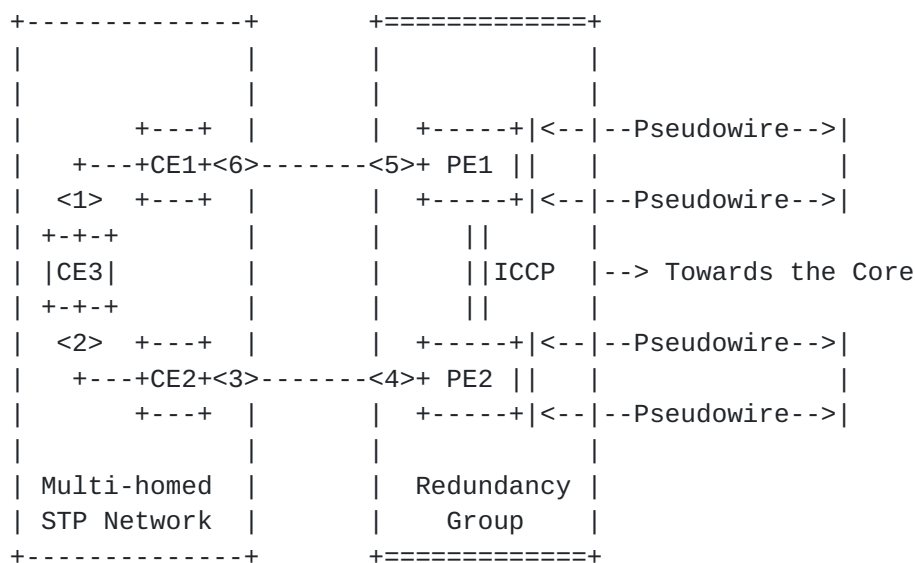
      Figure 2.1: A STP network is multihomed to RG running ICCP.

Figure 2.1 shows an example topology of this model. With ICCP, the
whole RG will be virtualized to be a single bridge. Each RG member
has its BridgeIdentifier (the MAC address). The numerically lowest
one is used as the BridgeIdentifier of the 'virtualized root bridge'.
The RG acts as if the ports connected to the STP network (port <4>,
<5>) are for the same root bridge. All these ports send the
configuration BPDU with the highest root priority to trigger the
construction of the spanning tree. The link between the peering PEs
is not visible to the bridge domains of the STP network. In this way,
the STP will always break a possible loop within the multi-homed STP
network by breaking the whole network into separate islands so that
each is attached to one PE. That forces all PEs in the RG to be
active. This is different from a generic VPLS [RFC4762] where the

root bridge resides in the customer network and the multi-homed PEs
act in the active-standby mode. Note that the specification of VPLS
remains unchanged other than for this operation. For instance, a
full-mesh of pseudowires (PWs) is established between PEs, and split-
horizon is still used to perform the loop-breaking through the core.

3. Spanning Tree Protocol Application TLVs

This section specifies the ICCP TLVs for the ICCP STP application.
The Unknown TLV bit (U-bit) and the Forward unknown TLV bit (F-bit)
of the following TLVs MUST be sent as cleared and processed on
receipt as specified in [RFC7275].

3.1. STP Connect TLV

This TLV is included in the RG Connect message to signal the
initiation of ICCP STP application connection.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|U|F|   Type=TBA1            |          Length                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Protocol Version      |A|          Reserved              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Optional Sub-TLVs                        |
~                                                              ~
|                                                              |
+                           +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            ...            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   - U=F=0

   - Type

     set to TBA1 (value to be assigned by IANA) for "STP Connect TLV"

   - Length

     Length of the TLV in octets excluding the U-bit, F-bit, Type,
     and Length fields.

   - Protocol Version

     The version of STP ICCP application protocol. This document
     defines version 0x0001.

- A bit

    Acknowledgement Bit. Set to 1 if the sender has received a STP
    Connect TLV from the recipient. Otherwise, set to 0.

- Reserved

    Reserved for future use. These bits MUST be sent as zero and
    ignored on receipt.

- Optional Sub-TLVs

    There are no optional Sub-TLVs defined for this version of the
    protocol.

3.2. STP Disconnect TLV

This TLV is used in RG Disconnect Message to indicate that the
connection for the ICCP STP application is to be terminated.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|U|F|   Type=TBA2              |        Length                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Optional Sub-TLVs                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
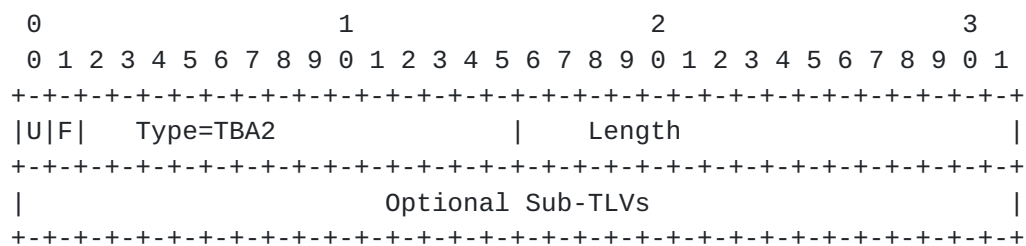
  - U=F=0

  - Type

      set to TBA2 for "STP Disconnect TLV"

  - Length

      Length of the TLV in octets excluding the U-bit, F-bit, Type,
      and Length fields.

  - Optional Sub-TLVs

      The only optional Sub-TLV defined for this version of the
      protocol is the "STP Disconnect Cause" sub-TLV, defined below:

3.2.1. STP Disconnect Cause sub-TLV

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|U|F|   Type=TBA13               |           Length              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Disconnect Cause String                    |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   - U=F=0

   - Type

     set to TBA13 for "STP Disconnect Cause TLV"

   - Length

     Length of the TLV in octets excluding the U-bit, F-bit, Type,
     and Length fields.

   - Disconnect Cause String

     Variable length string specifying the reason for the disconnect,
     encoded in UTF-8 [RFC3629] format. Used for operational
     purposes.

3.3. STP Config TLVs

The STP Config TLVs are sent in the RG Application Data message. When
STP Config TLV is received by a peer RG member, it MUST synchronize
the configuration information contained in the TLV. TLVs specified
from Section 3.3.1 through Section 3.3.5 defines specific
configuration information.

3.3.1. STP System Config

This TLV announces the local node's STP System Parameters to the RG
peers.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|U|F|   Type=TBA3            |         Length                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           ROID                               |
+                                                             +
|                                                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        MAC Address                           |
+                           +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
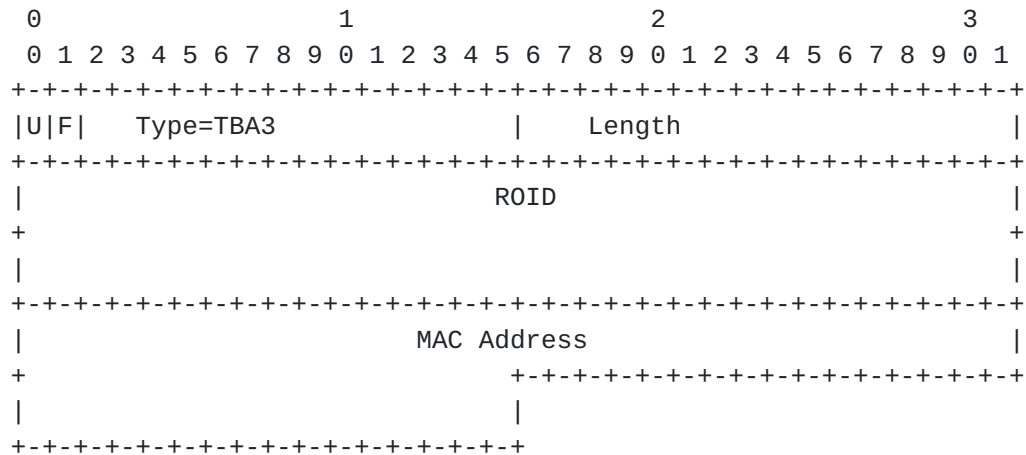
   - U=F=0

   - Type

     set to TBA3 for "STP System Config"

   - Length

     Length of the ROID plus the MAC address in octets. Always set to
     14.

   -ROID

     Redundant Object Identifier, format defined in Section 6.1.3 of
     [RFC7275].

   - MAC Address

     The MAC address of the sender. This MAC address is set to the
     BridgeIdentifier of the sender, as defined in [802.1q] Section
     13.26.2. The numerically lowest 48 bit unsigned value of
     BridgeIdentifier is used as the MAC address of the Virtual Root
     Bridge mentioned in Section 2.

3.3.2. STP Region Name

   This TLV carries the value of Region Name.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|U|F|   Type=TBA4              |          Length               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Region Name                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

- U=F=0

- Type

   set to TBA4 for "STP Region Name"

- Length

   Length of the TLV in octets excluding the U-bit, F-bit, Type,
   and Length fields.

- Region Name

   The Name of the MST Region as specified in [802.1q] Section
   3.142.

3.3.3. STP Revision Level

This TLV carries the value of Revision Level.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|U|F|   Type=TBA5              |          Length               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|       Revision Level         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

- U=F=0

- Type

   Set to TBA5 for "STP Revision Level".

- Length

   Length of the TLV in octets excluding the U-bit, F-bit, Type,
   and Length fields. Always set to 2.

- Revision Level

The Revision Level as specified in [802.1q] Section 13.8 bullet
c));

3.3.4. STP Instance Priority

This TLV carries the value of Instance Priority to other members in
the RG.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|U|F|   Type=TBA6            |     Length                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Pri  |      InstanceID     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

- U=F=0

- Type

  set to TBA6 for "STP Instance Priority"

- Length

  Length of the TLV in octets excluding the U-bit, F-bit, Type,
  and Length fields.

- Pri

  The Instance Priority. It is interpreted as unsigned integer
  with higher value indicating a higher priority.

- InstanceID

  The 12 bits Instance Identifier of the CIST or MSTI. This
  parameter takes a value in the range 1 through 4094 for MSTI as
  defined in [802.1q] Section 12.8.1.2.2 and takes value of 0 for
  CIST.

3.3.5. STP Configuration Digest

This TLV carries the value of STP VLAN Instance Mapping.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|U|F|   Type=TBA7            |        Length                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Configuration Digest                      |
~                                                              ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

  - U=F=0

  - Type

    set to TBA7 for "STP Configuration Digest"

  - Length

    Length of the STP Configuration Digest. Always set to 16
    octets.

  - Configuration Digest

    As specified in [802.1q] Section 13.8 bullet d)).

3.4. STP State TLVs

   The STP State TLVs are sent in the RG Application Data message. They
   are used by a PE device to report its STP status to other members in
   the RG. Such TLVs are specified in the following subsections.

3.4.1. STP Topology Changed Instances

   This TLV is used to report the Topology Changed Instances to other
   members of the RG. The sender monitors TCN messages and generates
   this list. The receiving RG member MUST initiate the Topology Change
   event, including sending BPDU with the Topology Change flag set to 1
   out of the designated port(s) of the Topology Changed bridge domains
   of the STP network, flushing out of MAC addresses relevant to the
   instances listed in this TLV.

   If the PE device supports MAC Address Withdrawal (see Section 6.2 of
   [RFC4762]), it SHOULD send an Label Distribution Protocol (LDP)
   Address Withdraw Message with the list of MAC addresses towards the
   core over the corresponding LDP sessions. It is not necessary to send
   such a message to PEs of the same RG since the flushing of their MAC
   address tables should have been performed upon the receipt of "STP
   Topology Changed Instances" TLV.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|U|F|   Type=TBA8            |   Length                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       InstanceID List                        |
~                                                              ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

      - U=F=0

      - Type

        set to TBA8 for "STP Topology Changed Instances"

      - Length

        Length of the TLV in octets excluding the U-bit, F-bit, Type,
        and Length fields.

      - InstanceID List

        The list of the InstanceIDs of CIST or MSTIs whose topologies
        have changed as indicated by the Topology Change Notification
        (TCN) Messages as specified in [802.1q] Section 13.14. The list
        is formatted by padding Instance ID value to 16 bit boundary as
        follows, where the bits in the "R" fields MUST be sent as zero
        and ignored on receipt.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|R|R|R|R| InstanceID#1         |R|R|R|R| InstanceID#2         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
~                          ... ...                             ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

3.4.2. STP CIST Root Time Parameters

   This TLV is used to report the Value of CIST Root Time Parameters
   ([802.1q] Section 13.26.7) to other members of the RG. All time
   parameter values are in seconds with a granularity of 1. For ranges
   and default values of these parameter values, refer to [802.1d1998]
   Section 8.10.2 Table 8-3, [802.1d2004] Section 17.14 Table 17-1, and
   [802.1q] Section 13.26.7.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|U|F|   Type=TBA9            |      Length                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    MaxAge                  |    MessageAge                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    FwdDelay                |    HelloTime                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| RemainingHops |
+-+-+-+-+-+-+-+-+
```

   - U=F=0

   - Type

     set to TBA9 for "STP CIST Root Time"

   - Length

     Length of the TLV in octets excluding the U-bit, F-bit, Type,
     and Length fields. Always set to 9.

   - MaxAge

     The Max Age of the CIST. It is the maximum age of the
     information transmitted by the bridge when it is the Root Bridge
     ([802.1d2004] Section 17.13.8).

   - MessageAge

     The Message Age of the CIST (see [802.1q] Section 13.26.7).

   - FwdDelay

     The Forward Delay of the CIST. It is the delay used by STP
     Bridges to transition Root and Designated Ports to Forwarding
     ([802.1d2004] Section 17.13.5).

   - HelloTime

     The Hello Time of the CIST. It is the interval between periodic
     transmissions of Configuration Messages by Designated Ports
     ([802.1d2004] Section 17.13.6).

   - RemainingHops

     The remainingHops of the CIST ([802.1q] Section 13.26.7) .

3.4.3. STP MSTI Root Time Parameter

This TLV is used to report the parameter value of MSTI Root Time to
other members of the RG. As defined in [802.1q] Section 13.26.7, it
is the value of remainingHops for the given MSTI.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|U|F|    Type=TBA10             |     Length                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Pri  |   InstanceID           | RemainingHops |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

    - U=F=0

    - Type

        set to TBA10 for "STP MSTI Root Time"

    - Length

        Length of the TLV in octets excluding the U-bit, F-bit, Type,
        and Length fields. Always set to 3.

    - Pri

        The Instance Priority. It is interpreted as an unsigned integer
        with higher value indicating a higher priority.

    - InstanceID

        The 12 bits Instance IDentifier of the Multiple Spanning Tree
        Instance (MSTID). As defined in [802.1q] Section 12.8.1.2.2,
        this parameter takes a value in the range 1 through 4094.

    - RemainingHops

        The remainingHops of the MSTI. It is encoded in the same way as
        in [802.1q] Section 14.4.1 bullet f).

3.5. STP Synchronization Request TLV

The STP Synchronization Request TLV is used in the RG Application
Data message. This TLV is used by a device to request from its peer
to re-transmit configuration or operational state. The following
information can be requested:

   - configuration and/or state of the STP system,
   - configuration and/or state for a given list of instances.
    The format of the TLV is as follows:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|U|F|   Type=TBA11            |      Length                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Request Number          |C|S|    Request Type            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     InstanceID List                          |
~                                                              ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   - U=F=0

   - Type

     set to TBA11 for "STP Synchronization Request TLV"

   - Length

     Length of the TLV in octets excluding the U-bit, F-bit, Type,
     and Length fields. Always set to 4.

   - Request Number

     2 octets. Unsigned integer uniquely identifying the request.
     Used to match the request with a corresponding response. The
     value of 0 is reserved for unsolicited synchronization, and MUST
     NOT be used in the STP Synchronization Request TLV. As indicated
     in [RFC7275], given the use of TCP, there are no issues
     associated with the wrap-around of the Request Number.

   - C-bit

     Set to 1 if the request is for configuration data. Otherwise,
     set to 0.

   - S-bit

     Set to 1 if the request is for running state data. Otherwise,
     set to 0.

   - Request Type

          14-bits specifying the request type, encoded as follows:

             0x00   Request System Data
             0x01   Request data of the listed instances
             0x3FFF Request System Data and data of all instances

       - InstanceID List

          The InstanceIDs of CIST or MSTIs, format specified in Section
          3.4.1.

3.6. **STP Synchronization Data TLV**

   The pair of STP Synchronization Data TLVs are used by sender to
   delimit a set of TLVs that are being transmitted in response to an
   STP Synchronization Request TLV. The delimiting TLVs signal the start
   and end of the synchronization data, and associate the response with
   its corresponding request via the 'Request Number' field. It's
   REQUIRED that each pair of STP Synchronization Data TLVs occur in the
   same fragment. When the total size of the TLVs to be transmitted
   exceeds the maximal size of a fragment, these TLVs MUST be divided
   into multiple sets, delimited by multiple pairs of STP
   Synchronization Data TLVs, and filled into multiple fragments. With
   the Request Number lost fragments can be identified and re-
   requested.

   The STP Synchronization Data TLVs are also used for unsolicited
   advertisements of complete STP configuration and operational state
   data. The 'Request Number' field MUST be set to 0 in this case.

   STP Synchronization Data TLV has the following format:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|U|F|   Type=TBA12           |   Length                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Request Number         |   Reserved                    |S|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

      - U=F=0

      - Type

         set to TBA12 for "STP Synchronization Data TLV"

      - Length

Length of the TLV in octets excluding the U-bit, F-bit, Type,
and Length fields. Always set to 4.

- Request Number

2 octets. Unsigned integer identifying the Request Number of the
"STP Synchronization Request TLV" which initiated this
synchronization data response.

- Reserved

Reserved bits for future use. These MUST be sent as zero and
ignored on receipt.

-S

S = 0: Synchronization Data Start
S = 1: Synchronization Data End

4. Operations

Operational procedures for AC redundancy applications have been
specified in Section 9.2 of [RFC7275]. The operational procedures of
ICCP STP application should follow these procedures except the
changes presented in this section.

4.1. Common AC Procedures

For the generic procedures of AC redundancy applications defined in
Section 9.2.1 of [RFC7275], the following changes are introduced.

4.1.1. Remote PE Node Failure or Isolation

When a local PE device detects that a remote PE device that is a
member of the same RG is no longer reachable (using the mechanisms
described in Section 5 of [RFC7275]), the local PE device checks if
it has redundancy ACs for the affected services. In case of redundant
ACs present, and if the local PE device has the new highest bridge
priority, the local PE device becomes the virtual root bridge for
corresponding ACs.

4.1.2. Local PE Isolation

When a PE device detects that it has been isolated from the core
network, then it need ensure that its AC redundancy mechanism will
change the status of all active ACs to standby. The AC redundancy
application SHOULD then send ICCP "Application Data" message in order
to trigger failover to another active PE device in the RG. Note that

this works only in the case of dedicated interconnect (Sections 3.2.1
and 3.2.3), since ICCP will still have the path to the peer, even
though the PE device is isolated from the MPLS core network.

4.2. ICCP STP Application Procedures

This section defines the procedures that are specific to the ICCP STP
application which are applicable for Ethernet ACs.

4.2.1. Initial Setup

When a RG is configured on a system that supports the ICCP STP
application, such systems MUST send an "RG Connect" message with "STP
Connect TLV" to each PE device that is member of the RG. The sending
PE device MUST set the A bit to 1 in that TLV if it has received a
corresponding "STP Connect TLV" from its peer PE; otherwise, the
sending PE device MUST set the A bit to 0. If a PE device receives an
"STP Connect TLV" from its peer after sending its own TLV with the A
bit set to 0, it MUST resend the TLV with the A bit set to 1. A
system considers the ICCP STP application connection to be
operational when it has both sent and received "STP Connect TLVs"
with the A bit set to 1. When the ICCP STP application connection
between a pair of PEs is operational, the two devices can start
exchanging "RG Application Data" messages for the ICCP STP
application. This involves having each PE device advertise its STP
configuration and operational state in an unsolicited manner. A PE
device SHOULD follow the following order when advertising its STP
state upon initial application connection setup:

   - Advertise system configuration TLV
   - Advertise remaining configuration TLVs
   - Advertise state TLVs

The update of the information contained in the State TLVs depends on
that in the configuration TLVs. By sending the TLVs in the above
order, the two peers may begin to update STP state as early as
possible in the middle of exchanging these TLVs.

A PE device MUST use a pair of "STP Synchronization Data TLVs" to
delimit the entire set of TLVs that are being sent as part of this
unsolicited advertisement.

If a system receives an "RG Connect" message with "STP Connect TLV"
that has a differing Protocol Version, it MUST follow the procedures
outlined in the "Application Versioning" Section of [RFC7275].

After the ICCP STP application connection has been established, every
PE device MUST communicate its system level configuration to its

peers via the use of "STP System Config TLV".

When the ICCP STP application is administratively disabled on the PE, or on the particular RG, the system MUST send an "RG Disconnect" message containing "STP Disconnect TLV".

4.2.2. Configuration Synchronization

A system that supports ICCP STP application MUST synchronize the configuration with other RG members. This is achieved via the use of "STP Config TLVs". The PEs in the RG MUST all agree on the common MAC address to be associated with the virtual root bridge. It is possible to achieve this via consistent configuration on member PEs. However, in order to protect against possible misconfigurations, a virtual root bridge identifier MUST be set to the MAC address advertised by the PE device with the numerically lowest BridgeIdentifier (i.e., the MAC address of the bridge) in the RG.

Furthermore, for a given ICCP STP application, an implementation MUST advertise the configuration prior to advertising its corresponding state. If a PE device receives any STP State TLV that it had not learned of before via an appropriate STP Config TLV, then the PE device MUST request synchronization of the configuration and state from its peer. If during such synchronization a PE device receives a State TLV that it has not learned before, then the PE device MUST send a NAK TLV for that particular TLV. The PE device MUST NOT request resynchronization in this case.

4.2.3. State Synchronization

PEs within the RG need to synchronize their state for proper STP operation. This is achieved by having each system advertise its running state in STP State TLVs. Whenever any STP parameter either on the CE or PE side is changed, the system MUST transmit an updated TLV for the affected STP instances. Moreover, when the administrative or operational state changes, the system MUST transmit an updated state TLV to its peers.

A PE device MAY request its peer to retransmit previously advertised state. This is useful in case of the PE device recovering from a soft failure and attempting to relearn state. To request such retransmissions, a PE device MUST send a set of one or more "STP Synchronization Request TLVs".

A PE device MUST respond to a "STP Synchronization Request TLV" by sending the requested data in a set of one or more STP configuration or state TLVs delimited by a pair of "STP Synchronization Data TLVs".

Note that the response may span across multiple RG Application Data
messages, for example when MTU limits are exceeded; however, the
above ordering MUST be retained across messages, and only a single
pair of Synchronization Data TLVs MUST be used to delimit the
response across all Application Data Messages.

A PE device MAY readvertise its STP state in an unsolicited manner.
This is done by sending the appropriate State TLVs delimited by a
pair of "STP Synchronization Data TLVs" and using a 'Request Number'
of 0.

While a PE device has sent out a synchronization request for a
particular PE device, it SHOULD silently ignore all TLVs from that
node, that are received prior to the synchronization response and
which carry the same type of information being requested. This saves
the system from the burden of updating state that will ultimately be
overwritten by the synchronization response. Note that TLVs
pertaining to other systems should continue to be processed normally.

If a PE device receives a synchronization request for an instance
that doesn't exist or is not known to the PE, then it MUST trigger
the unsolicited synchronization of all information by restarting the
initialization.

If during the synchronization operation a PE device receives an
advertisement of a Node ID value which is different from the value
previously advertised, then the PE device MUST purge all state data
previously received from that peer prior to the last synchronization.

4.2.4. Failure and Recovery

When a PE device that is active for the ICCP STP application
encounters a core isolation fault [RFC7275], it SHOULD attempt to
fail-over to a peer PE device which hosts the same RG. The default
fail-over procedure is to have the failed PE device bring down the
link(s) towards the multi-homed STP network. This will cause the STP
network to reconverge and to use the other links that are connected
to the other PE devices in the RG. Other procedures for triggering
fail-over are possible, and are outside the scope of this document.

If the isolated PE device is the one that has the numerically lowest
BridgeIdentifier, PEs in the RG MUST synchronize STP configuration
and state TLVs and determine a new virtual root bridge as specified
in Section 4.2.2.

Upon recovery from a previous fault, a PE device SHOULD NOT reclaim
the role of the virtual root for the STP network even if it has the

numerically lowest BridgeIdentifier among the RG. This minimizes
traffic disruption.

Whenever the virtual root bridge changes, the STP Topology Changed
Instances TLV lists the instances that are affected by the change.
These instances MUST undergo a STP reconvergence procedure when this
TLV is received as defined in Section 3.4.1.

5. Security Considerations

This document specifies an application running on the channel
provided by ICCP [RFC7275]. The security considerations on ICCP apply
in this document as well.

For the ICCP STP application, an attack on a channel (running in the
provider's network) can break not only the ability to deliver traffic
across the provider's network, but also the ability to route traffic
within the customer's network. That is, a careful attack on a channel
(such as the DOS attacks as described in [RFC7275]) can break STP
within the customer network. Implementations need provide mechanisms
to mitigate these types of attacks. For example, the port between the
PE device and the malicious CE device may be blocked.

6. IANA Considerations

The IANA maintains a top-level registry called "Pseudowire Name
Spaces (PWE3)". It has a sub-registry called "ICC RG Parameter
Types".

IANA is requested to make 13 allocations from this registry as shown
below. IANA is requested to allocate the codepoints in sequential
block starting from the next available value in the range marked for
assignment by IETF review (0x2000-0x2FFF) [RFC5226]. All assignments
should reference this document.

```
    Parameter Type Description
    -------------- --------------------------------
    TBA1           STP Connect TLV
    TBA2           STP Disconnect TLV
    TBA3           STP System Config TLV
    TBA4           STP Region Name TLV
    TBA5           STP Revision Level TLV
    TBA6           STP Instance Priority TLV
    TBA7           STP Configuration Digest TLV
    TBA8           STP Topology Changed Instances TLV
    TBA9           STP STP CIST Root Time TLV
    TBA10          STP MSTI Root Time TLV
    TBA11          STP Synchronization Request TLV
```

```
   TBA12           STP Synchronization Data TLV
   TBA13           STP Disconnect Cause TLV
```

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