802.1Qca – PCR
A Proposal

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Outline

- Proposal for 802.1Qca
- Summary of Choices
- Details, discussion

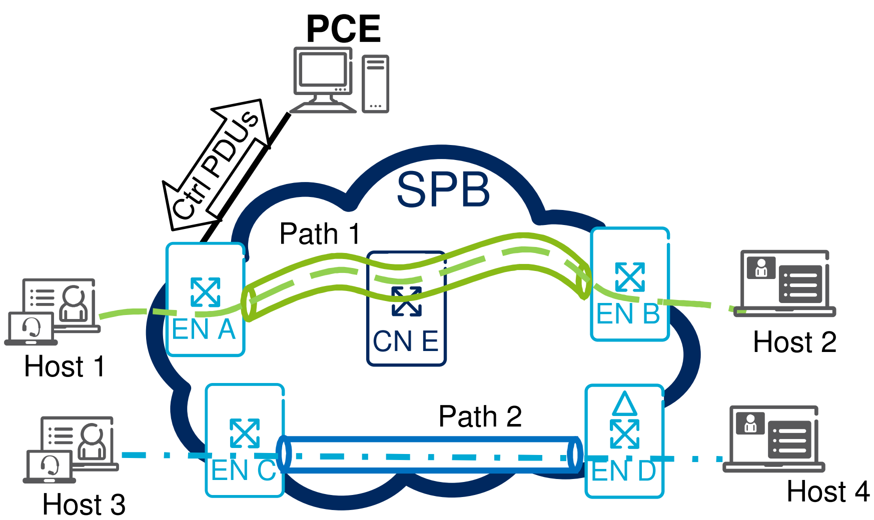
PAR Scope

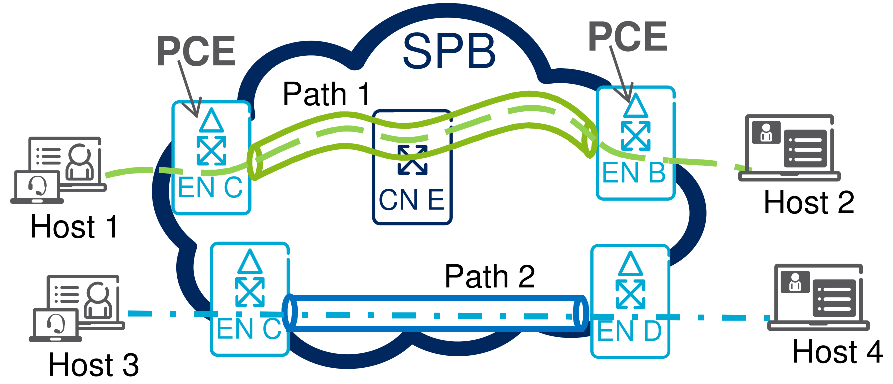
A. Explicit path control
B. Bandwidth and stream reservation
C. Redundancy (protection or restoration)
D. Distribution of control parameters for time synchronization
E. Distribution of control parameters for time scheduling

Proposal for 802.1Qca

Have a dedicated module/subclause for each item of the PAR scope

A. Explicit path control
   - Explicit Route Object (ERO) specified by Path Computation Element (PCE) (combined with Constraint Based Routing (CBR))
   - ERO flooded and installed by IS-IS





Proposal for 802.1Qca – cont'd

Have a dedicated module/subclause for each item of the PAR scope

A. Explicit path control
   - Explicit Route Object (ERO) specified by Path Computation Element (PCE) (combined with Constraint Based Routing (CBR))
   - ERO flooded and installed by IS-IS
B. Bandwidth and stream reservation
   - Performed by MSRP on top of topology controlled by IS-IS
   - Optimized by feeding Talker/Listener MSRPDUs into PCE(s)
C. Redundancy (protection or restoration)
   - Required new redundancy schemes provided by EROs
   - Automation may be provided under a new ECT-ALGORITHM
D. Distribution of control parameters for time synchronization
   - TLVs for the time synchronization parameters
E. Distribution of control parameters for time scheduling
   - TLVs for scheduling parameters

Summary of Choices

A. Explicit path control
   I. Determining the path
      1. Constraint Based Routing (CBR) (not really explicit control)
      2. Explicit Route Object (ERO) specified by Path Computation Element (PCE)
   II. Installing the path
      1. ERO distributed (flooded) by IS-IS
      2. ERO signaled by MSRP-TE
      3. ERO signaled by RSVP-TE

B. Bandwidth and stream reservation
   1. Reservation by MSRP
   2. Reservation by RSVP-TE
   3. MSRP functionality integrated into IS-IS

C. Redundancy (protection or restoration)
   1. PBB-TE
   2. EROs provide the paths for protection, only updated by PCE(s)
   3. Automatic maximum disjoint paths

Completely separate modules:

D. Distribution of control parameters for time synchronization

E. Distribution of control parameters for time scheduling

Details

References

[1] A. Fredette, “Running SRP on SPB/IS-IS”
http://www.ieee802.org/1/files/public/docs2012/new-avb-anfredette-srp-spb-v02.pdf

[2] F.-J. Goetz, “ISIS-SPB-PCR (IEEE 802.1Qca) Extensions for Path Control & Reservation,” http://www.ieee802.org/1/files/public/docs2012/ca-goetz-SPB-PCR-stream-ext-1112-v01.pdf

[3] RFC 3209 “RSVP-TE: Extensions to RSVP for LSP Tunnels”

[4] RFC 5305, “IS-IS Extensions for Traffic Engineering”

[5] RFC 5307, “IS-IS Extensions in Support of Generalized Multi-Protocol Label Switching (GMPLS)”

[6] RFC 5089, “IS-IS Protocol Extensions for Path Computation Element (PCE) Discovery”

[7] RFC 6060, “Generalized Multiprotocol Label Switching (GMPLS) Control of Ethernet Provider Backbone Traffic Engineering (PBB-TE)”

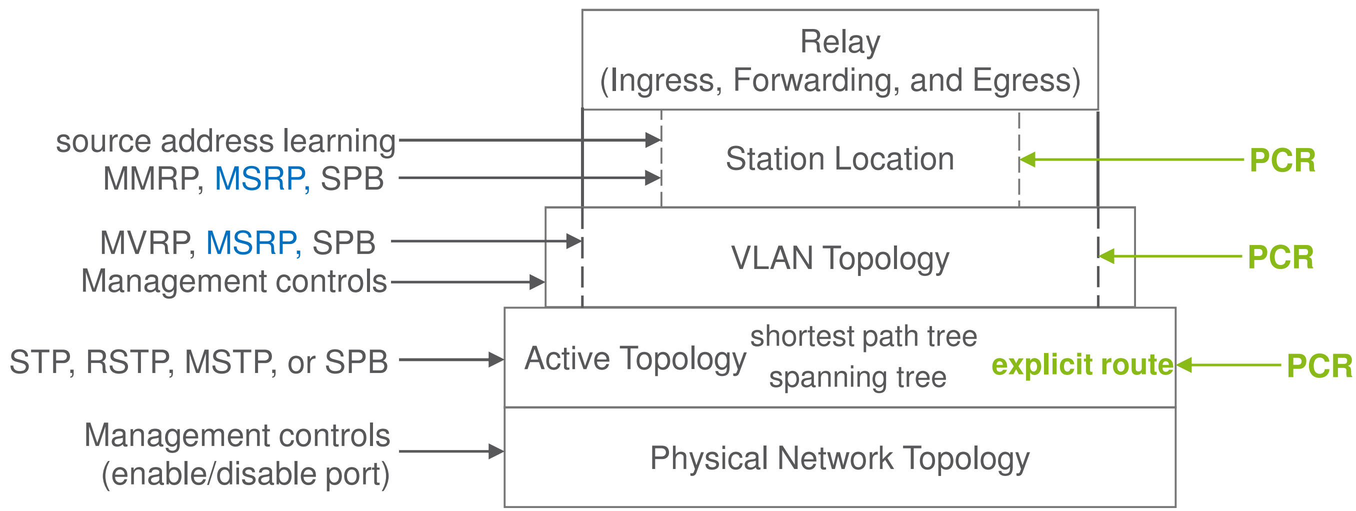
[8] A. Atlas et. al. “Algorithms for computing Maximally Redundant Trees for IP/LDP Fast-Reroute” https://datatracker.ietf.org/doc/draft-enyedi-rtgwg-mrt-frr-algorithm

[9] S. Previdi et. al. “IS-IS Traffic Engineering (TE) Metric Extensions”
https://datatracker.ietf.org/doc/draft-previdi-isis-te-metric-extensions

Modular Structure

- P802.1Qca's scope covers a wide range of features
- A modular specification would allow the application of these features as independent as possible and in different combinations as well, e.g.
  - Explicit path set-up only
  - Reservation on shortest path or on an explicit path
  - Redundancy between different combinations of explicit and shortest path
  - Both redundancy and reservation on shortest or on explicit path
- Each module could be an independent subclause within the Qca clause
- Notes
  - A solution only allowing a fixed combination (e.g. embedding path control into a reservation protocol) is most likely not the desired way forward (as it would not easily provide other combinations or a single feature e.g. path control only)
  - A solution dedicated to a particular combination might be more efficient for the given combination than a modular one
  - Using existing solutions if any would be advantageous

802.1 Topology Layers (Contexts)



black is the current Figure 7-1 [802.1aq]

green will be specified by P802.1Qca

- Each protocol is run on the context provided by the underlying layer
- (some protocols may control multiple layers, e.g. SPB)

Module A.
Explicit Path Control

Solution Alternatives/Components

1. Constraint Based Routing (Constrained Shortest Path)
   - It is not explicit path control, but can be a very useful component of the solution
2. Explicit Route Object (ERO)
   a) *either* IS-IS propagates ERO
   b) *or* a signaling protocol propagates ERO
3. External entity
   - The explicit path is determined by one or more entities external to the distributed control protocols

- We may combine these alternatives/components
- Note that one may only want to steer some traffic without any reservation or any additional feature. How to do it?

1. Constraint Based Routing

- Constraint Based Routing (CBR): shortest path meeting certain constraints
- Before running Dijkstra, links not meeting constraints are pruned based on e.g.
  - Available bandwidth
  - Link delay
  - Link delay variation
  - Link loss
  - Link color (requires configuration)
  - (extended Link State Database (LSDB) = Traffic Engineering Database (TED))
- The path is not explicit, it is influenced by configuration and the actual state, then automatically determined
  - Can be used e.g. to automatically find a path providing the bandwidth necessary for a stream
- What do we have so far
  - CBR is well known and already implemented
  - Constraints defined by [4], [5]
- To be done
  - Check whether existing constraints are satisfactory
  - Specify missing constraint if any

1. IS-IS TLVs for Link Attributes, e.g. for CBR

ISIS-SPB-PCR Link Metric Sub-TLV of [2]
Type (29)
Length
SPB Link Metric
Bandwidth
Link Speed
Bridge Delay
Traffic Class
Number PORTs
Port ID

Extended IS Reachability TLV of [4]
Type (22)
Length
Neighbor ID
Default Metric
Length of Sub-TLVs
Sub-TLV (3) Administrative Group (color, resource class)
Sub-TLV (9) Maximum Link Bandwidth
Sub-TLV (10) Maximum Reservable Link Bandwidth
Sub-TLV (11) Unreserved Bandwidth
Sub-TLV (18) Traffic Engineering Default Metric

IS-IS extensions for Traffic Engineering of [9]
Sub-TLV (?) Unidirectional Link Delay
Sub-TLV (?) Unidirectional Delay Variation
Sub-TLV (?) Unidirectional Packet Loss
Sub-TLV (?) Unidirectional Residual Bandwidth
Sub-TLV (?) Unidirectional Available Bandwidth

2. Explicit Route Object

- Explicit Route Object (ERO) [3]
  - Concatenation of hops which constitutes the explicitly routed path, which may contain
    - Strict hop: the path is exactly specified
    - Loose hop: any path can be used between the given nodes
    - Abstract nodes: group of nodes whose internal topology is opaque
- In case of loose hops, the ERO is combined with routing, e.g. CBR
  - Strict hops are not combined with routing
- What do we have so far
  - Unicast ERO
  - TLVs defined for IPv4, IPv6 and AS number
- To be done
  - Define TLV for Bridge ID / IS-IS System ID (Sys Name)
  - Define multicast ERO (description of a tree instead of a single path)

2. Explicit Route Object – cont'd

- ERO needs to be distributed by a protocol

2.a IS-IS distributes ERO
  - IS-IS flooding can be used to distribute EROs
  - State then only installed by nodes that need to
  - Computation of loose routes is done by nodes that are affected
  - To be done: specify ERO TLVs for IS-IS and their processing

2.b A signaling protocol distributes ERO
  - RSVP-TE [3]
    - Do we want to run RSVP on bridges?
    - To be done: adapt RSVP-TE to bridges (Bridge ID / IS-IS Sys ID)
  - MSRP-TE (enhanced, next version of MSRP) [1]
    - Could be good if one wants to perform both path control and reservation
    - To be done: specify MSRP-TE

- Do we want to require the use/implementation of a signaling protocol if one only wants to use the explicit path control feature of 802.1Qca?

3. External Entity

- The explicit path is determined by an entity external to the dynamic protocols applied, e.g. to IS-IS
- 3.a Path Computation Element (PCE) [6]
  - PCE is an application that is able to determine ERO; it is located within a network node or on an out-of-network server, etc.
  - To be done
    - Enable PCE support of bridging
    - Establishment of ERO
- 3.b External Agent, e.g. Software Defined Networking (SDN) Controller
  - 802.1Q-2011 (802.1Qay) supports path control by an External Agent
  - The explicit path determined by the External Agent then can be installed e.g. by [7]
  - Nothing to be done

A Solution for Explicit Path Control

i. Have a PCE also maintaining a replica of the LSDB (thus the TED as well)
   - ([6] provides handling of multiple PCEs e.g. for resiliency)

ii. PCE determines EROs

iii. ERO then flooded by IS-IS
   - Thus explicit routes may be taken into account during CBR (e.g. if it is based on the number of paths traversing a link)

iv. Nodes involved in the ERO then install forwarding state

- To be done
  - Specify missing IS-IS TLVs for Bridges (or in general for IS-IS)
    - e.g. ERO TLV; including multicast trees
  - Specify the operation based on the new and existing IS-IS TLVs

Module B.

Bandwidth and Stream Reservation

Solution Options

› Assuming that we have a separate module for explicit path control, the three options of [1] is reduced to two:

1. Reservation by MSRP
   - Topology is controlled by extended IS-IS
   - Reservations are performed by MSRP (Gen1 or Gen2)
   - (covers Model 1 and Model 2 of [1])
2. Reservation integrated into IS-IS
   - MSRP functionality integrated into IS-IS

› Interworking with MSRP (even Gen1) at Boundary Ports will be provided independently of the solution option taken
   - Similarly to the other two MRP Applications: MVRP and MMRP

1. Reservation by MSRP

- Today's principles are kept (MRP Application on top of Active Topology context)
- Topology is controlled by extended IS-IS
  - Shortest path provided by SPB
  - Explicit path provided by Module A of 802.1Qca
- MSRP
  - MSRP is then run on a new Context instead of the Base Spanning Tree Context
  - MSRP is then run as today (no paradigm change)
  - Thus, both Gen1 and Gen2 MSRP can be used
- Note that Model 2 of [1] integrates Module A and Module B into a single MSRP-TE solution

2. Reservation by IS-IS

- MSRP functionality is integrated into IS-IS
- Talker and Listener information carried by LSPs, thus stored in the LSDB
- Bridges are then able to compute and perform the appropriate reservations
- Computationally heavy

A Solution for Bandwidth and Stream Reservation

i. Have the solution of page 18 for explicit path control
ii. Run MSRP on top of explicit and/or (constrained) shortest paths

- In order to optimize the operation, PCE(s) should be aware of MSRP Attributes
  - PCE(s) should receive MSRPDUs of Talkers and Listeners (aside the LSPs received)
  - PCE(s) then would be able to determine optimal path for the Stream and initiate the installation of the path if it is not in place by handing the proper ERO to IS-IS
  - MSRP reservation could be then performed on the path as today by MSRPDUs
  - Note that PCE can be a central entity or even each bridge connected to an MSRP Talker could run a PCE application
- To be done: specify PCE application for MSRP

Module C.
Redundancy

802.1Qca's Task

- Note that the task of 802.1Qca is to provide the redundant paths required for the protection schemes aimed to be applied, for example
- 1+1 protection (static redundancy)
  - 802.1Qca should provide the two maximum disjoint paths
  - Injection and reception of the frames on these paths will be specified by "Seamless failover via frame replication and duplicate frame elimination for scheduled traffic"
- 1:1 protection (protection switching)
  - 802.1Qca will provide a solution for determining the paths (other than the solution specified by 802.1Q-2011)
  - Protection switching state machines are already specified by 802.1Q-2011 and 802.1Qbf

Protected Paths

- Paths under protection should not be (immediately) updated by IS-IS restoration after a topology change
  - This is provided today for VIDs allocated to the TE-MSTI
  - ECT-ALGORITHM could be specified ensuring this feature

1. Completely external to IS-IS
   - External Agent controls VLANs allocated to the TE-MSTI
   - It is there today in 802.1Q, nothing to be done
2. Semi-integrated to IS-IS
   - The EROs are only updated by the PCE
   - It is involved in the explicit path control solution of page 18
3. Fully integrated to IS-IS
   - Protected paths are carefully updated by IS-IS

3. Protection Paths Fully Integrated to IS-IS

- Each protection scheme can have its own ECT-ALGORITHM
  - Number of paths/trees determined
  - Constraints applied
  - Wait to Recompute delay value
  - Exact recomputation/update mechanism etc.
- 802.1Qca could e.g. define one algorithm
  - It could be based on the Maximally Redundant Trees (MRT) algorithm [8], which produces maximal disjoint trees
  - The disjoint paths/trees could be then used e.g. for 1+1 protection
  - Only one of the trees updated at a time after a topology change, which update is only performed after the Wait to Recompute delay