Consistent VID to MSTID Allocation

A contribtion to the IEC/IEEE 60802 Joint Project for discussion

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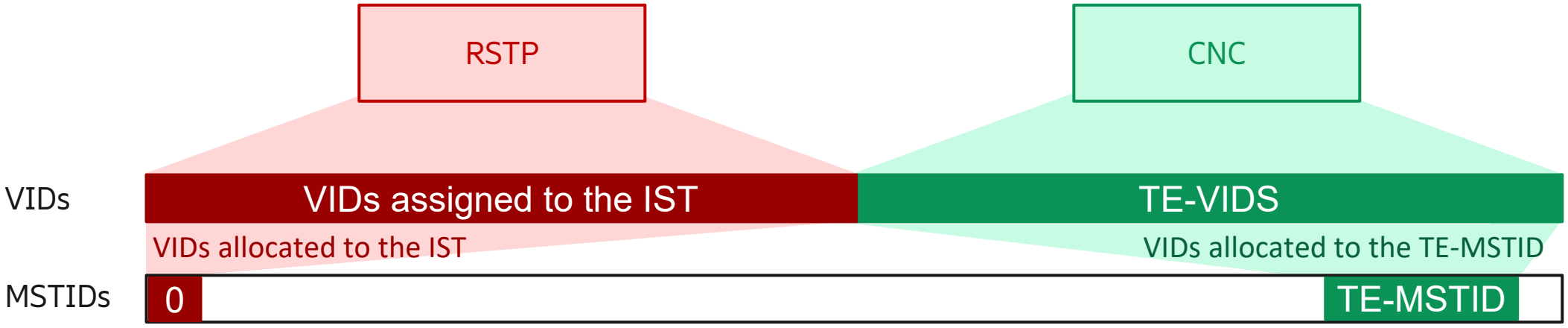
Acknowledgements and Disclaimer

- The presenter is grateful for and acknowledges the ideas and suggestions received from Mick Seaman and Balázs Varga.

- This contribution is related to item 16 on page 7 in https://www.ieee802.org/1/files/public/docs2021/60802-woods-D1-3-update-0721-v01.pdf
- However, this is just an initial contribution to kick-off group discussion on the subject, e.g., towards selection of preferred development direction.
- Note that the contribution may be imperfect in capturing potential solution ideas.
- Further discussions are needed.

Trigger to This Contribution:
Basic VID Allocation Approach/Scheme in Industrial Automation

- Traffic Engineered VLANs are planned to be applied together with VLANs that are associated with RSTP in industrial automation deployments
  - See, e.g., https://www.ieee802.org/1/files/public/docs2020/60802-dorr-MST-0820-v01.pdf :
  - "Support of TE-MSTID and RSTP based CIST fulfill all requirements."
- Another illustration of the approach:



Background: Loop Avoidance for VLANs

1. Consistent selection of active topology enforcement mechanism (control principle) for each VLAN throughout a network region/domain
2. Loop prevention is then performed by the selected active topology enforcement mechanism
   - Loops are avoided by RSTP, MSTP, SPB if they are the ones selected
   - Loops are and must be avoided by the central entity (external agent, CNC, SDN controller) if centralized approach is selected for a VLAN
     - The central entity establishes loop-free (Traffic Engineered) forwarding for the VLAN

- Note: This presentation focuses on step 1).

Background: VID → MSTID Allocation

- Base VID → MSTID allocation selects the control principle to be applied for a given VLAN
- Centralized
  - Base VID → TE-MSTID = 0xFFE
  - →Under the control of a central entity, e.g.: External Agent / CNC / SDN Controller
- Distributed
  - 0xFFC, 0xFFD → SPB
  - smaller than 0xFFC → MSTP
- It is per bridge configuration
- Allocation must be consistent through a Region to avoid loop, duplication, etc.

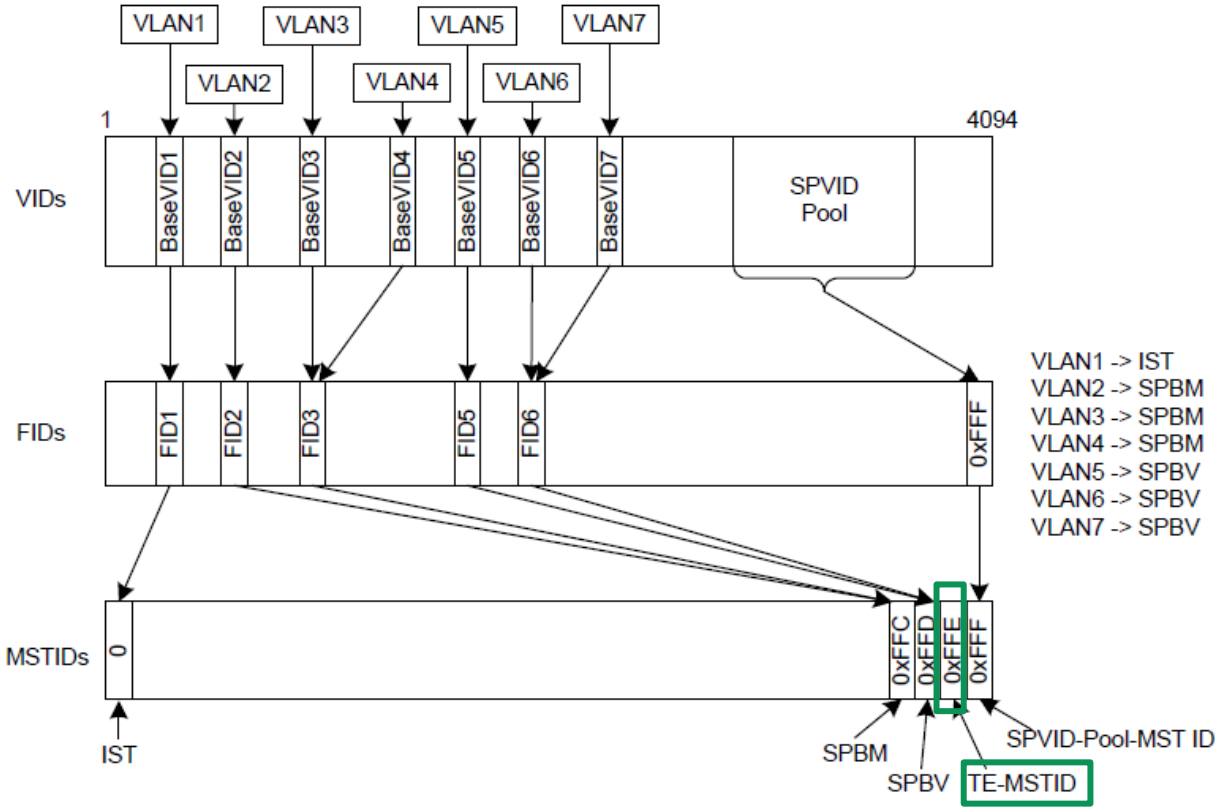


Figure 27-1—Configuring VLAN support in an SPT Region (example)

Background: TE VLANs

- Traffic Engineered (TE) VLANs are suggested to be used for TSN Streams
  - The VIDs used by TSN Streams can be allocated to the TE-MSTID in order to avoid spanning tree operations on the given VIDs, see 802.1Qcc-2018.
  - This contribution refers to such VIDs as TE VIDs and the corresponding VLANs as TE VLANs. (Note that TE VID and TE VLAN are not standard terms.)
- NOTE
  - TE-MSTID is only a configuration “knob” to make VLANs under the control of an entity outside of bridges (external agent, CNC, SDN controller, etc.), see previous slide

Background: VLAN Configuration Consistency

- MSTP introduced the possibility to allocate different VIDs to different spanning tree instances (MSTI: Multiple Spanning Tree Instance).
- **VLAN configuration consistency throughout bridges belonging to the same MST Region is essential for loop avoidance.**
- The MST Configuration Identifier (MCID) is carried in MST BPDUs and exchanged between adjacent neighbour bridges.
- MCID includes a Configuration Digest designed so that two matching identifiers have a very high probability of denoting the same allocation of VIDs to MSTIDs.

Caveats

- MSTP specific features are not exposed to RSTP in 802.1Q, e.g.:
  - The capability of allocating different VIDs to different spanning tree instances was not of interest in case of a single spanning tree instance.
  - The configuration “knob” for allocating VIDs to the TE-MSTID is not exposed to RSTP in 802.1Q.
  - MCID is not carried in RST BPDUs.
    - No VID to MSTID consistency check if not all the VIDs are allocated to the single spanning tree instance.

TODOs Identified So Far

A. Add configuration “knob” for allocating VIDs to the TE-MSTID in case of RSTP
B. Ensure VID to MSTID configuration consistency (at least throughout a TSN domain)
   - It is needed to be able to prevent network meltdown due to traffic loop.
   - A “signature” task: addition of a bridge to a TSN domain

Initial Ideas on Providing VLAN Configuration Consistency

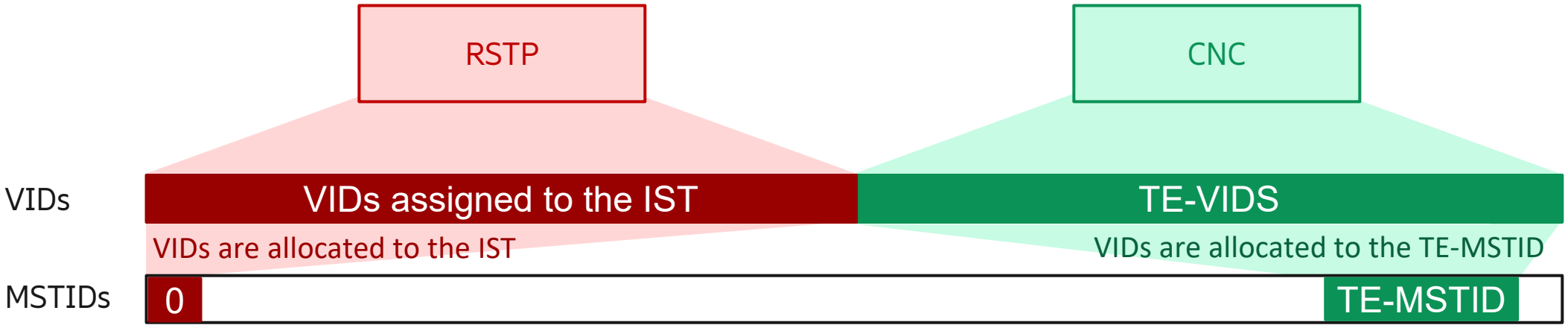
This is just a kick-off for group discussion.

Basic Ideas

- Main risk case: Addition of a new bridge
  a) Differing VID to MSTID assignments
  b) RSTP bridge that does not support TE-MSTID
- Basic solution possibilities
  - Default configuration
  - Configuration verification via protocol between adjacent neighbours
    i. Exchange configuration information between adjacent neighbours
       - MST Configuration Identifier (MCID) as specified in 13.8 in 802.1Q-2018
    ii. Detect configuration mismatch between adjacent neighbours
    iii. Block frame forwarding for mismatching VIDs between mismatching neighbours

Solution 1: Default Configuration

- A profile specification can specify default VID to MSTID allocations.
- Such defaults help to have the VID to MSTID allocation be the same throughout a deployment.
- One realization is that a certain VID range is allocated to the TE-MSTID, and the rest is allocated to the CIST (MSTID=0).
- Illustration of default VID to MSTID allocation



Solution 2: LLDP TLV

- A new LLDP TLV could be specified to exchange information on the VID to MSTID allocation in LLD PDUs between adjacent neighbours
  - MCID as specified in 13.8 in 802.1Q-2018
  - Provides similar capabilities to MCID exchanged via BPDUs.

- Configuration mismatch between adjacent neighbours needs to be detected

- Frame forwarding for mismatching VIDs needs to be blocked

Solution 3: LLDP TLV with MACsec/MKA Support

- MKA (MACsec Key Agreement) ensures that the communication is with an authenticated, authorized neighbour
  - The same TLV can be specified for Solution 2 and Solution 3
- Solution 3a: Run LLDP over MACsec
  - MACsec is used to protect all data transmitted between the adjacent neighbours
- Solution 3b: Carry the TLV in MKA
  - Secure communication before the use of the TE VLANs.
  - Independent of whether (or not) MACsec is used to protect data frames
  - EAPOL-Announcement carries the TLV in MKA

Summary

- Traffic loops must be prevented.
- This requires consistent VID to MSTID allocations.
- There are multiple options to provide consistent VID to MSTID allocation between Rapid Spanning Tree brides.