TSN Domain Proposal for 802.1Qdj

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Problem Statement

- The 802.1 TSN collection of standards introduce techniques including new methods for shaping traffic and new ways of configuring new and existing shaping techniques.
- Depending on the applications that need to be solved, applying the same traffic shaping methods may not be adequate for all applications within a LAN.
- Two possible solutions to this problem exist:
  - Standardizing mechanisms to bound the area within a LAN that the shapers apply to (TSN Domains) and creating mechanisms (TSN Interdomain/Intradomain communications) to make time sensitive stream reservations between multiple domains.
  - Using subnet boundaries to bound the area that the shapers apply to and creating mechanisms (DetNet) to make time sensitive stream reservations between multiple domains.
- Creating both standards will allow for flexible networks to be created, though the latter is out-of-scope for this group.

Currently Published Concepts

- Stream Reservation Protocol Domains
  - This concept modifies and uses the SRP Domains concept which the author believes includes preemptive/preemptable traffic, as well as extending the bounds to include time aware shaper boundaries. Section 34.2 provides more detail on SRP Domain Detection.
  - The definition of a SRP domain will need to be adjusted to include the Strict Priority Shaper.
- TSN Domains
  - This concept is informatively discussed in Annex U.2 7) of 802.1Qcc
  - The definition given assumes there is a boundary for time sensitive streams in a LAN, and that boundary will not allow time sensitive streams to traverse the boundary.
  - Normative text should be added and this text will need to be adjusted to allow for interdomain communications.

Overview of Suggested Additions to 802.1Q via the 802.1Qdj PAR

- Core Definition and Characteristics
  - Add a definition for TSN Domains in new section 46.1.5
  - Add characteristics of TSN domains in new section 46.1.5
  - Modify the definition of SRP Domain in 35.1.4
- Interdomain Communications
  - Add a definition of stream transformation for TSN Domains in a bridge in 35.2.2.10.5 part c, 46.1.4 and Appendix U.2 part 7
  - Include A TSN Domain identification TLV in LLDP in 46.1.5

Proposed Definition of TSN Domains for 802.1Q Section 46.1.5

- TSN Domain: A set of stations (end stations and/or Bridges), their Ports, and the attached individual LAN's that transmit Time-Sensitive Streams using a selection of: SRP Domains or RAP Domains, Preemption, Time Synchronization and Enhancements for Scheduled Traffic and that share a common management mechanism (or "policy engine").

Proposed Characteristics of TSN Domains for 802.1Q Section 46.1.5

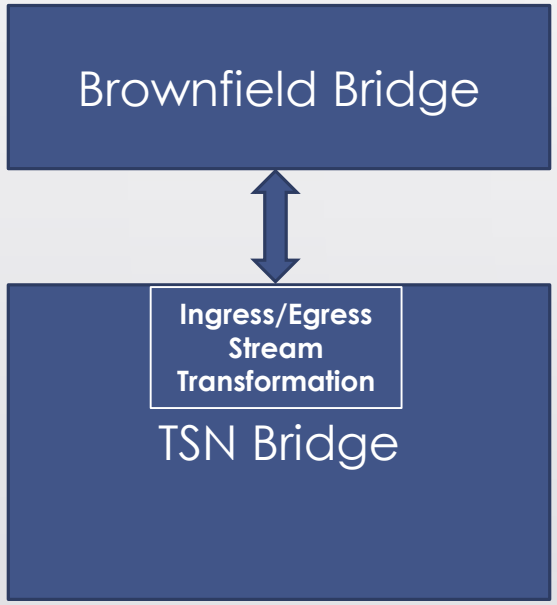
- One or more TSN Domains may exist within a single Local Area Network.
- A TSN Domain may not be shared among multiple Local Area Networks.
- The TSN configuration model (I.E. centralized, distributed, hybrid) is shared within a TSN domain.
- The TSN configuration authority (I.E. CNC) is shared within a TSN domain.
- Member stations support a common set of TSN mechanisms (Select individual stations may support additional mechanisms)
- Two TSN Domains may have identical configurations but stay separate.
- A port must only be a member of a single TSN domain

TSN Domain Characteristics For Discussion

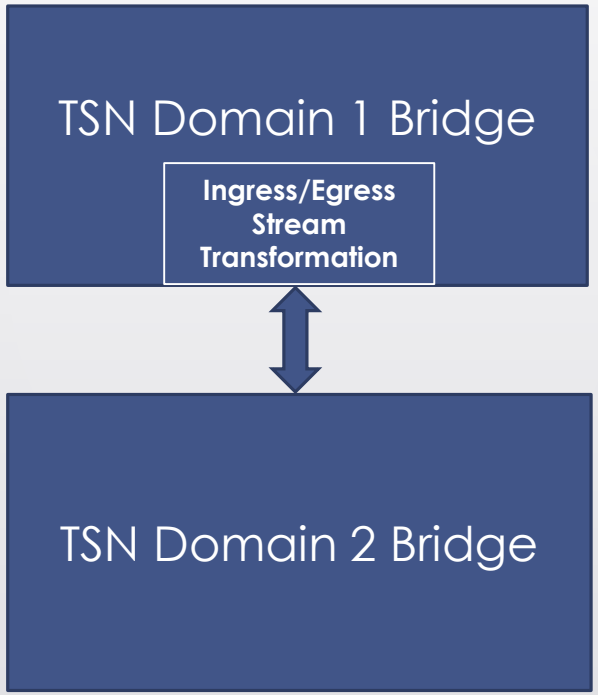
- Time
  - Should shared time domains be required for a TSN domain?
    - Is a time domain scalable to the same extent of a TSN domain with a vast number of stations?
    - Are there use cases where separate time domains exist and strict priority QoS can be used to pass traffic between them in one TSN domain?

TSN Domain Characteristics For Discussion

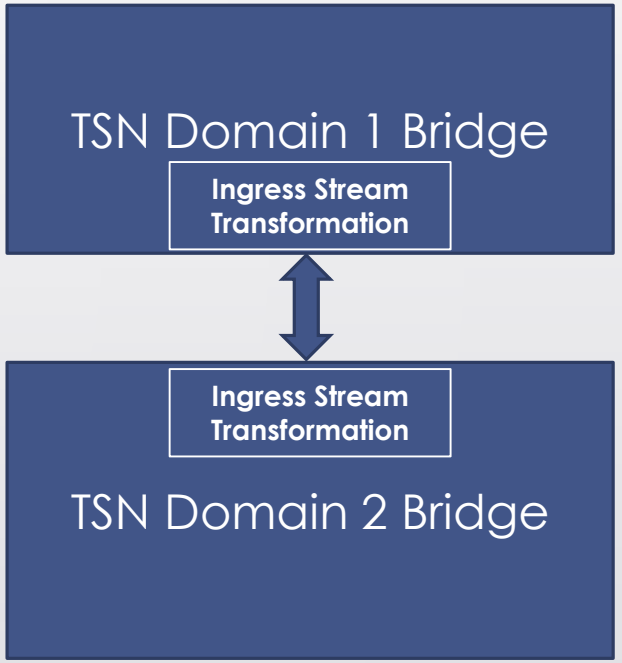
- Should a bridge be required to solely be in one TSN domain?



Standard Stream Transformation



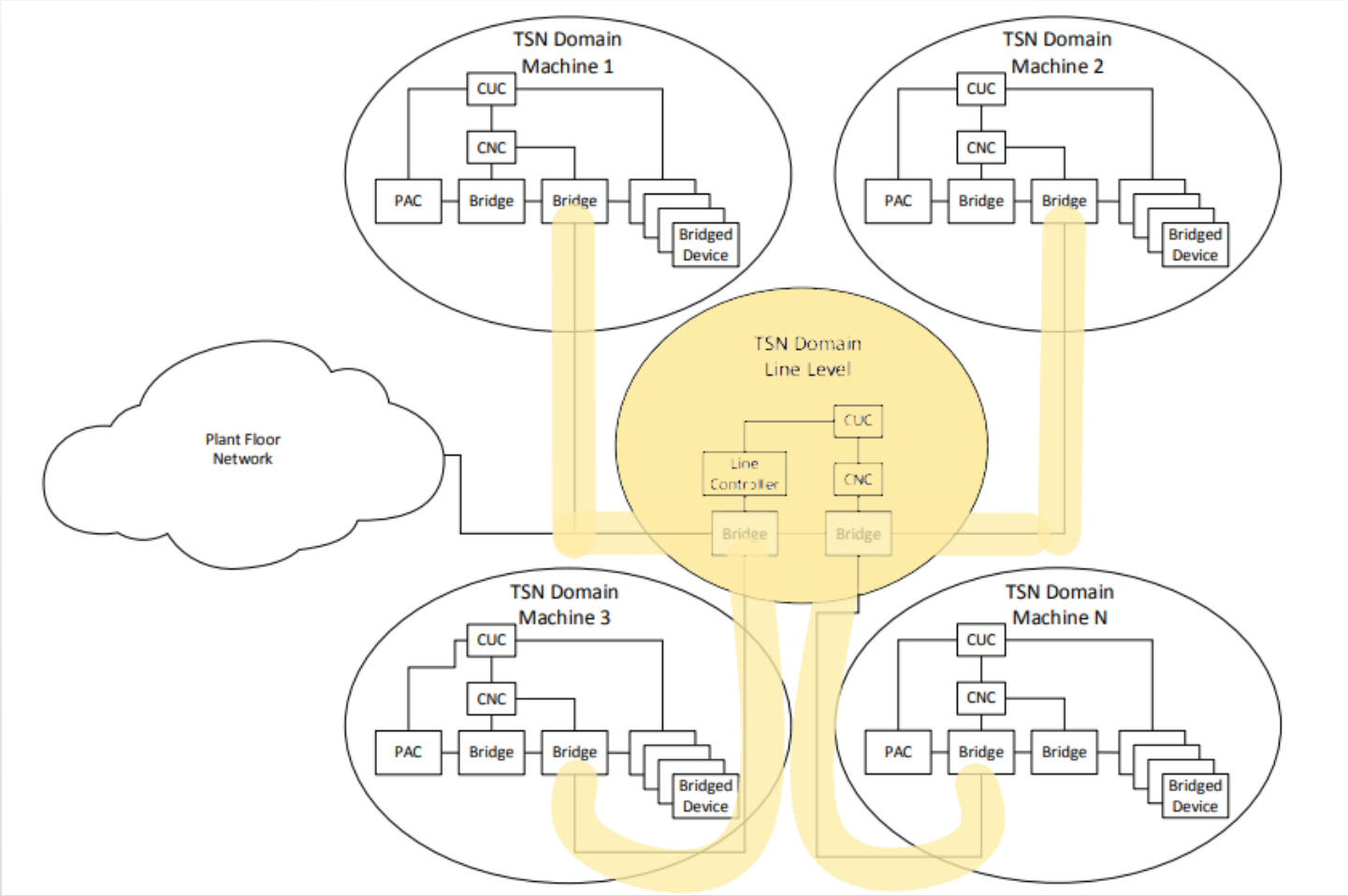
Option 1: Standard Stream Transformation for Interdomain Communication



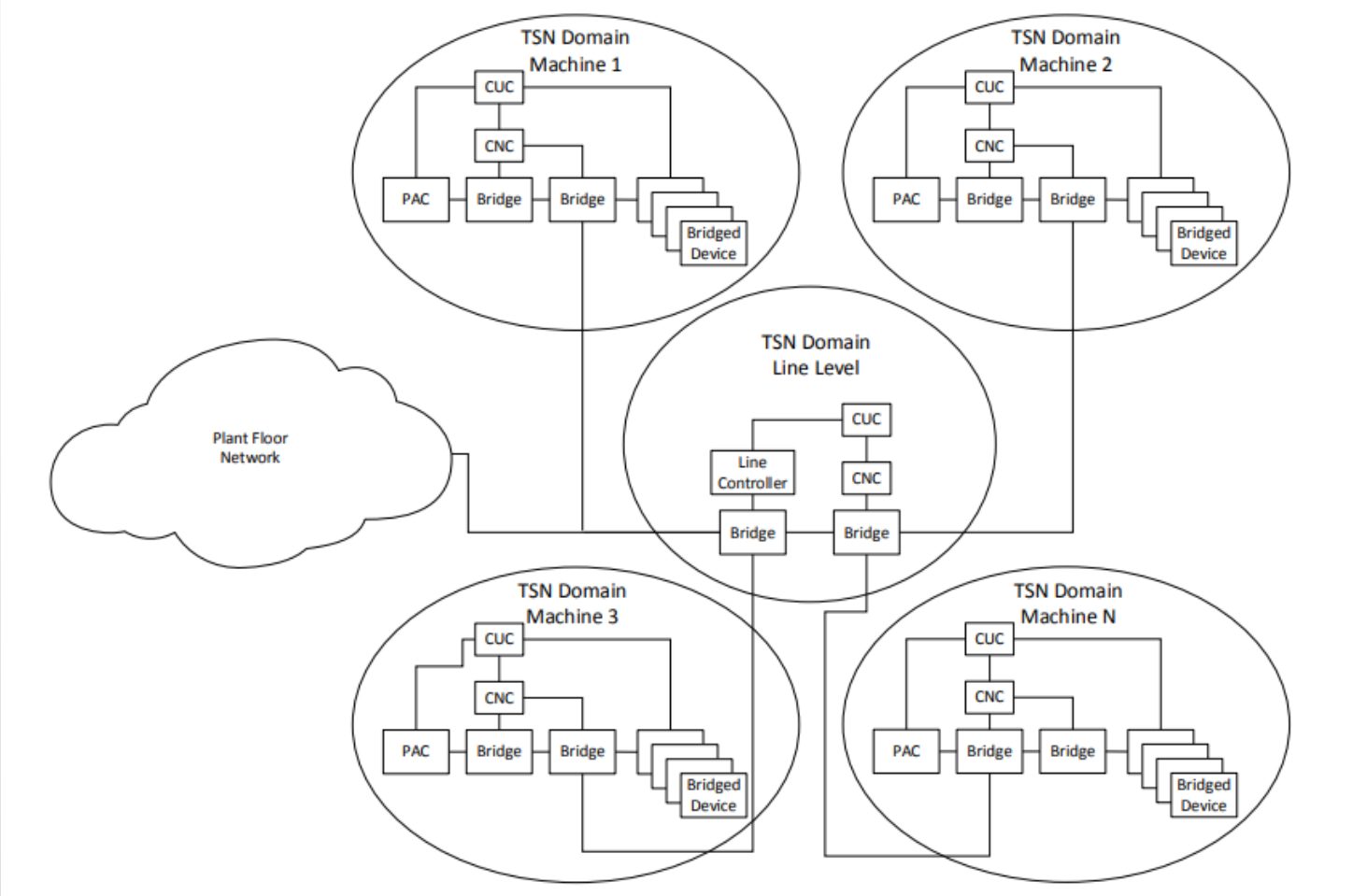
Option 2: Ingress Stream Transformation for Inter-domain Communication

Option 1: Standard Stream Transformation for Interdomain Communication

This is a typical factory automation scenario. The concept of TSN Domains as defined here will scale to every present TSN use case including AVB, Automotive, 5G, Fronthaul and Industrial Process Networks.



Option 2: Ingress Stream Transformation for Interdomain Communication



Additional Characteristics of TSN Domains for 802.1Q Section 46.1.5

- If Option 1 is chosen
  - Multiple domains will often be implemented in one bridge.
- If Option 2 is chosen
  - All ports of an end station or bridge belong to the same TSN Domain as the end station or bridge itself.
  - An end station or bridge cannot be a member of multiple TSN Domains.
  - Other devices, such as routers or gateways, may comprise multiple logical end stations and/or bridges. Each of these end stations and/or bridges can be member of a different TSN Domain.

SRP Domain Definition Modification

- Change 34.1 c) from:
  - A credit-based shaper algorithm….
- To the following:
  - A strict-priority or credit-based shaper algorithm…
- Change 35.1.4 a) from:
  - Those stations that transmit streams all support the credit-based shaper algorithm, defined in 8.6.8, as the transmission selection method for the SR class.
- To the following:
  - Those stations that transmit streams support the strict-priority shaper algorithm, defined in 8.6.8, or the credit-based shaper algorithm, defined in 8.6.8, as the transmission selection method for the SR class.

TSN Interdomain Stream Communications using Stream Transformation

- Add SRP/RAP Domain references to the following sections regarding stream transformation
  - 35.2.2.10.5 part c
  - 46.1.4
  - Appendix U.2 part 7

Preemption in TSN Interdomain Communication

- No additional work needed here
- The SRP/RAP domain definition along with stream transformation should be able to transform a preemptive stream in one domain to a preemptive stream in another domain if necessary.

Qbv Scheduling in TSN Interdomain Communication

- This is an area for invention.
- Possible solutions include:
  - "One big shared schedule" - Aggregate CNC scheduling function for all TSN domains that implement interdomain communication to one CNC, or communicate between multiple CNC's with a protocol built for sharing this data. Constrain the CNC to transmitting all scheduled interdomain communications first, then filling in scheduled gaps with intradomain scheduled traffic.
  - "Queue it" – Temporarily Hold traffic egressing one scheduled network in one time slot and ingressing another scheduled network at another time slot. The delta in schedule between each CNC will be your hold duration for latency calculation and queue sizing, and can be minimized for streams that require it.
    - Options include adding additional queuing or placing it in an existing queue. Can affect TSN domain schedule determinism if placed in an existing queue.

TSN Domain Identifier in 46.1.5

- Add a TSN domain identifier LLDP TLV for each port on each bridge and end-station that supports TSN.
- This configuration can be pushed down through a data sheet or network management(assuming a revision to 802.1Qcc adopts it)
- Unconfigured bridges will pick up TSN-IA domain port configuration from adjacent devices through LLDP. This enables device replacement and plug-and-play for bridged end-stations
- If bridges receive different TSN-IA configurations on different ports, only the ports that receive adjacent configurations through LLDP will be configured
- If the two ends of a link between two ports doesn't have matching TSN-IA configuration data plane communications on that link will not be established and an error will be asserted via the configuration tools

TSN Domain Identifier Characteristics in 46.1.5

- The TSN Domain Identifier should be human readable and unique
- Cloning a machine with a TSN Domain should create a unique identifier
- The CNC needs to be able to configure devices even if the data plane is unusable due to mismatched TSN Domain Configuration

Additional Reading

- [1] http://www.ieee802.org/1/files/public/docs2018/60802-Hantel-TSN-Interdomain-Communications-0718.pdf
- [2] http://www.ieee802.org/1/files/public/docs2019/60802-Hantel-Data-Sheet-Model-0119-v00.pdf
- [3] http://www.ieee802.org/1/files/public/docs2018/60802-industrial-use-cases-0918-v13.pdf Use Cases: 12, 19, 23, 27, 28, 33, 35
- [4] http://www.ieee802.org/1/files/public/docs2019/60802-Steindl-ExampleSelections-0119-v02.pdf
- [5] http://www.ieee802.org/1/files/public/docs2019/new-chen-TSN-Configuration-Interaction-0719-v01.pdf
- [6] http://www.ieee802.org/1/files/public/docs2018/60802-stanica-convergence-coexistence-0718-v03.pptx
- [7] http://www.ieee802.org/1/files/public/docs2019/60802-Hantel-TSN-IA-Domains-Constructability-0519-v01.pdf
- [8] http://www.ieee802.org/1/files/public/docs2019/60802-Hantel-TSN-Domains-vs-TSN-IA-Domains-0719-v00.pdf