User Stories

Contributors:
Guenter Steindl
Marius-Petru Stanica
Martin Ostertag
Rene Hummen
Stephan Kehrer
Mark Hantel

Terms

ES	End Station
B	Bridge
ME	TSN Domain Management Engine
Device	Bridge or End Station
Plug&Produce	The application of an End Station which is plugged to a TSN domain can without additional user or engineering tool action request, establish and use (real-time) streams for communication.
Power on	"After power on" is a state in which any application would be able to run.

Constraint

The following is an unsorted list of constraints. The order is incidental and not intended to convey meaning.

Application

No application actions are shown; only end stations and bridge related behavior

Communication before ME applies policy

The behavior depends on the history.

A) Device is part of the TSN Domain, previous ME configuration is stored
All configured traffic classes are available and can be used

B) Device is part of a different TSN Domain
TSN Domain identifier check shows Domain Boundary,
Only limited traffic classes are available

C) Device is in "out of the box" state
TSN Domain identifier check shows Domain Boundary,
Only limited traffic classes are available

Address assignment

Addresses may be assigned by DHCP/DNS and is not shown.

Security

Security, (e.g. authentication, encryption) is assumed to be part of the overall solution.

Synchronization

Synchronization is assumed to be part of the solution but ignored to simplify the user story discussions.

TSN Domain Identifier

The TSN Domain Identifier is expected to be unique in space and time to prevent accidental unintended combination of TSN domains (e.g. different feature sets and configurations may be active in these domains).

TSN Domain Management Engine

The following user stories assume at least three configuration models.

A) Complete offline engineered
   - Topology
   - Network and End Station
   - Streams

   Offline is equal to Online!
   Topology discovery and verification
   Bridge and End Station configuration
   Stream setup in Bridges and End Stations

B) Partial offline engineered
   - Partial topology
   - Network and End Station
   - Partial streams

   Core portion of machine, offline is equal to Online. Machine variants define additional bridges and end stations.
   Topology discovery and (for the core) verification
   Bridge and End Station configuration
   Stream setup in Bridges and End Stations (for the core portion)

C) Network and End Station only
   - Network and End Station

   Topology discovery
   Bridge and End Station configuration

Device pre-configuration situations

If a device supports plug & produce it must support the minimal set of features required to be managed by an ME.

60802 devices must implement features to enable the ME configuration step that allows plug & produce.

Device Options

1. The device is shipped out of the box with all plug & produce features enabled.

2. The device comes out of the box unable to be used as plug & produce (e.g. LLDP is disabled) but is harmless to the network and needs to be configured in-place before being usable by the ME.

3. The out-of-the-box configuration is harmful (e.g. IP address reuse, loops with STP disabled) to the network and needs to be configured stand-alone before being introduced to the network.

Examples:

- A. End-station non-configured, out-of-the-box
    - The end station lacks whatever configuration (network-related or not)
    - It comes with a producer MAC address
    - Some examples of features that may be present which require configuration to allow an ME to configure:
        - The end-station has a default IP address
        - If there is a bridge embedded with the end station, then
            - No spanning tree activated
            - No DHCP activated
            - LLDP and SNMP/Netconf agents deactived
            - No L3 routing active
        - Reachable over SSH over the default IP address, alternatively on another type of connection (e.g. USB, serial)
- B. Basic network configured end-station (OEM, system integrator, other)
    - The end station bears a requested MAC address/default MAC address
    - The end station bears a project-required fixed IP address / has its DHCP activated
    - The end station has its LLDP active, also SNMP/netconf
    - If a bridge is present too
        - The bridge has the default STP activated
- C. Advanced network interface configured end station
    - The end station bears a requested MAC address/default MAC address
    - The end station bears a project-required fixed IP address / has its DHCP activated
    - The end station has its LLDP active, also SNMP/netconf
    - The end station has a given TSN domain ID configured
    - The end station has its time synch protocol activated and pre-configured as required by a project
    - If a bridge is present too
        - The bridge has the default STP activated

US1: Simple TSN Domain Startup

Costumer creates a TSN Domain by configuring the ME with a TSN Domain identification and a network policy.

As a next step he creates a network out of four entities:

- ME
- B
- 2x E

as shown in Figure 1.

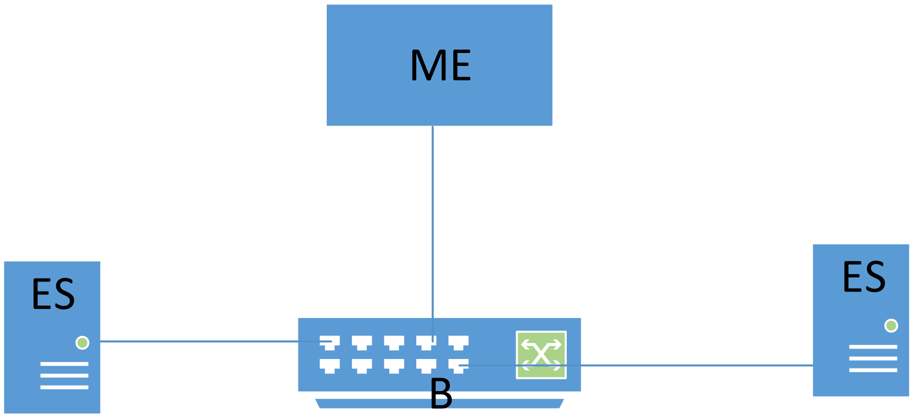

Figure 1: Simple TSN Domain

Expected behavior

The ME discovers the connected network. For any discovered device assigned to its TSN Domain the Ethernet portion will be configured according to the ME stored policy.

Thus, all devices of the TSN Domain will be configured according to the ME network policy.

Any unused port will be configured as “TSN Domain boundary”.

US2: Topology Updating / Topology change discovery

A ME needs an up-to-date topology including all bridges and end stations of a TSN Domain.

Expected Behavior

A ME can on a periodic basis walk its’ TSN domain to ensure the stored topology is still valid.

US2.1: Plugging an additional device

Customer plugs another bridge and/or end station.

When a user plugs a new device into a Time Sensitive Network domain, the user needs to be able to configure the device through the ME, and thus the ME needs to know it exists.

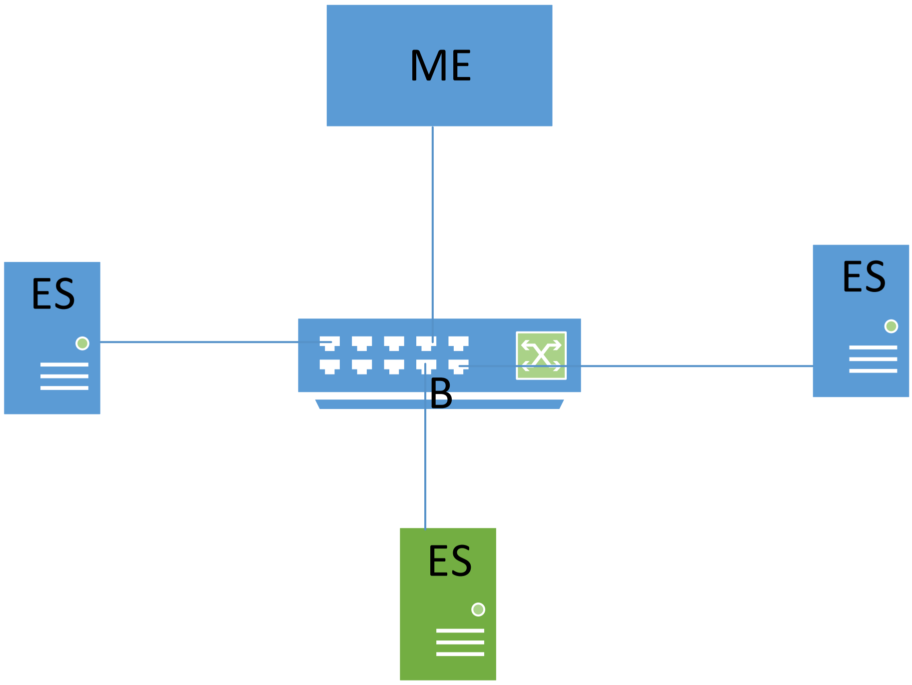

Figure 2: Simple TSN Domain – plug an ES

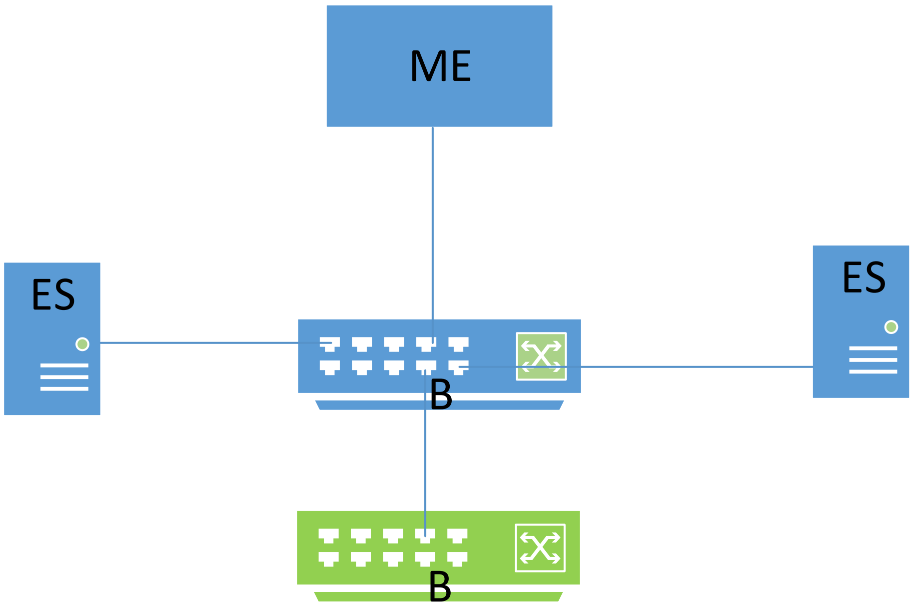

Figure 3: Simple TSN Domain – plug a Bridge

Expected behavior

ME discovers the additional connected device using Topology Discovery, checks (by using the TSN Domain identification) whether it belongs to this TSN Domain.

LLDP is implemented on every device that is 60802 conformant. The device plugged in will advertise its presence and identifiers to adjacent nodes. Identifiers must include MAC address, IP address, and TSN Domain Identifier.

If it belongs to the TSN Domain, then the ME configure the Ethernet portion according to the ME stored policy.

If not, no action.

Adjacent nodes can provide information about the new device to the ME. Adjacent nodes can store information about the new device in their memory to be read by a ME. Time constraints (60802 Use Case 20) may require the adjacent node to provide information to the ME.

US2.2: Removing a Device from The Topology

When a user removes a device from a TSN domain, the user needs to see this device removed from the ME.

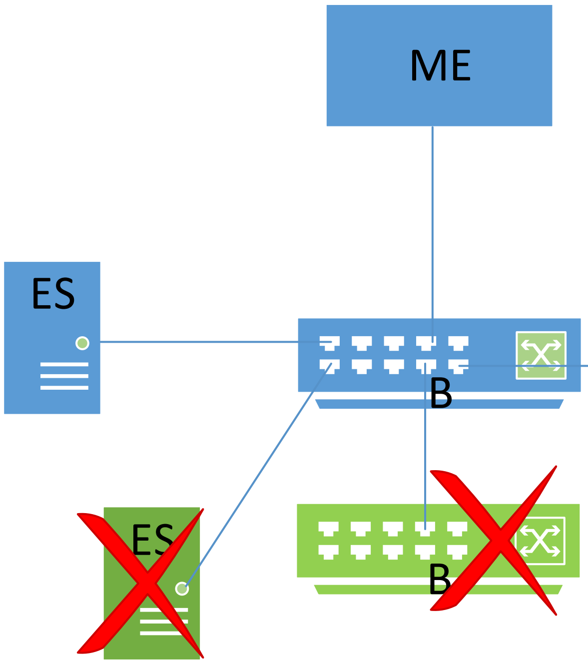

Figure 4: Simple TSN Domain – remove a device

Expected Behavior

The removed device will no longer be a part of the discovered topology.

Adjacent nodes can provide information about the removed device to the ME. Adjacent nodes can store information about the removed device in their memory to be read by a ME. Time constraints (60802 Use Case 20) may require the adjacent node to provide information to the ME.

US3: Combining two TSN Domains

A user introduces a new physical link that joins two TSN domains.

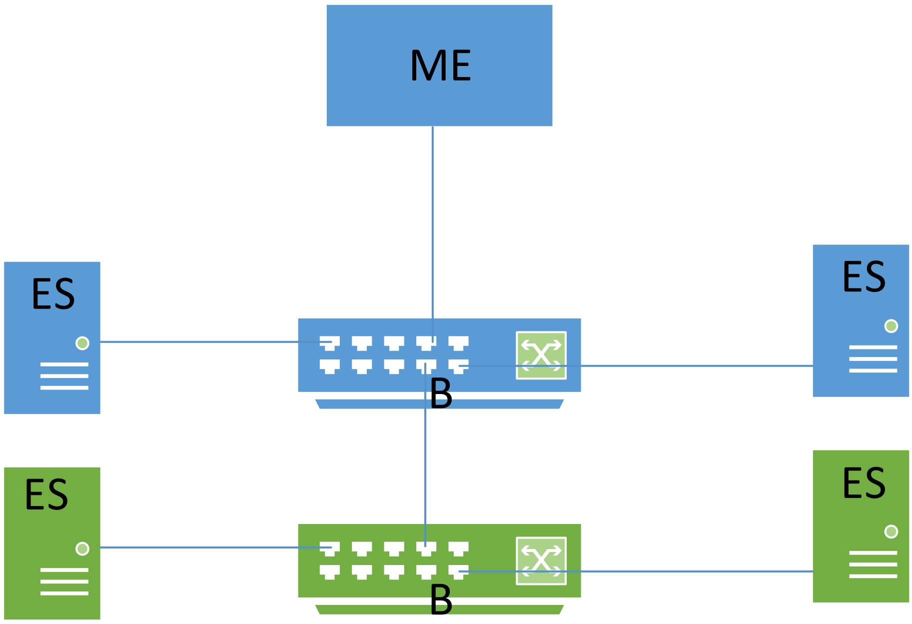

Figure 5: Simple TSN Domain – combine previously splitted TSN Domain

Expected Behavior

If each TSN Domain has the same identifier because they were previously combined or engineered to be combined by sharing compatible TSN mechanisms and identifier, the two domains will be joined into one. If each TSN domain has an independent ME, one ME will be selected. If the identifiers are different TSN Interdomain communications may be established by the Management Entities.

US4: Splitting a TSN Domain

A user removes a physical link that creates a single TSN domain.

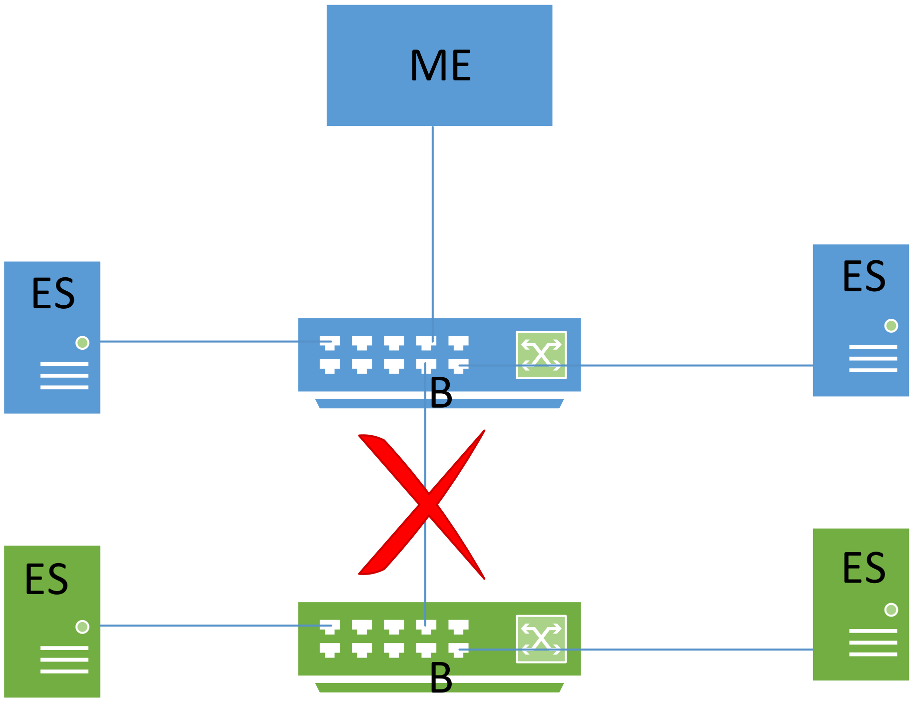

Figure 6: Simple TSN Domain –split TSN Domain

Expected Behavior

Each network will continue to operate as two separate TSN domains and are managed by separate Management Entities. If one of the resulting domains does not have a ME, no functions that require an ME will be available. Each will automatically maintain the same TSN Domain Identifier.

US5: Assigning TSN Domain Identifier

Whether a device belongs to a TSN Domain is identified by checking its TSN Domain Identifier. This identifier is expected to be available as LLDP TLV / MIB object defined in IEEE802.1Q scope.

Expected Behavior

When the user assigns the application driven identification, additionally the to be connected TSN Domain needs to be specified.

Thus, the ME can identify whether this device is in its responsibility or not.

US5.1: Auto assignment of TSN Domain Identifier

Additional to the TSN Domain Identifier, different means may be used to identify whether a connected device belongs to the TSN Domain or not.

Expected Behavior

If the A) configuration model of the ME is used, the device and its position in topology can be used to assign all addressing information to the device. This includes the TSN Domain Identifier.

US6: Media redundancy

Media redundancy is used to ensure availability of communication.

Simple topologies e.g. rings are often used to fulfill the requirements for media redundancy. More complex requirements lead to more complex topologies e.g. coupled rings allowing multiple concurrent faults.

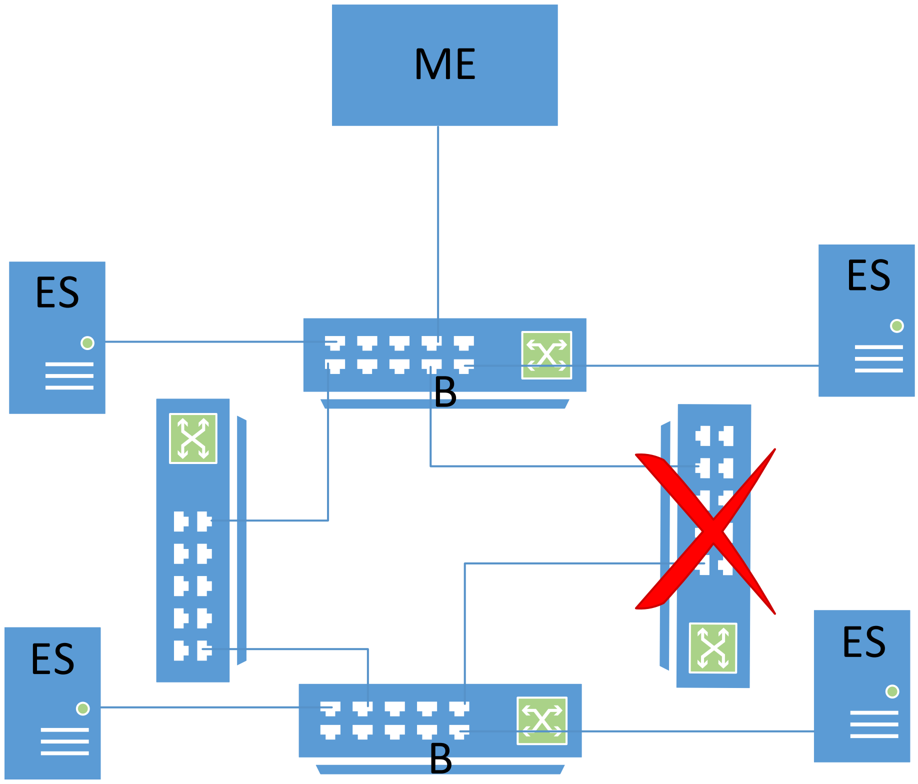

Figure 7: Simple ring topology – one fault

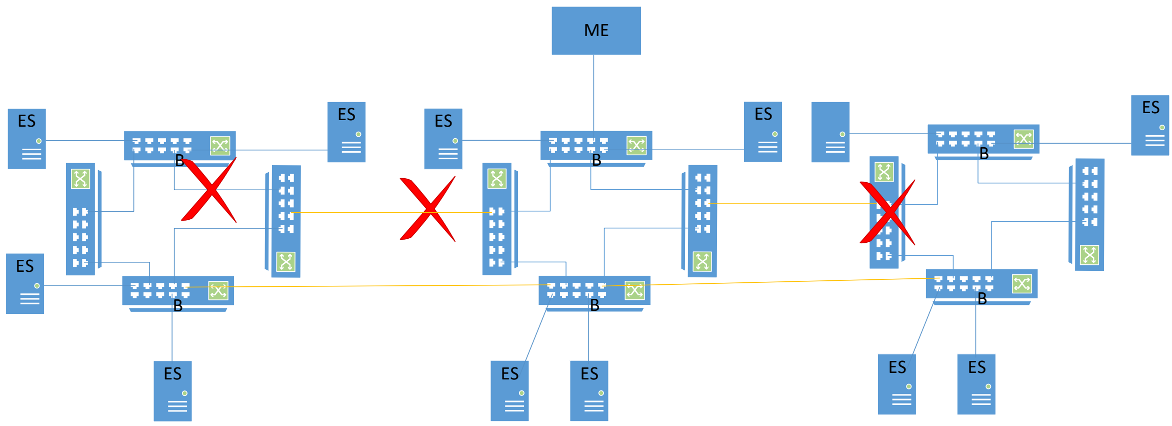

Figure 8: Coupled rings topology – multiple faults

Expected Behavior

One or more faults, e.g. wire break or disconnected bridge, do not stop the production until a repair happens.

US6.1: Switch over redundancy

Simple topologies (e.g. rings) are often used to fulfill the requirements for resiliency.

These requirements apply to simple rings and to coupled rings.

Expected Behavior

As soon as a fault happened, the system redirects the traffic to follow the substitution path. Depending on the application requirements the time which is needed to redirect the traffic may or may lead to a communication disturbance.

Spanning-tree protocols (e.g. RSTP, MSTP) can be used as a resiliency protocol.

If traffic engineered streams are used, the ME may need to “reroute” them according the new topology.US6.2: Seamless redundancy

Traffic engineering two most disjunct paths from Talker to Listener allow seamless redundancy with zero switch over time.

These requirements apply to simple rings and to coupled rings.

Seamless redundancy based on FRER may be solved by end-station FRER or bridge FRER at the end-station ports; it needs to be solved by bridge FRER at the ring coupling ports.

Expected Behavior

Seamless redundancy shall be available for simple and coupled rings and support one fault per ring.

US7: Application cycle

Synchronized applications need the same understanding of their application cycle. This understanding shall be independent from the time when the device is powered up or connected to the TSN Domain.

A common understanding of an application cycle is built out of the working clock in the following manner:

If you divide the integer working clock value by the integer “length of application cycle”, and the remainder is zero, the application cycle starts.

If a defined application cycle is addressed, the resulting quotient may be used to create a common understanding of future or past application cycles.

Expected Behavior

Application cycles are synchronized, if needed, independent from the time a device is connected to the network.

Base is the Working Clock.