Industrial Bridged and non-Bridged End Stations

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Definitions

- **TSN based system:** A TSN based system refers to any system that incorporates the core functions and technologies defined by the IEEE-802.1 TSN set of standards. This document will define the core set that is important to the industrial market.

- **TSN-based services:** Those functions defined within the 802.1 TSN set of standards that provide a benefit or utility to the overall TSN system and which act as a small functional component in the overall TSN solution. Such examples would include time synchronization services as delivered via 802.1AS-REV and scheduling services as defined by 802.1Qbv.

- **End-Station User Configuration Protocol:** The native industrial protocol associated with an end-station which has been traditionally used to configure that end-station for use in a control application. Examples of these protocols would be CIP, Profinet, EtherCat and Sercos.

- **Remote Management Unit (RMU):** A mechanism that converts CNC southbound configuration messages into the End Station User Configuration Protocol. This is sometimes called a “proxy”

- **Bridged End Station:** An end station that operates with an IEEE 802.1 bridge embedded within or alongside it.
Definitions

- **Constrained End Station**: An End Station which is limited in memory or processing capability.
- **Constrained Bridged End Station**: A Bridged End Station which is limited in memory or processing capability.
- **Brownfield End Station**: An End Station or a Bridged End Station which was designed before the existence of TSN technologies and which is installed in an existing system. It should be expected that limited firmware updates are possible.
- **TSN Data Gateway**: A mechanism that transfers non-TSN data stream onto a TSN stream.
- **Time Gateway**: A mechanism that translates time between various time domains. An example would be between an 802.1AS domain and an IEEE-1588 time domain.
Industrial Use Case

- The life cycle of an average industrial installation is very long
  - 20 years is typical
  - Require migration mechanisms to move to new technologies
    - Time Gateways
    - TSN Gateways
    - Natural place for gateways: Bridges

- Modular construction
  - Machine sections supplied by individual OEMs
  - Composable system design
    - Requires VLAN segmentation for functional bounding
  - Large end users will replicate machines many times and distribute globally across multiple locations
    - IP addressing schemes duplicated
    - “Cookie cutter” approach often requires NAT
Constrained Devices

Automation Architecture

Control
Field
Sensor / Actuator

Processing Power
- x86
- ARM A15
- ARM A7
- ARM M3
- ARM M0
- None

APPLICATION COMPLEXITY

SIZE, COST, POWER OF ETHERNET
Constrained Devices & RMU’s

Constrained devices have limited processing power and memory

- Won’t support multiple stacks for bridge configuration and end-station configuration
- Require Remote Management Unit Function between CNC and Device to translate bridge configuration functions.
- Uses native end station configuration protocol
  - Typically Industrial Standard Protocols like CIP, Profi, etc.
  - Native protocol will need to expand to include additional services
# End Station Profile Draft Proposal

<table>
<thead>
<tr>
<th></th>
<th>Bridged End Station (non-constrained)</th>
<th>Bridged End Station (constrained)</th>
<th>Non-Bridged End Station</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time Synchronization</strong></td>
<td>802.1AS-REV</td>
<td>802.1AS-REV</td>
<td>802.1AS-REV</td>
</tr>
<tr>
<td><strong>Preemption</strong></td>
<td>Preemption</td>
<td>Preemption (optional)</td>
<td></td>
</tr>
<tr>
<td><strong>Scheduling</strong></td>
<td>Qbv</td>
<td>Qbv</td>
<td>Qbv (optional)</td>
</tr>
<tr>
<td><strong>Bridge Config</strong></td>
<td>NETCONF or RESTCONF</td>
<td>ESUCP via RMU</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Device Config</strong></td>
<td>ESUCP</td>
<td>ESUCP</td>
<td>ESUCP (CUC Protocol)</td>
</tr>
<tr>
<td><strong>Policing</strong></td>
<td>Qci (optional)</td>
<td>Qci (optional)</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Redundancy</strong></td>
<td>CB (optional)</td>
<td>CB (optional)</td>
<td>CB (support through an adjacent bridge.) (Optional)</td>
</tr>
<tr>
<td></td>
<td>RSTP, MSTP</td>
<td>RSTP, MSTP</td>
<td></td>
</tr>
<tr>
<td><strong>Discovery Services</strong></td>
<td>LLDP</td>
<td>LLDP via RMU</td>
<td>LLDP (transmit only)</td>
</tr>
<tr>
<td><strong>Number of queues</strong></td>
<td>8</td>
<td>8</td>
<td>N/A</td>
</tr>
</tbody>
</table>

This work now a function of IEC/IEEE 60802 Joint Project
Device Types: Time Triggered Send

- Critical data delivery
- Synchronized with network
- Traffic must be delivered by a specific deadline
- No bridge function
- Requires support for Qbv
- Very fast updates and sampling
Device Types: Machine and Process I/O

- Critical data delivery
- No synchronization with network
- Traffic must be delivered with bounded latency
- No bridge function
- No requirement for Qbv, however updates are cyclic
- Update and sampling: Fast to medium times
Conformance Testing