Intent

• The intent of this presentation is to continue the conversation around TSN constructability with a focus on TSN-IA (Industrial Automation) Domains

• This presentation attempts to include previous contributions from the use cases document and presentations given by Guenter Steindl, Taro Harima, Marius Stanica, Lihao Chen & the author

• If there is group consensus the “contribution” slides should be added to 802.1 specifications and the next draft of 60802
Intent

• This presentation does not seek to define TSN domains as we have a definition in the 60802 profile currently.
• The definition of TSN domains seems to align with the high-level concept of “Functional Entities” that is being described in other standards activities. If possible, these concepts should be merged.
Background

When looking at the construction of TSN Domains for Industrial Automation, Industrial Automation networks and how they traditionally have been constructed should first be evaluated.
Background

• To further break this down, different stages in the lifecycle of an industrial automation network will be examined. They are meant to show a representative set of use cases that the concept of TSN-IA Domains are meant to solve.
  • The Network Design Stage
  • The Network Commissioning Stage
  • The Network Management Stage
IA Network Design Stage

- At design time, different machine builders are commissioned to create something
  - The scope could be as small as a machine enhancement or as large as a plant
- When the design is being created the overall network layout is often done, with plans for subnetting and communications
- Simulations need to be run using Network Calculus or Qbv scheduling to ensure TSN-IA Domains have the capacity to meet the current and planned future needs of member devices
- Data Sheets which contain device capabilities will allow vendors to select compatible hardware [1]
- TSN-IA Domains need to be defined and their member devices need to be identified at this time [2]
- Common TSN-IA domain identification mechanisms need to be specified [3]
IA Network Commissioning Stage

• At commissioning time, different machine builders and different fieldbuses are brought together on one network

• If the scheduling/network calculus that is done during the design stage specified everything perfectly, it should work but still needs to be tested

• If devices/machines are being integrated that are brownfield/off-the-shelf they will need to be integrated separately
  • TSN Gateway functions such as stream transformation can be used for brownfield devices [4]
  • Off-the-shelf machines may include their own TSN-IA domain(s) and either may have strict predefined inter-domain communications or may allow integrator defined inter-domain communications to be integrated with a larger network [5]
IA Network Management Stage

• Once an industrial automation network is running, provisions need to be included to keep the network running including:
  • Enhancing the network by adding devices [6]
  • Replacing devices due to upgrades or failures [7]
  • Modifying the network for retooling or to otherwise meet business needs [8][9]
Assumptions

• One single management entity (whether centralized, fully distributed or hybrid) will have configuration responsibility for a TSN-IA domain

• Extend RAP or existing "management" to handle configuration model selection and failover within a TSN-IA domain [10] [3]
  • Include IP address of CNC in “configuration” if it exists
  • Include IP address of NME in “configuration” if it exists

• The concept of TSN domain protection needs to be considered, but is separate from the core concept of a TSN-IA domain
802.1 Suggested Contributions

• Since support needs to be provided by 802.1 for the concept of TSN-IA domains, perhaps a normative generic TSN domain concept needs to be extended in 802.1Q (A reminder that some informative text already exists in 802.1Qcc Appendix U.2 part 7)
802.1 Suggested Contributions

• Suggestions for inclusion in LRP or RAP
  • A purpose built protocol such as a Controller-Controller-Protocol using LRP could be developed, per forthcoming proposal from Lihao Chen
  • Or RAP could be extended with:
    • A TSN-IA domain managed object to convey an identifier
    • A TSN-IA domain boundary configuration to set up stream transformation

• Suggestions for inclusion for a revision to 802.1Qcc
  • Include A TSN-IA identifier in the UNI for talkers & listeners in 46.2.3 and 46.2.4
  • Add a definition of stream transformation for TSN-IA domains in a bridge in 35.2.2.10.5 part c, 46.1.4 and Appendix U.2 part 7
P60802 Suggested Contributions

• TSN-IA Domain Identification
  • A single TSN-IA Domain Identifier per port must be included through LLDP
  • Bridge Ports should be configured to certain TSN-IA Domains
    • This configuration can be pushed down through a data sheet (assuming 60802 adopts the data sheet model), or through RAP (assuming Feng includes knobs and dials for this), or from a CNC (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
P60802 Suggested Contributions

- TSN-IA Domain Identification
  - The TSN-IA Domain Identifier should be human readable and unique [3]
  - Cloning a machine with a TSN-IA Domain should create a unique identifier
  - Network Management Entities need to be able to configure devices even if the data plane is unusable due to mismatched TSN-IA Domain Configuration[3]
P60802 Suggested Contributions

• TSN-IA Domain Boundaries
  • TSN-IA Domain Boundaries exist within bridges
  • They automatically occur when any ports within a bridge have a different TSN-IA domain configurations
  • This is a “TSN-Domain-Connector” function [3]
  • When streams are configured that go across a specific TSN-IA domain boundary, that TSN-IA boundary needs to be configured to know how to handle those streams
    • If strict-priority is being used, stream transformation may need to be used to normalize priorities between domains
    • If Qbv scheduling is being used, a shared schedule may need to be generated with multiple CNCs.
      • The TSN-IA boundary should be responsible for requesting the resource from a partner CNC just as though it were another end station.
      • An enhancement for this would be for a Head CNC to analyze the most efficient schedule between CNCs [11]
References