Conformance Class
IEC/IEEE 60802

Contributor group

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Abstract

This document describes an example Conformance Class based on “60802-Steindl-ExampleSelections-0119-v02.pdf” as a starting point for feature alignment. The parameters and values given in this document are presenting the ongoing discussions. Currently there is no agreement which attributes, parameters and values are mandatory within the profile.

Parameters are moved to “60802-Steindl-et-al-ExampleSelectionTables-xxxx-vxx.pdf”.

Log

V0.1	Initial version
V0.5	Update with Example Selections “Y” and “Z”
V0.6	Update after discussion in IEC/IEEE 60802
V0.7	Update after discussion in IEC/IEEE 60802
V1.0	Initial public version for IEC/IEEE 60802
V1.2	Version created during Edinburgh meeting
V1.3	Version created in preparation for Hawaii meeting
V1.4	Version created during Hawaii meeting
V1.5	Version created after Hawaii meeting
V1.6	Update after discussion in IEC/IEEE 60802
V1.7	Tables moved to Excel for easier handling
V1.8	Questionnaire updated
V2.2	Feedback integrated (YO, SI)
V2.3	Feedback integrated (ABB, B&R)
V2.4	Alignment with Example Selection Tables

Content

Figures

Tables

1 References

60802-industrial-use-cases-0918-v13.pdf

60802-Steindl-ExampleSelections-0119-v02.pdf

60802-Steindl-QuantityFigures-0519-v01.pdf

60802-Steindl-TimelinessUseCases-0718-v01.pdf

60802-Steindl-et-al-ExampleSelectionTables-0520-v24.pdf

2 Terms and Definitions

2.1 Definitions

Conformance Class	A selection of IEC and IEEE features and quantities which allows to solve the required use cases.

2.2 IEEE802 terms

Priority regeneration	See IEEE 802.1Q-2018 clause 6.9.4 Regenerating priority
Ingress rate limiting	See IEEE 802.1Q-2018 clause 8.6.5 Flow classification and metering

3 Feature selection constraints

3.1 General

The individual selection of features can be sorted into at least two classes:

- Self-restriction, not influencing others
- Restricting others

Its a process to find the right balance between “self-restriction” and “restricting others”. Often, defining features optional or having a few more classes is the way out of this deadlock.

3.2 Self-restriction

If a vendor of an end-station decides to support only a few queues or skip global time support, then this only limits its products, but no one else.

3.3 Restricting others

Any bridge feature is very likely to fall into this class. Thus, the balance between the different interest while getting a convergent network is a key for the success of industrial automation profile.

4 Devices classes

4.1 General

This document addresses two device classes:

- Full-blown
- Constrained

The term “Full-blown” is used to classify a device class which supports all needed features.

The term “constrained” is used to classify a device class which supports only a subset of the “all needed features”.

The understanding of the limitations of “constrained” devices (better: What are the expectations?) needs to be aligned between the different contributors.
The following chapters show the understanding of the contributors.

4.2 Question

Following questions are of interest for the discussion:

1. What is your understanding of constraint bridge or end-station?

Editor’s note: Why do you intend to develop two classes of devices?

2. Shall a vendor independent mix between “full-blown” and “constraint” devices in one TSN Domain be supported?

Editor’s note: This means, that a vendor independent configuration of the network portion of each device according to IEC/IEEE 60802 is supported.

3. Shall a vendor independent mix between “full-blown” devices in one TSN Domain be supported?

Editor’s note: Follow-up to Question 2 – or is this only required for class full-blown?

4. Shall a vendor independent mix between “constraint” devices in one TSN Domain be supported?

*Editor’s note: Let’s assume that in a TSN Domain only class constraints is supported. This means, that a **vendor independent** configuration of the network portion of each device according to IEC/IEEE 60802 is supported.*

5. Shall a mix between vendor independent “full-blown” and vendor dependent “constraint” devices in one TSN Domain be supported?

*Editor’s note: This means, that a mixture between **vendor dependent** configuration and vendor independent according to IEC/IEEE 60802 definitions of the network portion - is supported.*

6. Does for the end-stations the same usage model apply?

Editor’s note: Same principle – Question 1 to 5 – for end-stations. Assumption: Pure end-stations, without integrated bridge, do have lesser impact to the overall interoperability. Thus, it’s unclear to the editor whether we need two classes for them.

4.3 Drawings

Figure 1 shows the principle structure of an Automation System.

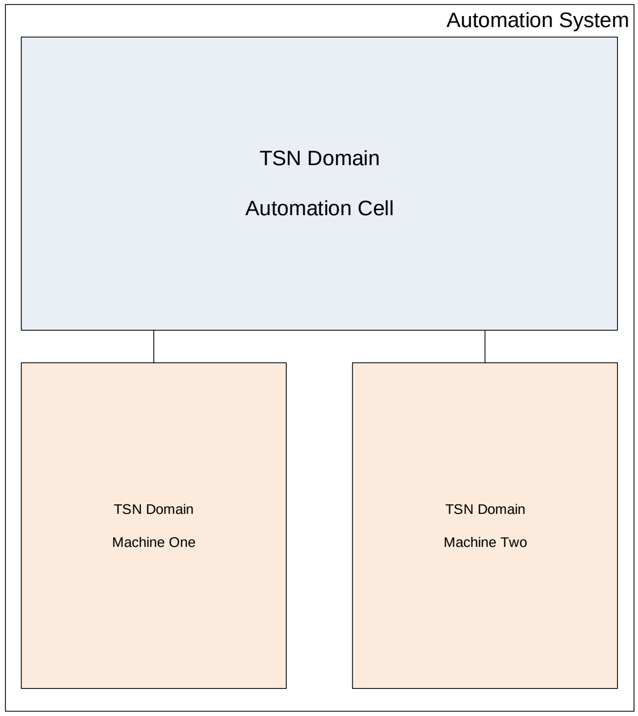


Figure 1 – Principle structure of an Automation System

Figure 2 shows one example for a possible usage of full-blown and constraint devices.

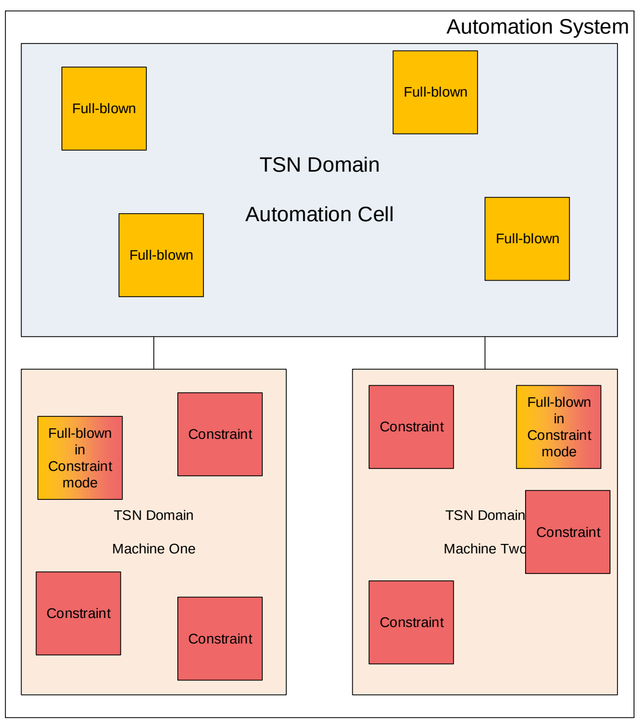


Figure 2 – Example for possible intended usage

4.4 Feedback from contributors

4.4.1 Siemens

Ethernet is the basis of the industrial communication. TSN is now part of Ethernet and thus, basis of the industrial communication, too.

Devices are intended to be used at all layers of the automation pyramid. Thus, the basic Ethernet requirements are identical for all devices.

Constraints are only acceptable if they do not interfere with the convergence. Do not disturb the others!

4.4.1.1 What is your understanding of constraint bridge or end-station?

The understanding of the term "Constraint" needs to be aligned among each contributor.

Constraints are only acceptable if they do not interfere with the convergence.

4.4.1.2 Shall a vendor independent mix between "full-blown" and "constraint" devices in one TSN Domain be supported?

(This means, that a vendor independent configuration of the network portion of each device according to IEC/IEEE 60802 is supported.)

Yes

4.4.1.3 Shall a vendor independent mix between "full-blown" devices in one TSN Domain be supported?

(Follow-up to Question 2 – or is this only required for class full-blown?)

Yes

4.4.1.4 Shall a vendor independent mix between "constraint" devices in one TSN Domain be supported?

(Let's assume that in a TSN Domain only class constraints is supported. This means, that a vendor independent configuration of the network portion of each device according to IEC/IEEE 60802 is supported.)

Yes

4.4.1.5 Shall a mix between vendor independent "full-blown" and vendor dependent "constraint" devices in one TSN Domain be supported?

(This means, that a mixture between vendor dependent configuration and vendor independent according to IEC/IEEE 60802 definitions of the network portion - is supported.)

No

4.4.1.6 Is it enough to support a vendor dependent mix of "constraint" devices in one TSN Domain?

No

4.4.1.7 Does the usage of end-stations follow the same model?

(Same principle – Question 1 to 5 – for end-stations. Assumption: Pure end-stations, without integrated bridge, do have lesser impact to the overall interoperability. Thus, it's unclear to the editor whether we need two classes for them.)

Yes

4.4.2 Rockwell

TBD

4.4.2.1 What is your understanding of constraint bridge or end-station?

The understanding of the term “Constraint” needs to be aligned among each contributor.

4.4.2.2 Shall a vendor independent mix between “full-blown” and “constraint” devices in one TSN Domain be supported?

(This means, that a vendor independent configuration of the network portion of each device according to IEC/IEEE 60802 is supported.)

TBD

4.4.2.3 Shall a vendor independent mix between “full-blown” devices in one TSN Domain be supported?

(Follow-up to Question 2 – or is this only required for class full-blown?)

TBD

4.4.2.4 Shall a vendor independent mix between “constraint” devices in one TSN Domain be supported?

(Let’s assume that in a TSN Domain only class constraints is supported. This means, that a vendor independent configuration of the network portion of each device according to IEC/IEEE 60802 is supported.)

TBD

4.4.2.5 Shall a mix between vendor independent “full-blown” and vendor dependent “constraint” devices in one TSN Domain be supported?

(This means, that a mixture between vendor dependent configuration and vendor independent according to IEC/IEEE 60802 definitions of the network portion - is supported.)

No, but may be supported with some restrictions (limited performance, topology, etc.)

4.4.2.6 Is it enough to support a vendor dependent mix of “constraint” devices in one TSN Domain?

TBD

4.4.2.7 Does the usage of end-stations follow the same model?

(Same principle – Question 1 to 5 – for end-stations. Assumption: Pure end-stations, without integrated bridge, do have lesser impact to the overall interoperability. Thus, it’s unclear to the editor whether we need two classes for them.)

TBD

4.4.3 Mitsubishi

4.4.3.1 What is your understanding of constraint bridge or end-station?

A three-port-Bridge which has constrained CPU and memory resources. Constrained bridge is mainly used in machine. It supports TSN features which is needed to converge isochronous and/or cyclic and none delay bounded communication with ±1µs TER over 100hops.

Constrained Bridge can reduce the functionality from Full Bridge

- by pre-configuring parameters in centralized model
- by specifying use case, line topology with 2 ports devices.

http://www.ieee802.org/1/files/public/docs2019/60802-Hotta-Traffic-Types-Mapping-to-TSN-Mechanism-0119-v01.pdf

- by using application-layer specific mechanisms

and can be connected with Backbone network via Full Bridge.

[Comment from the editor:
It is assumed that constraint devices ONLY support two external ports;
It is assumed that constraint devices NEVER used as TSN domain boundary;]

4.4.3.2 Shall a <u>vendor independent</u> mix between "full-blown" and "constraint" devices in one TSN Domain be supported?
No, but if they support common functions, they can be mixed.

4.4.3.3 Shall a <u>vendor independent</u> mix between "full-blown" devices in one TSN Domain be supported?
Yes.

4.4.3.4 Shall a <u>vendor independent</u> mix between "constraint" devices in one TSN Domain be supported?
No, but if they support common functions, they can be mixed.

4.4.3.5 Shall a mix between vendor independent "full-blown" and vendor dependent "constraint" devices in one TSN Domain be supported?
Yes, within the features of Constraint devices.

4.4.3.6 Is it enough to support a <u>vendor dependent</u> mix of "constraint" devices in one TSN Domain?
No. Full-blown devices can be mixed.

4.4.3.7 Does the usage of end-stations follow the same model?
Yes.

4.4.4 Yokogawa
This chapter provides the author's answers with supporting information from Process Automation (PA) viewpoints, to the questions distributed to the contributors for further discussions.

Full-blown Bridge & End-station

Typically used for a backbone network, on which a bunch of IA-Devices communicate each other using variety of OT protocols with various data rates and traffic types.

Constraint Bridge & End-station

Typically used for an (in cabinet) IO network or a field network, on which a limited number of friendly neighbor IA-Devices communicate each other using an OT protocol with limited data rate options and traffic types.

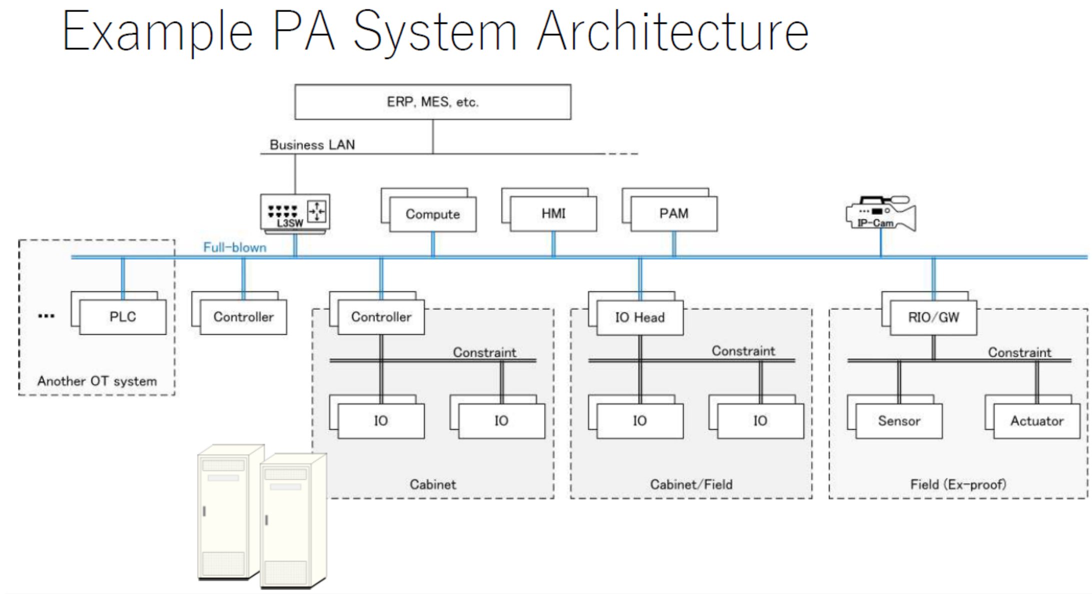


Figure 3 -- Yokogawa example system architecture

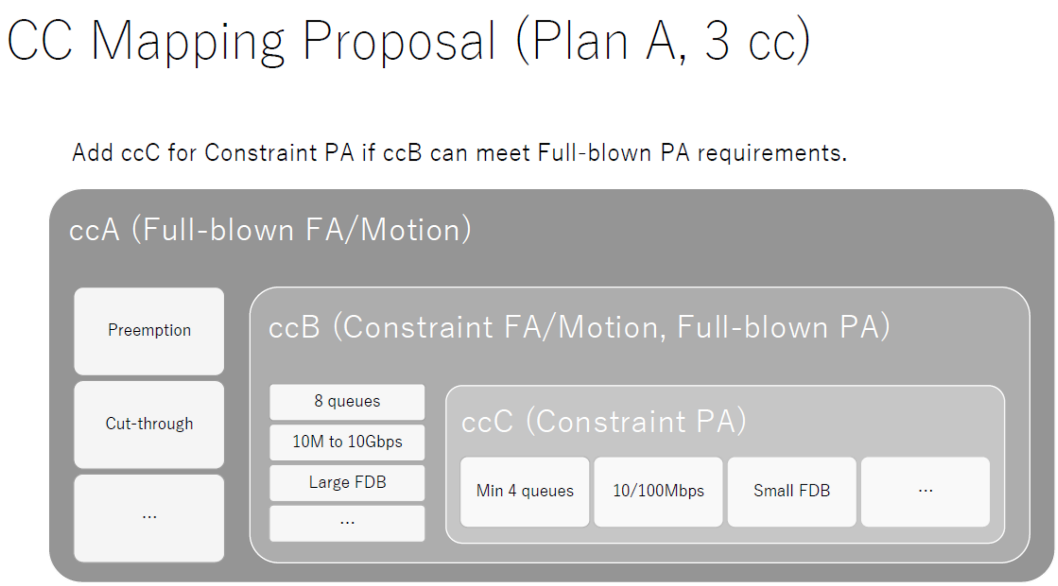


Figure 4 -- Yokogawa example CC mapping

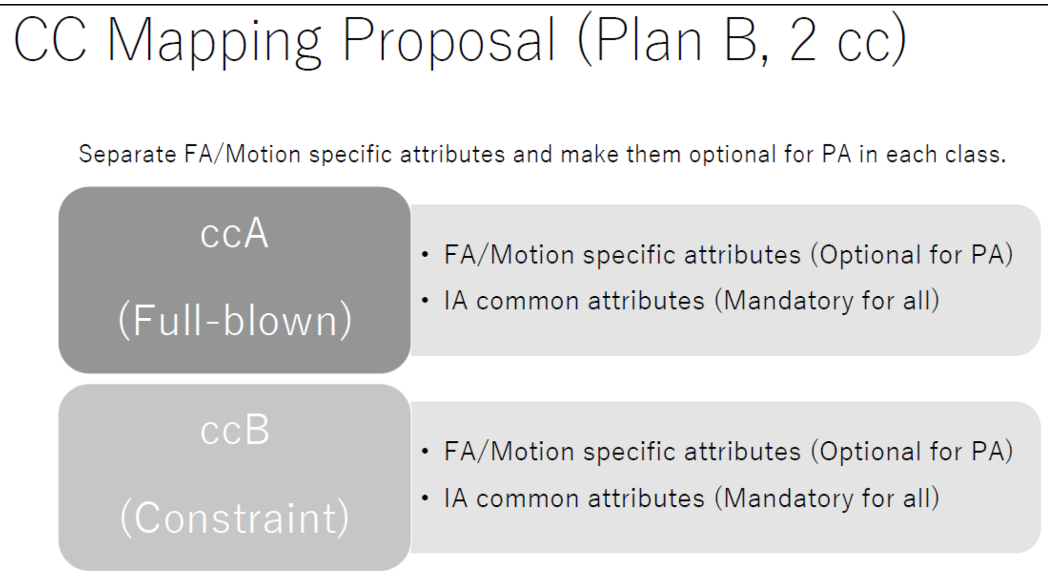


Figure 5 -- Yokogawa example CC mapping

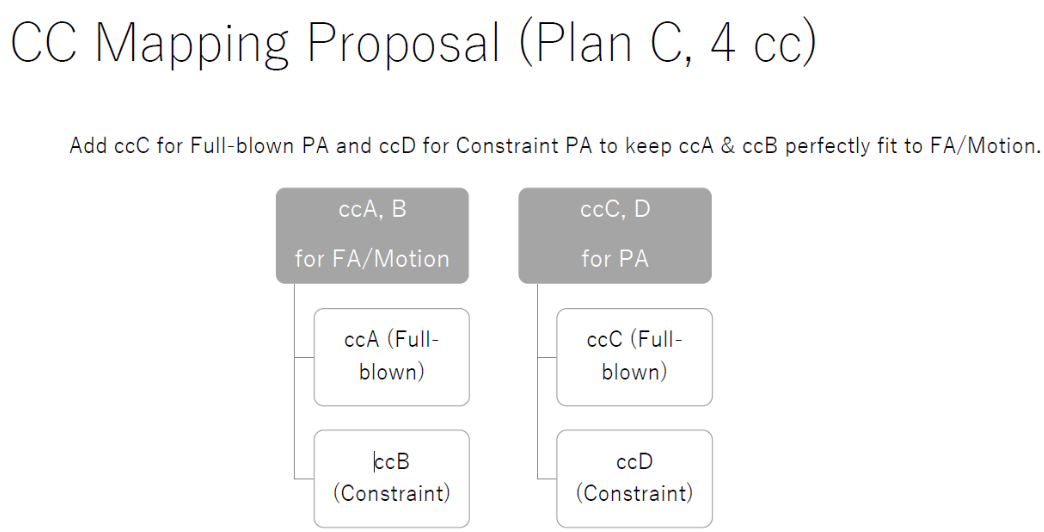


Figure 6 -- Yokogawa example CC mapping

4.4.4.1 What is your understanding of constraint bridge or end-station?

The understanding of the term “Constraint” needs to be aligned among each contributor.

Typically used for an (in-cabinet) IO network or a field network, on which a limited number of friendly neighbor IA-Devices communicate each other using an OT protocol with limited data rate options and traffic types.

Typical constraint factors:

- Limited resources due to power consumption
- e.g. MPU power, memory size
- Single OT protocol with limited functionality

- Limited Traffic Types
- Limited power source

Hazardous area installation

- Explosion-proof (limited power consumption)
- Water-/Dust-/Salt-damage-/Corrosion-/… proof
- Special physical layer (e.g. APL, optical fiber) support
    - For noise protection
    - For long distance connection

In-cabinet installation

- Limited data rate for heat control
- Limited footprint

Switch-less installation requirement

- Limited topologies (line/ring)

Less strict performance requirements on:

- Time error
- Timestamp accuracy
- Minimum network cycle
- …

4.4.4.2 Shall a vendor independent mix between "full-blown" and "constraint" devices in one TSN Domain be supported?

(This means, that a vendor independent configuration of the network portion of each device according to IEC/IEEE 60802 is supported.)

No, but may be supported with some restrictions (limited performance, topology, etc.)

4.4.4.3 Shall a vendor independent mix between "full-blown" devices in one TSN Domain be supported?

(Follow-up to Question 2 – or is this only required for class full-blown?)

Yes

4.4.4.4 Shall a vendor independent mix between "constraint" devices in one TSN Domain be supported?

(Let's assume that in a TSN Domain only class constraints is supported. This means, that a vendor independent configuration of the network portion of each device according to IEC/IEEE 60802 is supported.)

Yes, but only a single OT protocol (based on the same configuration mechanism) would be supported in that TSN Domain.

4.4.4.5 Shall a mix between vendor independent "full-blown" and vendor dependent "constraint" devices in one TSN Domain be supported?

(This means, that a mixture between vendor dependent configuration and vendor independent according to IEC/IEEE 60802 definitions of the network portion - is supported.)

No, but may be supported with some restrictions (limited performance, topology, etc.)

4.4.4.6 Is it enough to support a vendor dependent mix of "constraint" devices in one TSN Domain?

TDB

4.4.4.7 Does the usage of end-stations follow the same model?

(Same principle – Question 1 to 5 – for end-stations. Assumption: Pure end-stations, without integrated bridge, do have lesser impact to the overall interoperability. Thus, it's unclear to the editor whether we need two classes for them.)

Yes, available resources of pure end-stations could also be restricted according to the same constraint factors.

4.4.5 ABB (including B&R)

Ethernet is the basis of the industrial communication. TSN is now part of Ethernet and thus, basis of the industrial communication, too.

Devices are intended to be used at all layers of the automation pyramid.

Nevertheless, a commonly accepted set of Ethernet requirements is under investigation in various SDOs and the 60802 contributes to it by the current definitions of specific TSN-related parameters.

The notion of *network convergence* could be seen like the sharing of the same network segment/communication media by several Ethernet-based data exchange technologies (industrial automation or not), in order to achieve systems within the required performance, deployment flexibility, environmental impact and cost savings and without reliability, availability and engineering efficiency losses.

Thus, a notion of segmentation may still be required, especially in larger projects/topologies and presence of end stations with various hardware capabilities will still be required by the engineering efficiency, cost savings and environmental impact. Loss of performance due to bottlenecks must be avoided.

The cost savings aspect though is multi-faceted: besides the overall system costs, device-level costs and lifecycle-related costs must be considered, thus over-classification of 802.1 and 802.3 specific parameters should be avoided.

4.4.5.1 What is your understanding of constraint bridge or end-station?

The understanding of the term "Constraint" needs to be aligned among each contributor.

Constraint bridges refer mostly to embedded bridges with their external port count which needs to be smaller or equal than two. Additional aspects, for the constraint bridges could potentially be one or more of the ones shown in the attached Excel sheet concerning the example selection.

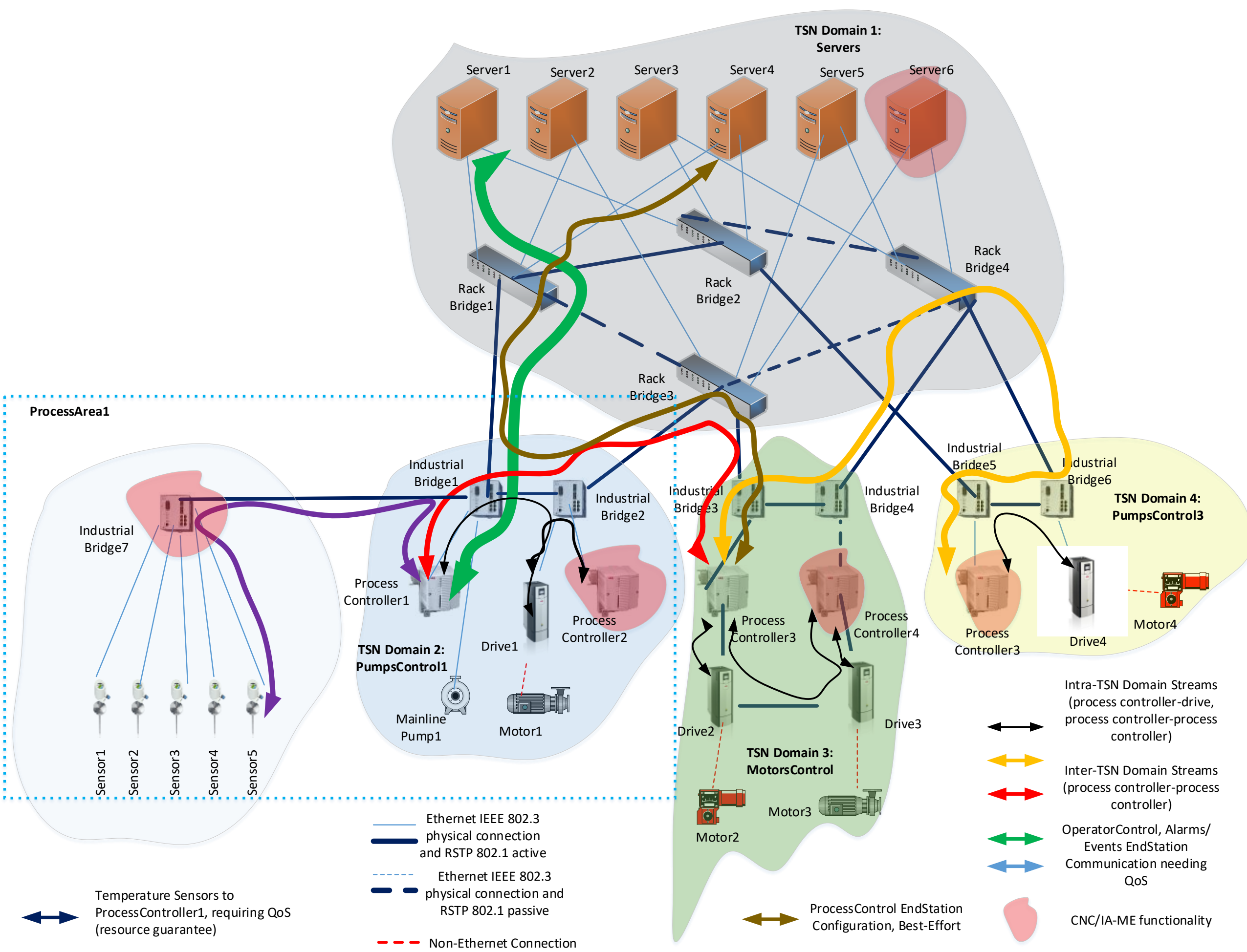
Infrastructure Bridges which are independent devices and may be used for connecting more than 2 devices together, due to a port count higher than two, can also be seen as constraint if they implement a subset of features specified in the attached Excel sheet concerning the example selection for constrained bridges.

The rest of Infrastructure Bridges cannot be seen as constraint, due to the high number of deployment scenarios they must have the flexibility to support.

Constraint end stations may exhibit a somewhat larger variation than bridges, in terms of:

- Hardware chipset
  - Processing power
  - Memory sizes (of various types)
- Other aspects as described in the attached Excel sheet concerning the example selection

Mixing constrained and fully capable devices in a system is dependent on the required topology and less on the TSN domains demarcation, see example:



4.4.5.2 Shall a vendor independent mix between "full-blown" and "constraint" devices in one TSN Domain be supported?

(This means, that a vendor independent configuration of the network portion of each device according to IEC/IEEE 60802 is supported.)

Yes, see the example system above.

4.4.5.3 Shall a vendor independent mix between "full-blown" devices in one TSN Domain be supported?

(Follow-up to Question 2 – or is this only required for class full-blown?)

Yes

4.4.5.4 Shall a vendor independent mix between "constraint" devices in one TSN Domain be supported?

(Let's assume that in a TSN Domain only class constraints is supported. This means, that a vendor independent configuration of the network portion of each device according to IEC/IEEE 60802 is supported.)

Yes

4.4.5.5 Shall a mix between vendor independent "full-blown" and vendor dependent "constraint" devices in one TSN Domain be supported?

(This means, that a mixture between vendor dependent configuration and vendor independent according to IEC/IEEE 60802 definitions of the network portion - is supported.)

See 4.4.5.2

4.4.5.6 Is it enough to support a vendor dependent mix of "constraint" devices in one TSN Domain?

It depends on the requirements of the TSN domain. It could be that a number of constrained bridges and constrained end stations may be sufficient in some cases.

No

4.4.5.7 Does the usage of end-stations follow the same model?

(Same principle – Question 1 to 5 – for end-stations. Assumption: Pure end-stations, without integrated bridge, do have lesser impact to the overall interoperability. Thus, it's unclear to the editor whether we need two classes for them.)

Yes

4.4.6 Others

TDB

5 TSN in Industrial Automation

5.1 General

Supporting a Conformance Classes shall allow interoperability for Bridges and End-Station as defined in the scope of IEC/IEEE 60802.

The document contains chapters for full-blown and constraint devices.

Editor's note:
Please make all changes with "track changes on"

5.2 Conformance Class

5.2.1 Standard selection

5.2.1.1 General

A Conformance Class selects out of the following standards

IEEE802.3-2018 - IEEE Standard for Ethernet

IEEE802.1Q-2018 - Bridges and Bridged Networks

IEEE802.1AB-2016 - Station and Media Access Control Connectivity Discovery

IEEE802.1AS-2020 - Timing and Synchronization for Time-Sensitive Applications

IEEE802.1CB-2017 - Frame Replication and Elimination for Reliability

5.2.1.2 Terms

Supported:
This feature is used in any class of device

Support, but optional:
This feature is intended to be used in some class of device.
For silicon vendors, these topics may be "supported", too.

Not used:
The used and thus the support of this feature is not intended.

Ω / TBD:
Not provided until agreed release date for this version.

—:
No quantities, because the assigned feature is not supported.

???:
The responsible editor is not able to fill this cell without a discussion with the other contributors.

5.3 Full-blown and constrained devices

See “60802-Steindl-et-al-ExampleSelectionTables-0520-v24.pdf” available at http://www.ieee802.org/1/files/public

6 Literature and related Contributions

Literature:

[1] “Cyber Physical Systems: Design Challenges”, E. A. Lee, Technical Report No. UCB/EECS-2008-8; http://www.eecs.berkeley.edu/Pubs/TechRpts/2008/EECS-2008-8.html

[2] Becker’s, K. (2015). Pattern and Security Requirements: Engineering-Based Establishment of Security Standards; Springer; ISBN 9783319166643

[3] PI: Isochronous Mode – Guideline for PROFINET IO; V1.0; June 2016; available at http://www.ieee802.org/1/files/private/liaisons

Related contributions:

[4] LNI traffic patterns for TSN: http://www.ieee802.org/1/files/public/docs2018/new-Bruckner-LNI-traffic-patterns-for-TSN-0118.pdf

[5] Multivendor Motion Control: http://ieee802.org/1/files/public/docs2018/new-industrial-enzinger-multivendor-motion-control-0318-v01.pdf

[6] Hierarchical Domain based Network: http://www.ieee802.org/1/files/public/docs2018/60802-harima-industrial-use-case-0518-v04.pdf

[7] Process Automation System Quantities: http://www.ieee802.org/1/files/public/docs2018/60802-sato-pa-system-quantities-0718-v01.pdf

[8] TSN Interdomain Communications: http://www.ieee802.org/1/files/public/docs2018/60802-Hantel-TSN-Interdomain-Communications-0718.pdf

[9] Cycle Timing Models: http://www.ieee802.org/1/files/public/docs2018/60802-enzinger-cycle-timing-models-0718-v04.pdf

[10] Isochronous Drive Synchronization: http://www.ieee802.org/1/files/public/docs2018/60802-enzinger-use-case-isochronous-drive-synchronization-0718-v01.pdf

[11] Machine Internal and Machine to Cell Controller (M2C) Embedded Communication: http://www.ieee802.org/1/files/public/docs2018/60802-essler-additional-use-case-0718-v01.pdf

[12] Coexistence & Convergence in TSN-based Industrial Automation Networks: http://www.ieee802.org/1/files/public/docs2018/60802-stanica-convergence-coexistence-0718-v03.pptx

[13] Flexible Manufacturing System (FMS) for Small Batch Customized Production: http://www.ieee802.org/1/files/public/docs2018/60802-Bai-small-batch-customized-production-0718-v01.pdf

[14] Multi-traffic transmission in industrial backbone network: http://www.ieee802.org/1/files/public/docs2018/60802-chen-multi-traffic-transmission-on-backbone-0918.pdf