Conformance Class
IEC/IEEE 60802

Contributor group

	Column
Ademaj, Astrit <astrit.ademaj@tttech.com>	TT
Dorr, Josef <josef.dorr@siemens.com>	SI
Enzinger, Thomas <thomas.enzinger@br-automation.com>	BR
Hantel, Mark <mrhantel@ra.rockwell.com>	RA
Hotta, Yoshifumi <Hotta.Yoshifumi@eb.MitsubishiElectric.co.jp>	MI
Kehrer, Stephan <Stephan.Kehrer@belden.com>	—
Sato, Atsushi (Alex) <a.satou@jp.yokogawa.com>	YO
Seewald, Maik <maseewal@cisco.com>	—
Stanica, Marius-Petru <marius-petru.stanica@de.abb.com>	AB
Steindl, Guenter <guenter.steindl@siemens.com>	SI
Leurs, Ludwig <Ludwig.Leurs@bosch-rexroth.com>	BO

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".

14   **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

15

16

17 # Content

111
112
113
114

Figures

122
123
124
125
126

127 **Tables**

128
129
130
131

132 # 1 References
133

134   60802-industrial-use-cases-0918-v13.pdf

135   60802-Steindl-ExampleSelections-0119-v02.pdf

136   60802-Steindl-QuantityFigures-0519-v01.pdf

137   60802-Steindl-TimelinessUseCases-0718-v01.pdf

138   60802-Steindl-et-al-ExampleSelectionTables-0520-v24.pdf

139

140

141

142

143

144

145

146

147

148

149

150

151   ## 2 Terms and Definitions

152   ### 2.1 Definitions

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

153   ### 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

154
155
156

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?

194 2. Shall a vendor independent mix between "full-blown" and "constraint" devices in one
195   TSN Domain be supported?
196
197 *Editor's note: This means, that a vendor independent configuration of the network portion*
198 *of each device according to IEC/IEEE 60802 is supported.*
199
200
201 3. Shall a vendor independent mix between "full-blown" devices in one TSN Domain
202   be supported?
203
204 *Editor's note: Follow-up to Question 2 – or is this only required for class full-blown?*
205
206
207 4. Shall a vendor independent mix between "constraint" devices in one TSN Domain
208   be supported?
209
210 *Editor's note: Let's assume that in a TSN Domain only class constraints is supported. This*
211 *means, that a **vendor independent** configuration of the network portion of each device*
212 *according to IEC/IEEE 60802 is supported.*
213
214
215
216 5. Shall a mix between vendor independent "full-blown" and vendor dependent
217   "constraint" devices in one TSN Domain be supported?
218
219 *Editor's note: This means, that a mixture between **vendor dependent** configuration and*
220 *vendor independent according to IEC/IEEE 60802 definitions of the network portion - is*
221 *supported.*
222
223
224 6. Does for the end-stations the same usage model apply?
225
226 *Editor's note: Same principle – Question 1 to 5 – for end-stations. Assumption: Pure end-*
227 *stations, without integrated bridge, do have lesser impact to the overall interoperability.*
228 *Thus, it's unclear to the editor whether we need two classes for them.*
229
230

231 ## 4.3 Drawings
232 Figure 1 shows the principle structure of an Automation System.

233
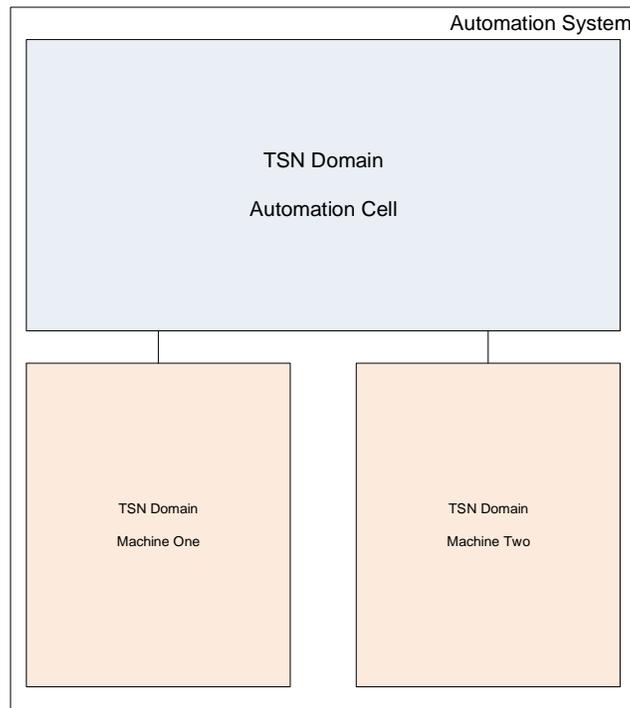
Figure 1 – Principle structure of an Automation System

235

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

237
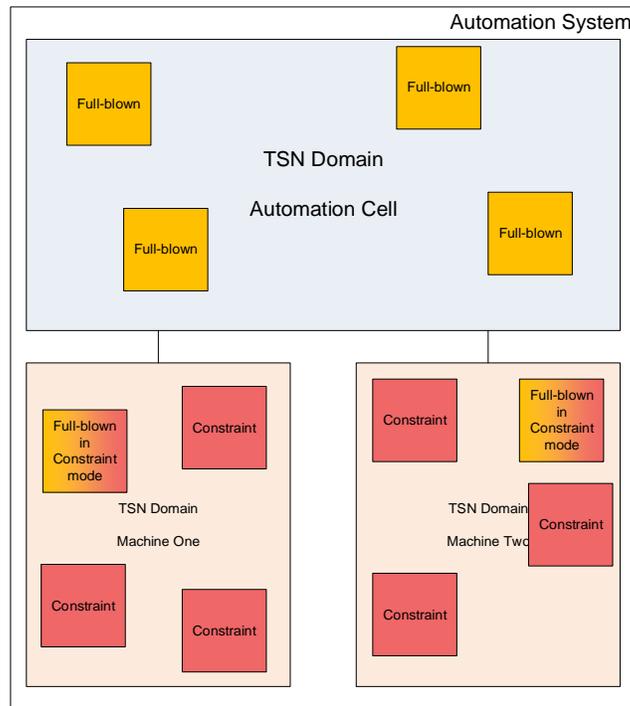
Figure 2 – Example for possible intended usage

239

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 <u>vendor independent</u> 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 <u>vendor independent</u> 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 <u>vendor independent</u> 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 <u>vendor dependent</u> 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.)

279   Yes

280   **4.4.2   Rockwell**
281   TBD

282   *4.4.2.1   What is your understanding of constraint bridge or end-station?*
283   The understanding of the term "Constraint" needs to be aligned among each contributor.

284   *4.4.2.2   Shall a <u>vendor independent</u> mix between "full-blown" and "constraint" devices in one TSN*
285   *Domain be supported?*
286   (This means, that a vendor independent configuration of the network portion of each device
287   according to IEC/IEEE 60802 is supported.)

288   TBD

289   *4.4.2.3   Shall a <u>vendor independent</u> mix between "full-blown" devices in one TSN Domain be*
290   *supported?*
291   (Follow-up to Question 2 – or is this only required for class full-blown?)

292   TBD

293   *4.4.2.4   Shall a <u>vendor independent</u> mix between "constraint" devices in one TSN Domain be*
294   *supported?*
295   (Let's assume that in a TSN Domain only class constraints is supported. This means, that a vendor
296   independent configuration of the network portion of each device according to IEC/IEEE 60802 is
297   supported.)

298   TBD

299   *4.4.2.5   Shall a mix between vendor independent "full-blown" and vendor dependent "constraint"*
300   *devices in one TSN Domain be supported?*
301   (This means, that a mixture between vendor dependent configuration and vendor independent
302   according to IEC/IEEE 60802 definitions of the network portion - is supported.)

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

304   *4.4.2.6   Is it enough to support a <u>vendor dependent</u> mix of "constraint" devices in one TSN*
305   *Domain?*
306   TBD

307   *4.4.2.7   Does the usage of end-stations follow the same model?*
308   (Same principle – Question 1 to 5 – for end-stations. Assumption: Pure end-stations, without
309   integrated bridge, do have lesser impact to the overall interoperability. Thus, it's unclear to the
310   editor whether we need two classes for them.)

311   TBD

312   **4.4.3   Mitsubishi**

313   *4.4.3.1   What is your understanding of constraint bridge or end-station?*
314   A three-port-Bridge which has constrained CPU and memory resources. Constrained bridge is
315   mainly used in machine. It supports TSN features which is needed to converge isochronous and/or
316   cyclic and none delay bounded communication with ±1µs TER over 100hops.

317   Constrained Bridge can reduce the functionality from Full Bridge

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

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

322   • by using application-layer specific mechanisms

323   and can be connected with Backbone network via Full Bridge.

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

327   *4.4.3.2 Shall a <u>vendor independent</u> mix between "full-blown" and "constraint" devices in one TSN*
328   *Domain be supported?*
329   No, but if they support common functions, they can be mixed.

330   *4.4.3.3 Shall a <u>vendor independent</u> mix between "full-blown" devices in one TSN Domain be*
331   *supported?*
332   Yes.

333   *4.4.3.4 Shall a <u>vendor independent</u> mix between "constraint" devices in one TSN Domain be*
334   *supported?*
335   No, but if they support common functions, they can be mixed.

336   *4.4.3.5 Shall a mix between vendor independent "full-blown" and vendor dependent "constraint"*
337   *devices in one TSN Domain be supported?*
338   Yes, within the features of Constraint devices.

339   *4.4.3.6 Is it enough to support a <u>vendor dependent</u> mix of "constraint" devices in one TSN*
340   *Domain?*
341   No. Full-blown devices can be mixed.

342   *4.4.3.7 Does the usage of end-stations follow the same model?*
343   Yes.

344   **4.4.4 Yokogawa**
345   This chapter provides the author's answers with supporting information from Process Automation
346   (PA) viewpoints, to the questions distributed to the contributors for further discussions.

347   Full-blown Bridge & End-station

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

350   Constraint Bridge & End-station

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

354

Example PA System Architecture
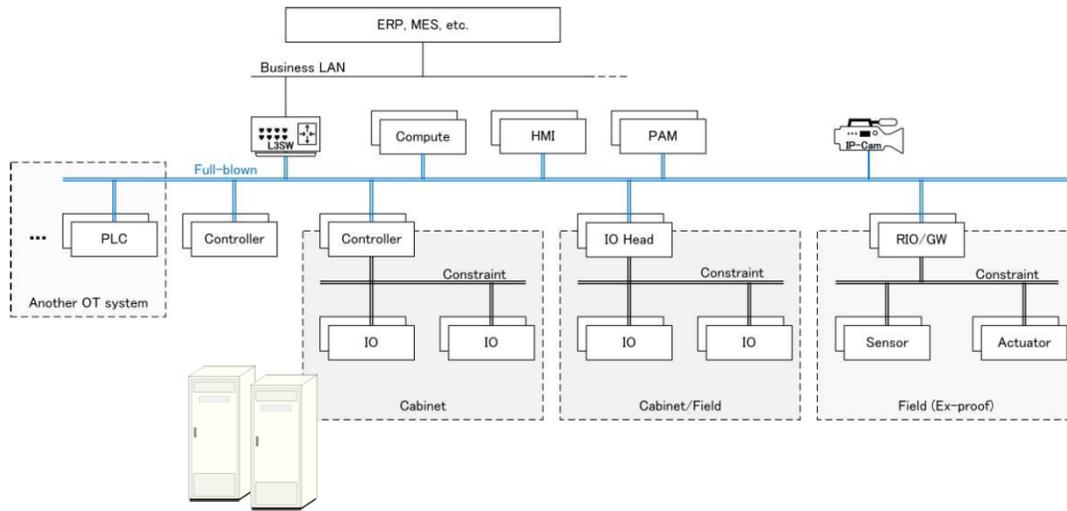
Figure 3 -- Yokogawa example system architecture

CC Mapping Proposal (Plan A, 3 cc)

Add ccC for Constraint PA if ccB can meet Full-blown PA requirements.
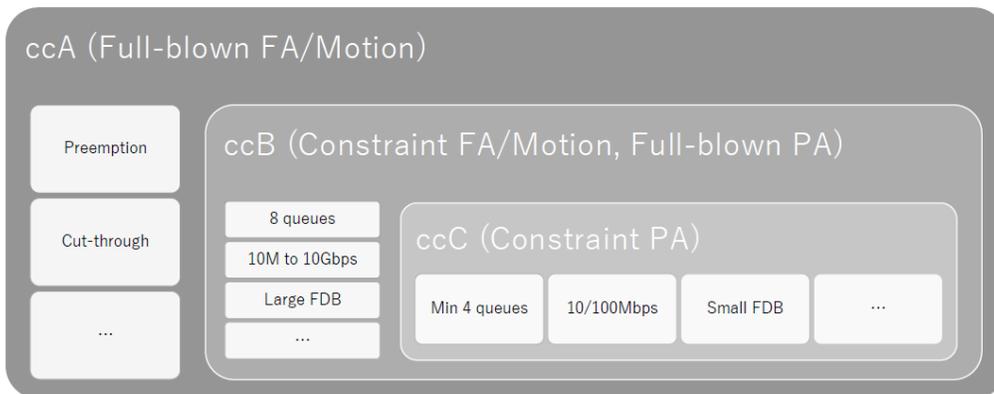
Figure 4 -- Yokogawa example CC mapping

CC Mapping Proposal (Plan B, 2 cc)

Separate FA/Motion specific attributes and make them optional for PA in each class.

| ccA (Full-blown) | • FA/Motion specific attributes (Optional for PA)
• IA common attributes (Mandatory for all) |
| ccB (Constraint) | • FA/Motion specific attributes (Optional for PA)
• IA common attributes (Mandatory for all) |
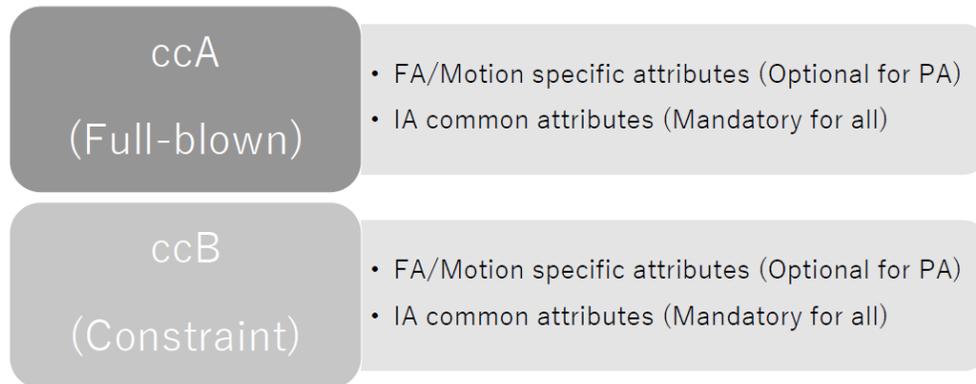
Figure 5 -- Yokogawa example CC mapping

CC Mapping Proposal (Plan C, 4 cc)

Add ccC for Full-blown PA and ccD for Constraint PA to keep ccA & ccB perfectly fit to FA/Motion.

ccA, B for FA/Motion	ccC, D for PA
ccA (Full-blown)	ccC (Full-blown)
ccB (Constraint)	ccD (Constraint)
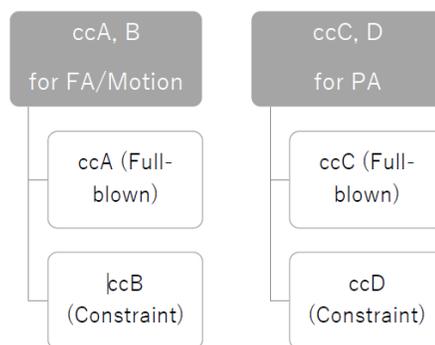
Figure 6 -- Yokogawa example CC mapping

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

376   • Limited Traffic Types
377   • Limited power source

378   Hazardous area installation

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

384   In-cabinet installation

385   • Limited data rate for heat control
386   • Limited footprint

387   Switch-less installation requirement

388   • Limited topologies (line/ring)

389   Less strict performance requirements on:

390   • Time error
391   • Timestamp accuracy
392   • Minimum network cycle
393   • …

394   *4.4.4.2 Shall a <u>vendor independent</u> mix between "full-blown" and "constraint" devices in one TSN*
395   *Domain be supported?*
396   (This means, that a vendor independent configuration of the network portion of each device
397   according to IEC/IEEE 60802 is supported.)

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

399   *4.4.4.3 Shall a <u>vendor independent</u> mix between "full-blown" devices in one TSN Domain be*
400   *supported?*
401   (Follow-up to Question 2 – or is this only required for class full-blown?)

402   Yes

403   *4.4.4.4 Shall a <u>vendor independent</u> mix between "constraint" devices in one TSN Domain be*
404   *supported?*
405   (Let's assume that in a TSN Domain only class constraints is supported. This means, that a vendor
406   independent configuration of the network portion of each device according to IEC/IEEE 60802 is
407   supported.)

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

410   *4.4.4.5 Shall a mix between <u>vendor independent</u> "full-blown" and vendor dependent "constraint"*
411   *devices in one TSN Domain be supported?*
412   (This means, that a mixture between vendor dependent configuration and vendor independent
413   according to IEC/IEEE 60802 definitions of the network portion - is supported.)

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

415 *4.4.4.6   Is it enough to support a <u>vendor dependent</u> mix of "constraint" devices in one TSN*
416 *Domain?*
417 TDB

418 *4.4.4.7   Does the usage of end-stations follow the same model?*
419 (Same principle – Question 1 to 5 – for end-stations. Assumption: Pure end-stations, without
420 integrated bridge, do have lesser impact to the overall interoperability. Thus, it's unclear to the
421 editor whether we need two classes for them.)

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

424 **4.4.5   ABB (including B&R)**
425 Ethernet is the basis of the industrial communication. TSN is now part of Ethernet and thus, basis of
426 the industrial communication, too.

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

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

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

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

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

442

443 *4.4.5.1   What is your understanding of constraint bridge or end-station?*
444 The understanding of the term "Constraint" needs to be aligned among each contributor.

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

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

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

454

455

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

457 • Hardware chipset
458   • Processing power
459   • Memory sizes (of various types)
460 • Other aspects as described in the attached Excel sheet concerning the example selection

461 Mixing constrained and fully capable devices in a system is dependent on the required topology
462 and less on the TSN domains demarcation, see example:
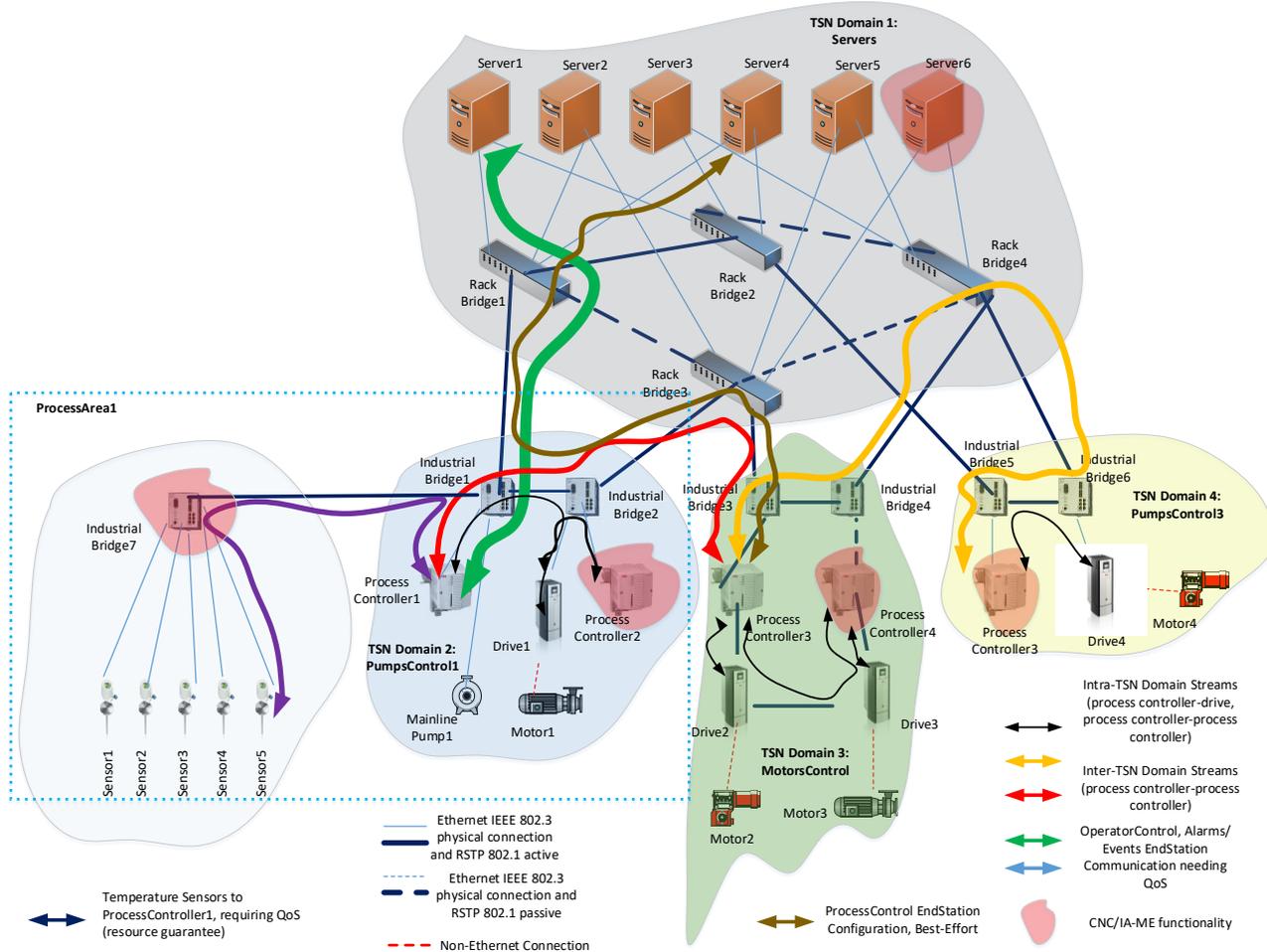
463

464

465 *4.4.5.2 Shall a <u>vendor independent</u> mix between "full-blown" and "constraint" devices in one TSN*
466 *Domain be supported?*
467 (This means, that a vendor independent configuration of the network portion of each device
468 according to IEC/IEEE 60802 is supported.)

469 Yes, see the example system above.

470 *4.4.5.3 Shall a <u>vendor independent</u> mix between "full-blown" devices in one TSN Domain be*
471 *supported?*
472 (Follow-up to Question 2 – or is this only required for class full-blown?)

473 Yes

474   *4.4.5.4   Shall a <u>vendor independent</u> mix between "constraint" devices in one TSN Domain be*
475   *supported?*
476   (Let's assume that in a TSN Domain only class constraints is supported. This means, that a vendor
477   independent configuration of the network portion of each device according to IEC/IEEE 60802 is
478   supported.)

479   Yes

480   *4.4.5.5   Shall a mix between vendor independent "full-blown" and vendor dependent "constraint"*
481   *devices in one TSN Domain be supported?*
482   (This means, that a mixture between vendor dependent configuration and vendor independent
483   according to IEC/IEEE 60802 definitions of the network portion - is supported.)

484   See 4.4.5.2

485   *4.4.5.6   Is it enough to support a <u>vendor dependent</u> mix of "constraint" devices in one TSN*
486   *Domain?*
487   It depends on the requirements of the TSN domain. It could be that a number of constrained
488   bridges and constrained end stations may be sufficient in some cases.

489   No

490   *4.4.5.7   Does the usage of end-stations follow the same model?*
491   (Same principle – Question 1 to 5 – for end-stations. Assumption: Pure end-stations, without
492   integrated bridge, do have lesser impact to the overall interoperability. Thus, it's unclear to the
493   editor whether we need two classes for them.)

494   Yes

495   **4.4.6   Others**
496   TDB

497

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.

532

5.3 Full-blown and constrained devices

534

535 See "60802-Steindl-et-al-ExampleSelectionTables-0520-v24.pdf" available at
536 http://www.ieee802.org/1/files/public
537

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

581 [12] Coexistence & Convergence in TSN-based Industrial Automation Networks:
582 http://www.ieee802.org/1/files/public/docs2018/60802-stanica-convergence-coexistence-
583 0718-v03.pptx
584
585 [13] Flexible Manufacturing System (FMS) for Small Batch Customized Production:
586 http://www.ieee802.org/1/files/public/docs2018/60802-Bai-small-batch-customized-
587 production-0718-v01.pdf
588
589 [14] Multi-traffic transmission in industrial backbone network:
590 http://www.ieee802.org/1/files/public/docs2018/60802-chen-multi-traffic-transmission-on-
591 backbone-0918.pdf
592
593
594