Requirements IEC/IEEE 60802

Contributors

Dorr, Josef <josef.dorr@siemens.com>
Joint Working Group: Pittsburgh 0518

Abstract

This document describes requirements for industrial automation based on TSN. The requirements are extracted and derived from:

- industrial use cases - http://www.ieee802.org/1/files/public/docs2018/60802-industrial-use-cases-0618-v07.pdf
- TSN-IA preCD Draft - http://www.ieee802.org/1/files/private/liaisons/65c-60802-Ed1-IS-preCD-OE_20180430_rev6p0.pdf

Log

V0.1	2018-05-23	Initial revision presented and reviewed at Pittsburgh
V0.2	2018-06-18	Incorporated Pittsburgh comments

1 60802 Requirements

1.1 Recap - 60802 preCD Draft Requirements

See [2] clause 6.2

Table 1 – requirements overview

The following properties are expected from an IEC/IEEE 60802 TSN network	
R1	Streams can be established and removed at any time in ad-hoc manner without effect on other established streams in the TSN domain, i.e. particularly without re-initialization of the TSN domain.
R2	TSN domain effectivity and efficiency is independent from the order in which streams were established and/or removed (in a non-overloaded situation)
~~R3~~	~~Applications in end nodes need not depend on how the network is organized (trees, etc.).~~[1)]
R4	In case of stream failure, sufficient diagnostics information is provided, so that the error cause and potential recovery measures can be identified.
R5	A TSN domain can be expanded dynamically at any time by attaching an additional TSN bridge to a spare port – without effect on established streams in the network.
R6	Removal of a bridge out of a TSN Domain which is in use will only affect streams which are using that bridge.
R7	TSN domain boundaries are enforced by TSN bridges and can optionally be controlled by network management to not interfere with TSN traffic and to support non-TSN traffic in a deterministic manner.
R8	The requirements of the various industrial traffic types are met.
R9	Bridges shall support a standardized network configuration/management interface.
~~R10~~	~~Several independent applications (e.g. multiple CPx systems, OPC UA@TSN…) are supported at the same time.~~[2)]
R11	Interoperability of bridges and the TSN function of end stations from different vendors need to be assured.
~~R12~~	~~Network can be partitioned according to the user's wishes into individual functional domains between bridges – optionally within a bridge so that streams of one functional domain do not cross into another functional domain~~[3)]
R13	A default set of parameters shall be provided.[4)]
R14	All industrial topologies, which are defined in IEC 61918 (e.g. linear, ring, star) – including topologies with redundant links as defined in IEC 62439-1 – shall be supported.
R15	The addition of TSN functionality to an Ethernet network shall not impact proper operation of upper functional safety layers used on top of Ethernet based fieldbuses or networks (see IEC 61784-3).
R16	The TSN–IA profile shall support redundancy for streams. TSN Network management should support reporting of independent physical paths and control of stream setup to allow

[1)] Deleted at the Pittsburgh interim: This is a requirement to applications, therefore out of scope for the profile.
[2)] Deleted at the Pittsburgh interim: This is a requirement to applications, therefore out of scope for the profile.
[3)] Deleted at the Pittsburgh interim: This requirement will be replaced by a contribution.
[4)] marked “not yet decided” in [2]

	management of redundancy.
R17	The TSN network should ~~also~~ allow redundancy recovery time to be calculated. ~~The TSN-IA profile defines an upper limit for the redundancy recovery time. The TSN-IA profile shall provide means for calculating the recovery time for given topologies.~~[5)]
R18	The TSN-IA profile shall support the extension of brownfield installations.
R19	The TSN-IA profile shall support connection of existing (for e.g. migration) or non-TSN devices to TSN networks with as little as possible disturbance of existing modes of operation.
R20	The TSN-IA profile shall consider protecting TSN domains against traffic from outside the domain – examples shall be provided.[6)]

1.2 Additional Requirements

The following requirements were added during the Pittsburgh interim:

R21	Bridges shall support standardized stream establishment.
R22	Different Link Speeds within and/or connecting to a TSN domain shall be supported.
R23	Support synchronization of multiple timescales with gPTP (e.g. universal time, working clock, redundant working clock).
R24	Minimum supported quantities shall be defined.

[5)] Deleted at the Pittsburgh interim
[6)] marked “not yet decided” in [2]

2 60802 Use Cases

See [1] for the detailed description of the use cases.

Table 2 – use cases overview

	Synchronization
UC1	Sequence of events
	Industrial automation mode of operation
UC2	Control Loops with guaranteed low latency
UC3	Control Loops with bounded latency
UC4	Reduction ratio of network cycle
UC5	Drives without common application cycle
UC6	Drives without common application cycle but common network cycle
	Industrial automation networks
UC7	Redundant networks
UC8	High Availability
UC9	Wireless
UC10	10 Mbit/s end-stations (Ethernet Sensors)
UC11	Fieldbus gateway
UC12	New machine with brownfield devices
UC13	Mixed link speeds
UC14	Multiple isochronous domains
UC15	Auto domain protection
UC16	Vast number of connected stations
	Industrial automation machines, production cells, production lines
UC17	Machine-to-machine communication
UC18	Pass-through traffic
UC19	Modular machine assembly
UC20	Tool changer
UC21	Dynamic plugging and unplugging of machines (subnets)
UC22	Energy saving
UC23	Add machine, production cell or production line
UC24	Multiple applications in a station using the TSN-IA profile
UC25	Functional safety
UC26	DCS device level reconfiguration
UC27	DCS system level reconfiguration
	Further Industrial automation use cases
UC28	Network monitoring and diagnostics
UC29	Security
UC30	Firmware update
UC31	Virtualization
UC32	Digital twin
UC33	Device replacement without engineering

3 Requirements vs. Use cases Cross reference

In the following sub-clauses for each requirement the affected use cases of [1] are listed:

R1: Streams can be established and removed at any time in ad-hoc manner without effect on other established streams in the TSN Domain, i.e. particularly without re-initialization of the TSN Domain

Needed by all use cases, in particular by the dynamic reconfiguration use cases:

UC19	Modular machine assembly
UC20	Tool changer
UC21	Dynamic plugging and unplugging of machines (subnets)
UC22	Energy saving
UC23	Add machine, production cell or production line
UC26	DCS device level reconfiguration
UC27	DCS system level reconfiguration
UC30	Firmware update
UC33	Device replacement without engineering

(see Summary~~Summary~~)

R2: TSN Domain effectivity and efficiency is independent from the order in which streams were established and/or removed (in a non-overloaded situation)

Needed by all use cases, in particular by the dynamic reconfiguration use cases:

UC19	Modular machine assembly
UC20	Tool changer
UC21	Dynamic plugging and unplugging of machines (subnets)
UC22	Energy saving
UC23	Add machine, production cell or production line
UC26	DCS device level reconfiguration
UC27	DCS system level reconfiguration
UC30	Firmware update
UC33	Device replacement without engineering

(see Summary~~Summary~~)

~~**R3: Applications in end nodes need not depend on how the network is organized (trees, etc.).**~~

- deleted -

R4: In case of stream failure, sufficient diagnostics information is provided, so that the error cause and potential recovery measures can be identified.

Needed by all use cases, in particular:

UC28	Network monitoring and diagnostics

(see Summary~~Summary~~)

R5: A TSN Domain can be expanded dynamically at any time by attaching an additional bridge to a spare port – without effect on established streams in the network.

Needed by all use cases, in particular by the dynamic reconfiguration use cases:

UC19	Modular machine assembly
UC20	Tool changer
UC21	Dynamic plugging and unplugging of machines (subnets)
UC22	Energy saving
UC23	Add machine, production cell or production line
UC26	DCS device level reconfiguration
UC27	DCS system level reconfiguration
UC30	Firmware update
UC33	Device replacement without engineering

(see Summary~~Summary~~)

R6: Removal of a bridge out of a TSN Domain, which is in use, will only affect streams, which are using that bridge.

Needed by all use cases, in particular by the dynamic reconfiguration use cases:

UC19	Modular machine assembly
UC20	Tool changer
UC21	Dynamic plugging and unplugging of machines (subnets)
UC22	Energy saving
UC23	Add machine, production cell or production line
UC26	DCS device level reconfiguration
UC27	DCS system level reconfiguration
UC30	Firmware update
UC33	Device replacement without engineering

(see Summary~~Summary~~)

R7: TSN domain boundaries are enforced by bridges and can optionally be controlled by network management to not interfere with TSN traffic and to support non-TSN traffic in a deterministic manner.

Needed by all use cases, in particular:

UC15	Auto domain protection
UC17	Machine-to-machine communication

(see Summary~~Summary~~)

R8: The requirements of the various industrial traffic types are met.

Needed by all use cases. Only stream based traffic types are covered by the use cases, in particular:

UC2	Control Loops with guaranteed low latency
UC3	Control Loops with bounded latency
UC4	Reduction ratio of network cycle
UC5	Drives without common application cycle
UC6	Drives without common application cycle but common network cycle

(see Summary~~Summary~~)

R9: Bridges shall support a standardized network configuration/management interface.

Needed by all use cases.

~~**R10: Several independent applications (e.g. multiple CPx systems, OPC UA@TSN…) are supported at the same time.**~~

- deleted -

R11: Interoperability of bridges and the TSN function of end stations from different vendors need to be assured.

Needed by all use cases, repeats the scope.

~~**R12: Network can be partitioned according to the user's wishes into individual TSN domains between bridges – optionally within a bridge so that streams of one TSN domain do not cross into another TSN domain.**~~

This requirement will be replaced by a contribution.

R13: A default set of parameters shall be provided.

- network configuration/management is not defined yet and intentionally postponed -

R14: industrial topologies, which are defined in IEC 61918 (e.g. linear, ring, star) – including topologies with redundant links as defined in IEC 62439-1 – shall be supported.

Needed by all use cases, in particular:

UC7	Redundant networks
UC8	High Availability
UC9	Wireless

(see Summary~~Summary~~)

R15: The addition of TSN functionality to an Ethernet network shall not impact proper operation of upper functional safety layers used on top of Ethernet based fieldbuses or networks (see IEC 61784-3).

Needed by all use cases, in particular:

UC25	Functional safety

(see Summary~~Summary~~)

R16: The TSN–IA profile shall support redundancy for streams. TSN Network management should support reporting of independent physical paths and control of stream setup to allow management of redundancy.

- network configuration/management is not defined yet and intentionally postponed -

Needed by all use cases, in particular:

UC7	Redundant networks
UC8	High Availability
UC9	Wireless

(see Summary~~Summary~~)

R17: The TSN network should ~~also~~ allow redundancy recovery time to be calculated. ~~The TSN-IA profile defines an upper limit for the redundancy recovery time. The TSN-IA profile shall provide means for calculating the recovery time for given topologies.~~

Upper limits and means for calculation are part of IEC 62439.

Needed by all use cases, in particular:

UC7	Redundant networks
UC8	High Availability
UC9	Wireless
UC32	Digital twin

(see Summary~~Summary~~)

R18: The TSN-IA profile shall support the extension of brownfield installations.

Needed by all use cases, in particular:

UC11	Fieldbus gateway
UC27	DCS system level reconfiguration

(see Summary~~Summary~~)

R19: The TSN-IA profile shall support connection of existing (for e.g. migration) or non-TSN devices to TSN networks with as little as possible disturbance of existing modes of operation.

Needed by all use cases, in particular:

UC12	New machine with brownfield devices
UC18	Pass-through traffic
UC26	DCS device level reconfiguration
UC30	Firmware update
UC33	Device replacement without engineering

(see Summary~~Summary~~)

R20: The TSN-IA profile shall consider protecting TSN domains against traffic from outside the domain.

Needed by all use cases, in particular:

UC15	Auto domain protection
UC18	Pass-through traffic
UC29	Security

(see Summary~~Summary~~)

R21: Bridges shall support standardized stream establishment.

Needed by all use cases, in particular:

UC24	Multiple applications in a station using the TSN-IA profile
UC31	Virtualization

(see Summary)

R22: Different Link Speeds within and/or connecting to a TSN domain shall be supported.

Needed by all use cases, in particular:

UC10	10 Mbit/s end-stations (Ethernet Sensors)
UC13	Mixed link speeds

(see Summary)

R23: Support synchronization of multiple timescales with gPTP (e.g. universal time, working clock, redundant working clock).

Needed by all use cases – particularly

UC1	Sequence of events
UC14	Multiple isochronous domains

(see Summary)

R24: Minimum supported quantities shall be defined

Needed by all use cases – particularly

UC16	Vast number of connected stations

(see Summary)

See [1] clause “Minimum required quantities”;
Action request: we encourage the members of the Joint Project to give their input for their major market relevance, according to clause “Minimum required quantities” of the use case document.

Summary

Table 3 – use cases / requirements cross reference of particular relevance

Requirements \ Use Cases	UC 1	UC 2	UC 3	UC 4	UC 5	UC 6	UC 7	UC 8	UC 9	UC 10	UC 11	UC 12	UC 13	UC 14	UC 15	UC 16	UC 17	UC 18	UC 19	UC 20	UC 21	UC 22	UC 23	UC 24	UC 25	UC 26	UC 27	UC 28	UC 29	UC 30	UC 31	UC 32	UC 33
R1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
R2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
~~R3~~	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
R5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
R6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
R7	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
R8	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
R9	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
~~R10~~	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R11	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
~~R12~~	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R14	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
R15	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
R16	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
R17	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
R18	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
R19	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
R20	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

	Use Cases																															
	UC 1	UC 2	UC 3	UC 4	UC 5	UC 6	UC 7	UC 8	UC 9	UC 10	UC 11	UC 12	UC 13	UC 14	UC 15	UC 16	UC 17	UC 18	UC 19	UC 20	UC 21	UC 22	UC 23	UC 24	UC 25	UC 26	UC 27	UC 28	UC 29	UC 30	UC 31	UC 32	UC 33
R21	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
R22	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
R23	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
R24	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

4 Literature

[1] “Industrial Use Cases”, IEC/IEEE JWG Contributor group;
http://www.ieee802.org/1/files/public/docs2018/60802-industrial-use-cases-0618-v07.pdf

[2] “IEC preCD 60802”
http://www.ieee802.org/1/files/private/liaisons/65c-60802-Ed1-IS-preCD-OE_20180430_rev6p0.pdf