Informative Annex Project Proposal for IEEE Std 802.1CB Sequence Recovery Function Configuration

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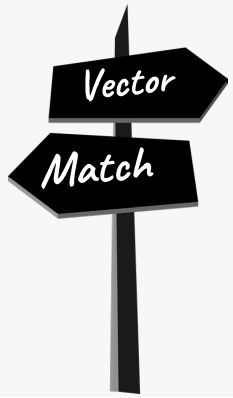
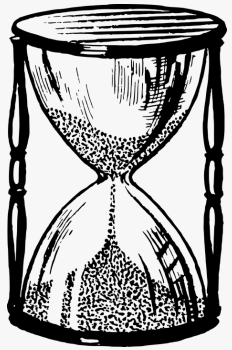
Background

Challenges: Incorrect configuration of parameters at eliminating device in IEEE Std 802.1CB can result in valid frames to be discarded entirely, passing of duplicates, and unexpected bursts.
Too high and too low values can jeopardize the reliability of FRER [Maile2022].



Match Recovery Algorithm (MRA):

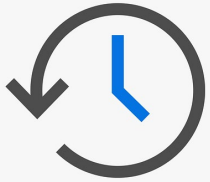
only applicable to **intermittent streams,**
otherwise MRA passes duplicates



Reset Timer:
SequenceRecoveryResetMSec

too low: unnecessary resets &
duplicates passed [Varga2023]

too high: discards (new) frames



Vector Recovery Algorithm (VRA):
frerSeqRcvyHistoryLength

too short: discards (new) frames [Hofmann2020]

too high: increased processing time can result in frame loss [Rana2023], $O(n)$ with n window size

Burst & Peak Rate Increase:

delay increase for flow [Thomas2022] and for interfering flows [Hofmann2020]
& buffer must be increased [Hofmann2020]

Background

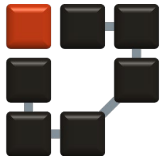
Discussion about a potential new IEEE 802.1 Project

with an Annex that includes guidelines for the configuration of the Sequence Recovery Function and burst dimensions

this can help the user / network administrator to understand the effects of duplicate elimination
+ enable proper configuration of FRER

Intended as informative only (i.e., no normative content added)

Background



Proposed Solution: Formulas for guidance of users to calculate fitting parameter values when using IEEE Std 802.1CB. Formulas can be obtained by only using the best- and worst-case path delays of the network and the traffic characteristics.

For formulas and more explanation, see:
https://mentor.ieee.org/802.1/dcn/24/1-24-0008-00-ICne-802-1cb-configuration-parameters-for-the-sequence-recovery-function.pdf
For all models, proofs, and simulation, see
http://arxiv.org/abs/2306.13469 / https://ieeexplore.ieee.org/document/9838905

Project Overview

Scope of the project

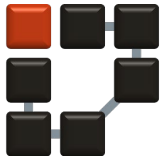
This amendment adds an informative annex that describes recommended values for the existing sequence recovery function parameters, dimensioning of buffer sizes, and associated traffic specification parameters to enable reliable duplicate identification, elimination and the forwarding of new frames.

Scope of the complete standard:

As in IEEE Std 802.1CB-2017:

This standard specifies procedures, managed objects, and protocols for bridges and end systems that provide identification and replication of packets for redundant transmission, identification of duplicate packets, and elimination of duplicate packets. It is not concerned with the creation of the multiple paths over which the duplicates are transmitted.

Project Overview



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Purpose

This informative annex includes recommend parameter values for the configuration of the Sequence Recovery Function and the dimensioning of bursts at eliminating devices using IEEE Std 802.1CB to

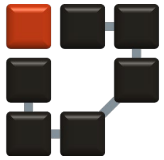
- identify and forward new frames and
- identify and eliminate duplicates.

This helps to understand the effects of duplicate elimination enable safe/reliable usage of FRER.

Need for the Project

To achieve fault tolerance introduced by IEEE Std 802.1CB, it is necessary to identify and eliminate duplicate frames and store and forward new frames. Currently, there exists no guidance on how to configure the sequence recovery function parameters and dimension buffer sizes in eliminating devices (end stations or bridges). This can lead to passing of duplicates and valid frames to be discarded entirely. This informative annex provides a guidance on parameter values and buffer sizes for the reliable behavior of IEEE Std 802.1CB.

Project Overview



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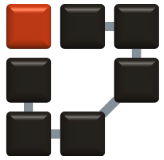
Stakeholders for the Standard

Developers, providers, and users of IEEE Std 802.1CB for networking services and equipment in industrial automation, in-vehicle networking, aerospace onboard networking, professional audio-video, data center and other systems requiring communication with the increased reliability of duplicate frame transmission.

Project Overview



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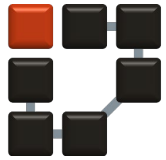
Managed objects

Describe the plan for developing a definition of managed objects. The plan shall specify one of the following:

a) The definitions will be part of this project.
b) The definitions will be part of a different project and provide the plan for that project or anticipated future project.
c) The definitions will not be developed and explain why such definitions are not needed.

This project will use method c).

Project Overview



FAU

Broad market potential

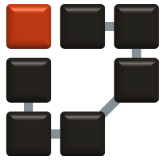
Each proposed IEEE 802 LMSC standard shall have broad market potential. At a minimum, address the following areas:

a) Broad sets of applicability.
b) Multiple vendors and numerous users.

a) *As in IEEE Std 802.1CB-2017:*
Redundant topologies are common in many industrial networks such as Industrial Automation, Energy Automation, Rail Systems. Growth rate of redundant systems is much higher than the growth of communication in general. Redundant topologies are also used in automotive in-vehicle networks for safety critical control applications and ring topologies are proposed for automotive backbone applications.

b) The amendment adds an informative annex that describes the settings of existing sequence recovery function parameters and dimensioning of buffer sizes in the base standard to support reliable handling of frames at eliminating devices. This description enables usage of the base standard in applications that require support for these parameter settings.

Project Overview



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Technical Feasibility

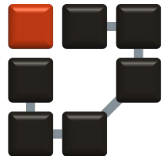
Each proposed IEEE 802 LMSC standard shall provide evidence that the project is technically feasible within the time frame of the project. At a minimum, address the following items to demonstrate technical feasibility:

a) Demonstrated system feasibility.
b) Proven similar technology via testing, modeling, simulation, etc.

a) The informative annex describes the setting of existing parameters that are currently deployed. All addressed parameters are already defined by IEEE Std 802.1CB; therefore, setting these parameters is feasible.

b) The informative annex relies on the proven technology provided by the base standard. Additionally, the proposed parameter values have been modeled, proven, and simulated in https://ieeexplore.ieee.org/document/9838905 (http://arxiv.org/abs/2306.13469).

Project Overview



FAU

Economic Feasibility

Each proposed IEEE 802 LMSC standard shall provide evidence of economic feasibility. Demonstrate, as far as can reasonably be estimated, the economic feasibility of the proposed project for its intended applications. Among the areas that may be addressed in the cost for performance analysis are the following:

a) Known cost factors.
b) Balanced costs.
c) Consideration of installation costs.
d) Consideration of operational costs (e.g., energy consumption).
e) Other areas, as appropriate.

The amendment does not imply additional hardware cost as it only adds description and recommendations for existing parameter settings. The proposed parameters and guidelines could potentially lower implementation costs by reducing over-provisioning for memory (required for the vector recovery algorithm and buffers).

References

"IEEE standard for local and metropolitan area networks–frame replication and elimination for reliability," IEEE Std 802.1CB-2017.

[Hofmann2020] *R. Hofmann, B. Nikoli´c, and R. Ernst, "Challenges and limitations of IEEE 802.1CB-2017," IEEE Embedded Systems Letters, vol. 12, no. 4, pp. 105–108, 2020.*

[Maile2022] *L. Maile, D. Voitlein, K. -S. Hielscher and R. German, "Ensuring Reliable and Predictable Behavior of IEEE 802.1CB Frame Replication and Elimination," ICC 2022 - IEEE International Conference on Communications, Seoul, Korea, Republic of, 2022, pp. 2706-2712, doi: 10.1109/ICC45855.2022.9838905.*

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[Rana2023] *S. K. Rana, H. Verma, J. Pal, D. Choudhary, T. V. Prabhakar, and C. Singh, "Enhancing Reliability of Scheduled Traffic in Time-Sensitive Networks using Frame Replication and Elimination," in IEEE 29th International Symposium on Local and Metropolitan Area Networks, Jul. 2023, pp. 1–6. doi: 10.1109/LANMAN58293.2023.10189416.*

[Varga2023] *B. Varga, J. Farkas, F. Fejes, J. Ansari, I. Moldován, and M. Máté, "Robustness and Reliability Provided by Deterministic Packet Networks (TSN and DetNet)," IEEE Trans. Netw. Serv. Manage., vol. 20, no. 3, pp. 2309–2318, Sep. 2023, doi: 10.1109/TNSM.2023.3284590.*

Thank you!

More information?

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