Technische Universität Braunschweig

INSTITUTE OF COMPUTER AND NETWORK ENGINEERING

Informative Annex Project Proposal (v2) for IEEE Std 802.1CB Sequence Recovery Function Configuration

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Acknowledgement

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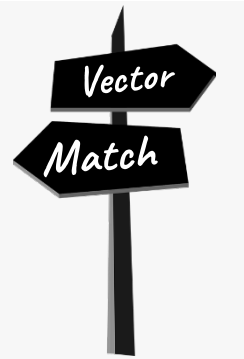
For original contribution, including models, proofs, and simulation, see http://arxiv.org/abs/2306.13469 / https://ieeexplore.ieee.org/document/9838905

This is the second version of this proposal.

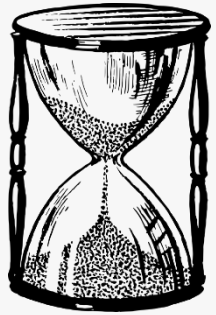
Background

Challenges: Incorrect configuration of parameters for elimination 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

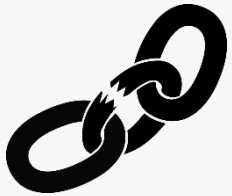
too low: unnecessary resets &
duplicates passed [Varga2023]

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]

Project Overview

- **Potential Title:**
  Annex (informative): Configuration Parameters for the Sequence Recovery Function
- **Scope of the project:** State what the Amendment is changing or adding.
  - This amendment adds an informative annex that describes recommended values for the existing sequence recovery function parameters and **for buffering frames (in relay and end systems) to give guidance on the proper usage of Frame Replication and Elimination for Reliability.**

Adapted

- **Need for the project:** Briefly detail the specific problem that the standard will resolve and the benefit that users will gain.
  - To achieve fault tolerance introduced by IEEE Std 802.1CB, it is necessary to identify and eliminate duplicate frames and store and forward **non-duplicate** frames. Currently, there exists no guidance on the configuration of the sequence recovery function parameters **and on buffering** for proper elimination. This can lead to passing of duplicates and valid frames to be discarded entirely. This informative annex provides a guidance on parameter values and buffering for the **proper** behavior of IEEE Std 802.1CB.

Adapted

- **Purpose:** A paragraph describing the purpose of the standard is not mandatory in the draft. However, if included, the purpose shall explain why the standards project is needed.

Removed

Project Overview

- **Stakeholders for the Standard:** Any parties that have an interest in or may be impacted (e.g., telecom, medical, environmental).
  - Developers, providers, and users of IEEE Std 802.1CB for networking services and equipment**. This includes** 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.

Adapt-ed

- **Are there other standards or projects with a similar scope? If yes, explain:** Identify any standard(s) or project(s) of similar scope(s), both within or outside of the IEEE, and explain the need for an additional standard in this area.
  - No.

New

Project Overview

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.

b) All vendors and users using IEEE Std 802.1CB-2017 can benefit from the informative annex regarding the configuration of Frame Replication and Elimination for Reliability.

Adapt-ed

Economic Feasibility

Demonstrate, as far as can reasonably be estimated, the economic feasibility of the proposed project for its intended applications, including:
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 buffering).

No change

Project Overview

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.
See https://ieeexplore.ieee.org/document/9838905 (http://arxiv.org/abs/2306.13469).

Adapt-ed

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.*

[Thomas2022] *L. Thomas, A. Mifdaoui and J. -Y. Le Boudec, "Worst-Case Delay Bounds in Time-Sensitive Networks With Packet Replication and Elimination," in IEEE/ACM Transactions on Networking, vol. 30, no. 6, pp. 2701-2715, Dec. 2022, doi: 10.1109/TNET.2022.3180763.*

[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.*

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Thank you!

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