Research project offer

Location : ISAE SUPAERO, Toulouse, France

Department : Department of Complex Systems Engineering (DISC)

Research group : Communication Networks (RESCOM)

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OFFER DESCRIPTION

Title : Reliability mechanisms for time sensitive networks

Proposed duration and period : 6 months from March 1st to end of August

Context	Time-Sensitive Networking (TSN) [1] offers a set of IEEE standards to bring timeliness and reliability to Ethernet technology. The major benefit of TSN is being an open standard, an overwhelming benefit for many embedded applications that have struggled for decades with multiple incompatible proprietary real-time Ethernet solutions. Therefore, TSN Ethernet can be the common communication protocol for many real-time applications and drives down the development and maintenance costs. TSN describes a set of features extending the functionalities and Quality of Service (QoS) of standard Ethernet to enable determinism, reliability and re-configurability. Our main focus in this project is the reliability mechanisms in TSN, specified in the IEEE 802.1CB Frame Replication and Elimination for Reliability (FRER) standard [2][4].
Objectives and work	The FRER standard specifies procedures for bridges and end stations that provide the identification and replication of frames for redundant transmission, as well as the elimination of duplicate frames. This standard enables the increase of reliability level of specific flows that do not tolerate loss, which favors the safety requirement. However, FRER can induce out of order phenomena of duplicate flows, which breaks the FIFO property of these flows. This fact is problematic for the schedulers downstream the elimination process of FRER, since they require the FIFO property to behave correctly. Moreover, FRER mechanism can lead to latency increase within the bridges implementing such a mechanism, as proved in [5]. In this project, the main goal is to cope with these issues to guarantee the good use of FRER in time-sensitive networks: • First, we need to analyze the state of the art concerning FRER • Implement a simulation model for FRER on OMNET++ [4] • Evaluate the performance of the system through simulation and conduct comparative analysis with the analytic results in [5] • Improve the performance of FRER through optimizing the routing and/or the use of reordering functions.

Bibliography:

[1] IEEE, "802.1Q - IEEE Standard for Local and Metropolitan Area Net-works—Bridges and Bridged Networks,"" https://standards.ieee.org/ stan-dard/802 1Q-2018.html, 2018.

[2] IEEE ,"802.1cb - IEEE standard for local and metropolitan area networks–frame replication and elimination for reliability,""https://standards.ieee.org/standard/8021CB−2017.html,2017.

[3] M. Pahlevan and R. Obermaisser, "Redundancy management for safety-critical applications with time sensitive networking," in2018 28th International Telecommunication Networks and Applications Conference (ITNAC).IEEE, 2018, pp. 1–7.

[4] D. Ergen¸c and M. Fischer, "Implementation and orchestration of IEEE 802.1cb FRER in OMNeT++," in2021 IEEE International Conference on Communications Workshops (ICC Workshops). IEEE, 2021, pp. 1–6.

[5] L. Thomas, A. Mifdaoui, and J.-Y. L. Boudec, "Worst-case delay bounds in time-sensitive networks with packet replication and elimination," arXivpreprint arXiv:2110.05808, 2021

Possibility to continue with a PhD (Yes/No) : Yes

REQUIRED APPLICANT PROFILE AND SKILLS	
Study level (tick possible choices)	☐Undergraduate students (3rd or 4th year) ■ Master students (1st or 2nd year) ☐ PhD students
Required profile and skills	Good background on computer networks Programming languages skills: C/C++, Java, Python Good background on optimization techniques/ graph theory Good level of spoken and written English
Other useful information	