First Study of the Proactive Transmission of Replicated Frames Mechanism over TSN

Inés Álvarez, Drago Čavka, Julián Proenza, Manuel Barranco

Universitat de les Illes Balears
GOBIERNO DE ESPAÑA MINISTERIO DE ECONOMÍA, INDUSTRIA Y COMPETITIVIDAD
EUROPEAN UNION EUROPEAN REGIONAL DEVELOPMENT FUND "A way to make Europe"
EUROWEB European Research and Education Collaboration with Western Balkan
Erasmus Mundus

Introduction

- Time-Sensitive Networking (TSN) Task Group.
- Developing a set of standards to provide Ethernet:
    - REAL-TIME GUARANTEES,
    - ONLINE MANAGEMENT,
    - RELIABILITY
- on the layer 2.

Introduction

- Time-Sensitive Networking (TSN) Task Group.

- Developing a set of standards to provide Ethernet:

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    - **RELIABILITY**

- on the layer 2.

Reliability in TSN

- Qci: Per-Stream Filtering and Policing.
- Error containment.
  - Detect babbling idiot.
  - Detect delayed frames.

Reliability in TSN

- Qca: Path Control and Reservation
  - Stablish multiple paths between nodes.
- CB: Frame Replication and Elimination for Reliability
  - Stablish logical links over the created paths.
  - Send replicated messages through the redundant links.

Reliability in TSN

- TSN does not have time redundancy on layer 2.
- What are the options to tolerate temporary faults?

Reliability in TSN

- Using spatial redundancy to tolerate temporary faults.
- Not a suitable solution:
  - High cost.
  - No efficient solutions (specially in highly critical systems).

Reliability in TSN

- Using ARQ-based protocols.
- Not a suitable solution (for HRT systems):
  - High jitter.
  - Non-deterministic bandwidth consumption.
  - ACK/NACK messages introduce new fault scenarios.

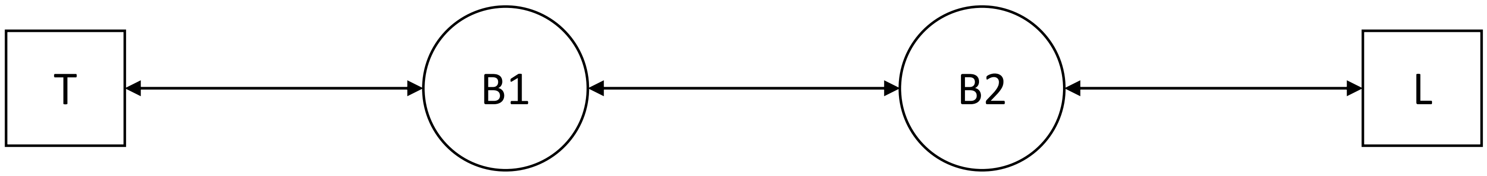
Reliability in TSN

- We propose to use proactive retransmissions.

- Lower cost than adding more paths.
- Lower jitter than with ARQ.
- Deterministic bandwidth consumption.
- More efficient than ARQ in the worst case scenario.

Proactive Transmission of Replicated Frames

End-to-end estimation and replication



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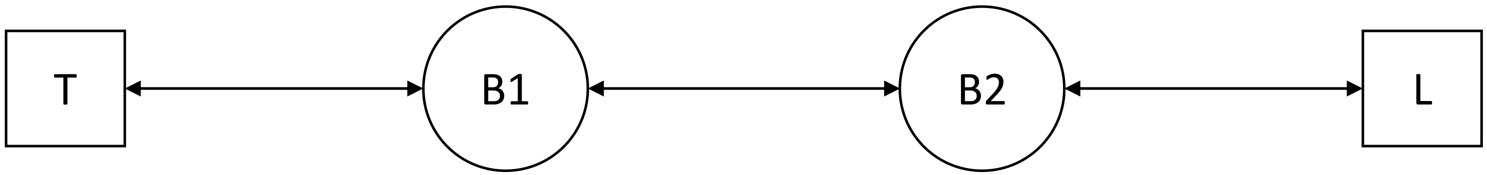
End-to-end estimation and replication

k=3



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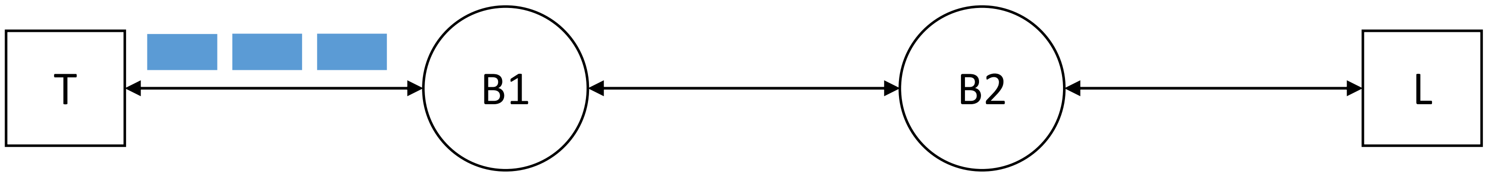

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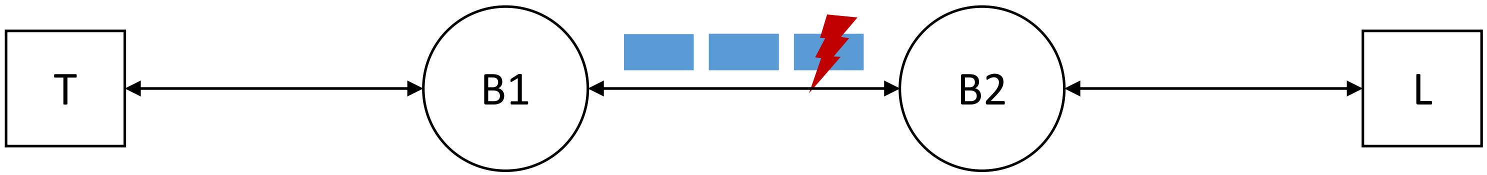

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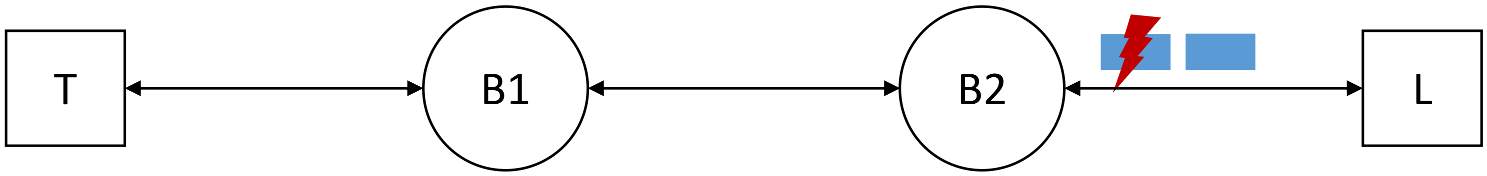

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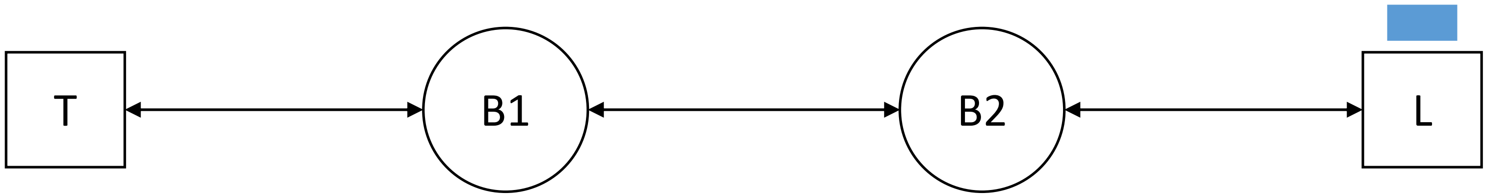
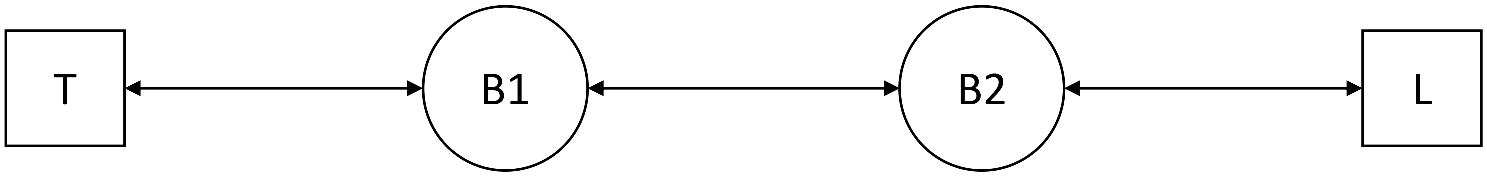


Proactive Transmission of Replicated Frames

End-to-end estimation, link-based replication



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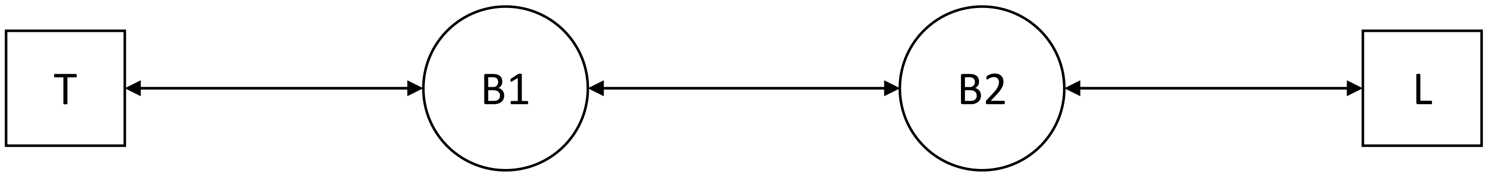

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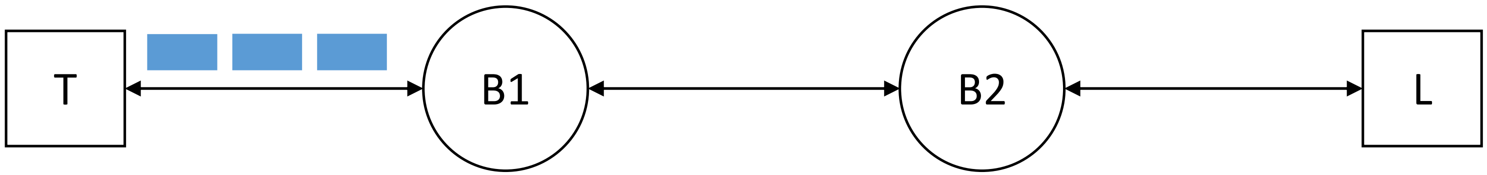

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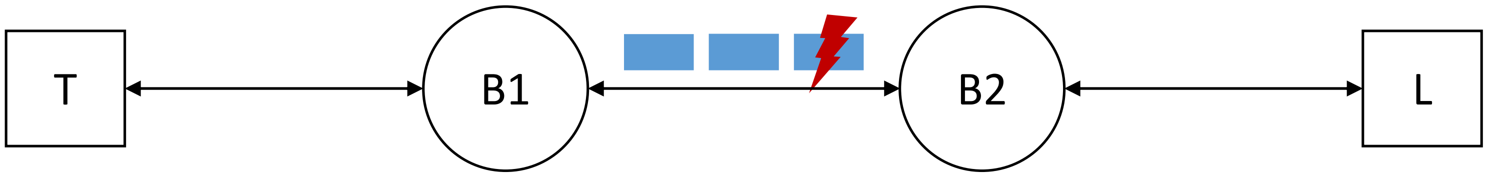

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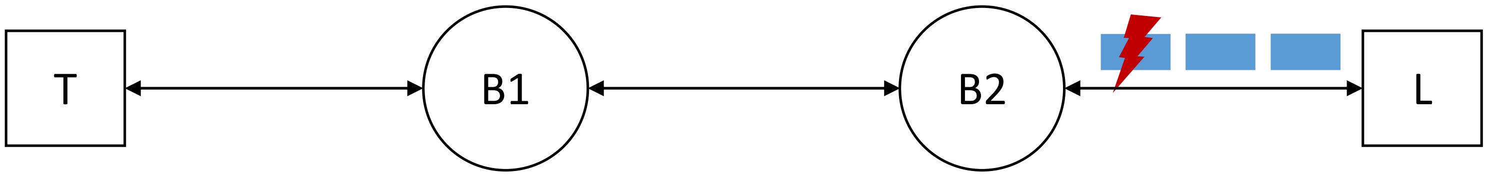

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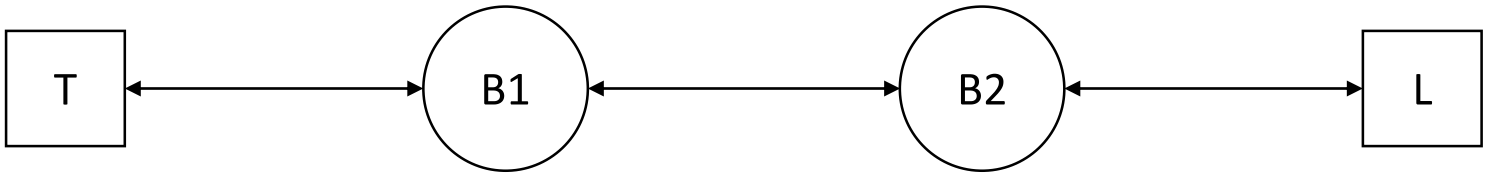

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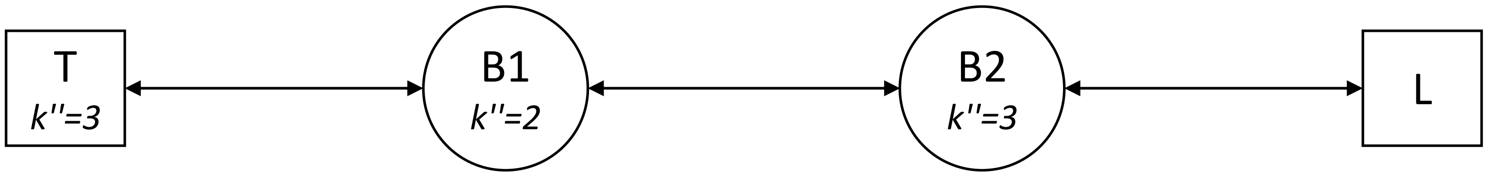

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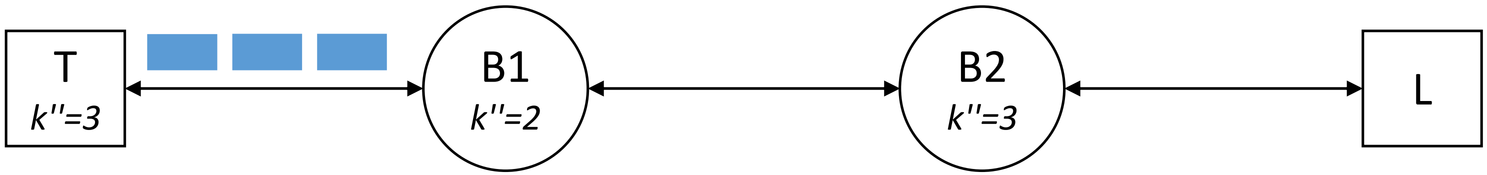

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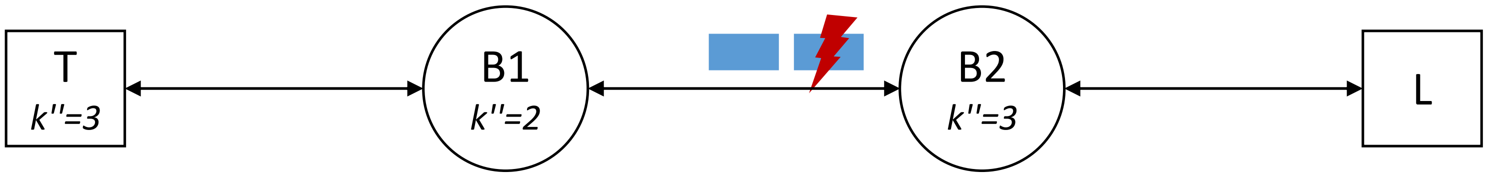

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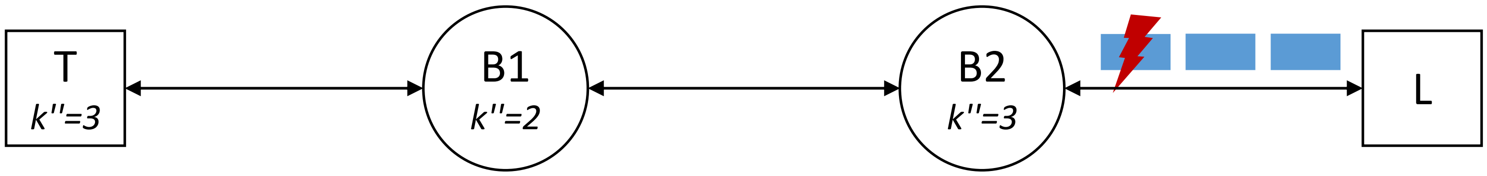


Proactive Transmission of Replicated Frames

Link-based estimation and replication

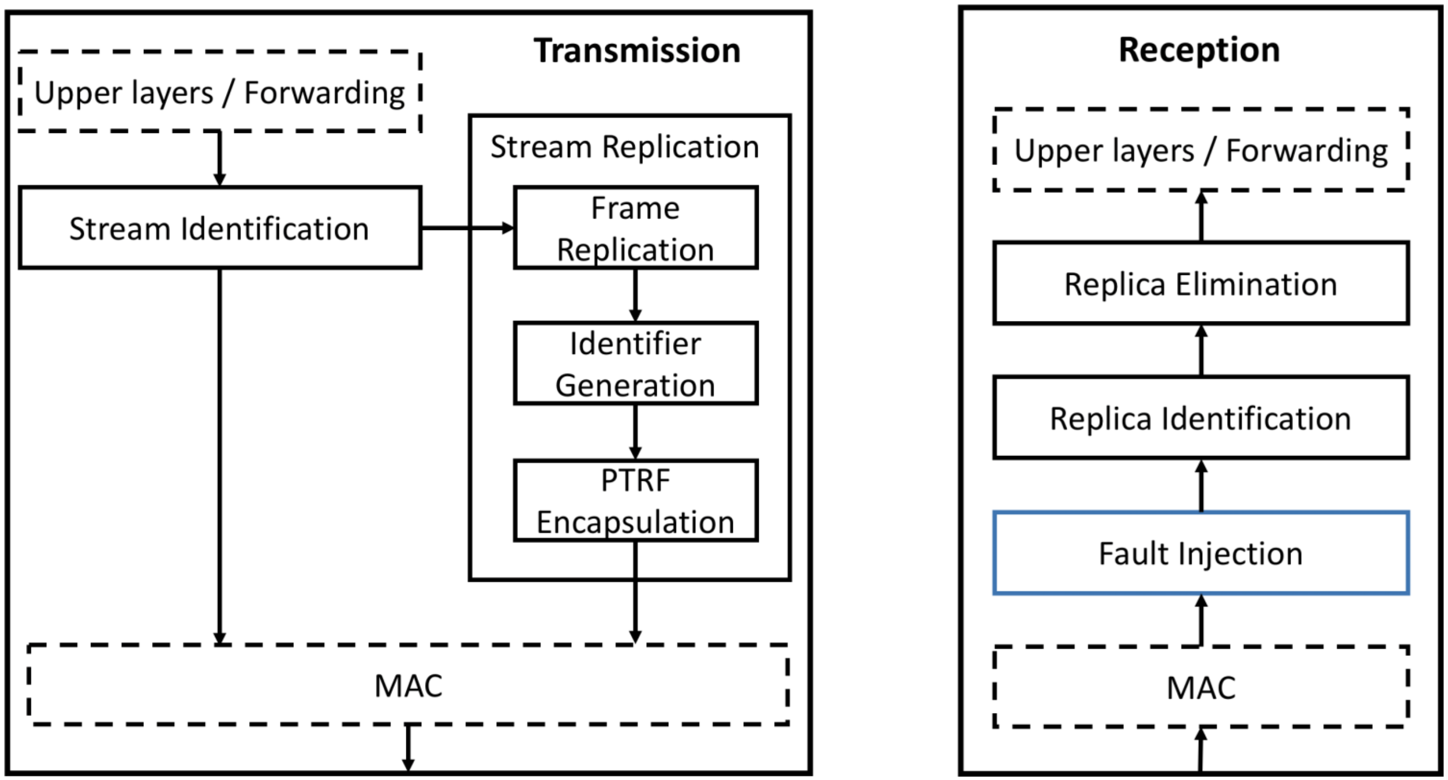
IN THIS WORK WE VALIDATE AND COMPARE THE APPROACHES OF THE TIME REDUNDANCY MECHANISM THROUGH SIMULATION

OMNeT++ simulation model

- Implement the PTRF mechanism over OMNeT++.
- TSimNet model as starting point [1].
- Additions:
  - Creation of replicas.
  - Identification and elimination of replicas.
  - Frame structure specification.

[1] P. Heise, F. Geyer, and R. Obermaisser. TSimNet: An Industrial Time Sensitive Networking Simulation Framework Based on OMNeT++. In 2016 8th IFIP International Conference on New Technologies, Mobility and Security (NTMS), Nov 2016.

OMNeT++ simulation model



Experiments

- We validated and compared the three approaches.

- We used exhaustive fault injection.
    - Inject all the possible combinations of frame losses.

- We used an automotive use case.
    - Study the behaviour of each approach in a realistic scenario.

Questions?

Please meet me at the poster!

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