Redundancy Strategy and Reliability Analysis of the FTT-enabled switch

Manuel Barranco

Unisversitat de les Illes Balears (UIB)

Luís Almeida

DEC-FEUP

Problem statement

- Networked Embedded Systems (NES) continuously require:
  - Higher bandwidth
  - More **heterogeneous** & complex traffic
  - Higher levels of **dependability**

Problem statement

How can we deal with the **increasing complexity** of NES while ensuring **timeliness together** with a sufficient **dependability** level?

Existing solutions

- Ethernet is a good candidate
  - High **bandwidth**
  - **Mature** technology (LAN domain)

Existing solutions

- However, current RT-Ethernet solutions
  - Focus on **bandwidth** efficiency **xor** strict **timeliness**
  - **Do not** address dependability

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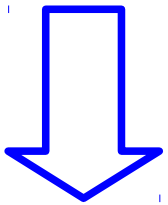

FTT-enabled Ethernet Switch

FTT-enabled Ethernet Switch

Basics

- Flexible Time-Triggered (FTT) Paradigm
  - **Synchronous** traffic (window)
  - **Asynchronous** and **NRT** traffic (window)

- **Integration** of the FTT **master** within the **switch**
  - **On-line** scheduling of the **synchronous** traffic
  - **Servers** for managing the **asynchronous** and NRT traffic (Server-SE based)

FTT-enabled Ethernet Switch

Advantages

- It is devoted to **outperform** RT-Ethernet solutions in terms
  - Traffic **management**
  - Scheduling **composability**

FTT-enabled Ethernet Switch

Advantages

- Has **dependability**-related **advantages** due to its underlying **star topology**
  - The switch is a **central bus guardian** as it shapes the traffic at the outlinks
  - Resilient to **spatial proximity** and **common-mode** failures

Present work **represents** a further **contribution** to the FTT-enabled Ethernet switch...

...in terms of dependability (**reliability**)

Objectives

- Reliability analysis (current FTT-ena. switch)
- Redundancy strategy
- Reliability analysis (proposed redundancy)

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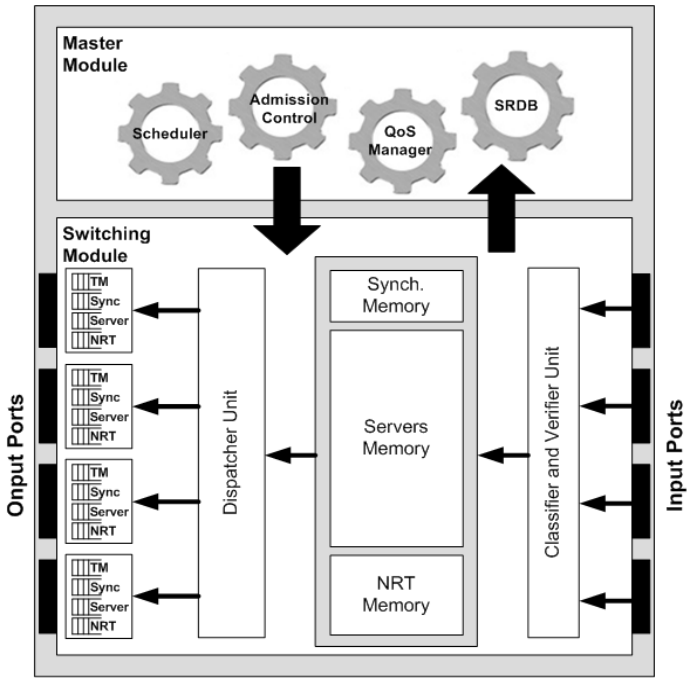
1st Reliability analysis

Goal

- To **quantify** the reliability achievable when:
  - Server-based scheduling is implemented in **software** vs **hardware**



- Which is better?
- Are they suitable for critical NES?

1st Reliability analysis

Tasks

- Define the **fault model**: permanent and transient faults
- Characterization of **parameters** that strongly **influence** dependability
- **Modelling** of the system using Stochastic Activity Networks (**SANs**)
- **Sensitivity** analyses

Objectives

- Reliability analysis (current FTT-ena. switch)
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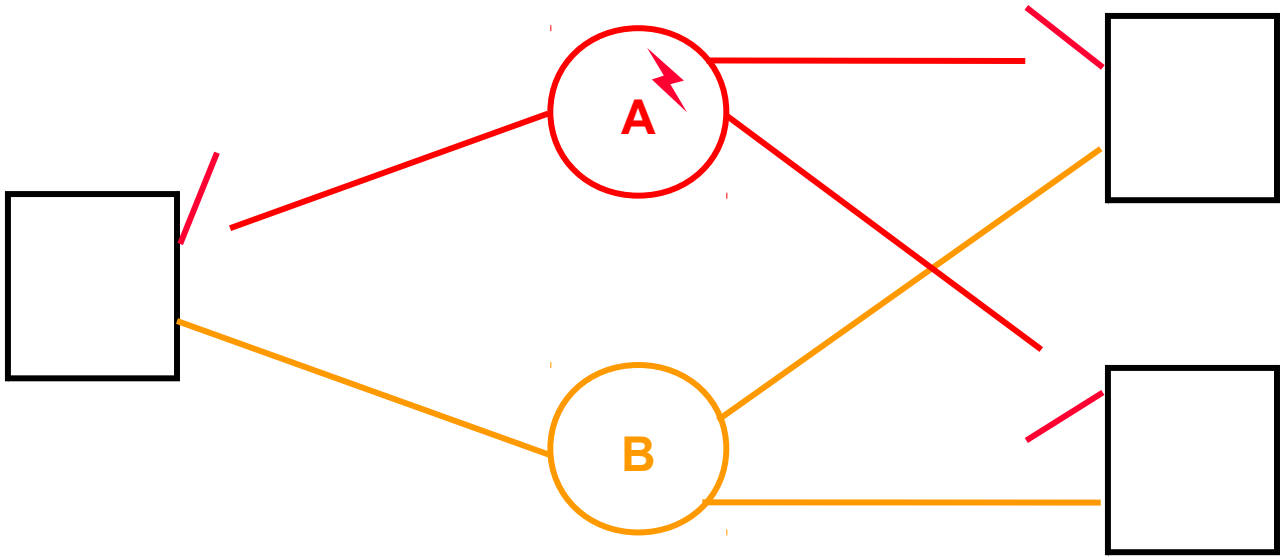
Redundancy strategy

Goal

- **Tolerate** faults at **links**, **controllers**, **transceivers** and/or **switches**



Redundancy strategy

Tasks

- **Adapt** as much as possible the ideas developed at the recent frameworks of:
  - Master **replication** in **FTT-CAN** (backup strategy)
  - **ReCANcentrate** (active replication)

- **Design specific** fault-treatment mechanisms like:
  - Detection of switch (master) faults
  - Replacement or masking of faulty switch

Objectives

- Reliability analysis (current FTT-ena. switch)
- Redundancy strategy
- Reliability analysis (proposed redundancy)

2nd Reliability analysis

Goal and tasks

- **Quantify** the **reliability** benefits of the proposed redundancy
  - **Guide** the **design** of the redundancy
  - **Justify** its **implementation** for critical NES
- The tasks basically are the same ones as for the first analysis

Conclusions

- The FTT-enabled Ethernet Switch can **outperform** other RT-Ethernet solutions in terms of **scheduling** and **dependability**
- But it is **still necessary** to **quantify** its dependability benefits for NES
- Particularly, it will be valuable to research on the **replication** of its infrastructure to achieve reliability levels **appropriate for critical** NES

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