First Implementation and Test of a Node Replication Scheme on top of the Flexible Time-Triggered Replicated Star for Ethernet

Alberto Ballesteros
Sinisa Derasevic
David Gessner
Francisca Font
Inés Álvarez
Manuel Barranco
Julián Proenza
The **FT4FTT** (Fault Tolerance for Flexible Time-Triggered Ethernet) project aims at providing an **architecture** that can support **distributed control applications** that are:

- **Predictable** → Have deadlines
- **Adaptive** → Have to work in changing environments
- **Highly-reliable** → Cannot suffer failures
Flexible Time-Triggered (FTT) on top of Ethernet allows developing distributed embedded systems that are predictable and adaptive.

- Master/multi-slave comm. model
- Slaves are regular nodes
- The master manages the comm.
The FT4FTT project

**Fault tolerance** to faults affecting the **network**

**Fault tolerance** to faults affecting the **nodes**
The FT4FTT project

Fault tolerance to faults affecting the network

• Flexible Time-Triggered Replicated Star (FTTRS)

Fault tolerance to faults affecting the nodes

• Active replication
• Voting
The FT4FTT project

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**The FT4FTT project**
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![Diagram showing network and nodes with labels and connections]
The FT4FTT project

Typical control applications cyclically perform three actions: sense, control and actuate.
The FT4FTT project

Typical **control applications** cyclically perform **three actions**: *sense*, *control* and *actuate*.

![Diagram showing sense, control, and actuation processes in both a single and replicated distributed control system.]
The FT4FTT project

Typical control applications cyclically perform three actions: sense, control and actuate.
In a previous work we designed the **Coordinate Dispatching for Node Replication** (CD4NR) mechanism to control the replicas:

- **Operation** of the replicas
- **Transmission** of messages
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In this work we present the prototyping and testing of the CD4NR mechanism and on a real FTTRS network.
Implementation and testing

**Implementation**
- Modification of *replicas* and *switches*
- New *experimental setup*
  - Inverted pendulum
  - Hardware-in-the-loop

**Testing**
- **Validate** the mechanism
- **Verify** implementation and integration with the rest of mechanisms
Implementation and testing

Implementation
- Modification of replicas and switches
- New experimental setup
  - Inverted pendulum
  - Hardware-in-the-loop

Testing
Test the tolerance of the system to permanent faults affecting the channel
- Switch crashes
- Failures in the links
Validate the CD4NR mechanism, as well as to verify its implementation and integration with the rest of the FT4FRT fault tolerant mechanisms. New experimental setup that implements an inverted pendulum using the hardware-in-the-loop technique.

Testing

Thank you for your attention!

See you at the poster session!
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