HaRTES - an FTT-enabled Switch

www.ieeta.pt/lse/hartes

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Problem

• Switched Ethernet presents attractive and well known advantages, which stimulate its use in Network Embedded Systems, but it was not designed to satisfy real-time requirements

Solutions and its Limitations

• **Using COTS switches**

  • **Traffic shapers or master-slave protocols**

    require a specific network stack layer to access the real-time services

    assume that all nodes comply with the protocol

    deny the connection of legacy nodes, since may compromise the system integrity - Poor robustness

• **Using customized switches**

  • **Profinet IRT**

    scheduling parameters are configured during the setup phase and they are obtained with a scheduling algorithm that is executed offline - Inflexible

  • **TTEthernet**

    scheduling for time-triggered traffic is performed offline by a planning tool ensuring interference free transmissions - Inflexible

Our Solution (FTT-enabled Switch)

• Enhanced switch based on the **Flexible Time-Triggered paradigm**

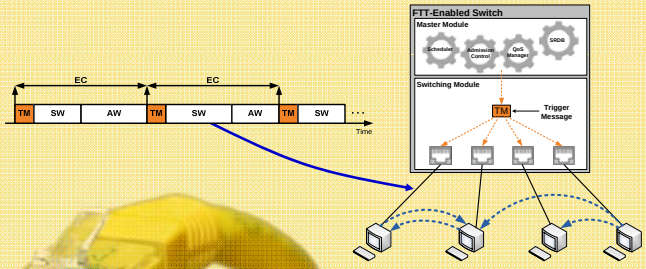
• Uses a **master-slave** control technique, being the master logically placed inside the switch

• Communication occurs in fixed slots, called **Elementary Cycles** (ECs), that are divided in synchronous and asynchronous windows

• Synchronous, asynchronous and non real-time traffic are supported

• The ECs start with a **Trigger Message** (TM) sent by the switch to the nodes containing the synchronous schedule for each EC

• **Asynchronous traffic** and non-real-time traffic are **autonomously triggered** by the nodes and managed by **servers**



Features

• **Traffic classification** and **confinement** at the input ports

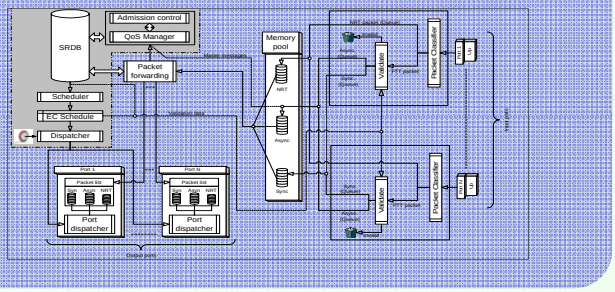
• Segregate the different kinds of traffic to the corresponding windows

• **Seamless integration of ordinary Ethernet nodes**, without interfering in the real-time subsystems

• Synchronization of parallel time triggered flows in different ports

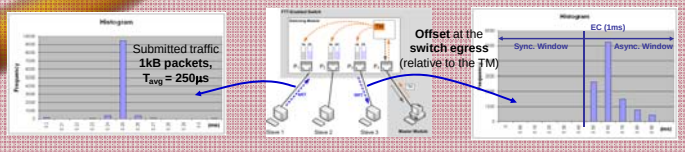
• Triggering of transmissions with **low jitter**, without relying on the nodes clock synchronization

• **Flexible and on-line scheduling techniques** with admission control capabilities, thus real-time communications flows can be **added**, **removed** and **updated** with strict temporal isolation



Results

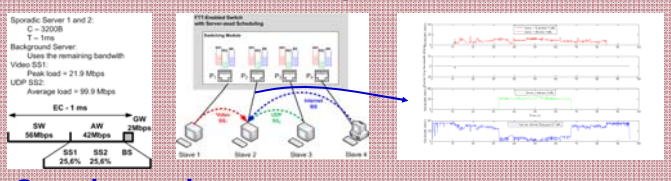
• **Traffic Confinement**



• **Regularity of the Trigger Message**

  • 100000 samples (ECs with 1 ms) → standard deviation equal to 27ns – jitter measured by a hardware sniffer with 10ns precision

• **Server-based Traffic Scheduling**



On going work

• Schedulability analysis of the server-based traffic scheduling

• Construction of multi-switch topologies

• Master replication

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