### HaRTES project

# Hard Real-Time Ethernet Switching

# **Project overview**

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Kickoff meeting, April 17, 2009, Aveiro

### Background

#### Initial work on Ethernet networks at the LSE:

- Started in 2001
- FTT-Ethernet
  - shared Ethernet
- FTT-SE
  - switched Ethernet
- VTPE

- implicit token passing, "PNet like" protocol

### Background

Some issues common to all COTS implementations have been identified:

- Necessarily cooperative
  - All nodes have to comply with the protocol
- Complex handling and signalization mechanism for aperiodic traffic
  - Scalability and efficiency problems for this class of traffic
- Impossible to implement traffic policing
  - Serious fault-tolerance problems

Those limitations can be addressed by using a **custom switch**, which led to the proposal of the HaRTES project

- Initially proposed in 2005, European project, with several partners
  - University of Aveiro, Balearic Islands University, ZHW, Austrian Academy of Sciences, Czech Technical Univ. in Prague, Catania University
  - Good evaluation but ... not good enough!
- In 2006 submitted to the Portuguese FCT Foundation (slim version)
  - Good evaluation but ... not good enough again! After complaining ... we got luck!

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General objective:

 Develop FPGA-based switching technology for Ethernet, capable of providing real-time communication services with operational flexibility.

Specific objectives:

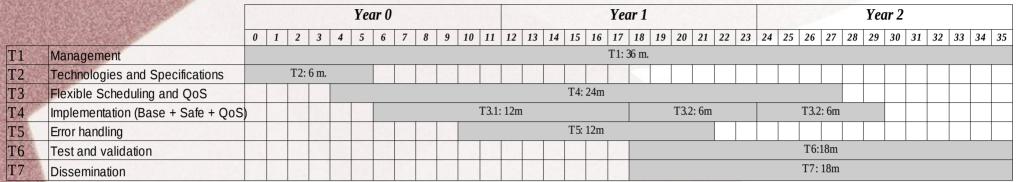
1. To include transmission control capabilities in Ethernet switches allowing the synchronization of parallel flows in different ports and the triggering of transmissions with low jitter;

### Specific objectives (cont):

- 2. Integrate flexible scheduling and QoS management services inside an Ethernet switch with transmission control capabilities:
  - Real-time communication objects can be added, removed or updated on-line, with timeliness guarantees.
- 3.Traffic management features to **separate different traffic classes** at the input ports and handle them with **mutual isolation**.
  - Seamless integration of ordinary Ethernet nodes (e.g. PCs) with general-purpose operating systems without jeopardizing the real-time properties. HaRTES project - kickoff meeting

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#### Task schedule



#### Resources

#### Manpower

- Faculty staff:
  - Luís Almeida
  - Paulo Pedreiras
  - Arnaldo Oliveira

  - Valter Filipe Silva
  - Joaquim Ferreira

- Post-grad
  - Ricardo Marau (PhD)
  - Rui Santos (PhD)
  - Ricardo Moreira (Msc)
- José Alberto Fonseca
  Grants (27month)
  - Alexandre Vieira

#### Budget

Total of 90K Euros

#### Project organization:

- T1 Management
  - Global project management issues
  - Results
    - Successful execution of the project, according to the respective plan.
    - All the necessary progress and final reports
    - **Coordination** of project activities and interaction between team members.

### T2 Technologies and specifications

 Survey of relevant switch technologies and architectures & evaluation of resource requirement due to the enhanced features (e.g. CPU, memory)

#### - Results

- Identification and characterization of relevant switching technologies and architectures
- Technical specifications of the enhanced switches to be developed within the project
- Assessment of the impact of the enhanced features of the prototype switches in terms of functionality and requirements.

### T3 Flexible scheduling and QoS

 Research on flexible scheduling & QoS management algorithms suitable to HW implementation. Specification of a middleware for accessing the extended services.

#### - Results

- Development of on-line scheduling mechanisms and algorithms
- Specification and development of QoS management policies suitable for on-line application.
- Definition of an adequate **middleware** to access the flexible scheduling and QoS management related services.

#### T4 Implementation

- Implementation of prototype switches.
  Broken down in 3 sub-tasks, each dedicated to building one switch with increasing functionality levels:
  - (B)**Basic**: extends a standard Ethernet switch with traffic sched. & transm. control capab.
  - (S) **Safe**: extends the Basic switch with traffic policing capabilities.
  - (Q) **QoS**: extends the Safe switch with dynamic QoS features.

#### - Results:

Three operational prototype switches (B,S,Q)

### T5 Error handling

 Error detection and containment issues (main focus on the time domain). Detection of error nature (permanent vs transient), avoid error propagation, disconnection and reintegration of nodes, ...)

#### Results

- Fault model for the S and Q switches;
- Specification and development of error detection mechanisms;
- Specification and development of faulttreatment mechanisms (port isolation and reintegration mechanisms).

#### T6 Test and validation

 Design & development of a test suit required to verify the capabilities of the proposed switches. Validation of the switches and their dependability analysis, using adequate modeling tools.

#### Results

- **Test set** for each of the switches to verify and validate each of their specific features.
- Results of the execution of the test sets.
- Validated switches (concerning their specifications).

### T7 Dissemination

 Project promotion and results dissemination (fliers, website and special sessions in industrial/scientific events). Development of a demonstrator (distributed control system) using the HaRTES switches.

#### - Results

- Publicity materials, website, organization of seminars and special sessions in related events, both scientific and industry-oriented.
- Demonstrator using the prototype switches in a setup that includes video streaming, feedback control, dynamic QoS management and unconstrained NRTtraffooject - kickoff meeting

### Current status (1)

#### Two PhD students involved in the last two years

- Definition of the switch architecture
- Basic switch functionality achieved:
  - Traffic dispatching and confinement
- Prospective work / new services & functionality
  - Server-based switch for managing asynchronous traffic (already validated in FTT-SE)
  - Flexible cycle organization, full asynchronous mode

### Current status (2)

Threats:

- Initial objectives proposed nearly 4 years ago
- Lack of resources to carry out the work at the proper pace!
- ... we are not alone anymore!!!
- Main competitors: Profinet & TTP/Ethernet
  - Inflexible management of RT traffic
    - Statically scheduled, run-time changes not allowed or severely limited and inefficient;
  - Poor or no support of soft real-time traffic;
  - Lack of support for dynamic QoS manag.
- ... so the HaRTES goals are still relevant