HaRTES project

Hard Real-Time Ethernet Switching

Project overview

Paulo Pedreiras

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!

HaRTES project - kickoff meeting

General objective:

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

Specific objectives:

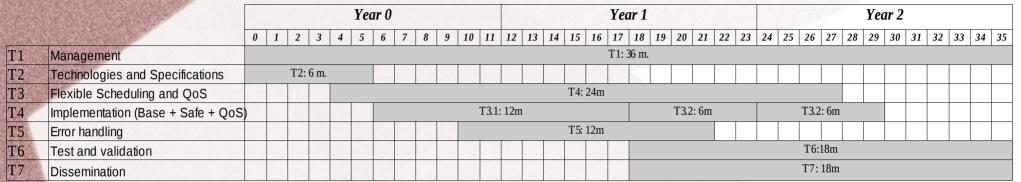
1. To include transmission control capabilities in Ethernet switches allowing the synchronization of parallel flows in different ports and the triggering of transmissions with low jitter;

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

April 17,2009

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