ERTCENS - EMBEDDED REAL-TIME COMMUNICATION USING EMERGING NETWORK STANDARDS

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The ERTCENS (Embedded Real-Time Communication using Emerging Network Standards) project has its focus in high-performance embedded real-time networking. Examples of applications are radar signal processing systems and radio base stations. Especially, we investigate the use of switched networks in such systems, treating aspects like real-time analysis, topologies, and dependability.

Keywords: Real-time communication, real-time systems, high-performance embedded networks, switched networks

1. Background and Motivation

The ERTCENS (Embedded Real-Time Communication using Emerging Network Standards) project focuses on high-performance (low latency and high bit-rate) embedded communication between different parts, boards, chips, or modules inside an embedded system. Some networks might be limited to cover a certain rack or box (e.g., a radar signal processing system or a radio base station unit), while other might cover a truck, an airplane, an automation industry, or a set of medical equipment, all networks being essential parts of embedded systems. Such embedded systems are getting more and more complex, distributed, performance demanding, heterogeneous and with rapidly changing conditions. New solutions and knowledge are therefore needed for real-time communication and resource handling in such systems to get them dependable, cost-effective, and predictable without increasing the engineering cost.

Moreover, novel emerging network standards, often incorporating switched interconnection technologies, give new features and performance possibilities. However, methods etc to bridge the gap from enabling networking technologies and standards to cooperating embedded systems with high real-time and reliability demands are needed. As an example, models to characterize the real-time performance must be developed.

2. Goals

The main goals of the project are:

- To develop analysis methods and understanding of standardized (COTS) networks to be able to use low-cost technology in embedded systems with high real-time and dependability demands.
- To evaluate limitations in current/emerging standards concerning real-time services and dependability.
- To develop methods etc that can be used in standardized networks, utilizing the existing hardware but adding software or analyzing methods to improve the support for real-time traffic.
- To develop a method or guidelines for the choice of topology, e.g., to avoid bottlenecks.
- Develop cost-effective support of timely and reliable end-to-end delivery of messages.
- To investigate how a holistic view of the communication in heterogeneous embedded networks can help the designer to avoid bottlenecks and to develop predictable system behavior.

3. Results

The real-time communication demands for three representative embedded systems applications have been characterized. Moreover, a survey of emerging COTS-based networks has been done. Also, an investigation of how to combine the best from vehicle networking and high-performance networking was done in the scope of a master thesis project. The result was a specific network protocol design.

We have developed an analysis framework to calculate on guaranteed real-time performance in switched networks with FCFC (First Come First Served) queuing. The framework is based on scheduling analysis and has shown better results than the well-known Network Calculus. In simulation studies, switched Ethernet has been assumed, but the framework should be rather easily adapted to other standards. Together with priority queuing (see Figure 1), we can even guarantee delay bounds for real-time traffic by having it going through the high-priority queue, not disturbed by other traffic through the low-priority queue.

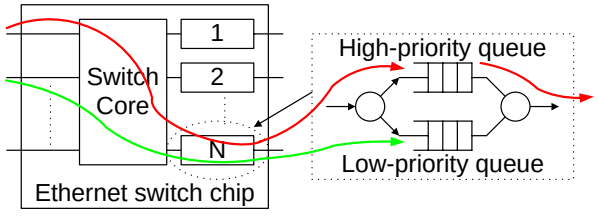

Figure 1. FCFS queuing combined with priority queuing.

In the area of topologies, we have developed a method to choose topology of a switched network carrying real-time traffic. The method can even be used to choose different topologies to reconfigure between during run-time when having several working modes to switch between.

Regarding the support of timely and reliable end-to-end delivery of messages, we have developed a basic framework for that. The framework includes both a retransmission scheme and analysis methods necessary to calculate real-time performance guarantees.

One PhD has been graduated within the scope of the project (Xing Fan).

PARTNERS AND STATUS

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Project leader is Magnus Jonsson, CERES.

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