A Comparative Study of Co-Kernel and Co-Processor based Solutions for High-Performance Real-Time Applications

Background

More autonomous systems contain applications that require high-performance capabilities and real-time guarantees. On the one hand, conventional micro-controllers cannot satisfy the

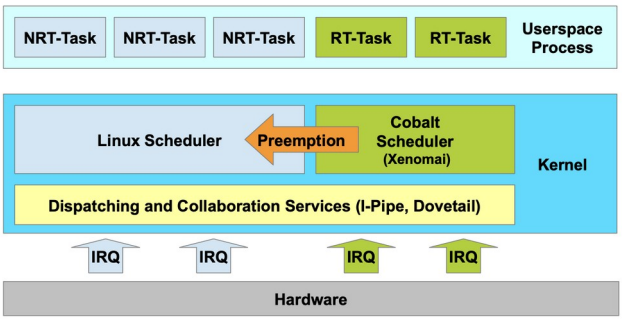

Figure 1: Xenomai 3 co-kerenel

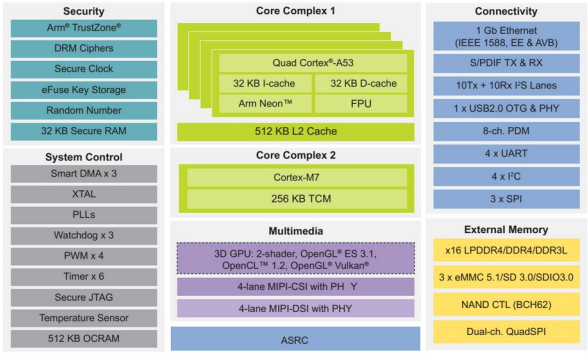

Figure 2: NXP – i.MX 8M Nano Processors Block Diagram where Coretex-M7 is a co-processor

high-performance requirements. On the other hand, high-performance processors, like ARM A53, have unpredictable execution behavior, which make them less suitable for real-time tasks. In addition, many high-performance applications cannot work on a real-time operating system (RTOS). Hence, Linux is preferred over RTOS for high-performance application. Linux is not real-time capable.

To overcome this challenge with high-performance real-time applications, there are two typical solutions: real-time co-kernel like Xenomai 3 and 4 and real-time capable co-processors like ARM cortex-M architecture. Many factors affect our decision on which solution to use. For instance, legacy code, hardness of the real-time constraints, dependency between high-performance and real-time tasks, etc.

Thesis Objective

In this project, we aim to carry out **an empirical comprehensive study on the pros and cons of each solution under difference case studies.**

You will:

- Evaluating the performance, determinism, and compatibility of both approaches
- Identifying trade-offs based on case studies and practical benchmarks
- Providing practical design recommendations for embedded system developers

Moreover, you may have a chance to visit DLR in Germany and present your findings.

Tools and Platforms

We would like to consider the following tools/platforms:

- Xenomai 3/4 with Linux

- ARM Cortex-M and Cortex-A SoCs (e.g., NXP i.MX 8M Nano)
- Real-time benchmarks and tracing tools
- Linux and RTOS environments

Learning Objectives

- Understand architectural differences between co-kernel and co-processor systems
- Gain hands-on experience in benchmarking and profiling embedded systems
- Evaluate trade-offs in designing high-performance real-time systems
- Strengthen skills in Linux/RTOS integration and performance analysis

Interested?

Please send us an email, write a bit about your motivation to work on the subject, your background, and at what stage of the master program you are. We will then set a meeting.

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