A Model-based Approach for Conditioning Software to Multi-Core using AUTOSAR

9th AUTOSAR Open Conference in Gothenburg

Timing-Architects Embedded Systems GmbH

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Model-based Conditioning Software to Multi-Core

1. Introduction
   - Challenges of Migration to Multi-Core
   - Timing Architects and TA Tool Suite™

2. Conditioning Software to Multi-Core using AUTOSAR
   - Sequencing Workshop using AUTOSAR
   - Model-Based Optimization using AUTOSAR

3. Conclusions
   - Benefits
   - Questions and Discussions
Introduction
Our Next Target:
**Mastering the Infrastructure for Autonomous Challenge**

New driving assistant systems enabling to drive at least fully automated are the next big challenge.

As in multi-core new tools can support in engineering and validating these systems.
Introduction

Challenges of Migration to Multi-Core I

Data- and Function Flow Model

Task_1
 Runnable_1

Task_2
 Runnable_2

Task_3
 Runnable_3
 Runnable_4

Task_4
 Runnable_5
Introduction

Challenges of Migration to Multi-Core II

Data- and Function Flow Model

Simulation of Dynamic Behavior

Timeline
Introduction

Challenges of Migration to Multi-Core III

Data- and Function Flow Model

Simulation of Dynamic Behavior

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Introduction

Challenges of Migration to Multi-Core IV

Data- and Function Flow Model

Simulation of Dynamic Behavior
Introduction

Challenges of Migration to Multi-Core V

Data- and Function Flow Model

Simulation of Dynamic Behavior

Fixed timing problem by adding offsets to the task activation. The result is still a speed-up compared to single-core solution.
Introduction

Challenges of Migration to Multi-Core VI

Data- and Function Flow Model

Simulation of Dynamic Behavior

Optimal solution by reallocation is trivial to find in this simplification. Imagine you have about 20,000 Runnables in your real system.
Tool Solution for Multi-Core
Tool Solution for Multi-Core

Timing-Architects Company

Founding

- 1st of April 2011
- Prof. Dr. Martin Hobelsberger and Dr. Michael Deubzer
- Common research project with Continental AG, University of Applied Science Regensburg, and TU Munich

TA Team

- 45 employees as of September 2016
- Technical Departments: Development, Consulting and Research
- All situated in the TA headquarter in Regensburg

Locations

- New TA headquarter in Regensburg at the TechBase
- Distributors:
  - South Korea: MDS Technology Co. Ltd.
  - Other location in preparation: Japan, US, and India

Customers

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Tool Solution for Multi-Core

TA Tool Suite™

Integrated Solution for designing, developing and verifying embedded multi- and many-core systems

Predictability by Design
Awareness by Simulation
Reliability by Verification
Improvement by Optimization
Tool Solution for Multi-Core

TA Tool Suite™

Integrated Solution for designing, developing and verifying embedded multi- and many-core systems

COMING SOON
Conditioning Software to Multi-Core using AUTOSAR
Conditioning Software to Multi-Core

ECU Configuration Description

Runnable-to-Task Mapping

Execution Sequence

Task-to-Core Allocation

OS Configuration

P(1)
P(10)

Core 1
Core 2
Conditioning Software to Multi-Core

System Configuration Description

Hardware Description

Core 1
Core 2
Core 3
LM 1
LM 2
LM 3
Bus / Crossbar
SM
Flash

Mapping Constraint

Core 1
Core 2

Timing Constraint

Min
Max

Software Description

SWC
Runnable_1
Runnable_2
Runnable_3

System Description

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Sequencing Workshop using AUTOSAR
Sequencing Workshop using AUTOSAR

Importing Information

ECU Configuration Description
- Runnable-Task Mapping
- Execution Sequence

System Description
- Software Description
- Timing Constraints

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Sequencing Workshop using AUTOSAR

Moderating Sequencing Workshop

ECU Configuration Description
- Runnable-Task Mapping
- Execution Sequence

System Description
- Software Description
- Timing Constraints

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Sequencing Workshop using AUTOSAR

Tool Support during Workshop

ECU Configuration Description
- Runnable-Task Mapping
- Execution Sequence

System Description
- Software Description
- Timing Constraints
Sequencing Workshop using AUTOSAR

Updating AUTOSAR Information

ECU Configuration Description
- Runnable-Task Mapping
- Execution Sequence

System Description
- Software Description
- Timing Constraints

- Modified Runnable-Task Mapping
- Changes in Execution Sequence

- Execution Order Constraints
- Data Age Constraints
- Event Chains
- Event Chain Constraints
Model-Based Optimization using AUTOSAR
Model-Based Optimization using AUTOSAR

ECU Configuration Description
- Runnable-Task Mapping
- Execution Sequence
- Task-to-Core Allocation
- OS Configuration

Aim Definition

System Description
- Software Description
- Hardware Description
- Timing Constraints
- Mapping Constraints

Importing AUTOSAR Description

Optimizer
Model-Based Optimization using AUTOSAR

E1CU Configuration Description
- Runnable-Task Mapping
- Execution Sequence
- Task-to-Core Allocation
- OS Configuration

Aim Definition

System Description
- Software Description
- Hardware Description
- Timing Constraints
- Mapping Constraints

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Model-Based Optimization using AUTOSAR

Visual Analysis of Results

ECU Configuration Description
- Runnable-Task Mapping
- Execution Sequence
- Task-to-Core Allocation
- OS Configuration

System Description
- Software Description
- Hardware Description
- Timing Constraints
- Mapping Constraints

Aim Definition

Optimizer
Model-Based Optimization using AUTOSAR

Updating AUTOSAR Description

ECU Configuration Description
- Runnable-Task Mapping
- Execution Sequence
- Task-to-Core Allocation
- OS Configuration

Aim Definition

System Description
- Software Description
- Hardware Description
- Timing Constraints
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- Runnable-Task Mapping
- Execution Sequence
- Task-to-Core Allocation
- OS Configuration

Optimizer
Conclusions
Conclusions

Master the Multi-Core Challenge

“Multi-core and multi-processor software projects are 4.5x more expensive, have 25% longer schedules, and require almost 3x as many software engineers.”
– VDC Research, Sept. 2010

- Project Time: 100% Single-Core vs. 100% Multi-Core (25% longer schedules)
- Engineers: 100% Single-Core vs. 100% Multi-Core (3 x as many engineers)
- Project Costs: 100% Single-Core vs. 100% Multi-Core (4.5 x more expensive)

Save Money
Save Time
Save Resources
Automization of Manual Steps
Conclusions

Questions and Discussions

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I hope you enjoyed the presentation!

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Thank you both for this perfect co-work.