Virtual Platforms for Automotive: Use Cases, Benefits and Challenges

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Virtual Platforms for Automotive

The importance of software in a modern car

- An estimated 40% of a vehicle’s cost is determined by electronics and software\(^1\)
- An estimated 90% of all innovations in automotive are driven by electronics and software\(^1\)

Efficient system development is a competitive advantage!

- More lines of code in a modern car than in a jumbo jet
- Increasing cross-linking of functions
- Increasing number of safety-critical applications

Efficient system development is becoming increasingly difficult!

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Why and where use virtual platforms?

Classical Development Flow

Spec Freeze  →  Tape Out  Silicon  →  SW Development  →  Integration & Verification  →  SoP

Arch Design  →  HW Development  →  Manufact.  \n
Issues

- Ambiguous specification
- Late SW/HW integration
- Late feedback of SW developers
- Limited number of HW systems
- Limited system visibility and control
- Hard to set up regressions and automated tests

→ **Real HW is the bottleneck**
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Executable models of hardware serve as virtual platform for SW and system development

Execution of **same binary** as on target platform

Simulation of hardware behavior and timing

**Like real HW, but**
- Earlier
- Observable & Controllable, Distributable & Scale-able, Repeatable, ...
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HW/SW Co-Design

Parallel Development Flow

Spec Freeze

HW Development

Tape Out

Manu-

fact.

Integration & Verification

SoP

SW Development

Classical Development

Arch

Design

HW Development

SW Development

Integration & Verification

Spec Freeze

Tape Out

Silicon

SoP

Timeline not to scale

Minimize Risks

• Re-Spins
• Ensure matching HW/SW

Maximize Performance

• MultiCore
• New IP / ASICs

Effort

SoP

Parallel

Classical

Time
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HW/SW Co-Design

Parallel Development Flow

- Spec Freeze
- HW Development
- SW Development
- Tape Out
- Integration & Verification
- Silicon
- Manufacture
- SoP
- Manu-
-fact.

Classical Development

Timeline not to scale

Minimize Risks
- Re-Spins
- Ensure matching HW/SW

Maximize Performance
- MultiCore
- New IP / ASICs

Time-to-Market
- Compiler
- Debugger
- Bring-up 1st silicon
- AUTOSAR base SW
- ComplexDriver
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Selected use case: HW-dependent SW

Examples:
- Microcontroller Abstraction Layer (MCAL)
- Complex Drivers

Advantages of virtual platforms:
- Visibility and controllability
  - Correlate instructions executed in SW with peripheral register accesses & values
- No special equipment required

"Warning!"
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Selected use case: Virtual HW as stimuli generator

Advantages of virtual platforms:
+ Realistic test cases
+ Increased test coverage
+ Verify design before HW Tape Out
+ Less re-spins

Virtual HW can also serve as a golden reference

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HW/SW Co-Design

Parallel Development Flow

- Spec Freeze
- HW Development
- SW Development
- Manufac.
- Integration & Verification
- Tape Out
- Silicon
- SoP

Classical Development

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Reduce Cost
- ECU prototypes & lab equipment
- Global development

Quality
- Regressions; Fault Injection; Coverage
- (MultiCore) Debugging
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Selected use case: SW stack integration & bring-up

+ MultiCore Debugging
+ Effects are repeatable
+ Check scheduling with function call graph
+ Performance analysis

Selected use case: Embedded SW Testing

+ Non-intrusive code coverage
+ Fault injection, corner cases
+ Parallel regression testing

Parallel Development Flow:
- Spec Freeze
- Tape Out: Silicon
- Manufacture
- SW Development
- HW Development
- Arch Design
- Integration & Verification
- Manu.
- Silicon
- HW Development
- manufactures
- SW Development
- Parallel Development Flow
- Spec Freeze
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Challenge: Changing Model Requirements

Development Process

- Core
- IP
- μC
- ECU

Complexity, Speed, Abstraction, #Users, Maturity, Ease of Use

One Model fits all?

- Expand usage range → higher ROI
  - Reuse of components, configurable subsystems
  - Reduce modeling costs

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Infineon

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Challenge: Model applicability

- **Models have to be tool-independent** (create here, use there)

SW tool environment and development processes:
- Reuse of test cases and scripts; for real HW, too
- Connections to SW tools and existing simulations

**Standards for automotive tool interfaces needed**

Quality:
- Successful abstraction depends on application (expected behaviour)
- Very close interaction with HW provider needed for verification
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Challenge: Model Cost

Missing modelling standards hinder cost-efficient usage!

Existing standards help (SystemC, TLM2.0) but not sufficient

⇒ **Standard for automotive model interfaces needed**

- SPI, CAN, LIN, FlexRay, Ethernet, ...
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Further Challenges

Hundreds of variants

- Robust variant and version handling
- Automated model assembly technology

Long lifetime of product generation

- Providing stable tool environment
- Complex legacy: HW, SW, tools and processes
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Summary

Benefits of virtual platforms:
+ Develop SW before HW is available
+ Efficient debugging
+ More thoroughly test functional safety aspects

Driving incentives:
→ Keep costs of SW development and testing low
→ TTM is becoming increasingly important
→ Maintaining high quality

Challenges:
→ Simulation speed vs. accuracy
→ Heterogeneity of use cases and collaboration models
→ Match existing development processes and tools
→ Standards on automotive interfaces of models and tools needed
Questions?