Virtual Platforms for Automotive: Use Cases, Benefits and Challenges

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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!

[1] *taken from De Schutter, T. et al. “Better Software. Faster! Best Practices in Virtual Prototyping”. Mountain View: Synopsys, 2014.*

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Why and where use virtual platforms?

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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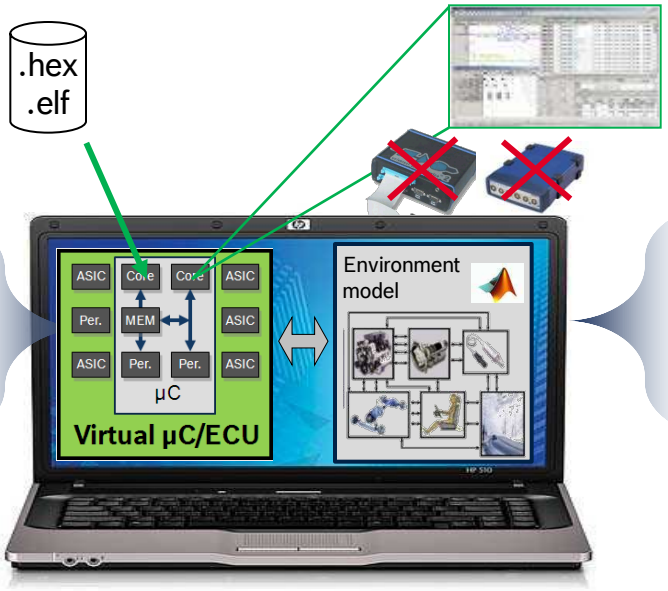
Executable models of hardware serve as virtual platform for SW and system development

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

Simulation of hardware **behavior and timing**



Same tool chain
compiler, debugger, calibration

Embedded in simulated environment (testbench)

Like real HW, but
- Earlier
- Observable & Controllable, Distributable & Scale-able, Repeatable, ...

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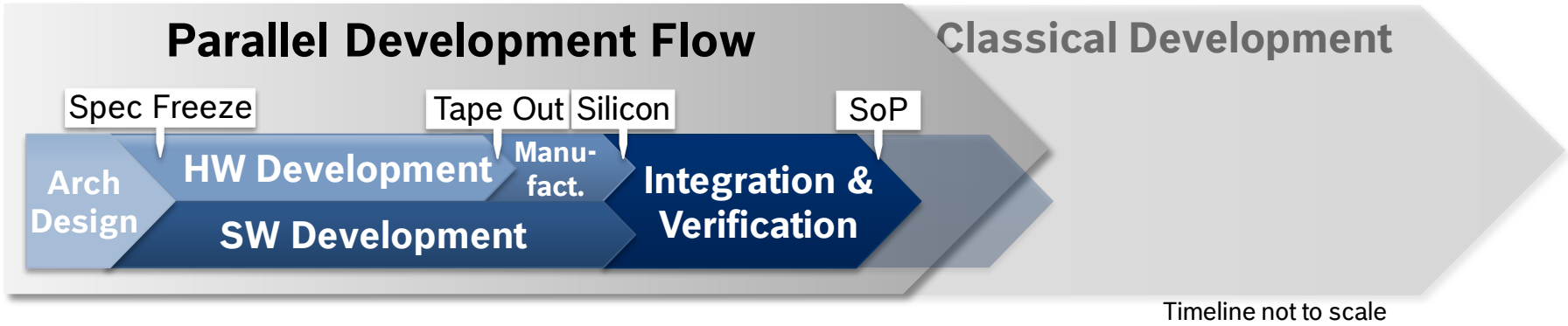
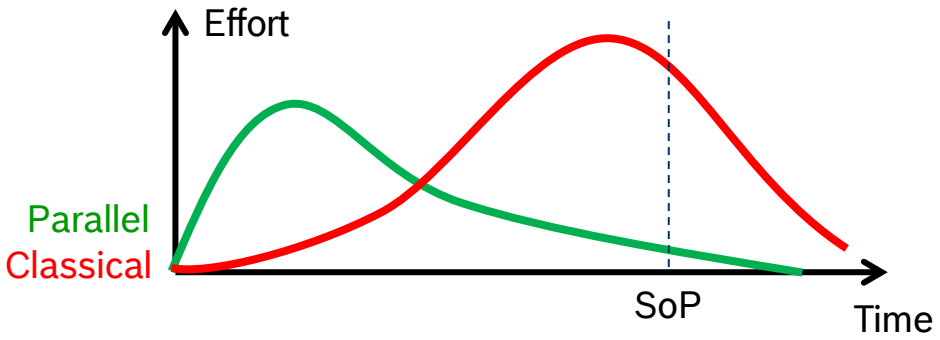
HW/SW Co-Design



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

Maximize Performance
- MultiCore
- New IP / ASICs



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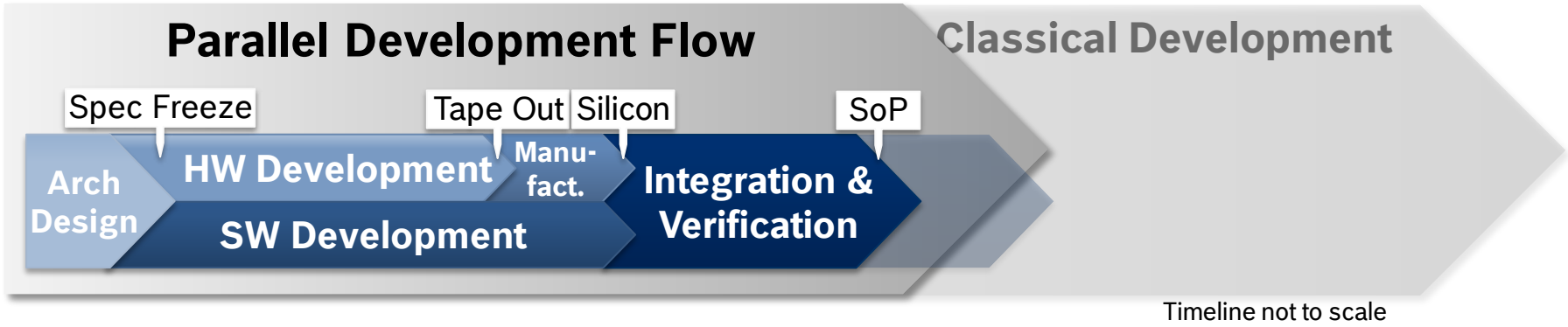
HW/SW Co-Design



Timeline not to scale

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

Maximize Performance
- MultiCore
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Time-to-Market
- Compiler
- Debugger
- Bring-up 1st silicon
- AUTOSAR base SW
- ComplexDriver

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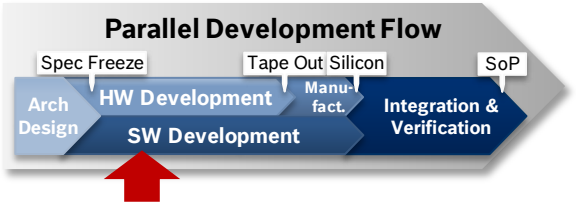
Selected use case: HW-dependent SW



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

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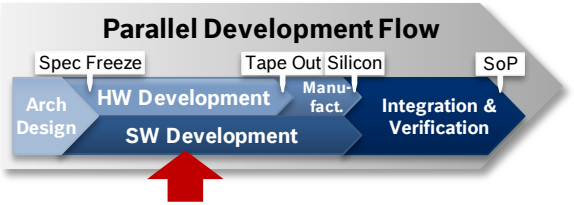
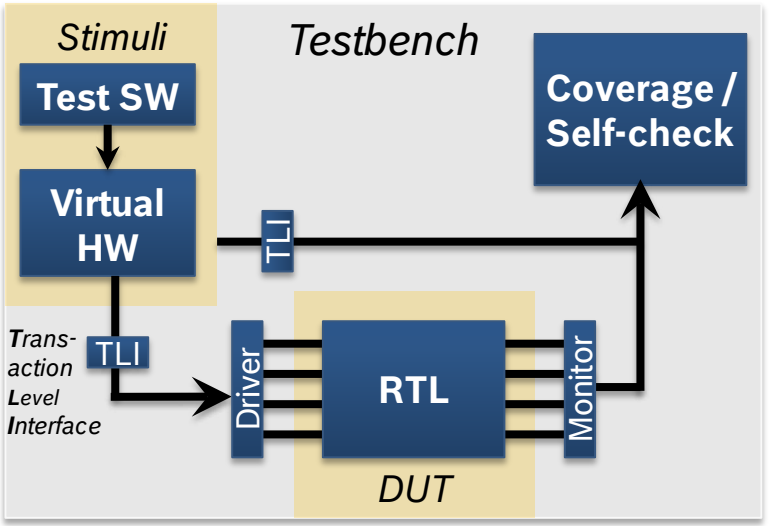
Selected use case: Virtual HW as stimuli generator





as in Leupers, R. et al. "Virtual platforms: Breaking new grounds". Design, Automation & Test in Europe Conference & Exhibition (DATE), 2012 , pp.685-690, 12-16 March 2012

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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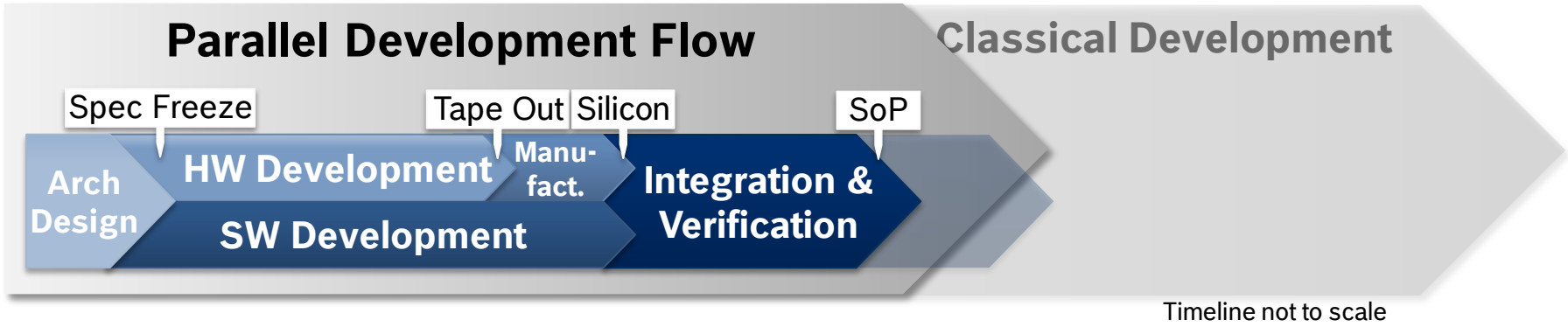
HW/SW Co-Design



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Reduce Cost
- ECU prototypes & lab equipment
- Global development

Quality
- Regressions; Fault Injection; Coverage
- (MultiCore) Debugging

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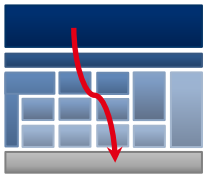
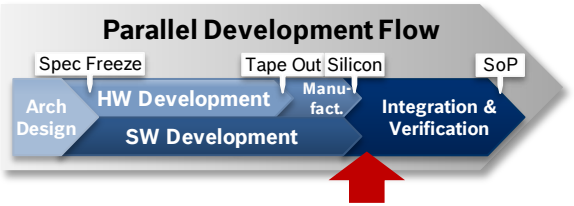
Selected use case: SW stack integration & bring-up

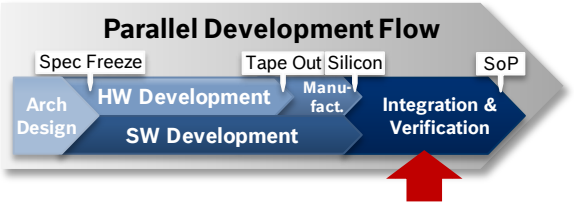


- + MultiCore Debugging
- + Effects are repeatable
- + Check scheduling with function call graph
- + Performance analysis



Selected use case: Embedded SW Testing

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



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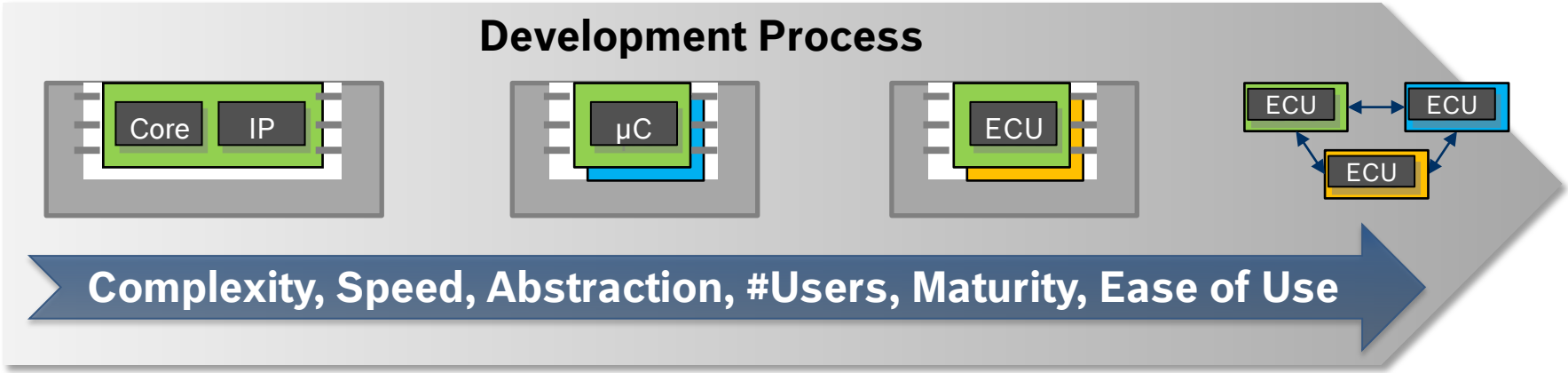
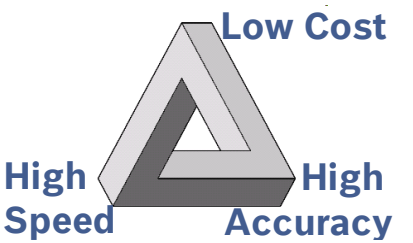
Challenge: Changing Model Requirements



One Model fits all?

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



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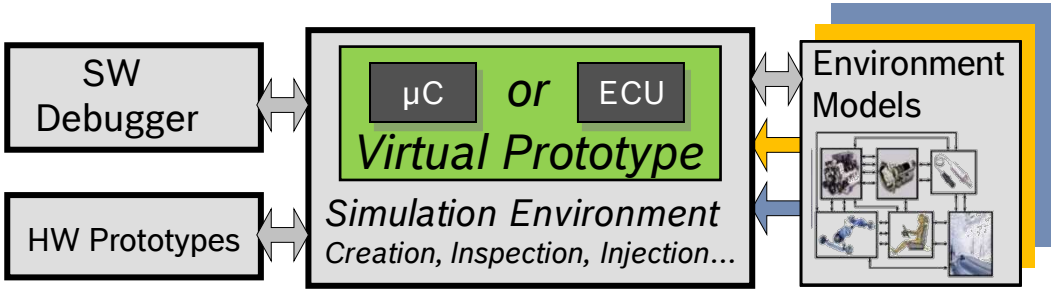
Challenge: Model applicability



Simulation Environment:

- ***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

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?