





Modeling, Analysis and Refinement of Heterogeneous Interconnected Systems Using Virtual Platforms

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Virtual Platform Workshop at DAC 2009

www.edacentrum.de/vision

Motivation

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- New applications by synergetic networking
 - New functionality is less and less the sum of dedicated components, but the intelligent interconnection of these components
 - innovation as result of networks of interconnected ECUs
 - added value results more and more from the networked functionality

• Suppliers are faced with an increasing system responsibility

- Supplier is not only responsible for the designed subsystem, but additionally for a safe integration of the subsystem into the entire system
 - today: Test of the requirements of a single component
 - in future: Validation of the entire system requirements under consideration of the designed component
- Consideration of the effects of a component on the entire system already in the design stage
 - comprehensive modeling of distributed systems

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early analysis and simulation of the system integration

Requirements for Different Application VISIO **Domains**

Automotive

- Transition from passive to active safety
- Passive systems: Innovation by increasing the complexity and number of ECUs
- Active systems: Innovation by interaction of ECUs, added-value by synergetic networking

Mobile Communication

- New application scenarios for mobile phones
- Mobile phone is not a dedicated application, but an integrated communication device in the embedding system
- Trend to complex product scenarios

New challenges

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Early consideration of the component behavior in the context of the entire system

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Body

Senso

- Early analysis of global safety requirements
- Flexible product variants

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Fast reaction on varying market requirements

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ESP

ACC

IVS



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Vision Virtual Platform Modeling

- Requirements
 - Graphical and textual model-based platform composition
 - Easy incorporation of user-defined component models
 - Semi-automated platform refinement
 - Mapping of embedded software

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- Automated generation of virtual prototypes
- Status

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- Many commercial tools already available
 - Mentor Platform Express/Vista Architect, CoWare Virtual Platform, Synopsys
 Innovator, Magillem MPA, VAST CoMET, CoFluent Studio, ...
 - Proprietary component characterization
 - Design services are offered for integration of user-defined components
 - IP-XACT-based component characterization
 - Limited support for vendor extension
 - Control on the internal data representation is missing
 - Limited support for refinement across multiple levels of abstraction
 - Design entry starts mostly on a very detailed level

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UML-based Platform Modeling and

Refinement

Model-based platform composition: Advantages

High flexibility

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- Easy software integration
- Modeling at arbitrary levels of abstraction
- Recommendations for appropriate usage of the UML
 - Do <u>not</u> use the UML for
 - Comprehensive IP block modeling including
 - hundreds of registers
 - dozens of RT level signal ports
 - Platform composition at RT level
 - Modeling of cycle-accurate behavioral description of hardware functionality
 - Do use the UML for
 - Platform composition at transaction level
 - Incorporation of externally specified component models
 - Mapping of functions onto platform components
 - Refinement by model to model transformation
 - Automatic generation of virtual prototypes







Platform Composition and Refinement



- Modeling techniques providing a holistic system
- Derivation of an optimized network architecture

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Generation of abstract executable models (virtual prototypes)

Component Modeling Methodology

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Component Specification Using XML

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- Interface information in XML format
 - Address spaces
 - Registers
 - Signal ports
- Concept similar to IP-XACT with enhancements
 - Documentation
 - Internal elements
 - Company-specific modifications

VISION Specification of the Control-Flow



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Platform Composition and Refinement



- Modeling techniques providing a holistic system
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Generation of abstract executable models (virtual prototypes)

IP-XACT Interface Specification

- Broad support and acceptance in industry
 - ARM, Infineon, STM, Philips Semiconductor, Cadence, Mentor, Synopsys, ...
- XML-based, IEEE standard
- ESL extensions since v1.4
- Basic elements:
 - component
 - Description of IP components (interfaces, implementation views, internal channels for bus components, ...)
 - busDefinition
 - High-level functionality of an interconnect (Protocol, ...)
 - design
 - Platform design (initialization on components, interconnections of interfaces)

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generator integration

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Generator API

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source: SPIRIT Consortium

Example: IP-XACT busDefinition

<?xml version="1.0" encoding="UTF-8"?> <spirit:busDefinition xmlns:spirit="http://www.spiritconsortium.org/XMLSchema/SPIRIT/1.4" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"</p> xsi:schemaLocation="http://www.spiritconsortium.org/XMLSchema/SPIRIT/1.4 Y:\workspace\GreenSocs\SPIRIT\P-XACT_ESL_alpha_2\schema\index.xsd"> <spirit:vendor>GreenSocs</spirit:vendor> <spirit:library>busdef.greensocs.greenbus</spirit:library> <spirit:name>genericrouter_1.0</spirit:name> <spirit:version>1.4</spirit:version> <spirit:directConnection>false</spirit:directConnection> <spirit:ports> <spirit:port> <spirit:logicalName>TRANSACTION</spirit:logicalName> <spirit:onMaster> <spirit:presence>required</spirit:presence> <spirit:initiative>requires</spirit:initiative> <spirit:protocol> <spirit:type>cable</spirit:type> <spirit:name>deneric</spirit:name> <spirit:parameters> <!-- add set/get-access to master and get-access to slave/system--> <spirit:parameter spirit:name="MAddr" spirit:format="long"/> <spirit:parameter spirit:name="MCmd" spirit:format="choice" spirit:choiceRef="MCmdType"/> <spirit:parameter spirit:name="MID" spirit:format="long"/> <spirit:parameter spirit:name="MBurstLength" spirit:format="long"/> <spirit:parameter spirit:name="MData" spirit:format="string"/> -vspirit.parameters </spirit:protocol> </spirit:onMaster> <spirit:onSlave> <spirit:presence>required</spirit:presence> <spirit:initiative>provides</spirit:initiative> <spirit:protocol> <spirit:type>cable</spirit:type> <spirit:name>generic</spirit:name> <spirit:parameters> <!-- add set/get-access to slave and get-access to master --> <spirit:parameter spirit:name="SData" spirit:format="string"/> <spirit:parameter spirit:name="SResp" spirit:format="choice" spirit:choiceRef="SRespType"/> </spirit:parameters> </spirit:protocol> </spirit:onSlave> </spirit:port>

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</spirit:ports>

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VISION Profile Extension VISION

- Extension of SysML and MARTE for flexible platform composition
 - by use of the VISION component model
 - which is based on the IP-XACT component model





- New stereotypes
 - to facilitate SoC platform composition
 - Specific attributes for back transformation into IP-XACT have to be taken into account

Platform Composition and Refinement



- Modeling techniques providing a holistic system
- Derivation of an optimized network architecture

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Generation of abstract executable models (virtual prototypes)

Platform Composition (Abstract)

- Flexible model-based platform composition using the VISON component model
- Import and export for IP-XACTbased IP libraries and platform templates
- "Drag-and-Drop" platform composition
- Modeling at multiple levels of abstraction
 - "Un-typed" modeling:
 - Easy and fast
 - w/o consideration of interfaces, protocols, etc.
 - "Typed" modeling:
 - Consideration of interfaces and protocols
 - Supporting semi-automated refinement

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Mapping Software onto HW Platform Components



Software mapping (deployment) is modeled using artifacts

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Mapping of C/C++ source code

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Mapping of UML behavior diagrams

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Generation of abstract executable models (virtual prototypes)

VISION Platform Refinement



- Parameterization of platform templates
- Insertion of protocol adapters
- Refinement is based on model to model transformation
- Generation of virtual prototypes with automated protocol adaptation
- Integration of VP components

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- Mapping of component specific protocol parameters onto the generic attributes of the interconnect
- Automatic type conversion or stub generation for manual conversion of complex data types
- In some cases few manual steps are needed for complete mapping (no specific attribute) or attribute generation (no generic attribute)

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Mapping Specific to Generic Protocols VISION



Results: Refined Typed Platform

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Results: Traffic Sign Recognition



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Results: Traffic Sign Recognition







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Conclusion

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- Holistic modeling of interconnected microelectronic systems needs a combination of different specification models
- Application specific XML editor to describe the component characteristics (address spaces, registers, ports, ...)
- Transformation of IP-XACT component descriptions into UML components
- Platform composition by use of component diagrams
- Performing platform refinement by automated protocol adaptation *"from un-typed platform models towards typed platform models"*
- Automated generation of virtual prototypes using SystemC



Thank you very much for your attention!

Questions?

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