Towards a Formal Description of Reference Architectures for Embedded Systems

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Agenda

Introduction

Current Formal Approaches

A Formal Description of Reference Architectures

Perspectives of Research

Conclusions

Embedded Systems

Sophisticated and complex
- Adaptability
- Dependability
- Cost
- Size
- **Safety-critical**

Reference Architectures

Standard for developing software systems of a particular domain

Includes business rules, styles, best practices, and software elements

Architecture Description (AD)

Tangible artifact expressing software architectures and reference architectures

Applications
- Reuse of architectural knowledge
- Assessment of architectural qualities
- Communication with stakeholders
- **Realization of reference architectures**

ISO/IEC/IEEE 42010
- Best practices for creating architecture descriptions

Motivation and Objetives

Reference architectures are often informally described
- Examples: textual descriptions and ad-hoc notations
- Ambiguous

Directions for enhancing the description of reference architectures with formal approches
- Allow rigorous and unambiguous descriptions
- Support for specification, analysis, and realization
- Ensure that future refinements will be well-formed

Formal description of reference architectures

Formal descriptions:
- Enable a precise, unambiguous description for realizing these systems
- Two abstraction levels:
  - Black-box: show required and provided interfaces
  - White-box level: internal configuration for realizing main building blocks
- Reinforce the use of standard terminology throughout different abstraction levels

Conclusions

Formal descriptions for:
- Consistently transferring and validating knowledge
- Automatically instantiating the reference architecture
  - Automated validation of software architectures against it

Conclusions

Future research:
- Assign appropriate formalism levels for reference architectures
  - Balance between accuracy and understandablity
  - Need of a consensus if formal, semi-formal, or hybrid approaches should be used

Conclusions

Future research:
- Consolidate a formality-centric method for developing reference architectures
  - Creation, translation, and maintenance of architectural descriptions of reference architectures, possibly supported by tools
  - Visualization of traces between requirements and design decisions, verification of quality attributes, and generation of concrete architectures

Conclusions

Future research:
- Co-design of hardware and software should also be considered at the reference architecture level
  - Meeting the complexity in the development of embedded systems
  - Separation of the portions of the problem solved in hardware and the ones solved in software
  - Enhancement of quality attributes related to both hardware and software besides supporting early verification, reuse, and interoperability

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