Quantitative Architectural Modeling and Analysis Using AADL

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Motivation

• Need: Support to make better decisions on system architectures
• Target systems: Space vehicle and other constrained computing environments
• Development phase: Architectural decisions made during the early design impact
• Decisions supported:
  – Extent and type of redundancy
  – Tradeoffs of reliability vs. Weight, power, and functional capability
  – Failure rate and recovery time requirements
  – Strategies for recovering from control and payload computing disruptions
  – Handling failure propagation and common mode failures
Modeling an Embedded System Architecture

Elements of an embedded system architecture

- *Application SW Architecture (task & communication)*
- *Computer platform architecture (processors & networks)*
- *Physical system/environment (interface with embedded SW/HW)*
- *Logical interface between software and physical system*
- *Physical interface between computer platform and physical system*
- *Deployment of software on computer platform*
Introducing the Architecture Analysis & Design Language (AADL)

• Society of Automotive Engineers (SAE) Aerospace Standard AS5506 (2004)
  – *Preceded by more than a decade of development under the DARPA Meta-H program*

• Includes representations of software, computational hardware, and system components for
  – *specifying and analyzing real-time embedded systems*,
  – *mapping of software onto computational hardware elements*.

• Effective for model-based analysis and specification
  – *Evolved from DARPA Meta H project*
  – *Highly structured, defined semantics allows for modeling and analysis*

• Annex libraries define extensions to the core language concepts and syntax
  – *Behavioral Annex, ARINC 653 Annex*,
  – *Error Annex of particular interest*
AADL Components (graphical representation)

- text and xml representations also defined
AADL/UML/SysML Relationship

Software and System Engineering

SysML

AADL

Error Annex

Behavioral Annex

AADL UML Profile

SysML UML Profile

UML 2.0

MARTE Performance
AADL Hardware/Software Architecture Representation

Vehicle Network

Inter-BCP Bus

Inter-PCP Bus

BCP

PCP

Bus Control Software

Data

Payload Control Software

Data
AADL Representation (using TOPCASED, continued)

**BCU Diagram**

**Control Channel Diagram**
(both Primary and Backup)
AADL Representation (using TOPCASED, continued)

Space Vehicle Diagram

SPCU Diagram
(next hierarchical level)