Analyzeable and Reconfigurable AADL Specifications for IMA System Integration

David Statezni
Advanced Technology Center
Rockwell Collins, Inc.
Outline

- Description of Model
- Description of Analysis
- Tool Status
Architecture Analysis & Design Language

An SAE Standard of an Architecture Definition Language

**Formal** Specification of Systems:
- Real-time
- Embedded
- Fault-tolerant
- Securely partitioned
- Dynamically configurable (e.g. reversion logic)

Software **task** and **communication** architectures

How they are **bound to HW** in
- Integrated Modular Architectures (IMA)
- Federated Hardware Architectures
Proof of Concept Example

Generic Display System with Rockwell Collin’s Switched Ethernet LAN

- Only LAN-related entities modeled
- Model generated from Input/Output & Thread data stored in Database

Model Size

- 5 Common Processing Modules
- 13 Virtual Machines
- 90 Threads
- 165 End-to-end Data Flows
CDU Subsystem Architecture

- Not modeled for this AADL example
Graphical Software (Logical) View
system CDU_Processor_Software

features

  CDU_DISP_ELICAS_Cmds_to_LI_MFD_SW_L_Out_Socket : port group
  PG_CDU_DISP_ELICAS_Cmds_Out;

  CDU_DM_Display_Buffer_NDO_from_CDU_L_SW_L_In_Group : port group
  PG_CDU_DM_Display_Buffer_NDO_In;

...end CDU_Processor_Software;

system implementation CDU_Processor_Software_Impl

subcomponents

  p_CDU_Display_Manager : process CDU_Display_Manager_Impl;
  p_CDU_IO_Manager : process CDU_IO_Manager_Impl;
  p_Communications_Manager : process Communications_Manager_Impl;
  p_Flight_Manager : process Flight_Manager_Impl;

connections

...flows

...end CDU_Processor_Software_Impl;
XML Software View

```xml
systemType

- name = CDU_Processor_Software
- comment = (5)
- flowSpecs
- features
- portGroup = (130)

systemImpl

- name = CDU_Processor_Software_Impl
- compType = #/CDU_Processor_Software
- connections
- flows
- subcomponents

  processSubcomponent = (4)

<table>
<thead>
<tr>
<th>name</th>
<th>classifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>p_CDU_Display_Manager</td>
<td>#/CDU_Display_Manager_Impl</td>
</tr>
<tr>
<td>p_CDU_IO_Manager</td>
<td>#/CDU_IO_Manager_Impl</td>
</tr>
<tr>
<td>p_Communications_Manager</td>
<td>#/Communications_Manager_Impl</td>
</tr>
<tr>
<td>p_Flight_Manager</td>
<td>#/Flight_Manager_Impl</td>
</tr>
</tbody>
</table>
```
HW (Physical) View with Mappings
Overall System Integration

Notes:
Identifiers with angle-bracketed terms are replicated for each unique set of terms, where terms are defined as:
- `<cpm>`: Common processing machine name
- `<cpmid>`: Longer name of cpm
- `<ndo>`: Network data object name
- `<sw>`: ASL switch side identifier
- `<vmr>`: Virtual machine and rate, indicating thread name

Identifiers with angle-bracketed terms are replicated for each unique set of terms, where terms are defined as:
- `<cpm>`: Common processing machine name
- `<cpmid>`: Longer name of cpm
- `<ndo>`: Network data object name
- `<sw>`: ASL switch side identifier
- `<vmr>`: Virtual machine and rate, indicating thread name
Analysis and Reconfiguration Tool

System generation from Translated XML AADL
- Automatic schedule generation
- Allocation of VMs to hosts

System analysis
- Schedulability, rate-monotonic analysis
- Network analysis

Editing and visualization
- Direct manipulation, tree view
- Graphs, tables, trade studies
Multiple Configurations for Trade-Off Studies

Original configuration from AADL

New configuration #1

New configuration #3

Slide 13
AADL Tool Status

Current Rockwell Program

- Common AADL Front-end
  {Eclipse-Open Source from CMU}
- Textual ADL
  {AADL}
- AADL Data Interchange
- As XML Schema

Future Work

- Graphical AADL
- Via UML Profile
- AADL Code Generation Tool
  {Future Tool Vendor}
- CPU & LAN Analysis Tool
  {Rockwell Scientific}
- Honeywell DoME
- Eclipse
  {Near Completion}
Project Accomplishments

Creation of Display System in AADL (Textual compiled to XML format)
Translation to Analysis /Reconfiguration Tool
Analysis of Initial Configuration for Fit
- CPU Schedulability/Schedule
- Network Latency
Generation of Alternate Configurations