ITEA SPICES

Support for Predictable Integration of
mission Critical
Embedded Systems

User Manual of AADS

2.0

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Date	**7-7-2009**	**7-7-2009**	
Visa			
Summary	**This document is the User Manual of the software AADS. AADS is a tool for simulating a subset of AADL.**		

Table of Contents

1 Preface

1.1 Table of versions

Version	Date	Description & rationale of modifications	Sections modified
1.0	7/7/2008	First version	All
2.0	7/7/2009	Modify the document to reflex changes of AADS version 2.0	1, 5, 6, Annex I

1.2 Table of references and applicable documents

Reference	Title & edition	Author or editor	Year
[1]	Architecture analysis & design language (AADL), AS5506, v1.0	SAE AS2C	2004
[2]	The Architecture Analysis & Design Language (AADL): An introduction.	P. Feiler, D. Gluch, J. Hudak	2006
[3]	POSIX de Tiempo Real.	Michael González Harbour	2004
[4]	An Extensible Open Source AADL Tool Environment (OSATE).	SEI	2006

1.3 Acronyms and glossary

Term	Description
AADL	Architecture and Analysis Design Language
AADS	AADL Simulator
ITEA	Information Technology for European Advancement
OSATE	Open Source AADL Tool Environment
POSIX	Portable Operating System Interface
SAX	Simple API for XML
SCoPE	System Cosimulation & Performance Estimation
SPICES	Support for Predictable Integration of mission Critical Embedded Systems
XML	eXtensible Markup Language

2 Subject

2.1 Purpose of the document

The purpose of the document is to describe the User Manual of the software tool AADS. This tool shall be able to provide a consistent manner, in accordance with a subset of the AADL standard, to simulate an AADL model using the tool SCoPE. This document specifies the way of using and the general characteristics of the tool AADS.

2.2 Editing particularities

2.2.1 Changes identification

All the changes made since the previous publication are identified using the sign | in the left margin of each line holding a modification.

2.2.2 Temporary editing

Special points are signalled like this:

. ***temporary***

. ***incomplete***

. ***to be defined***

. ***to be confirmed***

2.3 Application scope

The application scope of this document is the ITEA SPICES project, more specifically Work Package 3 of the project, Component Execution Support, task T 3.4 of the Work Package.

2.4 Edition and evolution of the document

The person responsible for the evolution of this document is Roberto Varona Gómez. This document will be in continuous evolution as required by the development of the tool AADS.

3 What makes AADS

The tool AADS allows modeling a subset of AADL for purposes of implementation and simulation. The starting point of the simulator will be an AADL specification. This AADL specification must contain a minimum functionality described by means of the some AADL properties in order to enable a proper simulation of the model. The AADL model will be parsed by AADS and a model defined with POSIX / C++ and XML will be obtained. This model will be simulated in order to check if the AADL constraints are fulfilled. As the design process advances and the real functionality are attached to the software components using the corresponding source code, the value of these properties will be refined. These refined properties will be added to the AADL model and a new model will be generated by AADS to check if the constraints are still fulfilled.

When the tool AADS is initiated it requests the name of two AADL XML files. One of these files is just the AADL model written in XML. The other is the result of an instantiation of a system implementation of a textual or object AADL model obtained with OSATE, a plug-in of the Eclipse platform used to process AADL models (see Fig. 1). These files are written in XML as they are easier to analyze using AADS because of the use of SAX.

Once the XML files have been parsed by AADS, files written in C++ with the extensions .h and .cpp and one XML file are created. The number and names of the files created depend on the AADL model parsed. The C++ files use POSIX functions and the XML file must be as specified to be used by the tool SCoPE.

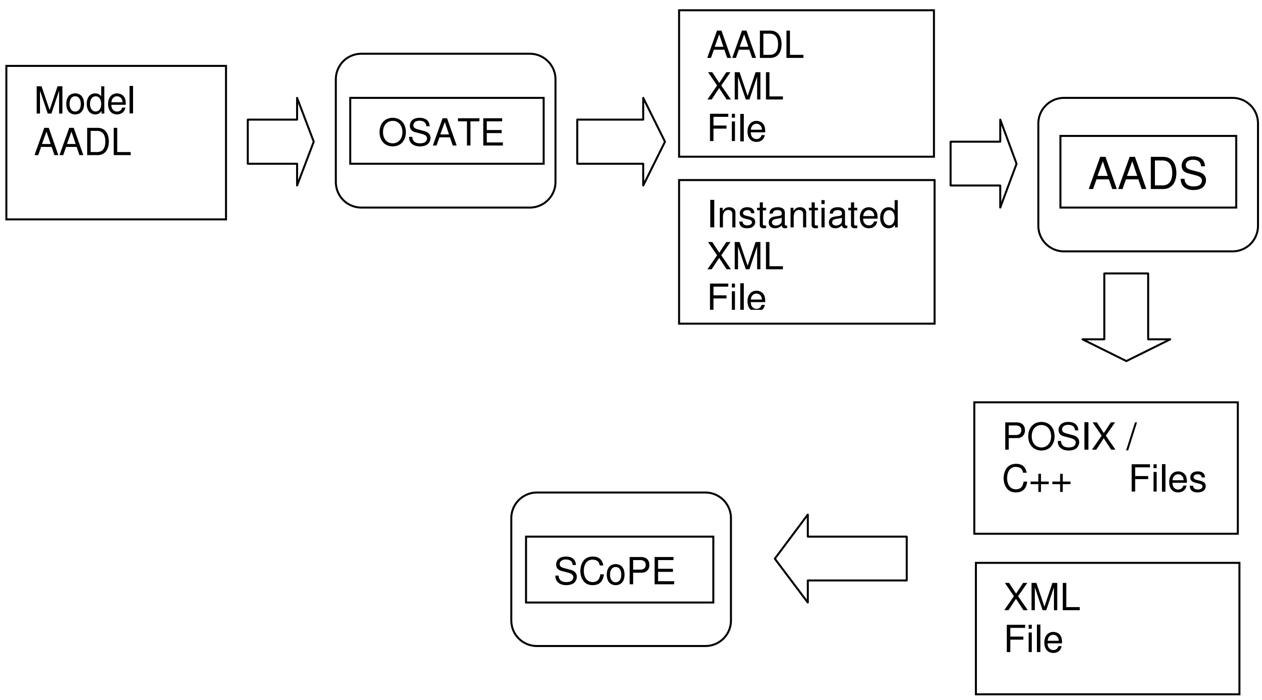


Fig. 1. Relationship among OSATE, AADS and SCoPE.

4 Installation of AADS

The tool AADS will be delivered as a plug-in of the Eclipse platform (see more about Eclipse in www.eclipse.org). This means that it will be necessary to install the Eclipse platform to run AADS as a button in the toolbar.

Before installing AADS you must run Eclipse in the computer. Then you must choose the "File" item from the menu bar and the "New" and "Other…" to select with a double click the wizard "Plug-in Project" in the directory "Plug-in Development". Using the wizard "New Plug-in Project" you must only write "AADS" in the box for "Project name", click the button "Next" and finally the "Finish" one.

If Eclipse is not in the "Plug-in Development perspective" you will be prompted to change it. It is better to change it for the installation.

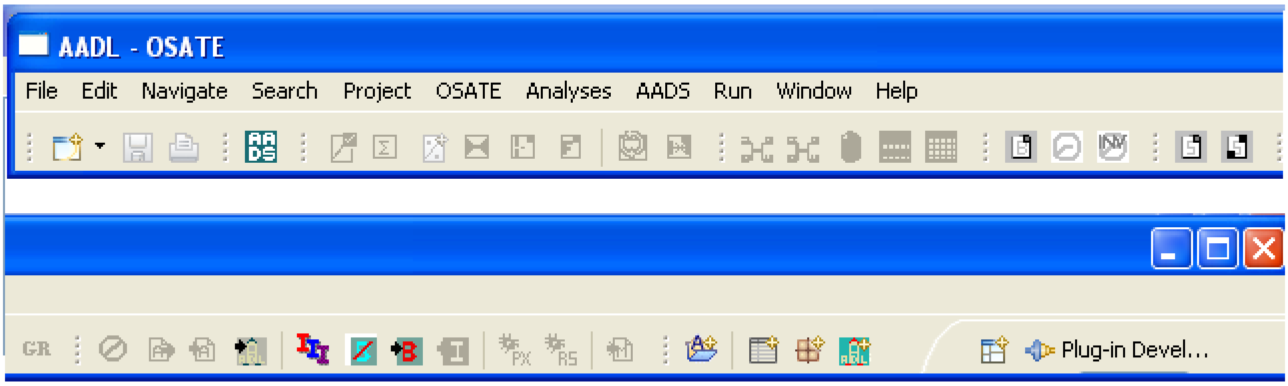
Then a new window of the AADS plug-in project appears with "Overview", "Dependencies", "Runtime", "Extensions", "Extension Points", etc. sections. In the section "Extensions" you must click the "Add" button and when the window "New Extension" appears choose in the section "Extension Wizards" the simple ""Hello, World" action set". You then click the "Next" button and can change the text "Hello, Eclipse world" in the "Message Box Text" with the text "AADS".

The next step is open "Windows Explorer" and overwrite the directory "AADS" recently created by Eclipse on your computer with the directory "AADS" delivered by the department TEISA of University of Cantabria. After this you must refresh information of Eclipse by clicking with the right button of your mouse over the directory "AADS" in the "Package Explorer" of Eclipse and clicking over "Refresh F5".

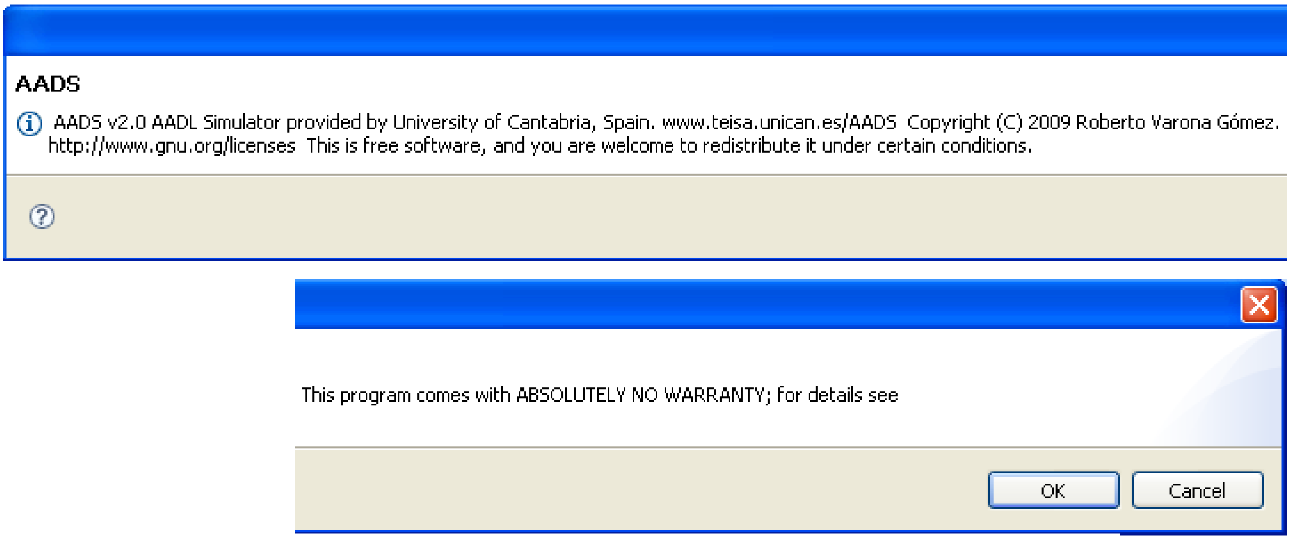
Finally click with the right button of your mouse over the directory "AADS" in the "Package Explorer" of Eclipse and click over "Properties". When the window "Properties for AADS" appear click over "Run/Debug Settings" and choose the "Edit" button of the "Eclipse Application". Once the window "Properties for Eclipse Application" is on, in the section "(x) = Arguments", in the subsection "Working directory", you can change the directory to "Other" and write for example "C:\AADL\model\cruise_control". AADS takes the input files from this directory and leaves there the output files.

5 Use of AADS

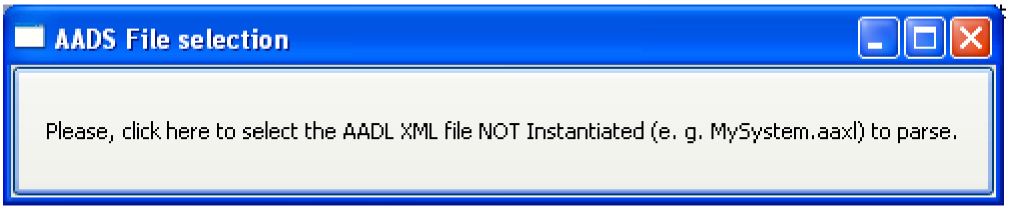
First of all the Eclipse platform must be initiated. After this, you must click with the right button of the mouse over the directory “AADS” in the view “Package Explorer”. You must choose “Run As” and then “1 Eclipse Application”. At this moment a new Eclipse application starts containing a button of AADS and an entry in the menu bar for AADS (the window is split in two in this document for better legibility):

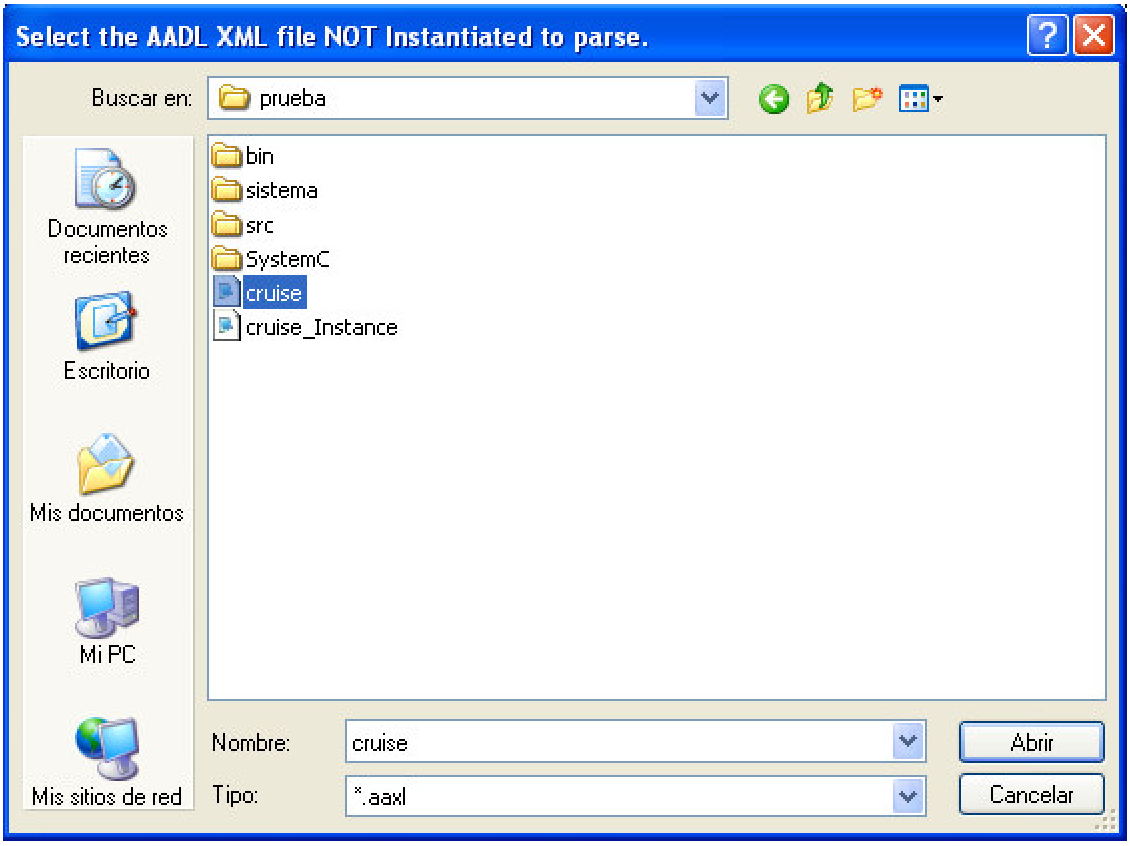


When you click over this button or over the menu bar the tool AADS starts. The following window arises showing a message (split in two in this document for better legibility):

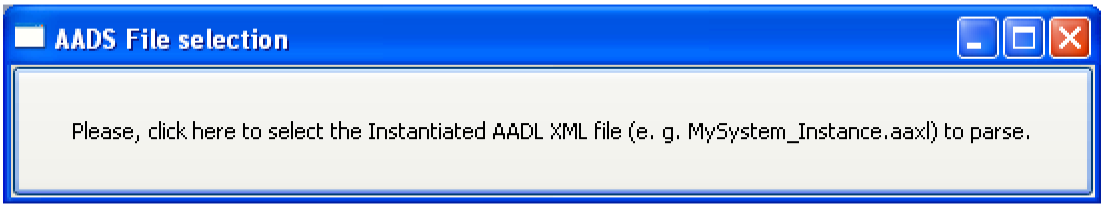


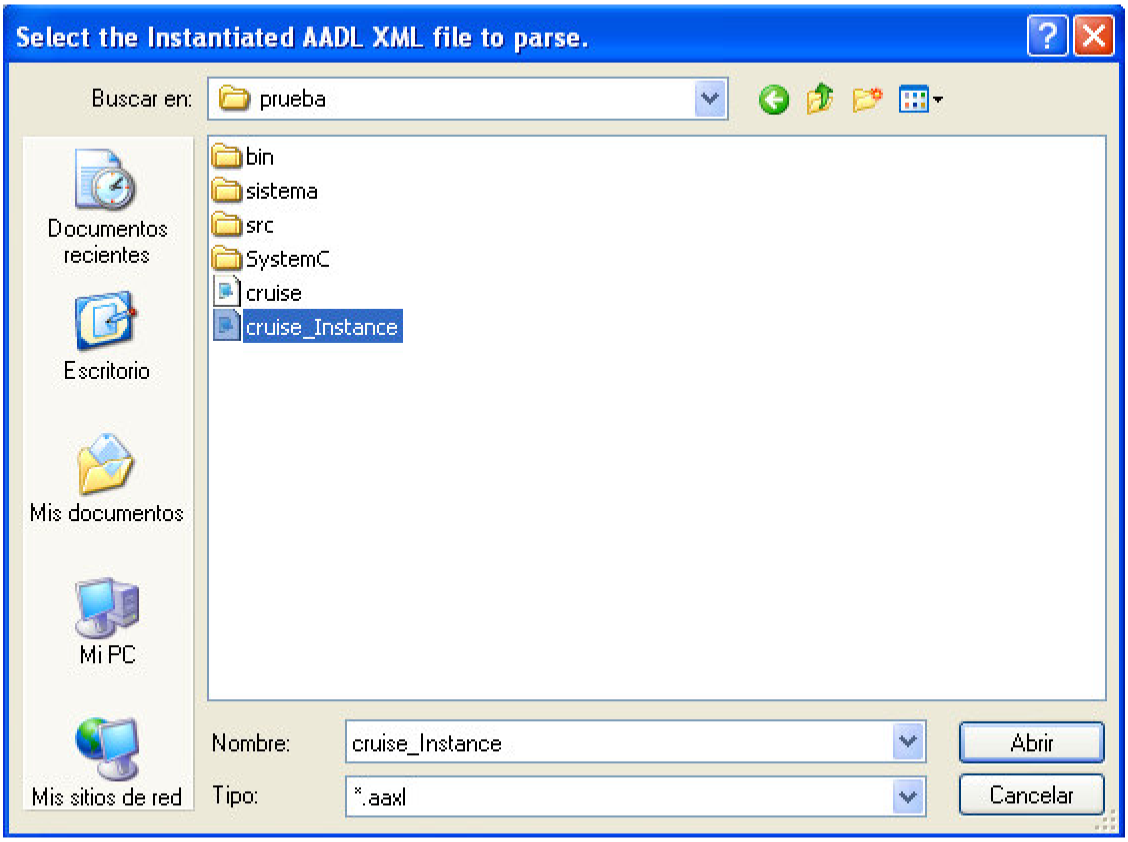
If the user clicks the OK button, the following windows appear asking the name of the file XML not instantiated to be parsed like for example cruise.aaxl.





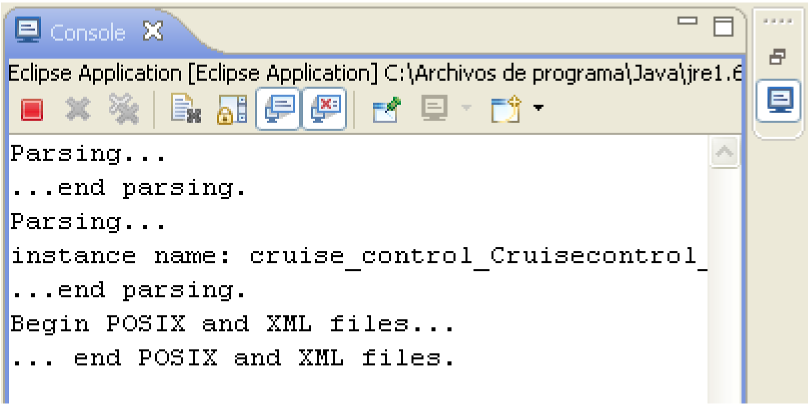
AADS parses the file and the following windows appear asking the name of the instantiated file written in XML to parse, for example cruise_Instance.aaxl.





It parses the file and produces some files written in C++ (files with extension .cpp and .h) complying with POSIX standard and a XML file. These files are in the working directory and can be used with the tool SCoPE.

The console of Eclipse shows the following information:



If the file exists but it is not the proper format, AADS will show the following messages (depending on the file) and will terminate.

```
Exception1 org.xml.sax.SAXParseException: The root element is required in a
well-formed document.
```

...

```
Exception1 org.xml.sax.SAXParseException: The markup in the document preceding
the root element must be well-formed.
```



```
…

java.lang.NullPointerException
	at parser.EscrituraFichero.HWComponent(EscrituraFichero.java:151)
	at parser.EscrituraFichero.GeneraXML(EscrituraFichero.java:101)
	at parser.EscrituraFichero.stringToFile(EscrituraFichero.java:64)
	at parser.Parseador.endDocument(Parseador.java:81)
	at org.apache.xerces.parsers.SAXParser.endDocument(SAXParser.java:1230)
	at 
org.apache.xerces.validators.common.XMLValidator.callEndDocument(XMLValidator.ja
va:1146)
	at 
org.apache.xerces.framework.XMLDocumentScanner$EndOfInputDispatcher.dispatch(XML
DocumentScanner.java:1499)
	at 
org.apache.xerces.framework.XMLDocumentScanner.parseSome(XMLDocumentScanner.java
:381)
	at org.apache.xerces.framework.XMLParser.parse(XMLParser.java:1098)
	at org.apache.xerces.framework.XMLParser.parse(XMLParser.java:1139)
	at parser.Index.ParsearDocumento(Index.java:40)…
```

…

6 Relation with SCoPE

The tool AADS creates files written in C++ with the extensions .h and .cpp and one file written in XML. The number and names of the files created depends on the model AADL parsed. These files are used by SCoPE as we can see in Fig. 1 to simulate the model. Therefore, the structure that these files have and functions supported by SCoPE must be known for AADS. AADS only produces files to use with the tool SCoPE, so the relationship between AADS and SCoPE is total dependence on the first regarding the second.

The XML file generated by AADS follows the 1.0 standard of W3C and uses UTF-8 encoding. The hardware architecture is structured through the XML file generated by AADS. It is used as part of the configuration parameters of SCoPE and is divided into: *HW_Platform, SW_Platform and Application.*

- **HW_Platform.** Any AADL implementation of a processor, memory, bus or device must be specified with its *category* and *name* in the *HW_Components* subsection of *HW_Platform*. The AADL property *Assign_Byte_Time* is used to set the *frequency* parameter in the XML file. For memories we use the properties *Read_Time* and *Write_Time*. These properties have their values in time units (ns, ms and so on) and must be transformed into MHz. To know the *mem_size* of a memory, both *Word_Count* and *Word_Size* AADL properties are required. Finally the *mem_type* of a memory is derived from *Memory_Protocol* in the AADL model. If the component is a processor *proc_type* must be specified.

  The *HW_Architecture* and *Computing_groups* subsections of *HW_Platform* are the next of the XML file. To know the *start_addr* of a memory we take the AADL property *Base_Address.* The *component* and *name* are inferred from the AADL model. Hardware components are grouped by buses as they are connected to them in AADL through the connections *bus access* and the features *requires bus access.*

- **SW_Platform.** This section has two subsections: *SW_Components* and *SW_Architecture*. This section takes into account the buses that are defined to make the equivalent nodes. In this section the operating systems are specified.

- **Application.** This section has two subsections: *Functionality* and *Allocation.* Filling the *Functionality* section is straightforward from the AADL model using the property of a thread *Activate_Entrypoint* for the *function* and *Source_Text* for the *file*. The *name* is the same as the one of the thread. For the *Allocation* section we need to know the property of a thread *Actual_Processor_Binding*, and find out which bus the processor is bound to and then find out which node that bus corresponds to. The AADL name of the thread is used for the *name* and the *component.*

Before using SCoPE, it must be installed, compiled and linked on a Linux system or a virtual machine with Linux. For more information about SCope you can visit http://www.teisa.unican.es/scope or write an e-mail to scope@teisa.unican.es or a letter to SCope, GIM - TEISA, University of Cantabria, AV. Los Castros s/n, ETSIIT, 39005, Santander, Spain.

So while AADS runs under Microsoft Windows, SCoPE runs under Linux; the files produced by AADS must be copied from one operative system to the other trough FTP, a shared directory or whatever.

Once the files created by AADS are in the Linux system, a makefile must be created to compile and link these files with the ones of SCoPE. The result of the command make is an executable file. When executing this file the simulation starts and at the end of simulation SCoPE shows the number of thread and context switches, use of cpu, running time, etc.

The tool SCoPE provides the technology to perform MPSoC HW/SW co-simulation with NoC (Network on Chip). It gets results for exploring the design space to choose the right processors and HW/SW partition for embedded systems. It also allows the simulation of different nodes connected through a NoC in order to analyse the behaviour of large systems. Commonly, these tools are based on slow ISSs. The differentiating feature of this technique is that SCoPE gets the performance estimations at source code level. This level of abstraction allows the simulation time to be reduced significantly while maintaining good accuracy.

SCoPE is a C++ library that extends, without modifying, the standard language SystemC to perform the co-simulation. On the one hand, it simulates C/C++ software code based on two different operating system interfaces (POSIX and MicroC/OS). On the other hand, it co-simulates these pieces of code with hardware described in SystemC.

An engineer with this tool can simulate specific software over a custom platform and obtain estimations of: Number of thread and context switches, running time and use of CPU, instructions executed and cache misses, energy and power (of core and instruction cache).

This library models the detailed behaviour of the RTOS including concurrency (among tasks in the same processor), parallelism (among tasks in different processors), scheduling and synchronization. Although the SystemC kernel executes processes following a non pre-emptive scheduling policy without priorities, SCoPE models pre-emption under different scheduling policies based on priorities.

SCoPE integrates a POSIX based API that allows the execution of a large number of software applications that follows this standard. POSIX is the main operating system interface nowadays, but it is not the only one. Thus, SCoPE has been improved to support extensions for other types of interfaces. An example is the integration with the MicroC/OS interface. This is a demonstration of the scalability of the tool, in terms of software support.

The design of embedded systems requires not only software handling but also hardware communication. For this reason SCoPE includes a set of more than a hundred driver facilities to implement this communication. One of the most extensively used operating systems in this sector is Linux, thus this driver facilities are based on the Linux kernel version 2.6. Furthermore, SCoPE is able to simulate the loading of kernel modules and the handling of hardware interruptions and their corresponding scheduling.

SystemC is the language used for the modelling of the hardware platform due to the easiness of implementation (C++ extension) and its simulation kernel. For the purpose of simulating different platforms SCoPE incorporates some generic hardware modules: a bus based on TLM2 used for the communication with peripherals and the transmission of hardware interruptions, a DMA for copying large amounts of data, simple memory for the simulation of cache and DMA traffic, a hardware interface for simple custom hardware connection, a network interface that works as a net card for the NoC and an external network simulator to implement the NoC connected to SCoPE.

System simulation comprises Multicomputation and Modular structure. Multicomputation: One of the advantages of this tool is the possibility of interconnection among independent nodes and simulating the interaction among them. Modular structure: Each RTOS component is an independent object that does not share any data with the others. Furthermore, each process is isolated from the rest of the system, thus a process with global variables can be replicated in many nodes without data collision problems. That is, each process has a separate memory space.

Annex I: Subset of AADL.

This annex lists alphabetically the subset of AADL implemented by AADS:

bus

composite data

data

device

memory

ports connections:

- data port
- event data port
- event port

process

processor

properties:

- Actual_Subprogram_Call
- Assign_Byte_Time
- Base_Address
- Compute_Entrypoint
- Compute_Execution_Time
- Device_Dispatch_Protocol
- Dispatch_Protocol
- Finalize_Execution_Time
- Finalize_Entrypoint
- Initialize_ Execution_Time
- Initialize _Entrypoint
- Memory_Protocol
- Period
- Read_Time
- Source_Code_Size
- Source_Data_Size
- Source_Stack_Size
- Source_Text
- UC::POSIX_Scheduling_Policy

UC::Priority
Word_Count
Word_Size
Write_Time

subprogram
subprogram calls
subprogram parameters
system
thread

Annex II: License.

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Version 3, 29 June 2007

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d) Convey the object code by offering access from a designated place (gratis or for a charge), and offer equivalent access to the Corresponding Source in the same way through the same place at no further charge. You need not require recipients to copy the Corresponding Source along with the object code. If the place to copy the object code is a network server, the Corresponding Source may be on a different server (operated by you or a third party) that supports equivalent copying facilities, provided you maintain clear directions next to the object code saying where to find the Corresponding Source. Regardless of what server hosts the Corresponding Source, you remain obligated to ensure that it is available for as long as needed to satisfy these requirements.

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A separable portion of the object code, whose source code is excluded from the Corresponding Source as a System Library, need not be included in conveying the object code work.

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