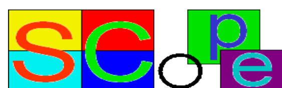
July, 2010



USER MANUAL
for
M3P SCoPE Plug-in:
XML Management for DSE

Version 1.0.5

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Contents

1.- OVERVIEW..5
1.1 Use for Design Space Exploration: Multicube Project..6
2.- BACKGROUND: 8
2.1 SCoPE..8
2.1.1 Software Estimation & Modeling..8
2.1.2 Hardware platform simulation..9
2.1.3 System simulation..9
3.- INSTALLATION AND USE..10
3.1 Installation requirements..10
3.2 Installation steps..10
3.2.1 Environment variables..10
3.3 Usage of M3-SCoPE..11
3.3.1 Using M3-SCoPE as a tool..11
3.3.2 Using M3P and SCoPE as C++ libraries..12
3.3.3 Using M3P and SCoPE with SystemC platform descriptions..12
3.4 Using the XML interface..13
3.5 Command line options..13
4.- SYSTEM DESCRIPTION..15
4.1 XML System Description file..15
4.1.1 General file structure..15
4.1.2 HW Platform..16
4.1.3 SW Platform..19
4.1.4 Application SW..21
4.1.5 Simulation parameters..23
4.1.6 Additional Rules..24
5.- SYSTEM CONFIGURATION..26
5.1 XML System Configuration file..26
6.- METRIC REPORTING..27
6.1 Metrics reported..27
6.2 XML Metric Definition file..28
6.3 XML Metric Report file..28
7.- ADDITIONAL FEAUTRES..29
7.1 Using the ARP library..29
7.1.1 Compilation for ARP-SCoPE integration..29
7.1.2 Using ARP-SCoPE in a simulation..29
8.- EXAMPLES..30
8.1 Hello World..30
8.2 Hello World Parameterized..34
8.3 Variable example..35
8.4 Vocoder..35
9.- Glossary..41

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1.- OVERVIEW

SCoPE is a SystemC extension for system modeling based on approximately (loosely) timed descriptions of the system components. As a SystemC extension library, SCoPE has been designed to receive the system descriptions as SystemC code. However, in order to minimize the designer effort, a easier interface for describing the systems is required.

This plug-in has been prepared to accept the system descriptions in a friendly format (XML) and automatically generate the system model. The use of the plug-in hides SCoPE and even SystemC to the user. Thus, the user does not require specific knowledge about SCoPE. Just by providing the system description in XML and the code of the SW tasks, the simulator creates the system model. Only in case the user wants to add specific HW components direct interaction with SCoPE is required.

The plug-in has been developed to simplify the interaction mechanisms between the modeling engine and the user or other tools, without loosing flexibility. Three input XML files have been and an XML output files have bee defined for this purpose (figure 1).

The three input files are the following: a file describing the entire system, except for punctual parameters, a file fixing these parameters, and file defining the metrics the simulation have to report. Component instantiations and connections are created automatically following the XML files. The System Description file is mandatory to use the M3Plugin. The System Configuration and the Metric Definition files are optional. The System Configuration file is required if the System Description file contain unresolved parameters. The Metric Definition file is required if the user expects the tool will report any metric in the XML output file. This can be useful it the user only needs to perform a timed system simulation or if the standard SCoPE reports provided in the shell at the end of the simulation are enough.

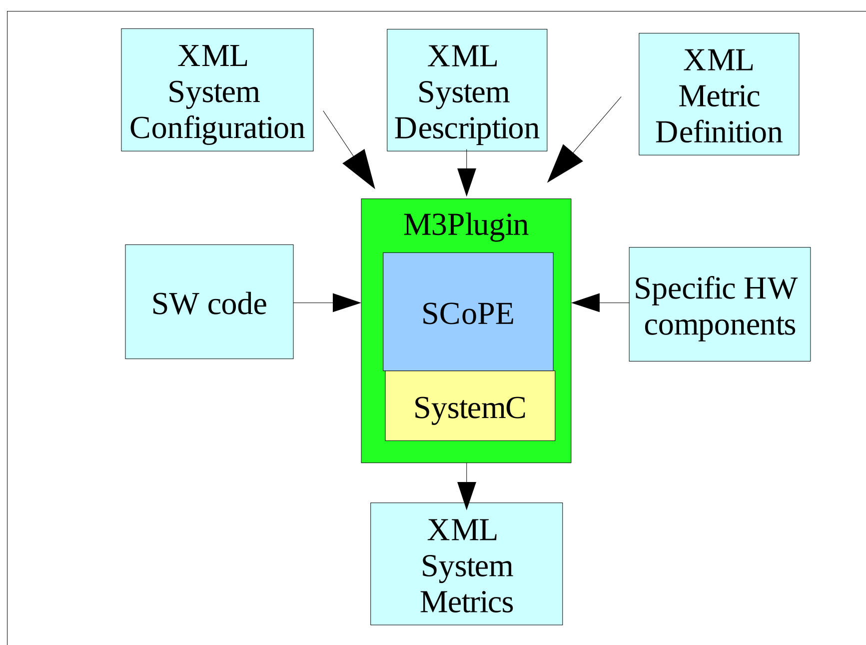

Figure 1: M3P inputs and output diagram

The plug-in generates an output file, called System Metrics, when the simulation finishes. This file

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contain the values of the metrics defined in the input Metric Definition file. These values are the result of the previous simulation. If no metrics file is provided, the output metrics file is empty.

The plug-in contains the sc_main function. The user does not require creating it. The plug-in creates the sc_main function with all the required functionality to create the system model from the XML files, execute the simulation and return the required metrics at the end of the simulation.

To create the simulator, the user has to compile the SW code using the SCoPE compiler. Then, the compiled code has to be linked with the SystemC library, the SCoPE library and the M3P library. This operation creates a simulation executable. Thus, the simulation can be run, by providing the name of the XML files as argument, as shown in section 3.

1.1 Use for Design Space Exploration: Multicube Project

The plug-in has been specially designed to interconnect SCoPE and a Design Space Exploration tool. The simplified and flexible XML interface together with the fast and accurate modeling capabilities of SCoPE makes this simulator really adequate to be user in a DSE design flow.

To use the M3P plug-in together with the SCoPE library in a DSE environment, the user has to create the use case simulator (figure 1). This includes SCoPE and the M3P plug-in, a XML system description file (see section 4) and all the system components: SW code and HW peripheral models. If the XML system description file has not unfixed parameters, nothing more is required to simulate the system.

However, this solution is not feasible for DSE. DSE requires performing several simulations modifying certain system parameters without recompiling. In that case, the XML System Description is expected to have unresolved all these parameters that can be modified. Thus, a XML System Configuration file with the values of these parameters is required. With that solution only modifying the XML System Configuration file multiple simulations can be performed without recompiling the use case simulation.

Furthermore, the XML Design Space file can inform both the DSE tool and the simulator about the metrics that are required to perform the exploration and decide the best configuration possible.

The tool infrastructure proposed has been defined in the European Multicube project. The MULTICUBE project focuses on the definition of an automatic multi-objective Design Space Exploration (DSE) framework to be used to tune the System-on-Chip architecture for the target application evaluating a set of metrics (e.g. energy, latency, throughput, bandwidth, QoS, etc.) for the next generation embedded multimedia platforms.

Figure 2 presents an example of a HW/SW system exploration using SCoPE and this plug-in. The System simulation (called “Use case simulator”) requires to be created:

- The models of the SW and Specific-HW components of the system.
- The XML System Description, containing how the system architecture, how the system components are connected and the required information to start the SW tasks.
- SCoPE and the M3P plug-in

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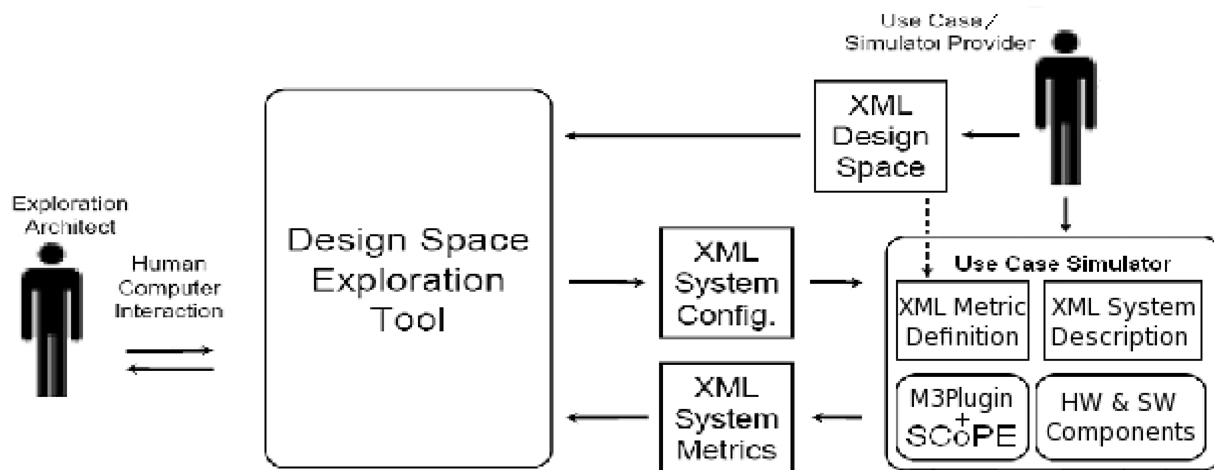

Figure 2: Using SCoPE and M3P as simulator for DSE

In that figure, to explore the best configuration for the HW/SW system, the XML Design Space file is also required. From the information of this file, the DSE tool generate multiple configurations and launch the corresponding simulator executions in order to obtain the performance results of each configuration. Them the DSE tool can decide which one is the best one analyzing the metrics reported by the simulator.

The specifications of the XML Design Space, XML System Configuration and XML System Metrics files have been defined in the Multicube Project. These specifications represents a standard way to create intermediate files. These files allows easy tool interconnection

The information required in the XML System Metrics file about which system metrics have to be reported at the end of the simulation can be provided as an specific file. Furthermore, as this information is usually part of the XML Design Space File it is also possible to reuse this file as an input to the use case simulator (See the dotted line in figure 2).

This plug-in has been created as part of the European Multicube project. For more information you can visit www.multicube.eu

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2.- BACKGROUND:

2.1 SCoPE

SCoPE tool provides the technology to perform MPSoC HW/SW co-simulation with NoC (Network on Chip). It gets results to explore the design space to choose the right processors and HW/SW partition for embedded systems. It also allows the simulation of different nodes connected throw a NoC to analyze the behavior of large systems.

Commonly, this kind of tools are based on slow ISSs. The main difference with this technique is that SCoPE gets the performance estimations at source code level. This level of abstraction allows to decrease several orders of magnitude the simulation time with a good accuracy.

SCoPE is a C++ library that extends, without modifying, the standard language SystemC to perform the co-simulation. On one side, it simulates C/C++ software code over High-level Operating System models. Currently two different operating system interfaces are supported (POSIX and MicroC/OS) but modeling other OSs is also possible. On the other hand, it co-simulates these pieces of code with hardware described on SystemC language.

2.1.1 Software Estimation & Modeling

An engineer with this tool can simulate a specific software over a custom platform and obtain estimations of:

- Number of switches
- Thread
- Context
- Time
- Running time
- Use of CPU (%)
- Executed instructions
- Cache misses
- Energy and power

RTOS Modeling

This library models the detailed behavior 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-preemptive scheduling policy without priorities, SCoPE models preemption under different scheduling policies based on priorities.

Operating system interfaces

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 unique. Thus, SCoPE has been improved to support extensions for other types of interfaces. An example is the integration with the uC/OS interface. This is a demonstration of the scalability of the tool, in terms of software support.

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Drivers

The design of embedded systems require not only software handling but also hardware communication. For this reason SCoPE includes a set of more of a hundred of driver facilities to implement this communication. One of the most extended operative 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 its correspondent scheduling.

2.1.2 Hardware platform simulation

SystemC is the language used for the modeling of the hardware platform due to the easiness of implementation (C++ extension) and its simulation kernel. For the purpose of simulate different platforms SCoPE incorporates some generic hardware modules.

- Bus based on TLM2 used for the communication with peripherals and the transmission of hardware interruptions.
- DMA for coping large amount of data.
- Simple memory for the simulation of cache and DMA traffic.
- Hardware interface for an easy custom hardware connection.
- Network interface that work as a net card for the NoC.
- External network simulator to implement the NoC connected to SCoPE. (Sicosys)

2.1.3 System simulation

- Multi-computation: One of the advantages of this tool is the possibility of interconnection among independent nodes and simulate 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.

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3.- INSTALLATION AND USE

Before installing the simulation engine, please visit
http://www.teisa.unican.es/gim/en/scope/source.html to get the latest version. Furthermore, there you will find an auto-installation script that will help you in checking and installing the latest versions of the simulation infrastructure.

3.1 Installation requirements

The installation of the M3P plug-in for SCoPE requires the following elements to be in your system:

- GNU C/C++ toolchain: gcc/g++ (v4.x), make

  Current version has been tested with g++ 4.4.
- zlib-devel library
- SCoPE v1.1.5

  Additional SCoPE requirements are:

  - SystemC 2.2

All the elements have been developed for 32 bit systems.

3.2 Installation steps

The M3P plug-in installation requires two steps.

- First the required environment variables have to be set properly.
- Then the tool can be installed using the “make” command.

A install.sh script for automatic installation of all components can be downloaded from the web page. The script downloads the required files, compiles them and modifies the environment variables required. It is prepared for bash shells, since it modifies the .bashrc file.

3.2.1 Environment variables

Edit your .bashrc file and add the next environment variables, or export them directly to the shell:

- export SYSTEMC=[systemc installation path]
- export SCOPE_HOME=[scope installation path]
- export SCOPE_XML_PLUGIN=[scope-xml-plugin installation path]

Example:

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echo ' export SYSTEMC='$SYSTEMC_PATH'/systemc2.2.0 ' >> $HOME/.bashrc

echo ' export SCOPE_HOME='$SCOPE_PATH'/SCoPE_v1.1.5 '   >> $HOME/.bashrc

echo ' export SCOPE_XML_PLUGIN='$XML_PATH'/m3p_v1.0.5 ' >> $HOME/.bashrc

Additionally, the variable LD_LIBRARY_PATH must be properly set when using dynamic libraries to build the system model.

3.2.2 Make and Install

Before makeing SCoPE plug-in ensure that SCoPE tool has been compiled. To install it, the SCoPE tar file has to be downloaded and uncompressed. To compile it, type 'make libraries'. Please, visit www.teisa.unican.es/scope for more information.

To compile the plug-in, go to the main installation directory, and then:

- To generate the M3P library file, type: $> make
- To compile the M3P examples, type: $> make examples
- To execute the M3P examples, type: $> make run

  It will execute the examples presented in section 7.

Examples are located in the '$SCOPE_XML_PLUGIN/examples' directory.

3.3 Usage of M3-SCoPE

When combining SCoPE with M3P both a tool and a library are created.

The tool created is called scope_tool.x and it can be found in the M3P/build folder. The tool includes all the facilities of M3P and SCoPE and avoids creating an specific executable for each design. The tool reads the XML files for system description and configuration and creates the system models. To run, the design-specific components must be developed as dynamic libraries, which names are provided in the XML files.

M3P and SCoPE can be also used as a pair of libraries. The libraries can be linked together with the design-specific code in order to generate the simulation executable. When using M3P+SCoPE in that way the system can be described both using XML files or SystemC code or a combination of both.

The arguments to be provided in both cases for using the resulting executable are the same, and they are described in section 3.5

3.3.1 Using M3-SCoPE as a tool

To use M3-SCoPE as a tool for simulating a system design, it is required to provide two set of elements: XML files and dynamic libraries with the application-specific code.

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The usage of the XML files is independent of the way of using M3-SCoPE and will be explained in further sections.

To integrate the application-specific code in the simulation, it is required to build it as dinamic libraries. The application-specific code contains the code of the application SW and the application-specific HW components. To generate the libraries it is required to execute the following rule:

```
g++ -fPIC -shared -fvisibility=protected $(CFLAGS) -o $(libNAME.so) $(OBJS)
```

It is recommended to generate an independent library for each HW or SW component.

If a component has to be instantiated in the design model more than once, it is required to create a copy of the library for each instance, providing different numbers. It is recommended to call them libNAME_%i.so, where %i is a number from 0 up to the number of instances.

Additionally it is required to set the environment variable LD_LIBRARY_PATH with the folders where the dynamic libraries are located.

3.3.2 Using M3P and SCoPE as C++ libraries

In general, to integrate M3P and SCoPE together with the system modeling code to obtain a simulation executable, it is required to add the libexpatmm.a libloadxml.a libraries during linkage step. Once the installation of the M3P plug-in is performed, those libraries are placed in the "m3p_path/build" directory.

When using M3-SCoPE as a library, to create an executable it is required to follow the next steps:

1.- Compile the SW system components using the SCoPE compiler. This compiler requires g++ v4 and inheritates all its flags and options. The compiler is in :

$(SCOPE_HOME)/compiler/sw_g++

2.- Compile the application specific HW components if any. To integrate HW components, please follow the SCoPE manual.

3.- Then, all the resulting object codes and libraries from steps 1 and 2 have to be linked together with the SystemC library, the SCoPE library. Linking other libraries can be required depending on the system to be modeled.

It is recommended to use the Makefiles provided with the M3P examples. To compile other examples with different SW components it is only required to modify the $OBJ list with the corresponding object files.

The plug-in provides a "sc_main" function in order to load all the XML files and create the described system. Thus, the user must not provide his own "sc_main" function.

3.3.3 Using M3P and SCoPE with SystemC platform descriptions

When using M3-SCoPE with SystemC code description instead of XML description files, it is required to include in the sc_main file two function calls.

The first function call is

"uc_xml_init_plugin(argc, argv);"

This function initializes the plug-in and must be called before the sc_start. It is recommended to put

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it as the first line of the sc_main function.

The second call is

"uc_xml_close_plugin();"

It closes the plugin and generates the report file. It should be called once the simulation is finished; after the sc_start function.

3.4 Using the XML interface

The SCoPE XML plug-in allows defining four types of XML files. The first two files can be used to describe the system to be modeled. The third is related to the output metrics. The last file is the file where SCoPE has to put the output data, and thus is not a configuration file itself.

XML files:

- XML System Description: Contains the system description, that is, component descriptions, architecture and allocation.
- XML System Configuration: Contains the system configuration parameters, that is, all these parameters that can be configured in the platform and have not been fixed in the System Description.
- XML Metric Definition: Contains definition of the metrics to be reported by SCoPE.

3.5 Command line options

The xml plug-in is an extension to SCoPE and thus to SystemC. The plug-in provides a generic sc_main function and handles a set of command line options. These options can be used to define the XML files to be loaded to configure SCoPE. These XML files contain the system description and the output definition.

```
Usage: SystemC_executable_name -xml file [option(s)]
```

The full set of command line options is:

```
  -xml file_name
  --xml-system-description file_name     File with the description of the
system to be simulated

  -xsc file_name
  --xml-system-configuration file_name  File with the system configuration
parameters

  -xmd file_name
  --xml-metric_definition file_name     File with the definition of the
metrics to be reported

  -xof file_name
  --xml-system-metrics file_name        File name for the output metric
report

  -h
  --help                                Shows the command options
```

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Only the first option is mandatory.

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4.- SYSTEM DESCRIPTION

4.1 XML System Description file

The XML System Description allows describing the system to be modeled. HW and SW components, HW and SW instances, architecture and task allocation is described in this file.

Each of the XML clauses is described in this document considering the following elements:

- Name: Clause name
- Description: What can be described with the clause
- Attributes: The possible attributes to be used to describe the element. They can be divided in
  - General attributes: Attributes applicable to any clause of this kind
  - Specific attributes: Attributes that can be applicable depending on the element described. For example, the processor type is only applicable if the component is a processor.
- Structure: XML code describing how to use the clause.

4.1.1 General file structure

The XML file must be created following the next structure:

```
< Description >
        < HW_Platform >
                < HW_Components >
                < HW_Architecture >
                < Computing_Groups >
        < /HW_Platform >

        < SW_Platform >
                < SW_Components >
                < SW_Architecture >
        < /SW_Platform >

        < Application >
                < Functionality >
                < Allocation >
        < /Application >

        < Simulation >
                < Implementation >
                < Variable >
        < /Simulation >
< /Description >
```

An additional clause, <Repeat>, can be used in any of the previous points to indicate that an element must be copied a certain number of times. This is specially important to create configurable platforms.

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4.1.2 HW Platform

Contains the description of the HW platform.

Attributes:

- name [Optional]: Name to identify the HW platform (See Implementation)

Structure:

```
< HW_Platform name="name" >
        < HW_Components >
        < HW_Architecture >
        < Computing_Groups >
< /HW_Platform >
```

HW_Components

Contains the general description of the elements that can be instantiated to create the HW platform.

Attributes:

- name [Optional]: Name to identify the HW platform (See Implementation)

Structure:

```
< HW_Components name="name" >
        < HW_Component >
        < HW_Component >
        ...
< /HW_Components >
```

HW_Component

Description of a HW component that can be instantiated to create the HW platform

General Attributes :

- name [Mandatory]: Name of the HW_Component
- category [Mandatory]: Type of component.

  - Possible values: processor, memory, icache, dcache, dma, bus, network, net_if, bridge and as_hw
- type [Optional]: Type of Component. Indicate the SCoPE component to be loaded. The argument must be the class name. If type="generic" or if no type is provided, the SCoPE default component for this category is used (if possible). - For processors, it represents the processor type for estimation purposes.
- library [Optional]: Library where the component is located. It is required for non-default SCoPE components.
- init_func [Optional]: Init function for non-default SCoPE components. When specified, it is used to create the component instead of executing the class constructor. The data type expected for the function depends on the type of component.

  - For Peripherals is: 'extern "C" UC_hw_if *(*init_func)(char* name, int start_addr,

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int end_addr, int irq, struct xml_component_info *);'

- For Buses is: 'extern "C" UC_TLM_bus_class *(*init_func)(char* name, float bandwidth, int main_mem_addr, struct xml_component_info *);'

- mem_size [Optional]: Amount of memory associated to the HW component in the memory map
- frequency [Optional]: Component frequency.
- width [Optional]: Component interface width.

  In communication components are the number of data lines.

  In HW components it represents the bus registers' size
- bus_priority [Optional(Master components)]: Priority for the bus arbiter.
- burst_size [Optional(Slave components)]: Maximum burst size.
- area [Optional]: HW area required by this component.
- static_power [Optional]: Mean power consumed when no bus events are received. In processors it is the power per instruction. In caches it is the hit energy.
- read_energy [Optional]: Energy consumed when a bus read event is received. In caches it is the miss energy
- write_energy [Optional]: Energy consumed when a bus write event is received.
- read_size_energy [Optional]: Variable energy consumed when a bus read events is received, depending on the buffer size. Total power is obtained as energy = read_size_energy * buffer_size
- write_size_energy [Optional]: Variable energy consumed when a bus write events is received, depending on the buffer size. Total power is obtained as energy = write_size_energy * buffer_size
- component_specific [Optional]: Additional parameters required for a non-default SCoPE component. It is provided to the init_func function as char*.

Specific Attributes :

`Cathegory: network`
- x_size [Optional]: Number of nodes in the x axis for a mesh network
- y_size [Optional]: Number of nodes in the y axis for a mesh network

`Cathegory: as_hw`
- activation_type [Optional]: Indicate if the component is master or slave

Structure:

```
< HW_Component name="proc_1" category="processor" proc_type="arm926t" .../ >
```

HW_Architecture

Contains the architectural description of the HW platform. The HW elements instantiated and its connections, as well as the hierarchy are described.

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Attributes:

- name [Optional]: Name to identify the HW platform (See Implementation)

Structure:

```
< HW_Architecture name="name" >
        < HW_Instance >
        < HW_Connection >
        ...
< /HW_Architecture >
```

HW_Instance

Instance of a HW component used to create the HW platform

General Attributes :

- name [Mandatory]: Name of the HW instance
- component [Mandatory]: Name of the HW component instantiated
- mem_size [Optional]: Amount of memory associated to the HW component in the memory map
- frequency [Optional]: Component frequency.
- width [Optional]: Component interface width.

  In communication components are the number of data lines.

  In HW components it represents the bus registers' size
- bus_priority [Optional(Master components)]: Priority for the bus arbiter.
- burst_size [Optional(Slave components)]: Maximum burst size.
- area [Optional]: HW area required by this component.
- static_power [Optional]: Mean power consumed when no bus events are received. In processors it is the energy per instruction. In caches it is the hit energy.
- read_energy [Optional]: Energy consumed when a bus read event is received. In caches it is the miss energy
- write_energy [Optional]: Energy consumed when a bus write event is received.
- read_size_energy [Optional]: Variable energy consumed when a bus read events is received, depending on the buffer size. Total power is obtained as energy = read_size_energy * buffer_size
- write_size_energy [Optional]: Variable energy consumed when a bus write events is received, depending on the buffer size. Total power is obtained as energy = write_size_energy * buffer_size
- start_addr [Optional]: Address at the memory map where the HW instance is placed
- irq [Optional]: Interrupt number
- local_id [Optional]: Identifier for the component. In net_if components is the mac address

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Specific Attributes :

`Cathegory: network`

- x_size [Optional]: Number of nodes in the x axis for a mesh network
- y_size [Optional]: Number of nodes in the y axis for a mesh network

`Cathegory: as_hw, dma`

- master-slave [Optional]: It indicates if the component must be connected as "master", "slave" or "both". Slave is selected by default.

Structure:

```
< HW_Instance name="my_net_if" component="net_if_1" start_addr="0x8000000" 
irq="5"  port="1" >
        < HW_Connection >
        ...
</ HW_Instance>
```

HW_Connection

Indicates that a predefined instance will be also connected at this point of the platform

General Attributes :

- name [Mandatory]: Name of the HW instance
- instance [Mandatory]: Name of the HW instance to be connected
- master-slave [Optional]: It indicates if the component must be connectedas "master", "slave" or "both". Slave is selected by default. Instance defined values for address, irq, latency and others are applied

Structure:

```
< HW_Connection name="net_if_1_connection" instance="my_net_if" / >
```

Computing_Groups

Contains the description of the HW groups which elements will cooperate as a unit to support a SW environment. For example it must be used to define the processors that will cooperate sharing the same OS in a SMP environment.

Attributes:

- name [Optional]: Name to identify the computing group (See Implementation)

Structure:

```
< Computing_Groups name="name" >
        < Computing_Group >
        < Computing_Group >
        ...
< /Computing_Groups >
```

4.1.3 SW Platform

Contains the description of the SW platform. Mainly the OSs and other elements of the SW platform.

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Attributes:

- name [Optional]: Name to identify the SW platform (See Implementation)

Structure:

```
< SW_Platform name="name" >
        < SW_Components >
        < SW_Architecture >

< /SW_Platform >
```

SW_Components

Contains the general description of the elements that can be instantiated to create the SW platform.

Attributes:

- name [Optional]: Name to identify the HW platform (See Implementation)

Structure:

```
< SW_Components name="name" >
        < SW_Component >
        < SW_Component >
        ...
< /SW_Components >
```

SW_Component

Description of a SW component that can be instantiated to create the SW platform

General Attributes :

- name [Mandatory]: Name of the SW component
- type [Mandatory]: Type of SW component.
  - Possible values: OS, middleware

Structure:

```
< SW_Component name="OS_1" type="OS"/ >
```

SW_Architecture

Contains the description of the components that integrate the SW platform.

Attributes:

- name [Optional]: Name to identify the HW platform (See Implementation)

Structure:

```
< SW_Architecture name="name" >
```

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```
        < SW_Instance >
        < SW_Instance >
        ...
< /SW_Architecture >
```

SW_Instance

Description of an instantiation of a SW component to create the SW platform

General Attributes :

- name [Mandatory]: Name of the SW component
- component [Mandatory]: Name of SW component to be instantiated
- hw_resource [Mandatory]: Name of HW resource where the SW component will be executed. It can be the name of a HW_Instance or a Computing_Group

Structure:

```
< SW_Instance name="OS_1" type="OS"/ >
```

4.1.4 Application SW

Contains the description of the application SW.

Attributes:

- name [Optional]: Name to identify the Application (See Implementation)

Structure:

```
< Application name="name" >
        < Functionality >
        < Allocation >
        ...
< /Application >
```

Functionality

Contains the description of the SW elements that can be instantiated to compose the application.

Attributes:

- name [Optional]: Name to identify the HW platform (See Implementation)

Structure:

```
< Functionality name="name" >
        < Exec_Component >
        < Exec_Component >
        ...
< /Functionality >
```

Exec_Component

Description of a SW task that can be instantiated to create the Application SW

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General Attributes :

- name [Mandatory]: Name of the SW executable component
- category [Mandatory]: Type of component.
  - Possible values: SW, driver and taskload

Specific Attributes :

`Cathegory: SW and driver`

- function [Mandatory]: Name of the function to be loaded. For compatibility reasons, it is recommended to declare the function as 'extern "C" ' in the source code
- file [Optional]: File where the function code is

`Cathegory: taskload`

- compute_time [Mandatory]: Time the task requires to be executed. In periodic tasks, the time of each execution
- period [Optional]: For periodic tasks, the task period
- data_size [Optional]: Amount of data transferred through the bus on each execution

Structure:

```
< Exec_Component name="task_1" category="SW" function="my_function"/ >
```

Allocation

Contains the description of the SW elements instantiated to compose the application.

Attributes:

- name [Optional]: Name to identify the HW platform (See Implementation)

Structure:

```
< Allocation name="name" >
        < Exec_Instance >
        < Exec_Instance >
        ...
< /Allocation >
```

Exec_Instance

Description of a SW task instance used to create the Application SW

General Attributes :

- name [Mandatory]: Name of the SW executable instance
- component [Mandatory]: Name of SW executable component
- resource [Optional]: HW resource where the task will run (HW_Instance or Computing_Group).
- os [Optional]: OS where the task will run. If no Resource is defined it is mandatory

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- arguments [Optional]: List of arguments the task will receive at startup
- policy [Optional]: Policy of the new task
- priority [Optional]: Priority of the new task

Structure:

```
< Exec_Instance name="my_task" component="task_1" resource="node0" arguments="-s
-t -f file"/ >
```

4.1.5 Simulation parameters

Contains the description parameters required to perform the simulation.

If the time is not specified and there is not required to specify an Implementation, the cathegory can be ommited in the XML file.

Attributes:

- time [Optional]: maximum simulation time. Requires indicating value and unit (s, ms, us, ns)
- backtrace [Optional]: Debug option. Indicates if any backtrace must be generated
  - Use backtrace="3" for printing the final thread status
  - Use backtrace="5" for online debugging
  - Use backtrace="15" for continous printing the thread status
- end_as_sw [Optional]: indicate to finish the simulation when all SW processes has been finished, even though the time is not completed or any HW component is active (usually, HW timer is always active).

Structure:

```
< Simulation time="200 ms" end_as_sw=”1” >
        < Implementation >
< /Simulation >
```

Implementation

Contains the set of previous descriptions selected to create the system model.

Note: If any clause set is not specified, all the sets present of this clause in the file will be loaded. This can produce inconsistencies if all these sets are not compatible. If it is not required to specify any set, the 'Implementation' clause is optional.

Attributes (Set type names):

- HW_Platform [Optional]: Name of the HW_Platform set to be loaded for the system model
- HW_Components [Optional]: Name of the HW_Components set to be loaded for the system model
- HW_Architecture [Optional]: Name of the HW_Architecture set to be loaded for the system model
- Computing_Groups [Optional]: Name of the Computing_Groups set to be loaded for the system model

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- SW_Platform [Optional]: Name of the SW_Platform set to be loaded for the system model
- SW_Components [Optional]: Name of the SW_Components set to be loaded for the system model
- SW_Architecture [Optional]: Name of the SW_Architecture set to be loaded for the system model
- Application [Optional]: Name of the Application set to be loaded for the system model
- Functionality [Optional]: Name of the Functionality set to be loaded for the system model
- Allocation [Optional]: Name of the Allocation set to be loaded for the system model

Structure:

```
< Implementation HW_Platform="HW_Plat_1" SW_Platform="SW_Plat_1"
Allocation="Alloc_2"/ >
```

Variable

Assign a value to a global variable in the simulation.

The variable provided is taken as an integer value. Strings, float or boolean values are not allowed.

Attributes:

- name [Mandatory]: The name of the global variable in the C/C++ code
- value [Mandatory]: The value to be assigned to the variable
- library [Optional]: The library (.so file) where the library has been declared. If no library is provided it is supposed to be in the main file.

Structure:

```
< Variable name="my_var" value="1" library="libmy_lib.so" / >
```

Plugin

Adds additional plugins to the simulation.

It allows indicating the library containing the plugin and the starting function.

Attributes:

- name [Mandatory]: Name of the plug-in
- library [Optional]: Library to be included
- entry [Optional]: Name of the function to be executed to integrate the plugin in M3-SCoPE.

Structure:

```
< Plugin name="debug" library="libscopedbg.so" name="scopedbg_loading" / >
```

4.1.6 Additional Rules

How to name a component:

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- By name: "component_name"
- By path: "//@HW_Platform/@HW_Architecture/@HW_Instance"
- By path when there are multiple components: "//@HW_Platform/@HW_Architecture/@HW_Instance.0/@HW_Connection.2" How to name a component which is in a repeat clause:
- By name: "component_name%i"
- By path: "//@HW_Platform/@HW_Architecture/@Repeat.1/@HW_Instance" How to use a configuration parameter:
- Adding '_' before the parameter name: mem_size="_parameter_name"

Repeat

Allows repeating groups of clauses. This is specially useful when combined with the XML System Configuration file. This allows defining a variable number of elements in the platform, as number of nodes, number of processors, ...

Attributes:

- number [Mandatory]: Name to number of times the internal elements must be repeated
- index [Optional]: Letter to be replaced by the instance number when preceded by '%' (See the example below)
- init [Optional]: Indicates the value of “index” the first time the Repeat clause is applied. If it is not specified, “index” starts with “0”

Structure:

```
< Repeat number="3" index="i" init="1">
        < Component_type name="name%i" >
        < Repeat number="_repeat_times" index="j" >
                < Component_type name="name_%i_%j" >
        < /Repeat >
< /Repeat >
```

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5.- SYSTEM CONFIGURATION

5.1 XML System Configuration file

The XML System Configuration file allows defining the value of the platform configuration paramenters. Number of processors in a SMP system, size of caches, bandwidth of a bus or memory delay are possible configuration parameters.

The name of the corresponding file can be specified using the -xsc file_name or

--xml-system-configuration file_name option.

File structure:

```
< simulator_input_interface  xmlns="http://www.multicube.eu/" version="1.3">
        < parameter name="mem_size" value="256" />
        < parameter name="num_proc" value="3"   />
        ...
< /simulator_input_interface >
```

Parameter use:

To the values are used to replace the parameters in the XML System Description file. The parameter to be replaced is named with the same name starting with "_".

Example:

```
XML System Configuration file:

        ...
        < parameter name="msize" value="256" />
        ...

XML System Description file:

        ...
        < HW_Component name="memory" mem_size="__msize" />
        ...
```

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6.- METRIC REPORTING

6.1 Metrics reported

The plugin has been developed to generate the following metrics when requested:

Metric Name	Default unit	Description
System_Area	mm2	This metric estimates the overall system area occupied by the architecture.
Execution_Cycles	Cycle	Estimates the number of cycles to execute the target application running on the target architecture.
Latency	Second	The latency is given by the number of cycles to execute the target application running on the target architecture times the duration of the clock period.
Instruction_Count	Instruct.	This metric estimates the number of instructions to execute the target application running on the target architecture.
Clock_Per_Instruction	Cycle/ Instruct.	Represents the average number of clock cycles required to execute an instruction.
Instructions_Per_Clock	Instruct. /Cycle	Represents the average number of instruction executed in each clock cycle.
MIPS	Million of instruct. / second	Represents the average number of million of Instructions Per Second
Hit_Rate	Percentage	This metric represents the percentage of cache hits with respect to the number of cache accesses.
Memory_Stall_Cycle	Cycle	This metric is given by the number of cache misses times the miss penalty cycles.
AMAT	Second	Sum of the cache hit time and the cache miss rate times multiplied by the cache miss penalty, expressed in seconds.
Bus_Bandwidth	bit/s	This metric refers to the medium rate at which information bit is transferred over the bus per time unit. It is obtained as total_information_transferred / total_time.
Network_Aggregate_Bandwidth	bit/s	This metric refers to the data bandwidth used by the Network-on-Chip. It is obtained as total_information_transferred / total_time.
Transport_Latency	Seconds	The transmission time refers to the difference in time between the arrival of the first and the last bits of the packet to the receiver.

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Energy_Consumption	Jules	This metric estimates the energy consumed by the target architecture during the execution of the target application.
Power_Consumption	Watt	The average power consumed by the target architecture during the execution of the target application.

6.2 XML Metric Definition file

The XML Metrics Definition file allows defining the metrics that SCoPE will report once the simulation is finished.

The file name can be specified using the command-line option -xmd file_name or

--xml-metric_definition file_name

```
File structure:
< system_metrics >
        < metric name="Execution_cycles"  type="integer" unit="cycle" />
        < metric name="Power_consumption" type="float"   unit="W"     />
        ...
< /system_metrics >
```

6.3 XML Metric Report file

The XML metric report file provides the metric values obtained from en executed simulation. Metrics selected to be reported must be indicated with a XML Metric Definition file.

The file name can be specified using the command-line option -xof file_name or

--xml-system-metrics file_name

File structure:

```
< simulator_output_interface xmlns="http://www.multicube.eu/" version="1.3">
      <system_metric name="latency" value="value"/>
      <system_metric name="instruction_count" value="value"/>
      ...
< /simulator_output_interface>
```

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7.- ADDITIONAL FEAUTRES

7.1 Using the ARP library

The Atomium Record/Playback(ARP©) library is a library included in the Atomium© package provided by IMEC. It allows recording and reusing information from one simulation to another. The functions required to record and playback timing information from SCoPE simulation have been integrated withing M3P.

The library ARP itself is not integrated with M3P and have to be obtained from IMEC.

7.1.1 Compilation for ARP-SCoPE integration

To integrated ARP into a SCoPE simulation it is required to compile the integration files specifically. To do so it is required to:

- Set the environment variable ARP_LIB with the path where the ARP library is installed.
- Go to the M3P main folder and execute “make arp_lib”

7.1.2 Using ARP-SCoPE in a simulation

To use the integration library within a simulation two steps are required.

- First it is required to prepare the source code with the corresponding marks following the rules of the ARP library.

- When running the simulation it is required to add the ARP-LIB plugin. To do so, it is required to add the following rule to the XML System Description file.

- For recording data:

  <Plugin name=“arp_scope” file=“libarp_scope.so” entry=“start_record” />

- For data playback

  <Plugin name=“arp_scope” file=“libarp_scope.so” entry=“start_playback” />

Additionally it is required to integrate the ARP library itself. To do so it can be added to the application specific code when linking or it can be added with

<Plugin name=“arp_lib” file=“lib_name.so” />

(E.j. <Plugin name=“arp_lib” file=“libarp_rhel4_g++3.4.6.so” />)

Note: Make sure that the m3p/build folder and the folder of the ARP library are included in the LD_LIBRARY_PATH environment variable.

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8.- EXAMPLES

Two examples are provided with the M3P distribution. The first one is a simple “hello world” example. It has been developed to show how to create a simple example. A second version of this example is also provided to show how to parameterize a system.

The second example is a GSM vocoder. It can show how to create a complex example and the capabilities of the tool.

The examples are in the $SCOPE_XML_PLUGIN/examples directory.

8.1 Hello World

To create the example we have to create:

- The SW code
- The platform descriptions
- The file indicating the metrics to be reported.

The SW code of this example is really easy. We can create a hello.cpp file with the followin code:

```
#include “stdio.h”
int hello_main(int argc, char **argv){
     printf(“Hello world\n”);
     return 0;
}
```

The System description required to execute that code can be also very simple.

First we have to create the HW platform. It will contain three components a processor (ARM9) a bus, and a memory.

```
<HW_Components>
     <HW_Component category="bus" name="AMBA" frequency="200" />
     <HW_Component category="processor" name="arm926t" frequency="200" />
     <HW_Component category="memory" name="Memory"  mem_size="500000K"
     frequency="200" mem_type="RAM" />
</HW_Components>
```

To connect the processor and the memory to the bus, we will include both in the bus instance:

```
<HW_Architecture>
     <HW_Instance component="AMBA" name="my_bus" >
          <HW_Instance component="arm926t" name="my_proc" />
          <HW_Instance component="Memory" name="mem" start_addr=”0x80000000” />
```

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```
    </HW_Instance>
</HW_Architecture>
```

Once created the HW plaform, we have to create an component for the OS, and instantiate it in to run over the HW processors instantiated above (“my_proc”).

```
<SW_Platform>
    <SW_Components>
        <SW_Component name="SO" type="OS" />
    </SW_Components>
    <SW_Architecture>
        <SW_Instance name="my_OS" component="SO" HW_Resource="my_proc" />
    </SW_Architecture>
</SW_Platform>
```

Once defined the HW and the SW infrastructure, we can indicate the SW application we want to execute. To do that, we have to provide the name of the main function. In our case, or application main function is called “hello_main”. We have to create a SW component with this function and instantiate it in “My_OS”.

```
<Application>
    <Functionality>
        <Exec_Component name="hello" category="SW" function="hello_main" />
    </Functionality>
    <Allocation>
        <Exec_Instance name="Hello_world" component="hello" os="my_OS" />
    </Allocation>
</Application>
```

Finally, we have to indicate the simulation time. In our case, 1 second will be enough to perform the “hello wold” application.

```
<Simulation time="1 s" />
```

Summarizing, the whole file (called “platform.xml”) is the following:

```
<?xml version="1.0" encoding="UTF-8"?>
<Description xmi:version="2.0" xmlns:xmi="http://www.omg.org/XMI" name="Hello_world">
    <HW_Platform>
        <HW_Components>
            <HW_Component category="bus" name="AMBA" frequency="200" />
            <HW_Component category="processor" name="arm926r" frequency="200"/
            >
            <HW_Component category="memory" name="Memory"
            mem_size="500000K"  frequency="200" mem_type="RAM" />
```

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```xml
		</HW_Components>
		<HW_Architecture>
			<HW_Instance component="AMBA" name="my_bus" >
				<HW_Instance component="arm926t" name="my_proc" />
				<HW_Instance component="Memory" name="my_memory"
				start_addr="0x80000000" />
			</HW_Instance>
		</HW_Architecture>
	</HW_Platform>
	<SW_Platform>
		<SW_Components>
			<SW_Component name="SO" type="OS" />
		</SW_Components>
		<SW_Architecture>
			<SW_Instance name="my_OS" component="SO" SW_Resource="my_proc"
			/>
		</SW_Architecture>
	</SW_Platform>
	<Application>
		<Functionality>
			<Exec_Component name="hello" category="SW" function="hello_main" />
		</Functionality>
		<Allocation>
			<Exec_Instance name="Hello_world" component="hello"
			os="my_OS" />
		</Allocation>
	</Application>
	<Simulation time="1 s" />
</Description>
```

Finally, we have to create the System Metrics file, to indicate the tool which metrics have to be reported. In our case we will ask for the latency and the power consumption. The required file (metrics.xml) contains:

```xml
 <?xml version="1.0" encoding="UTF-8"?>
 <system_metrics>
	<system_metric name="Latency" type="float" unit="Second"/>
	<system_metric name="Power_Consumption" type="float" unit="Watts"/>
```

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</system_metrics>

Finally, we have to compile and execute as “run.x -xsd platform.xml -xmd metrics.xml -xof output.xml” to obtain the results of the simulation in the “output.xml” file. To make and execute it you can type “make run”.

Once executing, first, the simulator will load the input xml files and it will create the system model. The output provided by the example is:

```
                SystemC 2.2.0 --- May 16 2008 09:54:21
           Copyright (c) 1996-2006 by all Contributors
                       ALL RIGHTS RESERVED
XML System Configuration file not found.

File: platform.xml -> (OPENED)
Loading platform description.
Platform description loaded.
Creating platform.
Platform created.
File: platform.xml -> (LOADED)
Simulation time: 1 s
```

Then the simulation starts, and the “hello wold” is printed out.

After that, the simulation finishes and global performance information is returned:

```
Main finish
Simulated time: 1 s

RTOS:  0
        Number of m_processes created:  1
        Number of m_processes destroyed:  1
        Mean process duration (process start - process end): 1.111e-06 sec
        Last SW execution time:  1.111e-06 sec
processor_0_rtos_0
        Number of thread switches:  100
        Number of context switches: 0
        Running time: 100111 ns
        Use of cpu: 0.0100111%
        Instructions executed: 15
        Instruction cache misses: 100
        Core Energy: 30 nJ
```

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```
Core Power: 3e-05 mW
Instruction Cache Energy: 4045 nJ
Instruction Cache Power: 0.004045 mW
```

Furthermore, a “output.xml” file has been created, with the results of the metrics required in “metrics.xml”:

```
<?xml version="1.0" encoding="UTF-8"?>
<simulator_output_interface xmlns="http://www.multicube.eu/" version="1.3">
    <system_metric name="latency" value="0.000001111"/>
    <system_metric name="power_consumption" value="0"/>
</simulator_output_interface>
```

8.2 Hello World Parameterized

To show how to include a parameter in a system description a new example is provided by minimally modifying the previous one.

Let's suppose that the memory address is not completely fixed in the platform and can be moved. Thus, instead of fixing the address as “0x80000000” in the “platform.xml” file, we will substitute that value by “__MEM_ADDR”. The result is:

```
<HW_Instance component="Memory" name="my_memory" start_addr="__MEM_ADDR" />
```

Then we need to define this parameter in the XML System Configuration file. That file will be:

```
<?xml version="1.0" encoding="UTF-8"?>
<simulator_input_interface xmlns="http://www.multicube.eu/" version="1.3">
    <parameter name="MEM_ADDR" value="0x80000000" />
</simulator_input_interface>
```

Note that in the first file, the parameter start with “__” and not in the second one. This characters are used to detect in the system description which strings are not a real values but configurable parameters.

Finally, we have to compile and execute as “run.x -xsd platform.xml -xsc parameter.xml -xmd metrics.xml -xof output.xml” to obtain the results of the simulation in the “output.xml” file. To make and execute it you can type “make run”.

The results are equal to the previous example.

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8.3 Variable example

Simple example that uses a system description in SystemC code and shows how to use a variable to configure the execution of the code.

The system contains a global variable (int global_variable=0;) declared in the variables.c file. The variable is initialized with '0' value and printed. The variable can be configured using the XML files to have different values depending on the execution.

In the XML System Description file the variable is defined as a configurable one:

```
<Simulation>
    <Variable name="global_variable" value="__value"/>
</Simulation>
```

In the XML System Configuration file, a value is assigned:

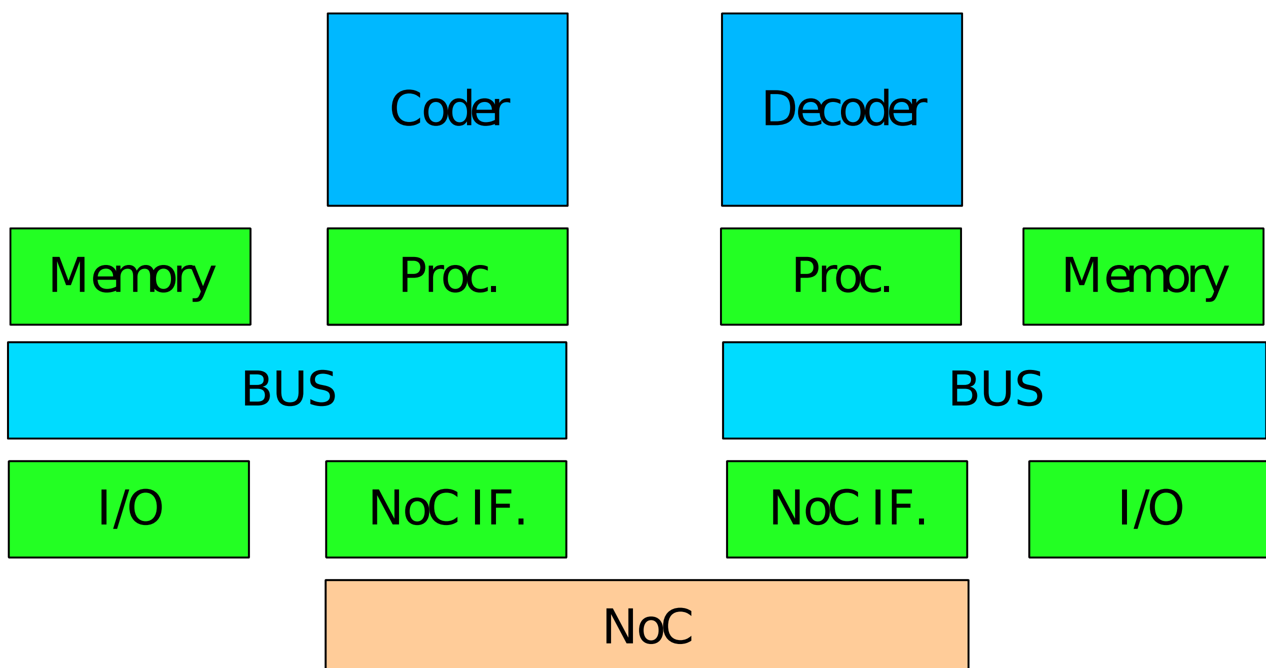
```
<parameter name="value" value="13" />
```

Then, during the execution, the global variable has not '0' value, but '13'.

8.4 Vocoder

Example that uses the XML system description file and the XML system configuration file.

The example is prepared to run a GSM coder and a decoder, both composed of several SW tasks. The HW platform contains two SMP nodes connected through a network.



The XML platform file required to describe this platform is the following :

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```
<?xml version="1.0" encoding="UTF-8"?>
<Description xmi:version="2.0" xmlns:xmi="http://www.omg.org/XMI" name="vocoder">
	<HW_Platform name="HWPlat_1" >
		<HW_Components name="HWComponents_1">
			<HW_Component category="bus" name="AMBA" frequency="200" />
			<HW_Component category="network" name="mesh" frequency="200"
			x_size="2" y_size="1" />
			<HW_Component category="processor" name="arm926t" frequency="200" /
			>
			<HW_Component category="memory" name="Memory"
			mem_size="536870K" frequency="200" mem_type="RAM" />
			<HW_Component category="net_if" name="network_if" mem_size="100"
			frequency="200" />
		</HW_Components>
		<HW_Architecture name="HWArch_1">
			<Repeat number="__NUM_NODES" index="a">
				<HW_Instance component="AMBA" name="bus0" >
					<HW_Instance component="arm926t" name="Processor%a" /
					>
					<HW_Instance component="Memory" name="Memory%a"
					start_addr="__MEM_ADDR" />
					<HW_Instance component="network_if" name="NoC_if%a"
					start_addr="__NOC_ADDR" irq="5" />
				</HW_Instance>
			</Repeat>
			<HW_Instance component="mesh" name="NoC" >
				<HW_Connection instance="//@HW_Platform/@HW_Architecture/
				@Repeat.0/@HW_Instance.0/@HW_Instance.2" name="conn0"/>
				<HW_Connection instance="//@HW_Platform/@HW_Architecture/
				@Repeat.1/@HW_Instance.0/@HW_Instance.2" name="conn1"/>
			</HW_Instance>
		</HW_Architecture>
		<Computing_groups name="HWGrp_1">
			<Repeat number="__NUM_NODES" index="i">
				<Computing_group name="node%i" >
					<Computing_Resource  name="//@HW_Platform/
@HW_Architecture/@Repeat.%i/@HW_Instance.0/@HW_Instance.0" />
```

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```
                </Computing_group>
            </Repeat>
        </Computing_groups>
    </HW_Platform>
    <SW_Platform name="SWPlat_1">
        <SW_Components name="SWPlat_1">
            <SW_Component name="SO" type="OS" />
        </SW_Components>
        <SW_Architecture  name="SWArch_1">
            <Repeat number="__NUM_NODES" index="i">
                <SW_Instance name="OS%i" component="SO"
                HW_Resource="node%i" />
            </Repeat>
        </SW_Architecture>
        <Functionality  name="Func_1">
            <Exec_Component name="Coder" category="SW" function="coder_main"
            file="./functions.o" />
            <Exec_Component name="Decoder" category="SW"
            function="decoder_main" file="./functions.o" />
            <Exec_Component name="tun" category="driver" function="tun_init"
            file="./functions.o" />
        </Functionality>
    </SW_Platform>
    <Application>
        <Allocation  name="Alloc_1">
            <Exec_Instance name="_Coder" component="Coder" resource="node0" />
            <Exec_Instance name="_Decoder" component="Decoder"
            resource="node1" />
            <Exec_Instance name="tun0" component="tun" resource="node0" />
            <Exec_Instance name="tun1" component="tun" resource="node1" />
        </Allocation>
        <Allocation  name="Alloc_2">
            <Exec_Instance name="_Coder" component="Coder" resource="node1" />
            <Exec_Instance name="_Decoder" component="Decoder"
            resource="node2" />
            <Exec_Instance name="tun0" component="tun" resource="node0" />
            <Exec_Instance name="tun1" component="tun" resource="node1" />
```

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```
        </Allocation>
    </Application>

    <Simulation time="40 s" >
        <Implementation HW_Components="HWComponents_1" Allocation="Alloc_1"/>
    </Simulation>
</Description>
```

To completely define the platform, some parameters has to be fixed. The required configuration file is:

```
<?xml version="1.0" encoding="UTF-8"?>
<simulator_input_interface xmlns="http://www.multicube.eu/" version="1.0">
    <parameter name="MEM_ADDR" value="0x80000000" />
    <parameter name="NOC_ADDR" value="0x60000000" />
    <parameter name="NUM_NODES" value="2" />
</simulator_input_interface>
```

Once executed, the output obtained in the shell is:

```
                  SystemC 2.2.0 --- May 16 2008 09:54:21
              Copyright (c) 1996-2006 by all Contributors
                          ALL RIGHTS RESERVED
      File: parameter.xml -> (OPENED)
      Loading configuration parameters.
      Configuration parameters loaded.
      File: parameter.xml -> (LOADED)
      File: platform.xml -> (OPENED)
      Loading platform description.
      Platform description loaded.
      Creating platform.
      Platform created.
      File: platform.xml -> (LOADED)
      Simulation time: 40 s
```

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```
Main finish
Simulated time: 40 s


RTOS:  0
        Number of m_processes created:  1
        Number of m_processes destroyed:  1
        Mean process duration (process start - process end):  27.3985 sec
        Last SW execution time:  27.3985 sec
processor_0_rtos_0
        Number of thread switches:  6739
        Number of context switches: 0
        Running time: 27177315700 ns
        Use of cpu: 67.9433%
        Instructions executed: 3667971480
        Instruction cache misses: 1400881
        Core Energy: 7.33594e+09 nJ
        Core Power: 183.399 mW
        Instruction Cache Energy: 1.10599e+10 nJ
        Instruction Cache Power: 276.499 mW
RTOS:  1
        Number of m_processes created:  1
        Number of m_processes destroyed:  1
        Mean process duration (process start - process end):  27.3981 sec
        Last SW execution time:  27.3981 sec
processor_0_rtos_1
        Number of thread switches:  4882
        Number of context switches: 0
        Running time: 3082860608 ns
        Use of cpu: 7.70715%
        Instructions executed: 415470102
        Instruction cache misses: 393756
        Core Energy: 8.3094e+08 nJ
        Core Power: 20.7735 mW
        Instruction Cache Energy: 1.26216e+09 nJ
        Instruction Cache Power: 31.554 mW
```

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9.- Glossary

Application Programing Interface (API): Set of routines, data structures, object classes and/or protocols provided by libraries and/or operating system services in order to support the building of applications.

Approximately timed: Modeling style for which there exists a one-to-one mapping between the externally observable states of the model and the states of some corresponding detailed reference model such that the mapping preserves the sequence of state transitions but not their precise timing.

Computing group: Group of computing elements, usually processors, organized to work cooperatively, emulating a more powerful single computing unit. The elements of the computing group work controlled by a single operating simple and usually in a symmetric way.

Design Space Exploration (DSE): Process that explores all the system design possibilities in order to obtain an optimal design.

Extensible Markup Language (XML): General-purpose specification for creating custom markup languages. It is classified as an extensible language, because it allows the user to define the mark-up elements. XML's purpose is to aid information systems in sharing structured data, especially via the Internet, to encode documents, and to serialize data.

HW platform: Group of HW components working together that provides the required support to the SW components and provided the required specific functionality required to perform the required application(s).

HW/SW partition: Process of dividing the system functionality in SW and HW components.

Instruction Set Simulator (ISS): Simulation model, usually coded in a high-level programming language, which mimics the behavior of a mainframe or microprocessor by "reading" binary instructions and maintaining internal variables which represent the processor's registers.

Metric: Set of units which can be used to specify anything which can be measured, along with the procedures to carry out measurements and the procedures for the interpretation of the assessment in the light of previous or comparable assessments.

Metric Definition file: XML file listing the system metrics the simulation must measure and report.

Network on Chip (NoC): Is a new approach to System-on-a-chip (SoC) design. NoC-based systems can accommodate multiple asynchronous clocking that many of today's complex SoC designs use. The NoC solution brings a networking method to on-chip communication and brings notable improvements over conventional bus systems

Node: Active electronic device or group of devices attached to a network, and capable of sending, receiving, or forwarding information over a communications channel. A node is a connection point, either a redistribution point or a communication endpoint.

Platform: Sort of hardware architecture or software framework (including application frameworks), that allows software to run. Typical platforms include a computer's architecture, operating system, programming languages and related runtime libraries or graphical user interface.

Real-Time Operating System (RTOS): Multitasking operating system intended for real-time applications. Such applications include embedded systems , industrial robots, spacecraft, industrial control, and scientific research equipment. A

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RTOS facilitates the creation of a real-time system, but does not guarantee the final result will be real-time; this requires correct development of the software. Key factors in an RTOS are therefore a minimal interrupt latency and a minimal thread switching latency.

SW platform: Group of generic SW components used to provide the required support to the SW applications.

System Configuration file: XML file defining the values required for the system configuration parameters to perform a simulation.

System Descriptions file: XML file describing the system. It contains a description of the HW platform, SW platform and SW application.

System Metrics file: XML file where the obtained estimation for the system metrics are reported.

SystemC: Set of library routines and macros implemented in C++, which makes it possible to simulate concurrent processes, each described by ordinary C++ syntax. Instantiated in the SystemC framework, the objects described in this manner may communicate in a simulated real-time environment, using signals of all the datatypes offered by C++, some additional ones offered by the SystemC library, as well as user defined.

SCoPE: SystemC framework for system modeling based on approximately (loosely) timed descriptions of the system components.

Timed simulation: Simulation performed using timed models of the system components. The resulting simulation considers both the system functionality and the associated timing.

Transaction-Level Modeling (TLM): High-level approach to modeling digital systems where details of communication among modules are separated from the details of the implementation of functional units or of the communication architecture. Transaction requests take place by calling interface functions of these channel models, which encapsulate low-level details of the information exchange. Communication mechanisms are modeled using channels, such as busses or FIFOs.

TLM2: The second major version of the OSCI Transaction Level Modeling standard.

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