2nd ESA Workshop on Astrophysics

Fred van Lieshout – Dutch Space B.V.
Introduction

- History
- What is EuroSim?
- Scope
- Applications
- EuroSim simulator development life cycle
History

- Initially developed by Dutch Space (Fokker Space).
- On-going development as joint effort by EuroSim consortium partners:
  - Dutch Space,
  - NLR,
  - Atos Origin.
- Early releases only available on IRIX (SGI) platform.
- Port to Linux and Windows NT platforms.
What is EuroSim?

- A set of tools that support all phases of space and non-space programs through real-time simulations
- Supports person and/or hardware-in-the-loop
- Allows re-use of existing model software
Scope

Users

EuroSim Tools

Application Model SW

EuroSim SW Libraries

Operating System & Device Drivers

Computer Hardware

Man in-the-loop

Configurable Operator Deck

Hardware in-the-loop

GUI

API
Applications

- Mission Preparation and Training Equipment (MPTE) for the European Robotic Arm (ERA)
- Automated Transfer Vehicle (ATV) Test Facilities
- Grid assist (OASE)
- Herschel/Planck
- Virtual Spacecraft Reference Facility (VSRF)
- European Drawer Rack (EDR)
- And many more… (see www.eurosim.nl)
Simulator development life cycle

Model code

Dictionary

Model Editor

Schedules

Schedule Editor

Simulation

Simulation Controller

Results

Test Analyzer

Development

Preparation and Execution

Analysis

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What is a Model

Model Editor window

Organizational nodes
File nodes
Variable nodes
Entry nodes
Logging Window

File properties

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Editing the API

- Parameter indicator
- Minimum and Maximum bounds
- Unit
- Initial value in source
- Description field
- API selector
- Output of source parsing
Simulator Development Tasks
Part 4: defining schedule

Create model framework

Attach files to framework

Include API calls

Identify API items

Create Schedule
- defining tasks from API entry points
- combining tasks with timing information and events

Build simulator

Define schedule

Purpose:
- achieve Real-Time, parallel Simulation
- achieve requested changes in Simulator State

Build tasks

Create Schedule
Scheduling Tasks and Simulation States

EuroSim States and Transitions

Steady States

Transition States

Relations between states, triggers and scheduling graphs

<table>
<thead>
<tr>
<th>state</th>
<th>trigger</th>
<th>activated scheduling graph</th>
</tr>
</thead>
<tbody>
<tr>
<td>standby</td>
<td></td>
<td>standby</td>
</tr>
<tr>
<td>executing</td>
<td></td>
<td>executing</td>
</tr>
<tr>
<td>init</td>
<td></td>
<td>initialising</td>
</tr>
<tr>
<td>stop</td>
<td></td>
<td>exit</td>
</tr>
<tr>
<td>reset</td>
<td></td>
<td>exit, followed by initialising</td>
</tr>
</tbody>
</table>
Predefined input events:
- External Interrupt
- Notice
- Warning
- Error
- Fatal
- State Entry
- State Exit
- RT error
- RT mode entry
- NRT mode entry

Predefined output events:
- Initialize
- Pause
- Go
- Abort
- Reset
- Stop
- Quit
- RT mode
- NRT mode

Schedule Editor Window: Initializing State
Scheduling of Tasks

Task:
- zero or more entry points

Timers

External event

Asynchronous Store

Frequency changer

Task: zero or more entry points
Task Characteristics

Task Dialog Window

API Entrypoints

List of Entrypoints in task

Re-ordering

Derived from schedule

List of Entrypoints

in task

Data Dictionary

TaskName: thermoDynamics

Processor: Any

Priority: Moderate

Preemptable: Yes

Allowed duration: 20 ms

Period: 20 ms

Deadline: 

Statistics

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Min</th>
<th>Mean</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Running</td>
<td>0</td>
<td>0</td>
<td>0 (estimated)</td>
</tr>
<tr>
<td>Blocked</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Preempted</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Duration</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Offset</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Finished</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Errors: No error
Scheduler Timing

Schedule Configuration:
Frequency 200Hz
Processors: 3

Processor

P1
Real time

P2

P3
Non Real time

P0

Basic Cycle (5ms)

100Hz/10ms
2Hz/15ms

Internal Event

External Event
Test preparation and execution

Model code

Project Management

Dictionary

Model Editor

Schedules

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Simulation Controller

Simulation results

 executable

Test Analyzer

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Test Preparation and Execution tasks

Create empty mission

Reference to a model

Reference to a schedule

Define Actions

Define MMI

Define Init condition

Executing

Link to model definition (API)

To run a simulation

Initial state of the model

• Recording
• Stimuli
• Scripts

Init condition

MMI

Define

Recording
Stimuli
Scripts

Ref to a model

Create empty mission

Ref to a model
Simulation Controller Overview

Execution Controls

Various Tab Pages

Input Files tab page: for Simulation definition

The Message Pane

Simulation Controller overview: Input Files tab page

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Scenarios: Creating MDL scripts

Script Action Editor (ref: SUM Appendix E Model Definition Language)
Recorders

Recorder Action Editor

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Stimuli files

**.stim file**

**.rec file**

**stimuli**

**time** | **data**
--- | ---
0.9 | 10
1.9 | 15
2.9 | 17
3.9 | 19
4.9 | 20
5.9 | 18

**simtime Z**

at 0.5 Hz

<table>
<thead>
<tr>
<th>simtime</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>6</td>
<td>19</td>
</tr>
</tbody>
</table>

**soft**

**hard**
Creating Monitors and MMI’s (MMI tab page)

.mmi file

MMI tab page

(on-line) Monitors

Run-time messages window

MMI tab page
Simulation Execution

- **Stimuli Data Files**
- **Heater = off**
- **On-Line Interactions**
  - raise heater failure
- **Simulation**
- **DataDict**
- **Schedule**
- **Simulator**
  - init
  - reset
  - go
  - pause
  - stop
  - abort
- **On-Line Monitoring**
- **Data Recording**

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Slide 22
Output files

During a simulation run files are generated:

- Journal File
- Timings file
- Recording file(s)
- Test result file

Created in directory with a name like 2002-07-18/23:33:17, which includes the date and time of simulation run.
Test Analysis

Project Management

Model code

dictionary

schedules

executable

Schedule Editor

Model Editor

Simulation Controller

Test Analyzer

Development

Preparation and Execution

Analysis

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Test analysis

Simulator

Index File

* .tr

Filename Variable
celltemp.rec /simulation_time
celltemp.rec /Hardware/thermo.f/thermo$celltemp

Data Files

* .rec

# EuroSim recording file
Version: Mk3-rev0
Date recorded: Fri-Jul-19-12:03:21-MDT-2002
Mission: ../../thermo.mdl
Record size: 56
Dict: ../../thermo.IRX64/thermo.dict
SimTime: /simulation_time
TimeFormat: relative
Number of variables: 2
/simulation_time: struct timespec
/ Hardware/thermo.f/thermo$celltemp: float[3][4]

Journal File

/2002-07-19/12:03:021/EsimJournal

====================================
Sim: thermo.sim
User: qw75503, Test Conductor
Simulation: non realtime
Hostname: troi
Date of test: Fri Jul 19 12:03:21 MDT 2002
====================================

/projects/spades/users/quirien/EUROSIMCURSUS/EfoCourse/model/thermo.IRX64/thermo.dict with loader values
startup message: async-main applying default settings from datadict: "thermo.dict"
startup message: async-main applied initial condition file:
"/projects/spades/users/quirien/EUROSIMCURSUS/EfoCourse/model/thermo.init" no comment
"/projects/spades/users/quirien/EUROSIMCURSUS/EfoCourse/model/thermo.mdl"
Test Analysis Tools, Test Analyzer:

Create Plot file: *.plt

PLOTTING:
• PV-Wave
• GNU plot

Test Analyzer main window

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Test analysis results

gnuplot

PV-WAVE
Questions?

More info: www.eurosim.nl