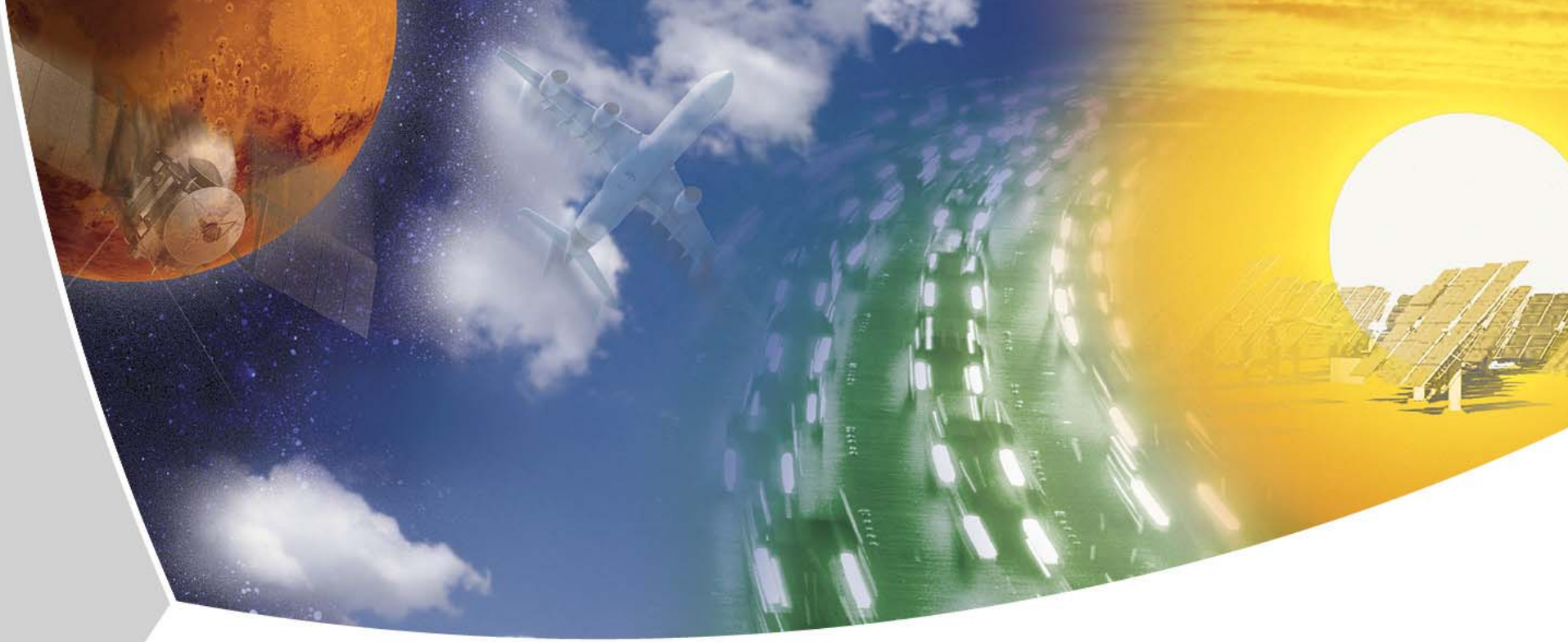


DLR's Virtual Satellite Approach

Holger Schumann
DLR - Simulation and Software Technology
SESP 2008, 07.10.08

Deutsches Zentrum
für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

Outline

- Motivation
- The Virtual Satellite Project
  - Implementation
    - Data Model
    - Basic Framework RCE
    - System Component Repository
    - System Editor
    - Automation and Analysis Environment
  - Experiences with SMP2 and SIMSAT
- Conclusions

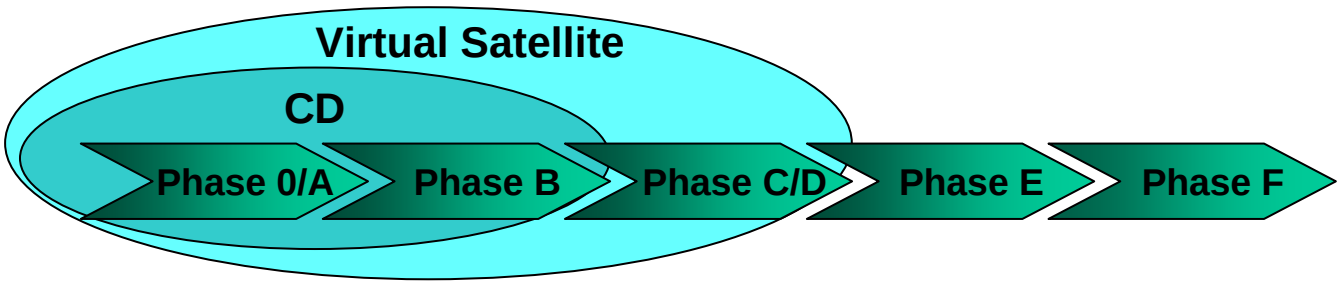
Motivation

- Decision for starting a DLR compact satellite program in 2007
  - Series of 100 kg satellites
  - Based on a generic reusable standard satellite bus (SSB)
  - AsteroidFinder first mission
    - Detection of inner Earth objects (IEOs)
    - Launch around end of 2011
  - Caused by successful DLR BIRD satellite and OOV-TET
- Founding of the Institute for Space Systems
  - Founding of the Concurrent Engineering Facility (CEF)
- Need for a simulation-based development process for satellites identified
  - Virtual Satellite project


CEF

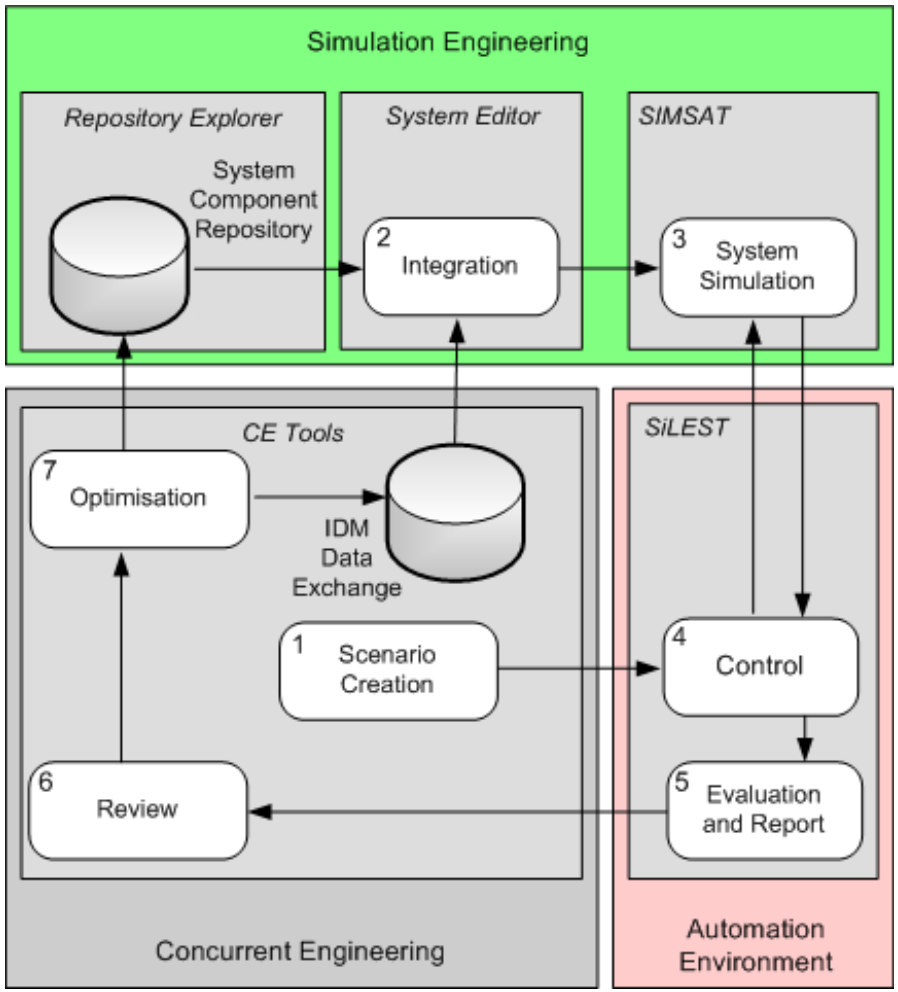
The Virtual Satellite Project
Overview

- Objectives
  - Evaluation of a suitable system description language
  - Definition of a system design model
  - Creation of a central System Component Repository for reuse of models
  - Support for a rapid system simulation generation
  - Application in DLR's compact satellite program using the CEF
- Scheduled for 2007 – 2009
- Budget nearly 1000 kEur



The Virtual Satellite Project

Overview of process and supporting tools



Implementation
Data Model

- Requirements
  - Unique central data model for all phases
  - IDM and ECSS E-TM-10-25A compatible
  - Parameter assigned to System Components (object orientation)
  - Hierarchy of System Components (derivation and composition)
  - References to files (e.g. SMP2 binaries)
  - Design options, projects, versioning

- Implementation based on work of the Technical University Munich (Institute of Astronautics)

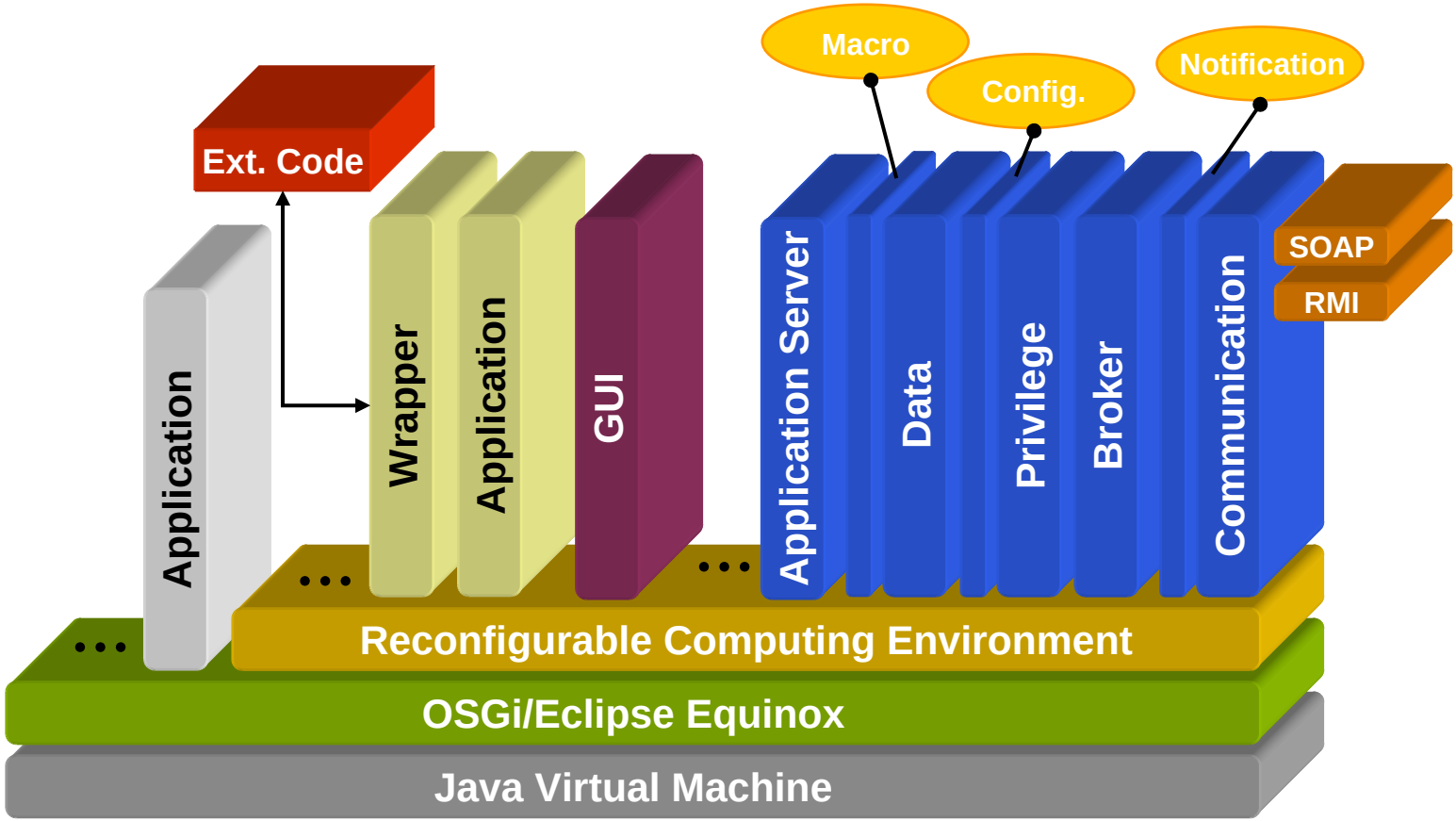
Implementation
Basic Framework RCE

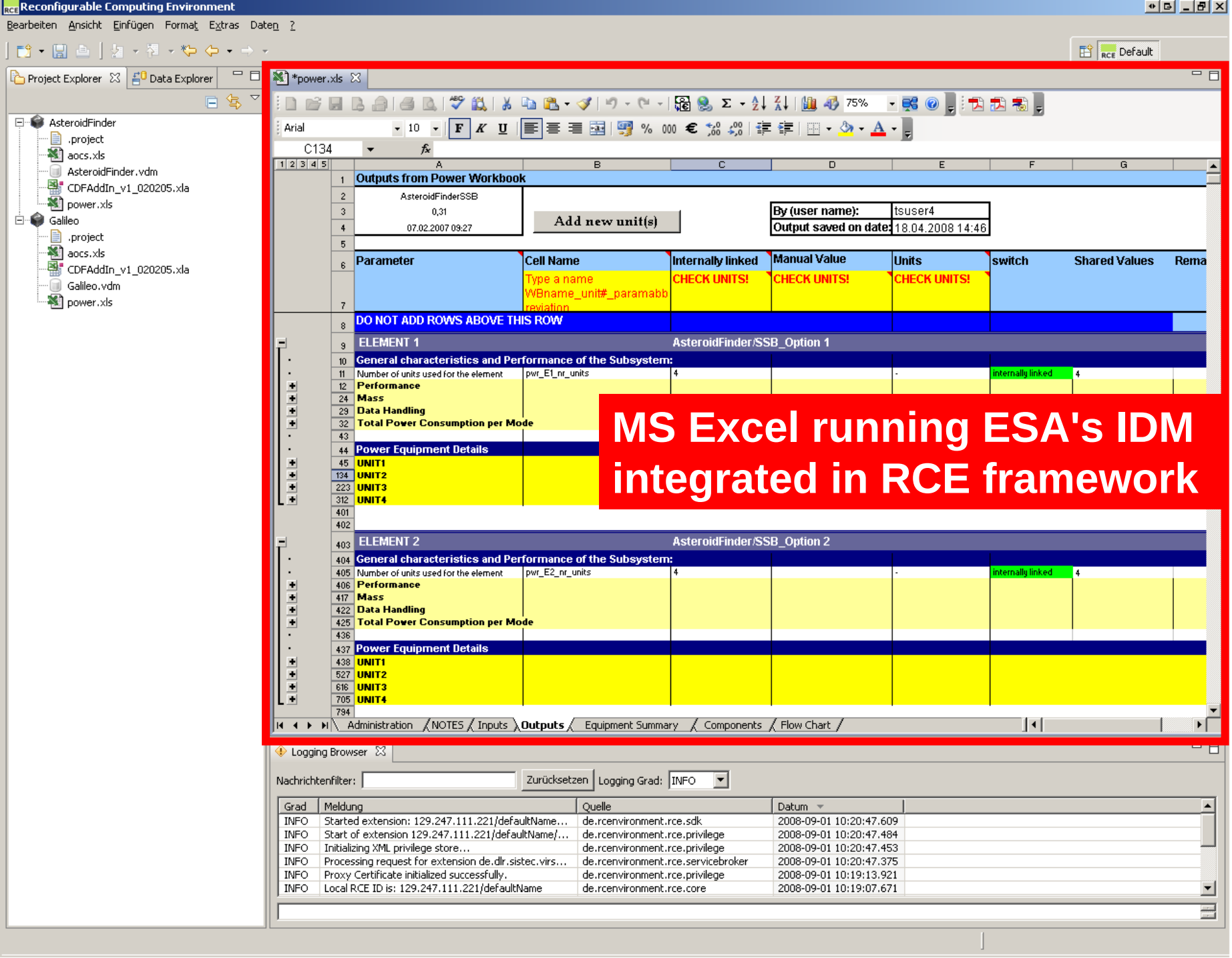
- Many projects need similar software components
  - Data management, graphical user interface, distributed computing, service-oriented communication, …

- Reinventing basic software components each time is a waste of time
  - Idea: Use a general purpose integration platform

- **Reconfigurable Computing Environment (RCE)**
  - "Standing on the shoulders of giants."
    - based on OSGi and Eclipse
  - Developed by Simulation and Software Technology, DLR
  - Prepared to achieve objectives of ESA's OCDS project

Implementation
Basic Framework RCE




Reconfigurable Computing Environment
Bearbeiten Ansicht Einfügen Format Extras Daten ?
Default
Project Explorer
Data Explorer
AsteroidFinder
.project
aocs.xls
AsteroidFinder.vdm
CDFAddIn_v1_020205.xla
power.xls
Galileo
.project
aocs.xls
CDFAddIn_v1_020205.xla
Galileo.vdm
power.xls
*power.xls
Outputs from Power Workbook
AsteroidFinderSSB
0,31
07.02.2007 09:27
Add new unit(s)
By (user name): tsuser4
Output saved on date: 18.04.2008 14:46
Parameter
Cell Name
Internally linked
Manual Value
Units
switch
Shared Values
Type a name WBname_unit#_paramabbreviation
CHECK UNITS!
DO NOT ADD ROWS ABOVE THIS ROW
ELEMENT 1
AsteroidFinder/SSB_Option 1
General characteristics and Performance of the Subsystem:
Number of units used for the element
pwr_E1_nr_units
internally linked
Performance
Mass
Data Handling
Total Power Consumption per Mode
Power Equipment Details
UNIT1
UNIT2
UNIT3
UNIT4
ELEMENT 2
AsteroidFinder/SSB_Option 2
pwr_E2_nr_units
Administration
NOTES
Inputs
Outputs
Equipment Summary
Components
Flow Chart
MS Excel running ESA's IDM integrated in RCE framework
Logging Browser
Nachrichtenfilter:
Zurücksetzen
Logging Grad: INFO
Grad
Meldung
Quelle
Datum
INFO Started extension: 129.247.111.221/defaultName... de.rcenvironment.rce.sdk 2008-09-01 10:20:47.609
INFO Start of extension 129.247.111.221/defaultName/... de.rcenvironment.rce.privilege 2008-09-01 10:20:47.484
INFO Initializing XML privilege store... de.rcenvironment.rce.privilege 2008-09-01 10:20:47.453
INFO Processing request for extension de.dlr.sistec.virs... de.rcenvironment.rce.servicebroker 2008-09-01 10:20:47.375
INFO Proxy Certificate initialized successfully. de.rcenvironment.rce.privilege 2008-09-01 10:19:13.921
INFO Local RCE ID is: 129.247.111.221/defaultName de.rcenvironment.rce.core 2008-09-01 10:19:07.671

Implementation
System Component Repository

- Objectives
  - Storage of simulation models and collection of DLR knowledge
  - Provision of ready-to-use SMP2 model binaries
- Composition of a System Component
  - Platform independent description (UML or Catalogue)
  - Further metadata (version, parameter constraints, usage history)
  - Implementations (SMP2 binaries)
  - Source Code (C++, Simulink, Modelica)
  - Assembly for components containing a system
- Repository Explorer tool
  - Browsing of components, provision of information and binaries
  - Management of repository (add components, import catalogues)

Implementation
System Editor

- Objectives
  - Creation of an interdisciplinary system model (according to IDM)
  - Provision of a simulink-like editor for assembling System Components (interaction with Repository Explorer)
  - Creation of an SMP2 simulation (Assembly, Schedule, simulation architecture)

- Implementation using modern Eclipse technologies (Ecore, EMF, GMF)

Implementation
Automation and Analysis Environment

- Objectives
  - Support of formal definition of operation scenarios (simulation inputs and expected outputs)
  - Initialisation and control of simulation as well as fetching results
  - Automated evaluation of results and report generation

- **SiLEST (Software-in-the-Loop for Embedded System Test)**
  - Nationally funded project, successfully finished in 2006
  - Output: Simulation-based test process for embedded systems (e.g. satellites), supporting tools
  - Professionally applied by IAV GmbH (automobile industry), TU Berlin (research), and DLR

Experiences
with SMP2 and SIMSAT

- SIMSAT MIE
  - Very useful to understand SMP2 (rules-based validation)
  - Not applicable to our engineers
  - Graphical editor for assemblies/schedules needed
  - Maturity of user interface improvable
- SIMSAT code generator
  - Generation of Makefiles very useful
  - Merge feature very useful, but improvable
- SMP2
  - Usage of several Assemblies, Schedules and binaries allowed
  - Problems with inter model communication (interface-based, component-based), Resolver service worked fine

Conclusions

- Simulation-based design and development process defined
- Supporting tools based on DLR's RCE framework partly implemented
- IDM and ECSS compatibility preserved
- SMP2 used for supporting portability and reusability
- Application in DLR's compact satellite program using the CEF