ECSS-E40-Demonstration Simulator

Presenting E40 Demo Sim for SESP 2008

Presented by:

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Project Overview

- The main activities of the ECSS E-40-07 Demonstration Simulator are:
  - ⇨ Take Virtual Spacecraft Reference Facility models (mixture of C/C++ and Matlab) and port to SMP2
  - ⇨ Port the architecture (model integration) and update to demonstrate SMP2
  - ⇨ Porting configuration data from VSRF
  - ⇨ Regression Testing of SMP2 simulator based on original VSRF test on each of the three different infrastructures
  - ⇨ Produce SMP2 Demonstration Scenarios
  - ⇨ Provide Demonstration Kit

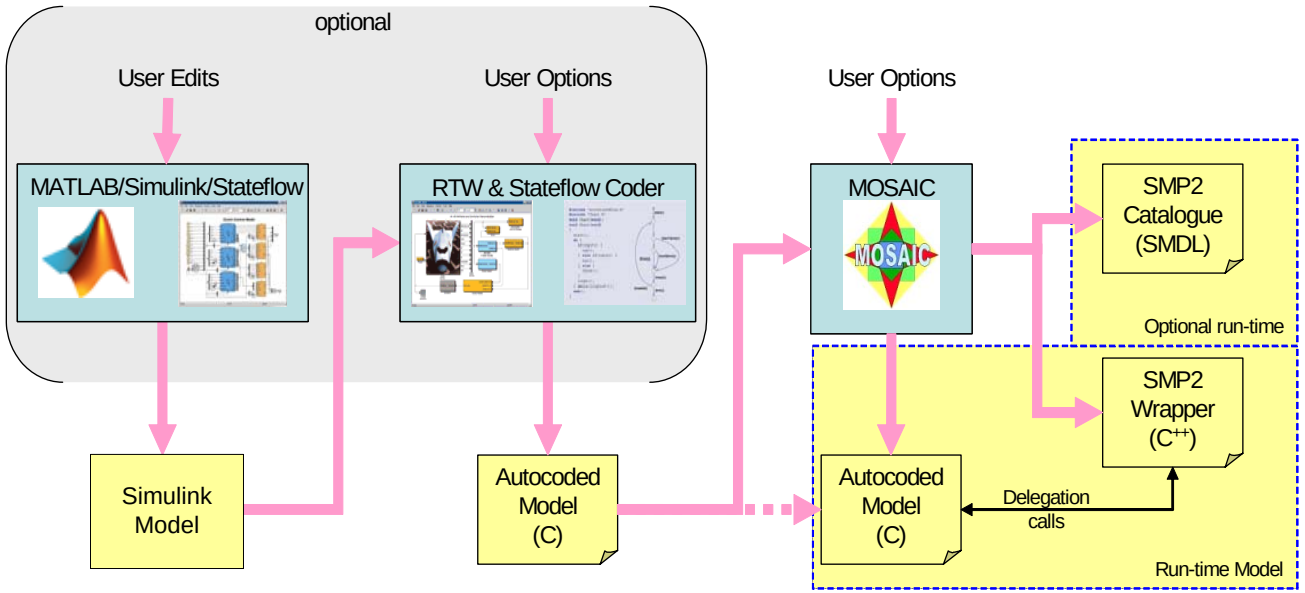
Porting VSRF models to SMP2

- The model porting activity involves taking the existing VSRF models and converting them to SMP2.

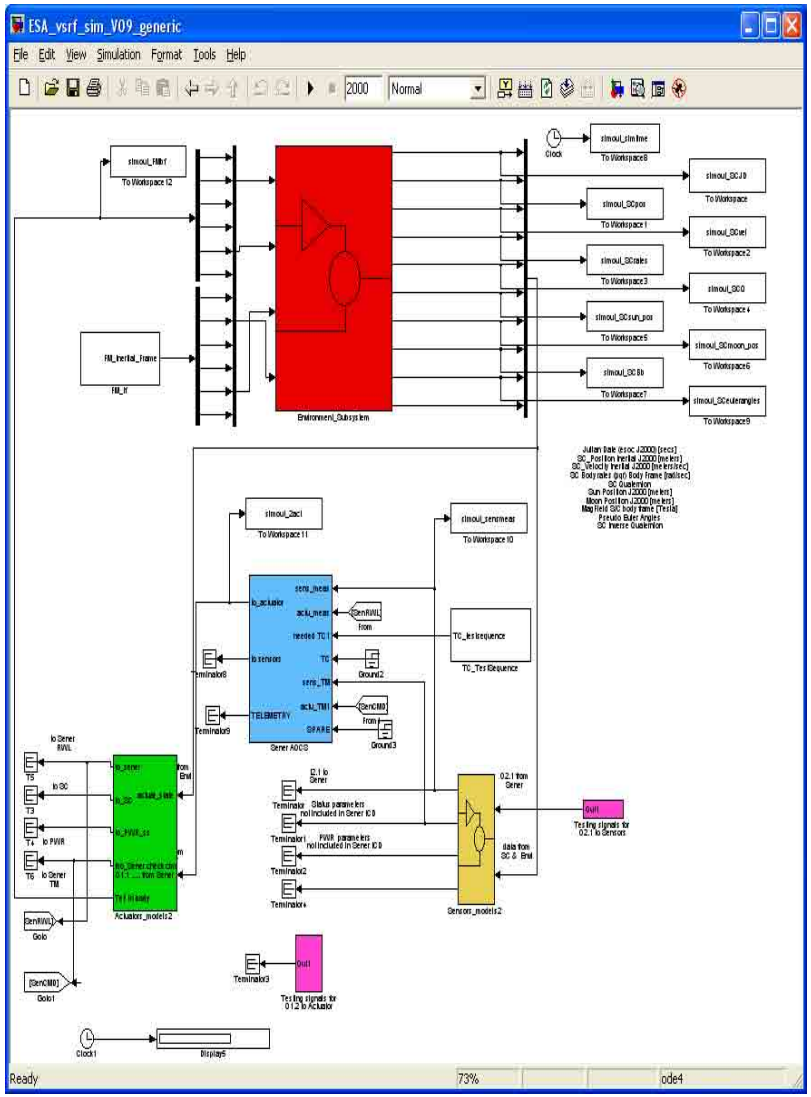
Model Category	Model Type	Model Source	Schedule Frequency	Impl. Type
Environment Models	Spacecraft Orbit and Environment	FVB	4 Hz	C++
Space Segment Models	Power Generation Storage and Distribution	FVB	4 Hz	C
	Body Dynamics	FVB	4 Hz	C++
	Thermal	FVB	4 Hz	C
	Communications	FVB	4 Hz	C
	Payload Model "GoldenEye"	FVB	4 Hz	C
	AOCS OBS	FVB	4 Hz	C
	OBDH	FVB	4 Hz	C
Sensors and Actuators	Star Tracker	AFS	100 Hz	MATLAB
	Sun Sensor	AFS	100 Hz	MATLAB
	Magnetometer	AFS	100 Hz	MATLAB
	Gyro	AFS	100 Hz	MATLAB
	GPS	AFS	100 Hz	MATLAB
	Reaction Wheel	AFS	100 Hz	MATLAB
	Magnetorquer	AFS	100 Hz	MATLAB
	Thrusters	AFS	100 Hz	MATLAB

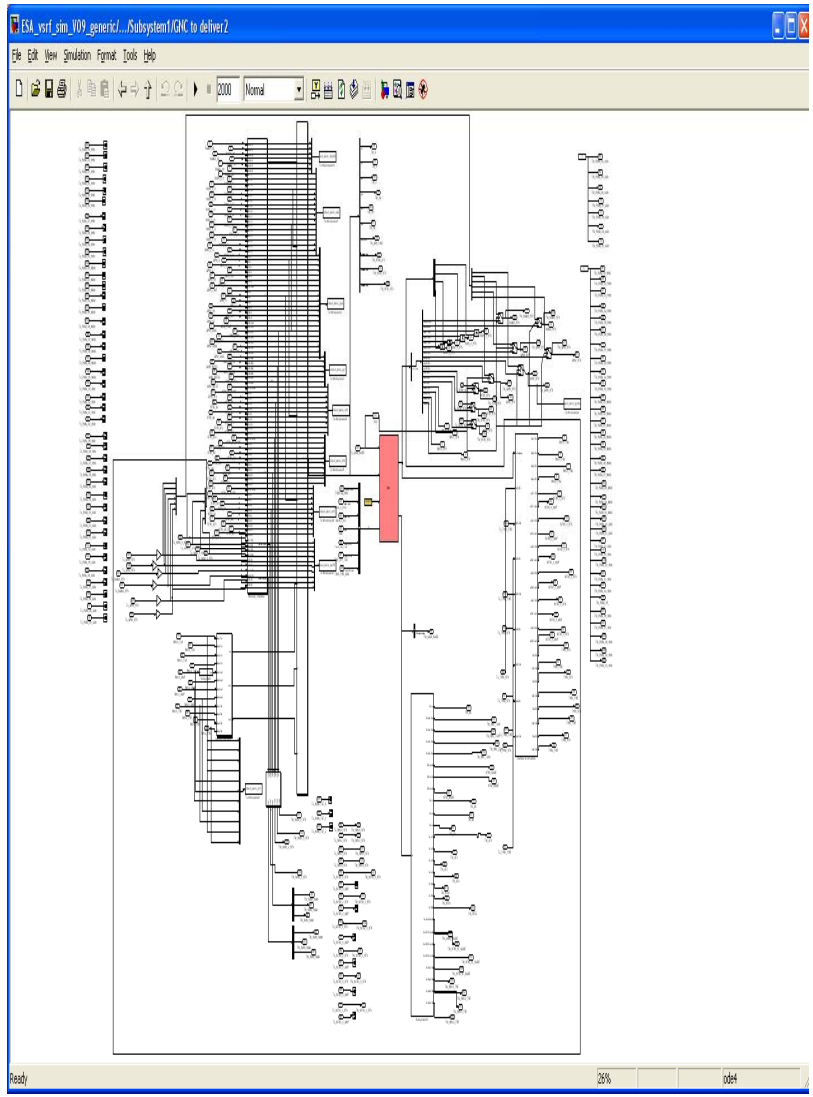
Porting MATLAB/Simulink models to SMP2

- Using the RealTimeWorkshop and Stateflow Coder.
- MOSAIC 7.1 is used to generate both SMP2 C++ wrappers and model catalogues for each model.

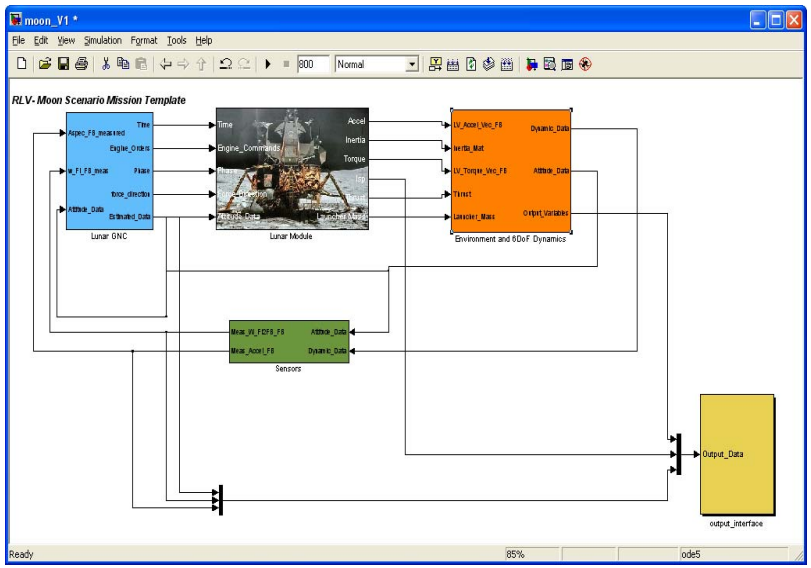


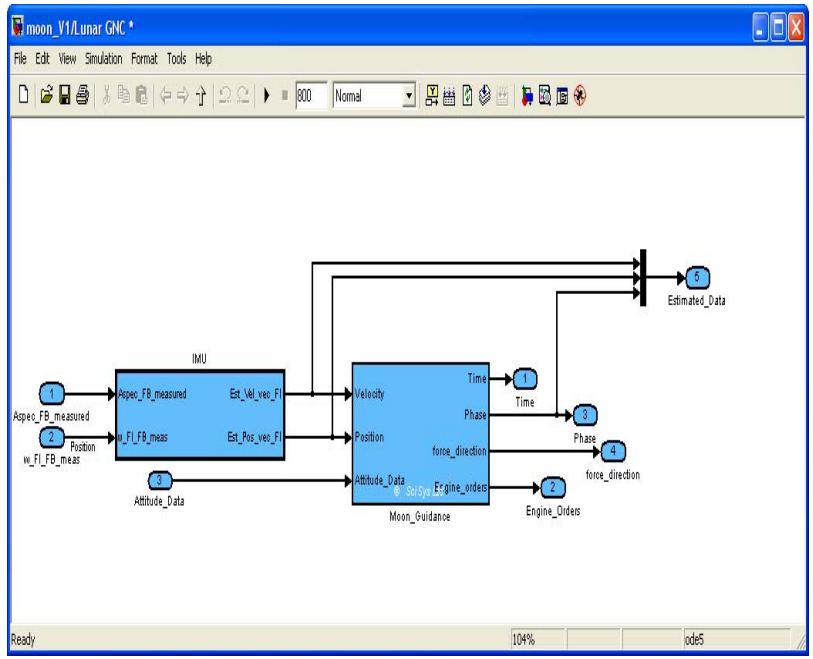
Simulink VSRF



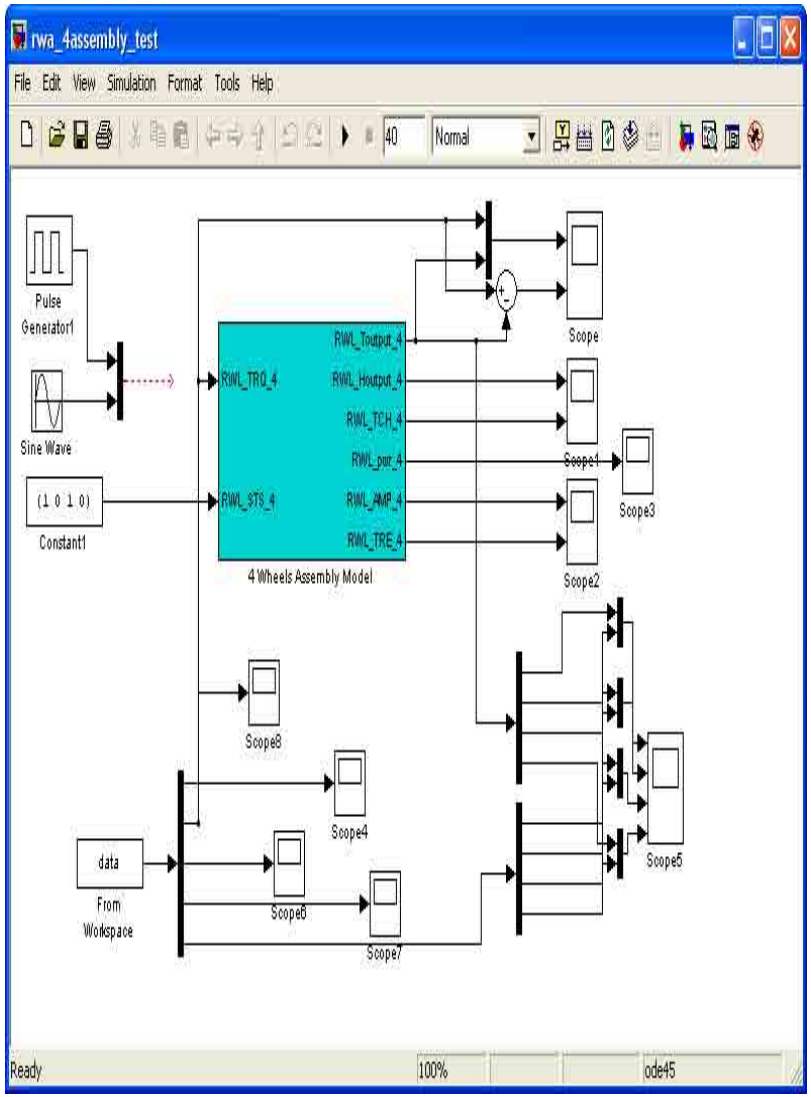


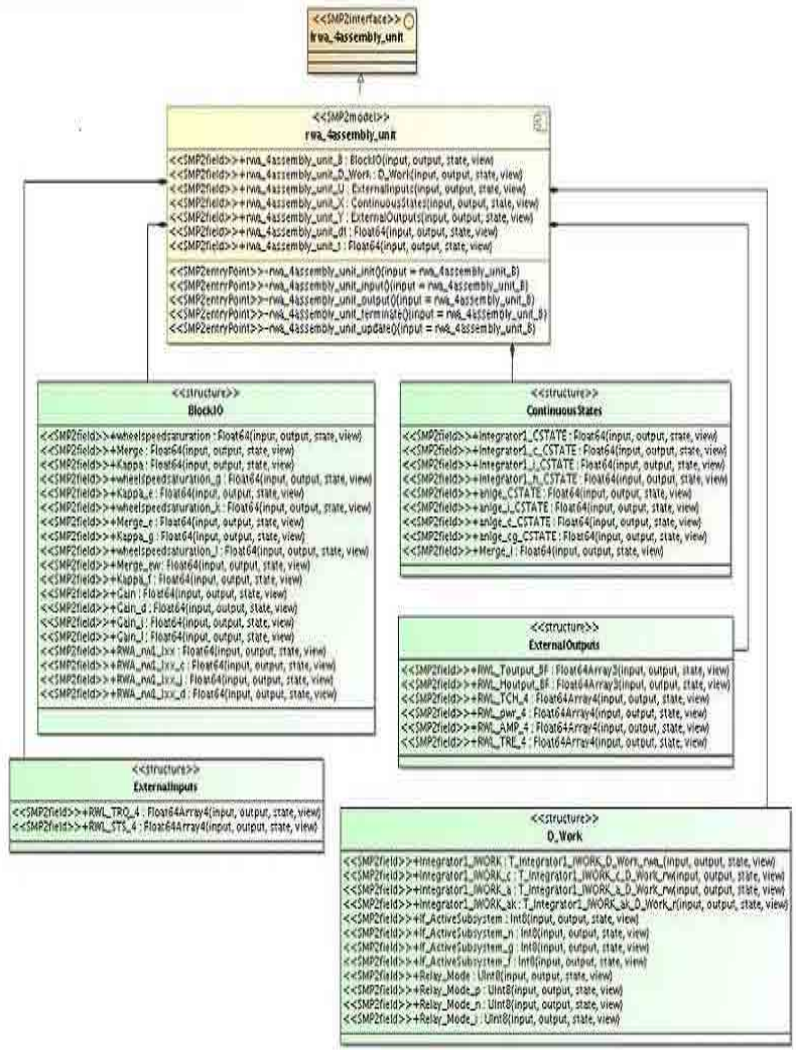
Tidy Simulink





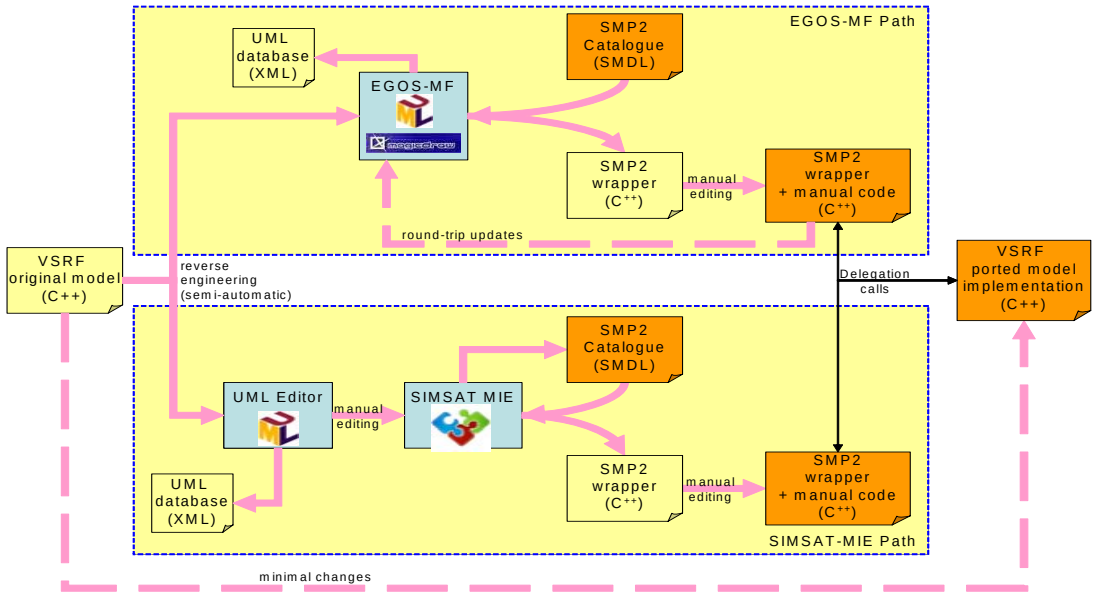
Example Porting Reaction Wheel





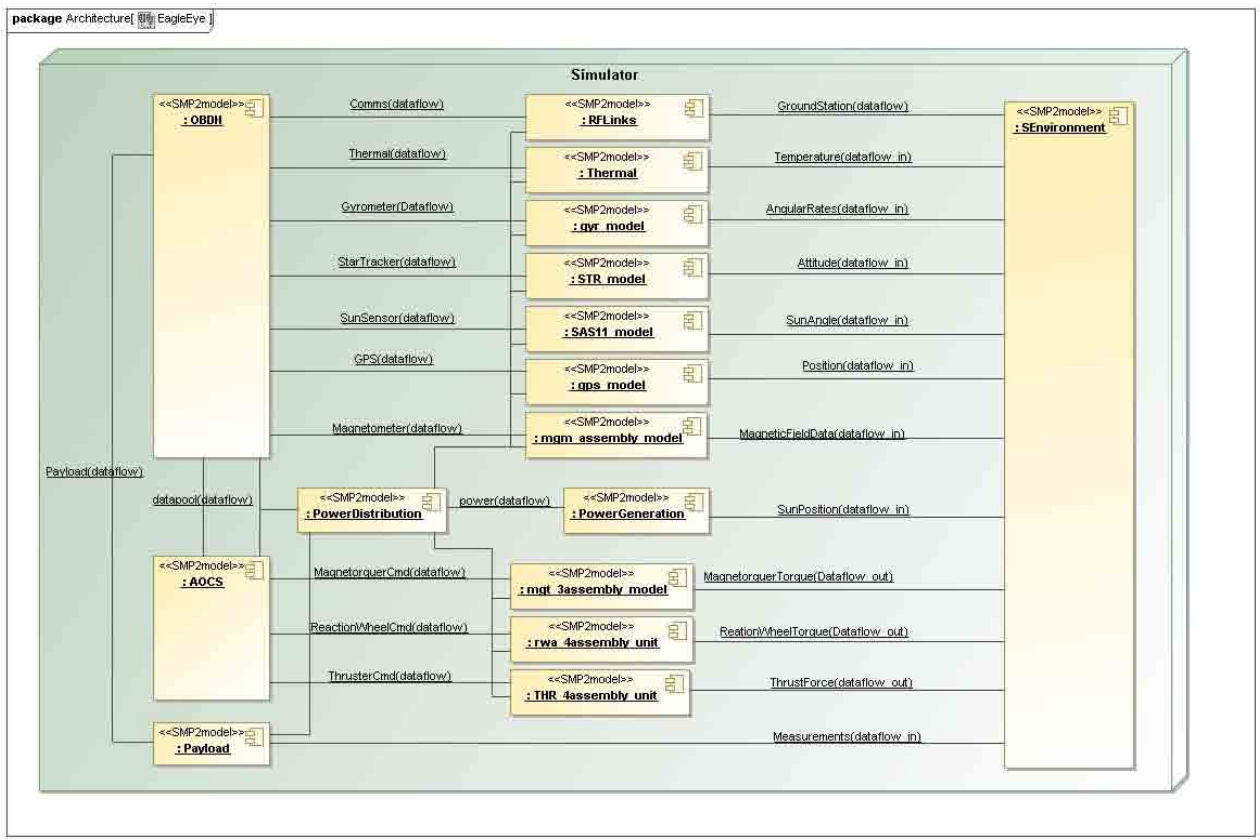
Porting C\C++ Models

- The C++ model porting approach involves the following steps:
  - ⇨ Reverse engineering C++ header files into the EGOS MF (Eclipse with MagicDraw UML Plugin),
  - ⇨ Adding SMP2 specific stereotypes to model components ,
  - ⇨ Exporting the design as an SMP2 catalogue
  - ⇨ Loading the catalogue into the SIMSAT4 MIE and auto-generating SMP2 C++ wrappers using the SIMSAT4 MIE code generator.
  - ⇨ Adding code manually to delegate SMP2 wrapper calls to the underlying VSRF C++ classes.



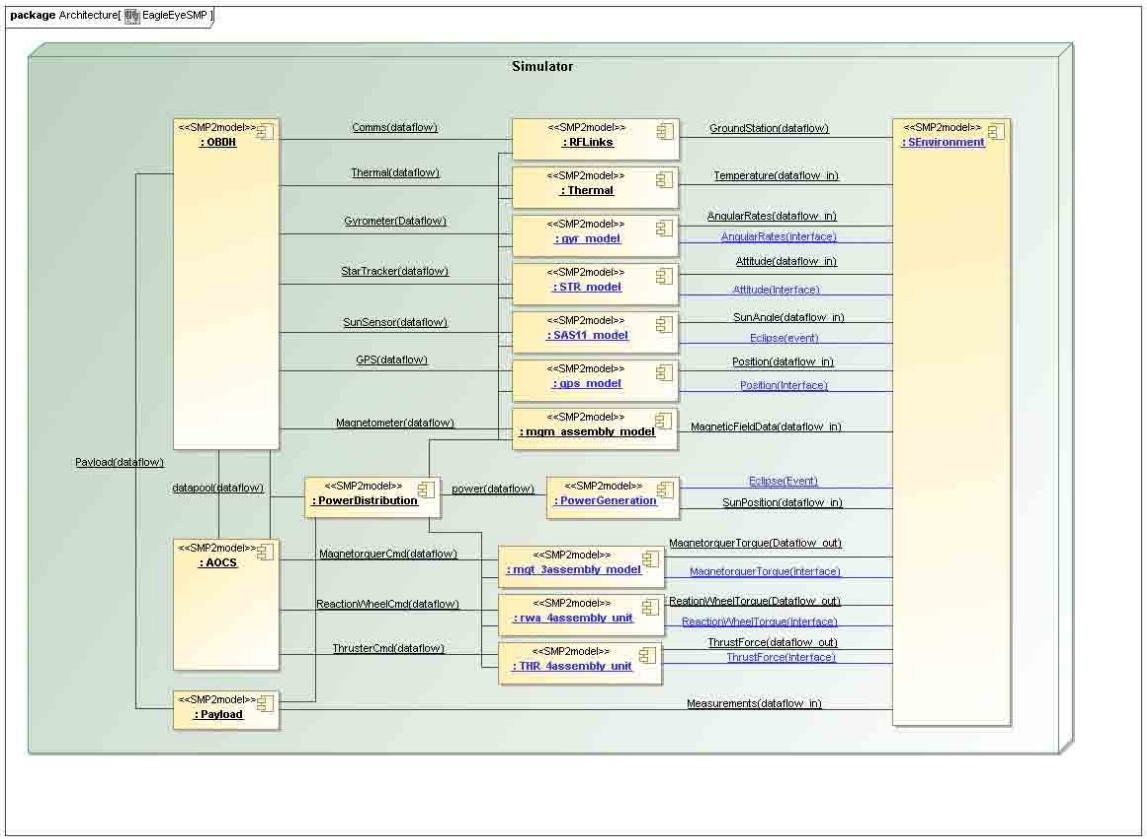
Integrating Models

- The top level architecture activity involves
  - ⇨ Recreating the VSRF architecture in SIMSAT-MIE (assembly) according to the original implementation (Dataflow design) and ported SMP2 catalogues...



Updating Architecture

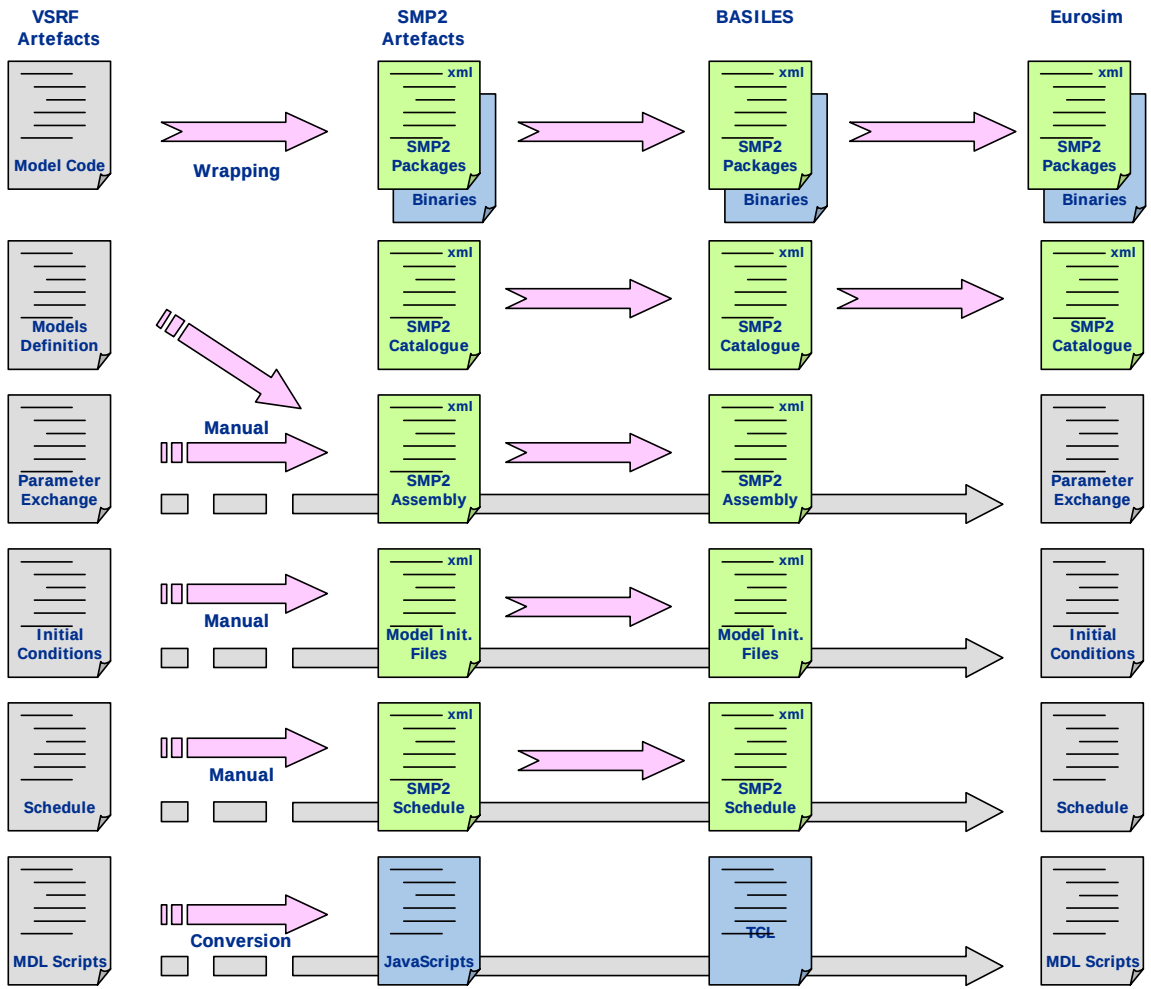
- ... Updating the architecture to show additional SMP features that are to be implemented and demonstrated (Dataflow, Event and Interface based design).



Configuration Data Porting

- The configuration data files to be converted will come from a representative Eagle Eye VSRF test case that exercises all VSRF models. The conversion process can be summarised as:
  - ⇨ Convert the FVB configuration of the VSRF and the EuroSim parameter exchange file to an SMP2 assembly file
  - ⇨ Convert the EuroSim Schedule file\Parameter Exchange File to an SMP2 Schedule file
  - ⇨ Convert the EuroSim Initial Condition files to JavaScript (SIMSAT) (or in the SMP2 assembly when not specific to a single simulation test.)
  - ⇨ Convert the EuroSim Initial Condition files to TCL (BASILES) (or in the SMP2 assembly when not specific to a single simulation test).
  - ⇨ Convert the EuroSim runtime MDL scripts to JavaScript (SIMSAT)
  - ⇨ Convert the EuroSim runtime MDL scripts to TCL (Basiles)
- Data conversions have been thus far performed manually.

Configuration Data Porting



Testing of SMP2 VSRF on three different infrastructures

- Ported VSRF models will be executed in three different simulation infrastructures:
  - ⇨ EuroSim (only dataflow port)
  - ⇨ SIMSAT 4
  - ⇨ Basiles
- Infrastructure conformance to SMP2 standards

Conformance	Feature	BASILES	EUROSIM	SIMSAT-4
Level 1				
	Catalogue	✓	✓	✓
	Package	N/A[a]	N/A[b]	✓
Level 2				
	Catalogue	✓	✓	✓
	Assembly	✓	×	✓
	Data Flow Model Links	✓	✓	✓
	Event Model Links	✓	×	✓
	Interface Model Links	✓	×	✓
	Schedule	✓	×	✓
Auxiliary Data				
	Scripts	Tcl	MDL ASCII	JavaScript
	Initialisation Data	Tcl	Binary/Text	JavaScript
	Runtime Data Files	Text/Binary[c]	Text/Binary[c]	Text/Binary[c]
	Save/Restore data	BASILES Binary	EuroSim Binary	SIMSAT Binary/XML
	Output Data Files	Text/Binary[c]	Text/Binary[c]	Text/Binary[c]

Demonstration Scenarios

- Demonstrations scenarios include the following SMP2 features:
  - ⇨ Catalogue and source file exchange between platforms (EuroSim(Windows) and BASILES \ SIMSAT)
  - ⇨ Assembly reconfiguration (BASILES \ SIMSAT)
  - ⇨ Schedule Reconfiguration (BASILES \ SIMSAT)
  - ⇨ Binary Model Exchange (BASILES and SIMSAT)
  - ⇨ Interface Links (BASILES \SIMSAT)
  - ⇨ Event Links (BASILES \SIMSAT)
  - ⇨ Use of Models from Different Libraries. (BASILES \SIMSAT\EuroSim)
- Model upgrade from dataflow based to interface and event based.

Demonstration Kit

- A dedicated laptop to run the E40 Demo Sim.
- Installation of SIMSAT, BASILES and EUROSIM.
- Demonstration of each scenario on each platform.
- Installation and training is combined in a single easy to use session consisting
  - ⇨ Demonstration Simulators
  - ⇨ PowerPoint presentation describing the Demonstration Simulators and how to run the demonstration scenarios.
  - ⇨ Demonstration scenarios for each simulation infrastructure

Summary

- Starting with VSRF, ported models and data to SMP2
- Regression tested against original VSRF test cases
- Demonstration of three SMP2 complaint simulator environments.
- To demonstrate SMP2 features for industry
- All on one laptop!

Questions

Thanks!