



# The SVF–Lite Configuration in the End-To-End Avionics System Test Bench Concept

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**SESP 2012** 26/09/2012

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European Space Agency

#### **Presentation Outline**

#### End-To-End Avionics System Test Bench (E2E-ATB)

• Overview

#### • ESA SGEO SVF-Lite

- Idea / Goal
- Architecture
- Implementation

#### SVF-Lite Status, Results and Lessons Learned







# The End-To-End Avionics System Test Bench (E2E – ATB)

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### **Avionics System Test Bench (ATB)**



The ATB is an open facility that allows technology and standards assessment, validation and demonstration in context.

#### Typical issues with technology

#### verification and validation:

- Validation not performed "in context"
- Validation in a simplified environment or by similarity is simply not good enough
- Too costly to develop verification environments each time

Leon 2 Rasta Assembly, Simulator host and EGSE Reference Facility host





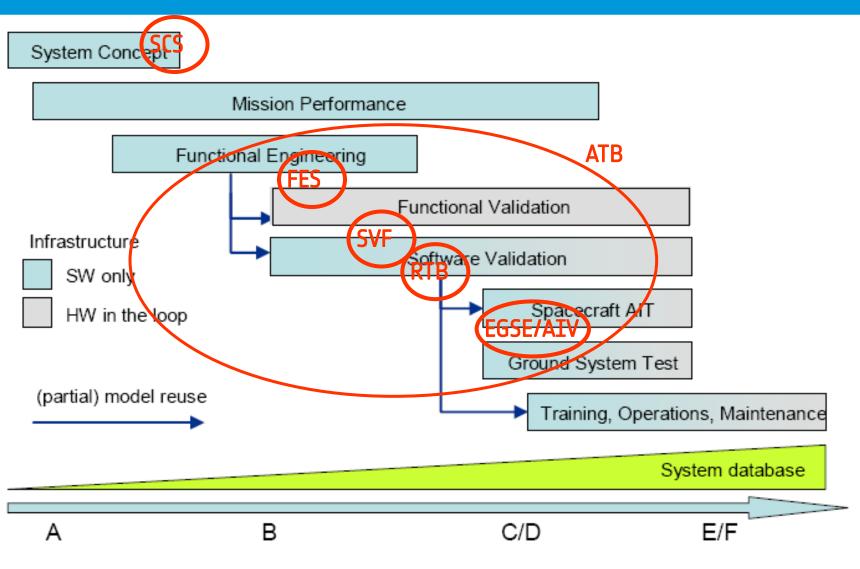
## ATB: The main use cases

- Standards and Technology Demonstration the ATB infrastructure is used as a representative environment for standards and technology assessments. Both development process and avionics application related standards and technologies are in the scope of this use case. The ATB infrastructure can be provided as a CFI as part of a study (TRP, GSTP etc.) contract.
- Technology Assessment in Support of Projects The ATB can be used in the support of projects when need rises to perform specific technology assessments (shadow engineering, independent validation etc.) in the area of avionics systems.
- Staff Competence the ATB infrastructure deployed in the Avionics Lab is used as an in-house hands-on training facility for staff. The aim here is to maintain and improve the competences of the TEC-SW staff in avionics systems and the related standards and technologies.





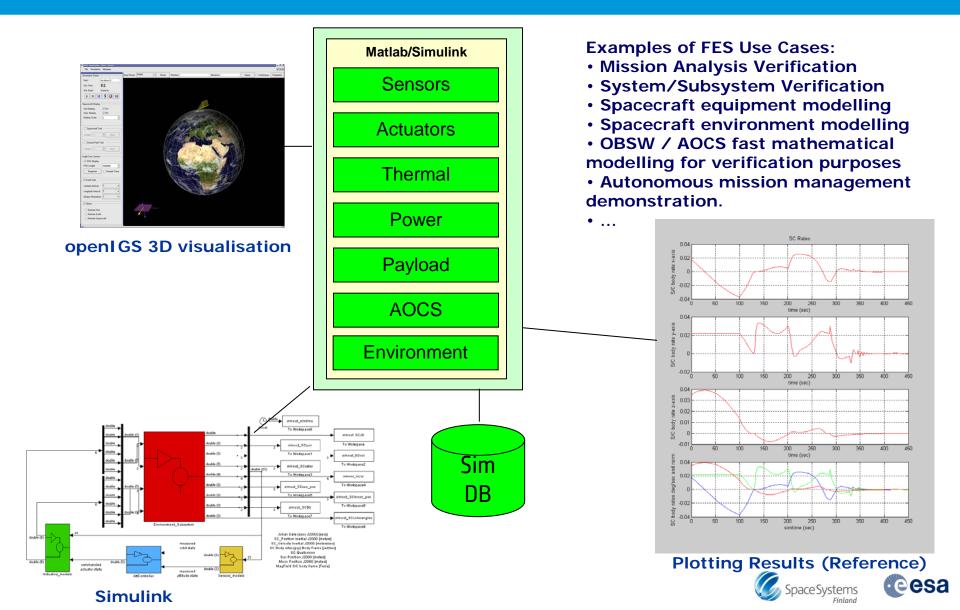
## ATB: Lifecycle support (ETM-10-21)



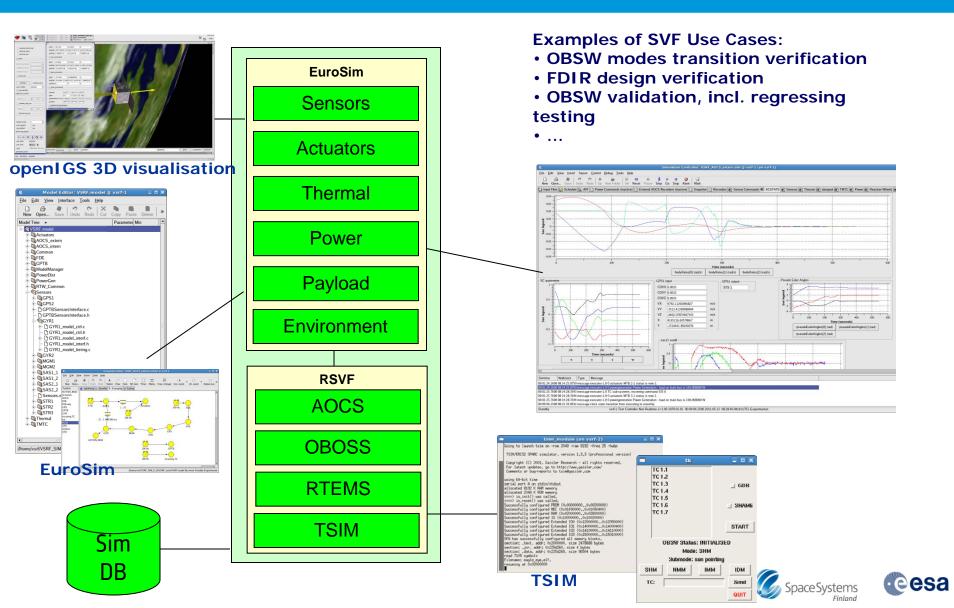




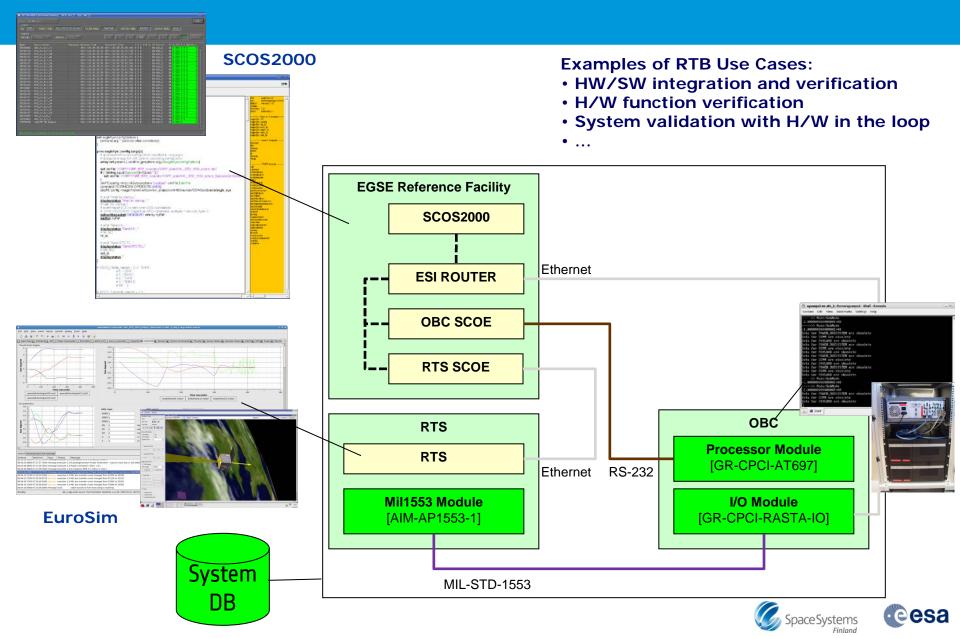
## **ATB: Functional Engineering Simulator (FES)**



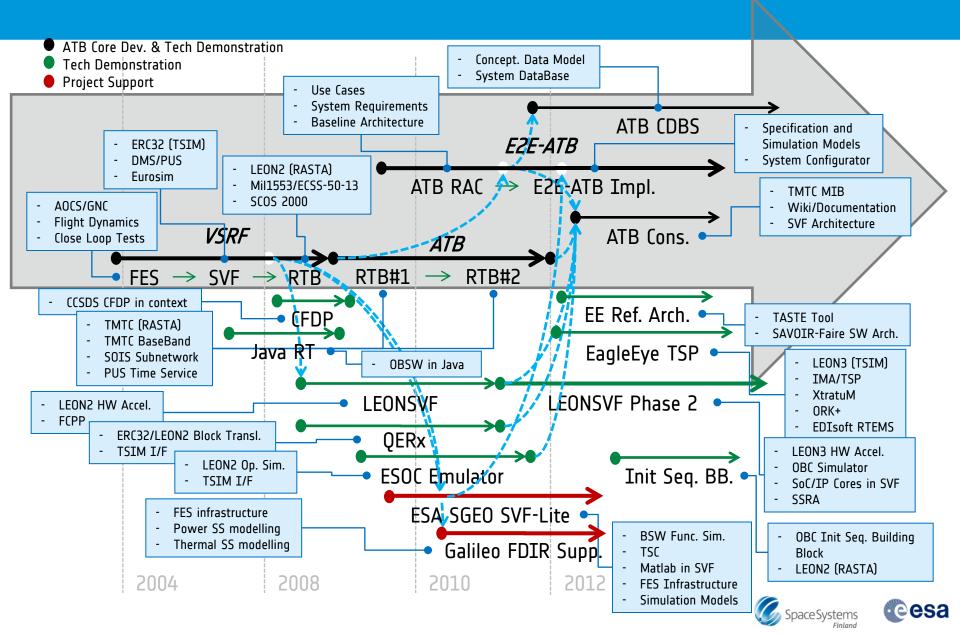
#### **ATB: Software Validation Facility (SVF)**



#### **ATB: Real Time Bench (RTB)**



#### **ATB: Past, Present and Future**



## **E2E-ATB:** Rationale

- Knowledge, Experience, Lessons Learned → Top Down approach
- ATB Requirements and Architectural Consolidation activity
  - Consistent set of Use Cases, User Requirements and S/W Requirements, and a top level architecture captured in UML.

#### ATB – FES Enhancements activity

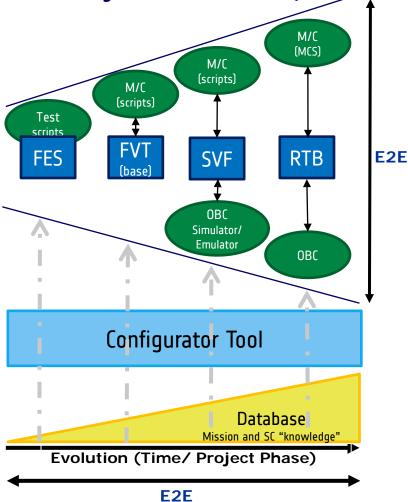
- FES Simulator architecture and definition of (models) interfaces
- FES Infrastructure functionality
  - S/C H/W resembling architecture
  - Automated (Regression) Unit Testing
  - > Interface, parameter and plotting definition using DB and Bus Objects
- Currently ongoing implementation activity: E2E-ATB
  - E2E-ATB Technical domain improvements:
    - Overall Architecture (taking into account the results of SSRA and SMP2)
    - Deployment approaches (using a Configurator Tool)
    - Implementation and Testing
    - (Maintainable) set of Documentation consistent with evolving models

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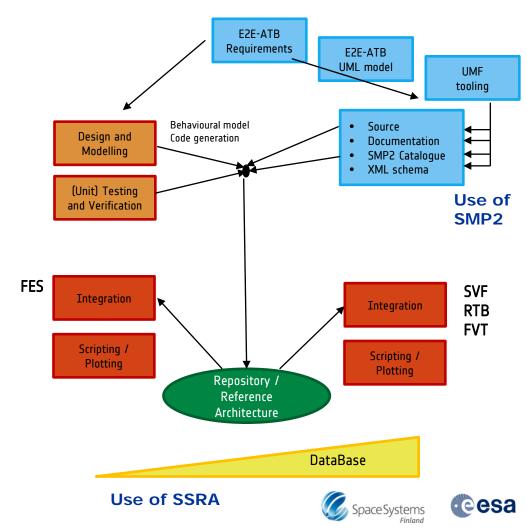
Space Systems

#### **E2E-ATB: 2 Main Challenges**

 Improve configurability and deployment (from Repository and System Database):

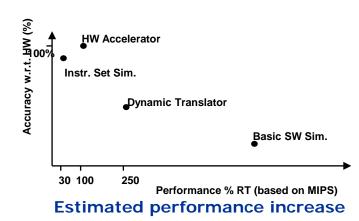


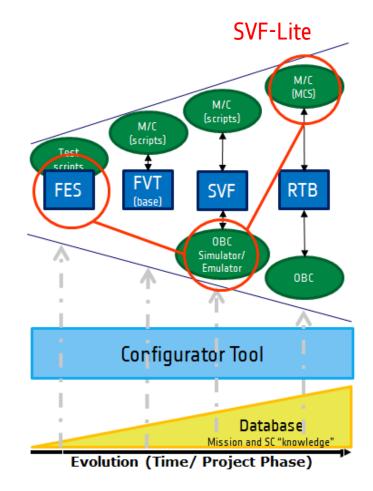
 Merge of 2 conceptually different simulation models:



#### **E2E-ATB: SVF-Lite**

- Background / Rationale:
  - ATB experience: "Intermediate" versions used for verification purposes.
  - ATB experience: simulator porting issues (modelling, interfacing, scheduling)
  - > SVF performance:
    - To increase performance (at cost of representativity), by replacing TSIM by BSW functional simulation.
  - Direct use of MCS TM/TC scripts
  - Other improvements (e.g FES infrastructure)





#### **ATB SVF-Lite Concept**







## **ESA SGEO SVF-Lite**

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## **ESA SGEO SVF-Lite: Objectives**

#### ESA SGEO SVF-Lite top-level objectives

All within the context of the 3 ATB Use-Cases:

The main objective of the ESA SGEO SVF is to provide **complementary** and **internal** support to the **ESA SGEO project team** for the purpose of **flight OBSW functional verification and validation**. In specific the area of **FDIR** on **System** and on **AOCS** level. This SVF will **not** replace the Industry SGEO SVF. However it is expected that the implementation efforts on the SVF-lite give **unmatched insight and review** capabilities in the Industrial SVF and OBSW (e.g. on interface level).

The activities will be focused on the **independent functional verification** of the software product. It would also be possible to perform reassessment of engineering margins, feasibility and performance parameters as part of shadow engineering in specific cases.

#### The ESA SGEO SVF-Lite foresees to support the following SGEO activities: **OBSW** Independent Varification

#### **OBSW Independent Verification**

- Performance analysis
- AOCS functional verification
- AOCS onboard software verification
- Onboard software verification

• Specifically for **FDIR**, which is defined on system level and detailed on subsystem or equipment level and therefore spread over many areas, it is believed that the an SVF-Lite can contribute in providing a tool to probe, define and assess failure scenarios.

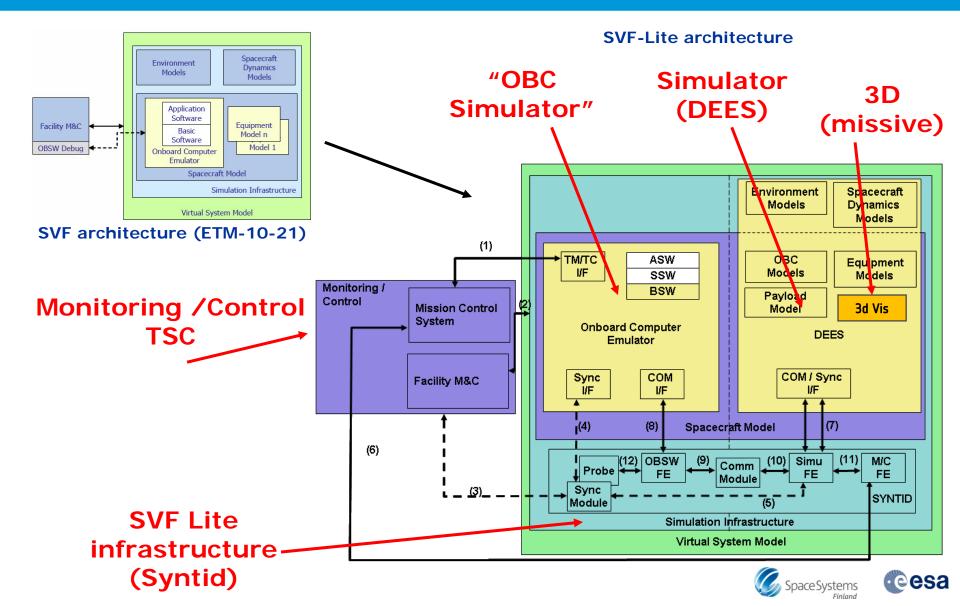
#### User Requirements driving design and implementation:

- · Constraint to be able to run the unaltered ASW.
- Goal to be able to run/rerun the original test cases from industry without any manual modifications to the test-scripts.
- In vice-versa, the goal to be able to generate / develop new test cases and test-scripts to be run at industry facilities.
- Wish to execute in faster than real time mode.
- $\cdot$  Wish to directly reuse the FES (models and infrastructure)





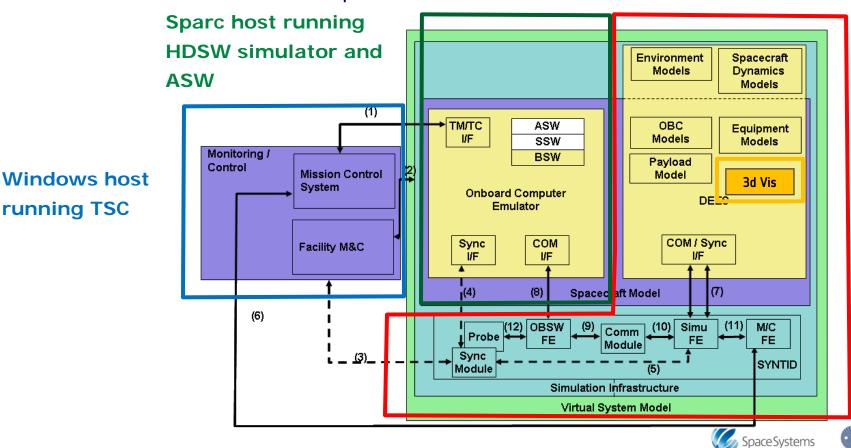
#### ESA SGEO SVF-Lite: Architecture (1/3)



## ESA SGEO SVF-Lite: Architecture (2/3)

- 2 configurations:
  - HDSW Simulator and ASW in loop
  - SSF Device Simulator in loop

Linux host running Matlab DEES and Syntid

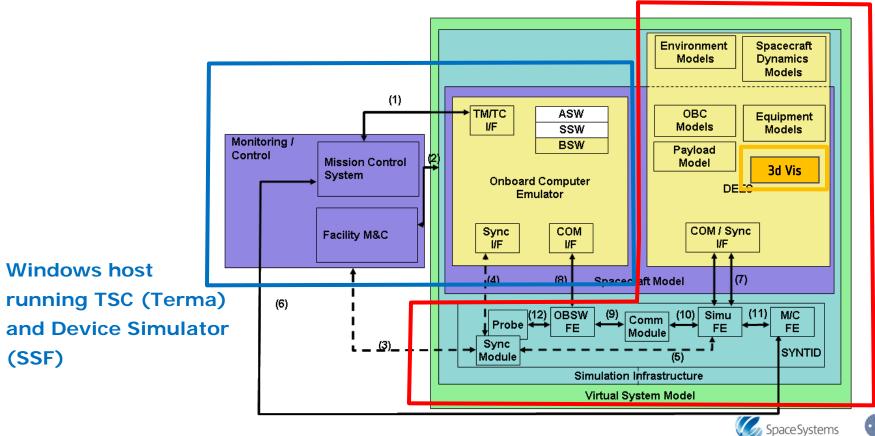




## ESA SGEO SVF-Lite: Architecture (3/3)

- 2 configurations:
  - HDSW Simulator and ASW in loop
  - SSF Device Simulator in loop

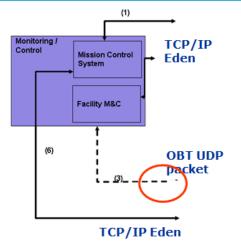
Linux host running Matlab DEES and Syntid





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# ESA SGEO SVF-Lite: Monitor and Control Component (1/2)



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utope57 2012-07-17713:25:38:573	"EDEN: EGGE Server stopped listening" "EDEN: socket closing" "EDEN: socket disconnected"		

- Monitoring and Control Component:
  - Based on existing Terma product (TSC)
    - "light weight"
    - MIB files (+ merge with SCOE MIB)
    - uTope Scripts
  - Used to setup (e.g. acceleration and probing) and connect the components of the SVF-Lite,
  - Used to initialise all components consistently,
  - Single point to observe and interact with SVF (Ground TM/ TC and Failure Injection)
  - Used to monitor online or analysis data

Additional Feature was added to drive the TSC based on OBT UDP packet





# ESA SGEO SVF-Lite: Monitor and Control Component (2/2)

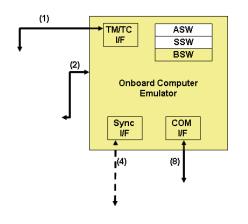
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utope63	2012-07-17115:58:17.399		Count Cheymony Probe subscription were only from Toric_CTRL	
utope63	2012-07-17T15:58:17.399		STEP 3 : Prepare firing	
utope63	2012-07-17T15:58:17.399		=== Act.1: turn on equipment, including ADE1 and SCE1	
utope63	2012-07-17T15:58:17.399		OBT = 5.200027	
utope63	2012-07-17T15:59:18.453		=== Act.2: Prepare ADE1 for firing: set ADE1 to Global Activation mode; open PIV, turn PT on	
utope63	2012-07-17T15:59:18.453		OBT = 65.200027	
utope63 utope63	2012-07-17T15:59:38.634 2012-07-17T15:59:38.634		=== Act.3: Pressurize by means of SCE1: set plenum pressure setpoint (2.2 bars), SCE1 to C( OBT = 85,200027	GT_EXEC mode
utope63	2012-07-17115:59:58.893		0B1 = 65.200027	
utope63	2012-07-17T15:59:58.894		====== STEP 4 : Start detumbling ====================================	
utope63	2012-07-17T15:59:58.894		OBT = 105.200027	
utope63	2012-07-17T15:59:58.894		=== Act.1: Fire thruster to decrease the S/C bodyrates	
utope63	2012-07-17T16:00:19.088			
utope63	2012-07-17T16:00:19.088		====== STEP 4B (CONTINGENCY CASE): SCE pressure failure and reconfiguration ======	
utope63	2012-07-17T16:00:19.088		=== Act.1: Failure injection: SCE1 pressurization is not sufficient for firing	
utope63 TSC	2012-07-17T16:00:19.088 2012-07-17T16:00:19.190		OBT = 125.200027 "EDEN: CMD,ANSW ' Failure injection OK,' from 'TEFE_CTRL'"	
utope63	2012-07-17116:00:19.190 2012-07-17T16:00:20.308		=== Act.2: Fire thruster (but no torque produced, because of insufficient chamber pressure) -	
utope63	2012-07-17T16:00:20.308		OBT = 126.200027	
utope63	2012-07-17T16:00:21.318		=== Act.3: Reconfiguration sequence: pressurization by means of SCE2; turn off SCE1	
utope63	2012-07-17T16:00:21.318		OBT = 127.200027	
utope63	2012-07-17T16:00:51.769			
utope63	2012-07-17T16:00:51.769		====== STEP 5: Complete detumbling ====================================	
utope63	2012-07-17T16:00:51.769		=== Act.1: Fire thruster to reduce S/C bodyrates	
utope63 utope63	2012-07-17T16:00:51.770		OBT = 157.200027	
utope63 utope63	2012-07-17T16:00:52.779 2012-07-17T16:00:52.779		====== STEP 6: Reset the Probe Subscriptions: ====================================	
utope63	2012-07-17116:00:52.779 2012-07-17T16:00:52.779		OBT = 158,200027	
utope63	2012-07-17T16:00:52.779		=== Act.1: Free the Switch ON -command's Probe subscription:	
utope63	2012-07-17T16:00:52.779		X X X, X, RT X, SA X, X, ID 7777, period 0.	
TSC	2012-07-17T16:00:52.783		"EDEN: CMD, ANSW ' Probe subscription went OK. ' from 'TEFE_CTRL'"	
utope63	2012-07-17T16:00:54.279		=== Act.2: Free the dummy device's output value's subscription:	
utope63	2012-07-17T16:00:54.280		X X X, X, RT X, SA X, X, ID 8888, period 0.	
TSC	2012-07-17T16:00:54.283		"EDEN: CMD, ANSW ' Probe subscription went OK. ' from 'TEFE_CTRL'"	
utope63 utope63	2012-07-17T16:00:55.280 2012-07-17T16:00:55.280		=== Act.3: Free OBT subscription:	
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utope63	2012-07-17T16:00:55.780		as an energy of the subscription more over them the subscription more over them the subscription the	
	2012-07-17T16:00:55.780		====== STEP 7: Default Finish: ====================================	===
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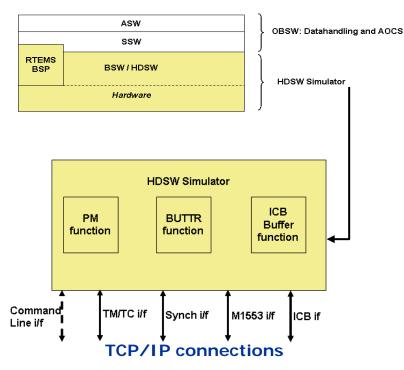






## ESA SGEO SVF-Lite: OBC Simulator Component (1/3)





- OBC simulator: HDSW and ASW
  - HDSW Simulator is based on existing RUAG HSIM
  - It replaces the BSW and H/W layer (including the processor).
  - ASW & SSW layers are built with the HDSW simulator into a single executable
  - Compilation and execution on the Sparc Sunblade 100 host platform
  - Provided Interfaces:
    - > TM/TC (TCP/IP)
    - Command / Test Interface
    - ICB and MIL Interfaces (TCP/IP)
    - "10hz" Synch Interface (TCP/IP)





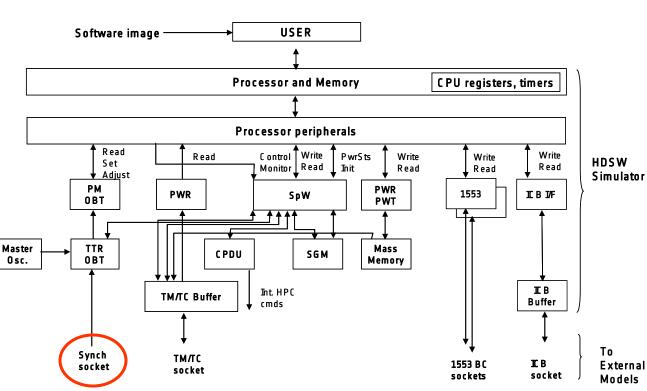
## ESA SGEO SVF-Lite: OBC Simulator Component (2/3): HDSW simulator

#### **HDSW simulator functions:**

- Packet TC decoder
- TM encoder
- Processing function (no alarm signal generation, no error detection and correction functions)
- Timing and Synchronisation
- SMU Mass Memory (simplified)
- SGM (simplified)
- RM (simplified)

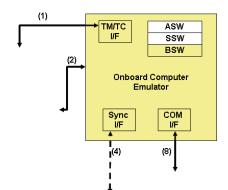


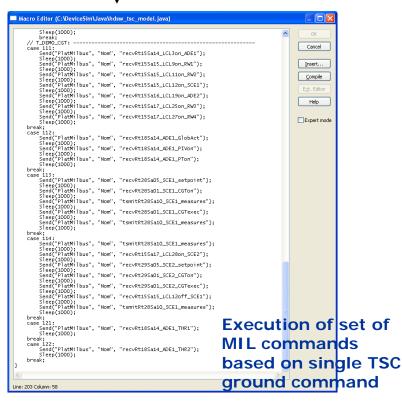




#### **HDSW Simulator Functionality**

## ESA SGEO SVF-Lite: OBC Simulator Component (3/3): Device Simulator



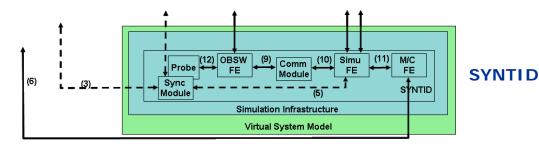


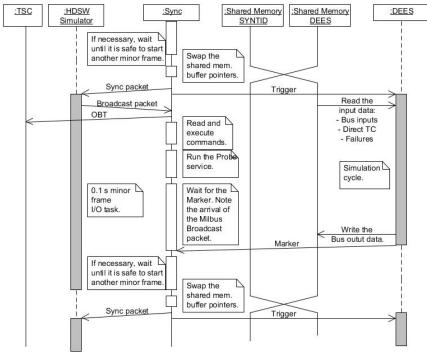
#### **OBC simulator: Device Simulator**

- Device Simulator is existing SSF product
- Device Simulator replaces HDSW simulator and ASW (in terms of reception and handling of interfaces)
- Provides MIL1553 and ICB commands to DEES
- Preparation of test scenarios in accordance to ground commanding and to obtain reference results.

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#### **ESA SGEO SVF-Lite: SYNTID Component**





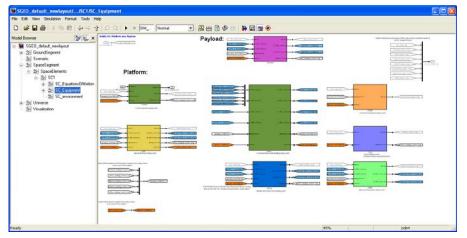
#### Synchronisation DEES, OBC simulator and TSC

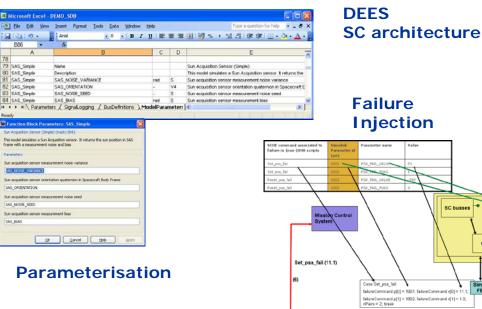
SYNTID Component: •

- Data Exchange •
- Logging ٠
- Synchronisation
- Probe ٠

	X vsrf@atb10:eo/sgeo_svf/Syntid <@atb10>	
	= 00142.989 mainLoop: Marker! ####################################	X vsrf@atb10:o/sgeo_svf/Adapter <@atb10> X
	= 00142.989 mainLoop:	= ADAPTER STARTED =
	- retVal = 1 pro 1. = 00142,989 Trigger st. = 00143,090 main(oop; OBT Broadcast timeout	- Initialising the tools: readConfig: Reading the config file.
	= 00143,090 0BT: Coarse = 0x00000355; Fine = 0xC126 = 00143,090 mainLoop: Marker! ####################################	I/F Id - IP Addr Port 0 127.0.0.2 0 E_SIFE
	= 00143.090 mainLoop: < SYNC >> = 00143.090 ***sendSyncPacket - toolSend failed! send: Bad file descriptor	1 131,176,22,45 18106 E_0BFE_PLAT 2 131,176,22,45 18107 E_0BFE_PAYL 3 131,176,22,45 18132 E_0BFE_ICB
	<ul> <li>retVal = -1 pro 1.</li> <li>00443.190 Trigger set.</li> <li>00143.191 mainLoop: OBT Broadcast timeout</li> <li>00143.191 OBT: Coarse = 0.x00000355; Fine = -x0ABF</li> </ul>	4 131,176,22,46 1151 E_TEFE 5 131,176,22,46 1152 E_TEFE_FAIL 6 131,176,22,46 1153 E_TEFE_DTC
	= 00143.131 mainLoop: Marker! ####################################	7 131.176.22.45 18159 E_SYNC 8 131.176.22.46 18101 E_ADMPT_TSC 9 131.176.22.45 18102 E_ADMPT_HDSW
	<pre>= 00145.191 ***sendSyncPacket - toolSend failed send: Bad file descriptor - retVal = -1 pro 1. = 00145.191 Triager set.</pre>	10 131.176.22.45 4765 E_TSC_OBT = 00000.000 === SGED SWF SYNTID LOG FILE: 2012-07-17 - 14:22:28.383 ===
	= 00143.232 mainLoop: OBT Broadcast timeout = 00143.232 UBT: Coarse = 0x00003555; Fine = 0xF453 = 00143.232 mainLoop: Market = ==================================	= 00000.000 = 00000.000 = 00000.000 Initialise the PUS interface towards HDSW Simu.
	= 00143.292 mainLoop: nextImeToRum = 143291, = 00143.292 mainLoop:	- Client socket 4 created, - Connected into 131.176.22.45, port 18102.
	<pre>send: Bad file descriptor - retval = -1 pro 1, = 00143.292 Trigger set, = 00143.393 main.cos: OBT Prodeast timeout</pre>	= 00000.000 Initialise the PUS interface towards TSC. Listening socket 5 created
	<ul> <li>- 00145,333 0B1: Coarse = 0x00000356; Fine = 0x0DF3</li> <li>= 00143,333 nainLoop; Marker! ####################################</li></ul>	Listening = 00000,000 Client (to HDSW Simu) socket = 4 - Client from 131,176,22,45, port 3503 accepted at socket 6.
	= 00143.333 mainLoop:	= 00040,820 Server (to TSC) socket = 6 = 00040,820 INITIALISATION READY = 00040,820 Receiving and sending packets
	<ul> <li>retVal = -1 pro 1.</li> <li>00143,393 Trigger set. ************************************</li></ul>	= 00042,839 handleCmdExec - New EPOCH = 1342527791 = 00000,223 So far, 0 TCs and 0 TMs received.
	= 00143.434 0BT: Coarse = 0x00000356; Fine = 0x278C = 00143.434 mainLoop: Marker! ####################################	= 00006,260 main - Received a TC packet from TSC. = 00006,260
	= 00143.494 meinLoop: (SYNC >> = 00143.494 meinEdSupChacket - toolSend failed send: Bad file descriptor	= 00006,260 00 00 00 E 00 00 00 19 00 C0 8B 00 07 10 82 = 00006,260 01 00 00 6F 08 3D = 00006,260
	- retVal = -1 pro 1.	= 00006,280 readHdswlf - Received a TM packet from OBSW. = 00006,280
Syntid a	and adapter messaging	= 00006,260 00 00 01 B 00 00 00 09 00 C0 1A 00 11 10 01 = 00006,260 01 1A 00 00 00 02 CA 5A C0 13 00 C0 8B D0 D0 = 00006,260 01 A0 00 00 00 02 CA 5A C0 13 00 C0 8B D0 D0
		= 00066,843 main - Received a TC packet from TSC.

### **ESA SGEO SVF-Lite: DEES Component**





- **DEES Component:** •
  - **Direct FES reuse** •
  - Full representative closed-loop • dynamic SC simulator
  - DFFS DB: •
    - Parameterisation
    - Interface definition
    - Failure definition
    - Automated plotting definition

Interfaces:

SC busses

Injection

C-mex

(7)

FE

DEES (M/S)

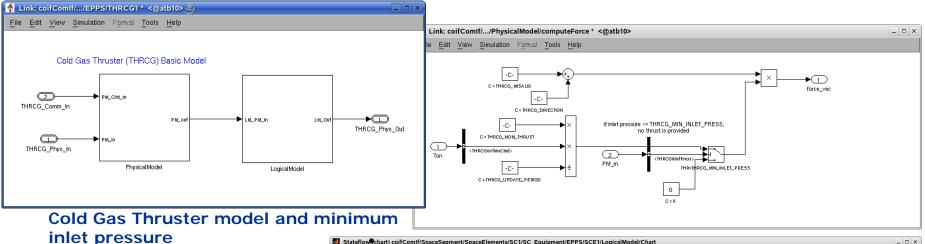
Shared memory to SIM FE

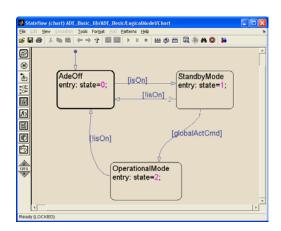
Synchronisation via SYNTID



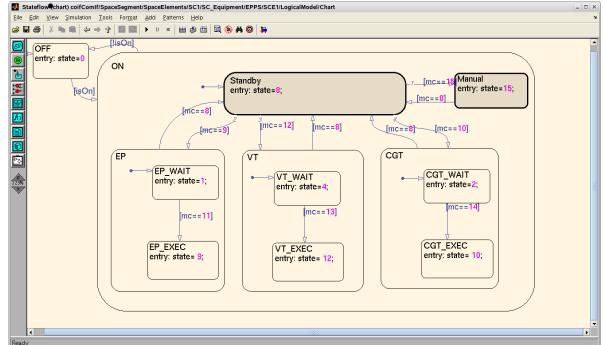


## ESA SGEO SVF-Lite: DEES Component Modelling





Actuator Driver Electronics and Support Control Electronics Stateflow diagrammes



#### ESA SGEO SVF-Lite: DEES Component Simulation Model parameter definitions

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257 THRCG_DIRECTION_X	-	Thrust direction (direction cosines)	n .	V3			101	•			8.8.8.V		70 UT (	10.0	1 00	•	
258 THRCG DIRECTION Y	-	Thrust direction (direction cosines)		V3													
259 THRCG DIRECTION Z		Thrust direction (direction cosines)		V3													
260 THRCG MISALIG X	-	Thrust misalignment		V3													
261 THRCG MISALIG Y	-	Thrust misalignment		V3													
262 THRCG MISALIG Z	-	Thrust misalignment		V3													
263 THRCG NOM THRUST	N	Nominal thrust		s													
264 THRCG_MIN_INLET_PRESS	Pa	Mimimum inlet pressure required to generate any thrust		s													
265 THRCG LOCATION X	m	Thruster location (in SGF), needed for torque computation		- V3													
266 THRCG LOCATION Y	m	Thruster location (in SGF), needed for torque computation		VЗ													
267 THRCG LOCATION Z	m	Thruster location (in SGF), needed for torgue computation		V3													
268 THRCG_UPDATE_PERIOD	s	Scheduling period of the numerical model		s													
269 THRCG_GRAVITY_SURFACE_CONST	m/s2	Gravity surface constant (g0), used in the mass consumption computation		s													
270 THRCG SPECIFIC IMPULSE	s	Specific impulse (Isp), used in the mass consumption computation (massCor	s= UPDATE	s													
271 THRCG OVERWRITE THRUST FAIL FLAG	-	Overwrite thrust failure flag (-1: no fail; 1=fail).		s													
272 THRCG_OVERWRITE_THRUST_FAIL_VAL_V1	N	Thrust vector provided when overwrite thruster failure is enabled		V3													
273 THRCG_OVERWRITE_THRUST_FAIL_VAL_V2	N	Thrust vector provided when overwrite thruster failure is enabled		V3													
274 THRCG_OVERWRITE_THRUST_FAIL_VAL_V3	N	Thrust vector provided when overwrite thruster failure is enabled		V3													
275 THRCG2_DIRECTION_X	-	Thrust direction (direction cosines)		V3													
276 THRCG2_DIRECTION_Y	-	Thrust direction (direction cosines)		VЗ													
277 THRCG2_DIRECTION_Z	-	Thrust direction (direction cosines)		V3													
278 THRCG2_MISALIG_X	-	Thrust misalignment		V3													
279 THRCG2_MISALIG_Y	-	Thrust misalignment		V3													
280 THRCG2_MISALIG_Z	-	Thrust misalignment		V3													
281 THRCG2_NOM_THRUST	N	Nominal thrust		s													
282 THRCG2_MIN_INLET_PRESS	Pa	Mimimum inlet pressure required to generate any thrust		s													
283 THRCG2_LOCATION_X	m	Thruster location (in SGF), needed for torque computation		V3													
284 THRCG2_LOCATION_Y	m	Thruster location (in SGF), needed for torque computation		V3													
285 THRCG2_LOCATION_Z	m	Thruster location (in SGF), needed for torque computation		V3													
286 THRCG2_UPDATE_PERIOD	s	Scheduling period of the numerical model		s													
287 THRCG2_GRAVITY_SURFACE_CONST	m/s2	Gravity surface constant (g0), used in the mass consumption computation		s													
288 THRCG2_SPECIFIC_IMPULSE	s	Specific impulse (lsp), used in the mass consumption computation (massCon	S= UPDATE	s													
289 THRCG2_OVERWRITE_THRUST_FAIL_FLAG	-	Overwrite thrust failure flag (-1: no fail; 1=fail).		s													
290 THRCG2_OVERWRITE_THRUST_FAIL_VAL_V1	N	Thrust vector provided when overwrite thruster failure is enabled		V3													
291 THRCG2_OVERWRITE_THRUST_FAIL_VAL_V2	N	Thrust vector provided when overwrite thruster failure is enabled		V3													
292 THRCG2_OVERWRITE_THRUST_FAIL_VAL_V3	N	Thrust vector provided when overwrite thruster failure is enabled		V3													
H + + H Parameters / SignalLogging / BusDe	efinitions	/ ModelParameters /		<		1											>

#### **Simulation Model Parameter definition**

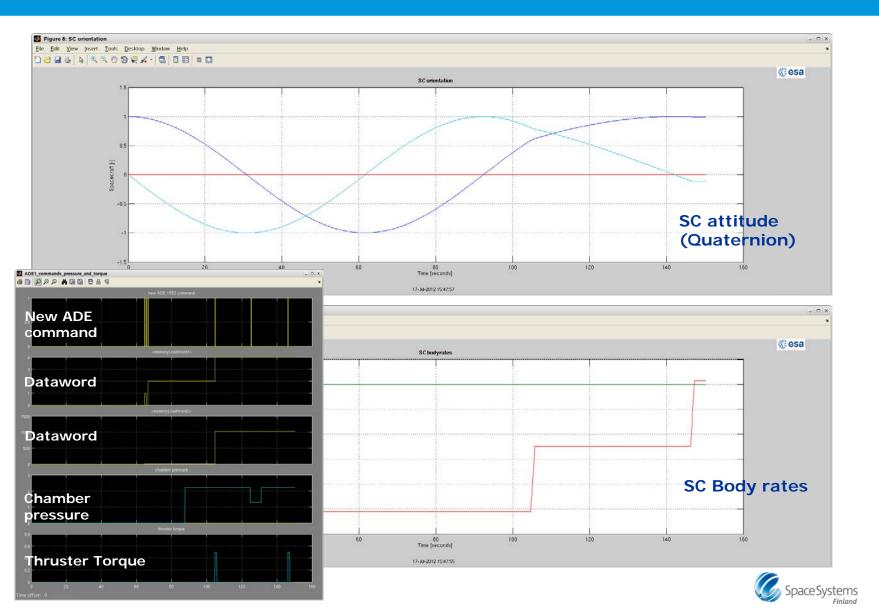




#### ESA SGEO SVF-Lite: DEES Component SCE telemetry and calibration

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1 Bus name	Element name	Description SCE power consumption	Units	Dimensions	Туре	TypeInBus	Conver	sion SA	Data	Word	DataPosit	ion Use	dBits Upda	<u>it</u>				
282 SCE_Basic_Power_Out_T	SCEpowerCons	This field is modeled according to simulation parameter	W	s	double													
283 SCE_Basic_Phys_Out_T	pressToEpta1	pressure to the EPTA1 system	bar		double									C	C :		N/a	
284 SCE_Basic_Phys_Out_T	pressToEpta2	pressure to the EPTA2 system	bar		double								DEE	2	Simul	atior	i ivio	aei
285 SCE_Basic_Phys_Out_T	pressToCgt	pressure to the CGT system	bar		double								D					
286 ADE_Basic_Comm_In_T	memoryLoadReceived	1= memory load command received since last call	-		double	int			14	1		0	BUSU	E	M defi	ηιτιο	n	
		memory load command. Refer to SGEO-THA-ICD-0003																
287 ADE_Basic_Comm_In_T	memoryLoadWord1	issue 4.0 (January 2011)	-	S	double	int			14	1		0	16					
288 ADE_Basic_Comm_In_T	memoryLoadWord2	memory load command	-	S	double	int			14	2		0	16					
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289 ADE_Basic_Comm_In_T	memoryLoadWord3	memory load command	-	S	double	Int			14	3		0	16					
290 ADE_Basic_Comm_In_T	memoryLoadWord4	memory load command		s	double	int			14	4		0	16					
250 ADE_Basic_Conini_II_I	memoryLoauvvoru4	niemory load command	-	5	double				14	4		0	10					
291 ADE_Basic_Comm_In_T	memoryLoad/Vord5	memory load command	_	s	double	int			14	5		o	16					
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292 ADE_Basic_Comm_In_T	memoryLoadWord6	memory load command	-	s	double	int			14	6		0	16					
293 ADE_Basic_Comm_In_T	memoryLoadWord7	memory load command	-	S	double	int			14	7		0	16					
294 ADE_Basic_Comm_In_T	memoryLoadWord8	memory load command	-	s	double				14	8		0	16					
295 ADE_Basic_Comm_Out_T	hkRegister0	Housekeeping register 0	-		double				8	1		0	16					
296 ADE_Basic_Comm_Out_T	hkRegister1	Housekeeping register 1	-	s	double	int			8	2		0	16					
297 ADE Basic Comm Out T	rejectedTccounter	Currently modeled as zero data		s	double	int			8	3		0	16	_				
of hbc_basic_comm_cat_r	rojootourroodantoi	,			acabic							-						
		last received commanded value for the thruster																
		Rationale: according to EPPS SW Spec issue 2 page 90. Note that this definition does NOT depend on																
298 ADE_Basic_Comm_Out_T	tv1onTime	Synch considerations!		s	double	int			8	4		0	16					
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		Rationale: according to EPPS SW Spec issue 2 page																
299 ADE_Basic_Comm_Out_T	tv2onTime	90. Note that this definition does NOT depend on		s	double	int			8	5		0	16					
		last received commanded value for the thruster																
		Rationale: according to EPPS SW Spec issue 2 page																
BOD ADE_Basic_Comm_Out_T	tv3onTime	90. Note that this definition does NOT depend on	-	S	double	int			8	6		0	16					
		last received commanded value for the thruster																
		Rationale: according to EPPS SW Spec issue 2 page		_					_	_								
301 ADE_Basic_Comm_Out_T	tv4onTime	90. Note that this definition does NOT depend on	-	S	double	int			8	7		0	16	×				
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#### ESA SGEO SVF-Lite: DEES Component Test Results plotting



esa

#### ESA SGEO SVF-Lite: 3D Visualisation Component



#### 3D visualisation

- Intuitive comprehension results
- Based on Missive (e.g. Stereoscopic capabilities)
- Using SGEO CAD model
- TCP/IP connection

Space Systems



**SGEO 3D visualisation** 





# SVF-Lite Concept: Status, Results, Lessons Learned

**SESP 2012** 26/09/2012

European Space Agency

## **ESA SGEO SVF-Lite: Status**

- Current status of the SVF-Lite configuration:
  - Full infrastructure deployed (TSC, SYNTID, OBC Simulator, Visualisation and DEES (incl. environmental models and most of SGEO platform RT simulation models).
  - 2 Configurations:
    - HDSW Simulator with V2 of ASW
    - Device Simulator doing MIL-1553 and ICB IO
  - Acceleration factor: currently at 5x times faster than Real Time
    - Profiling of DEES shows 10x times faster within grasp
    - End-goal is still appr. 20x times faster



## ESA SGEO SVF-Lite: Results (1/2)

# Functionality wise: the SVF-Lite leverages from different concepts of FES and "traditional SVF" and RTB:

- 1. FES part:
  - Direct reuse of Matlab/Simulink FES environment
    - **Openness** of simulator infrastructure
    - **Direct insight** into Simulation Models
  - FES architecture and infrastructure using scripts, strict bus definitions and high degree of parameterisation of:
    - Simulation Models including failure injection.
    - Plotting of data
  - Integration of Simulation Model documentation
  - Coding and acceleration capabilities for the DEES



## ESA SGEO SVF-Lite: Results (2/2)

# Functionality wise: The SVF-Lite leverages from different concepts of FES and "traditional SVF" and RTB (cont.):

- 2. RTB part:
  - Reuse of Monitoring and Control system, **TSC** in this case.
    - Light-weight SCOS
    - Use of actual MIB files for TM/TC definitions
    - Possibility of rerunning **test scenarios** from Industry (use of uTope)
    - Separation of OBSW MIB and SCOE MIB
    - New in this case: accelerated mode of TSC
- 3. SVF part:
  - Use of **HDSW Simulator** for acceleration at cost of representativity.



# ESA SGEO SVF-Lite: further acceleration improvements

- Further improvements / consolidation to speed up system
  - Merging of Hosts versus usage of network
  - **OBSW** with **marker** (TBC)
  - ICB tuning and MIL1553 TM acquisition (autonomous SYNTID-response fixed TM)
  - Acceleration of **DEES**:
    - Simulink solver (discrete or continuous versus hybrid system),
    - Accelerator mode / code generation,
    - Dedicated (project specific) Simulation Models (granularity)
  - Connection and usage of **other OBC emulators / simulators**



## ESA SGEO SVF-Lite: Lessons Learned / Conclusions

- Unsurpassed reviewing capabilities for the ESA SGEO project team!
  - Running ASW on independent SVF
  - Knowledge digging (reviewing) while modelling
- Benefits of direct FES reuse has to be traded versus performance:
  - Infrastructure: used solver, online plotting and monitoring
  - Simulation Models: level of detail, modelling techniques (e.g. failure injection)
  - Of course in some cases trade-off possible!
- Performance increase of HDSW Simulator and ASW versus representativity (TBC))
- Use of Device Simulator for obtaining reference results and for modelling against ICD
- Not always possible to rerun the industrial scripts, because of different SCOE TC
- Importance of centralized data management (TM/TC definitions, Interfaces, Simulation Model parameters, failure injections, RT data specification)









## Thank You.

## **Questions?**

**SESP 2012** 26/09/2012

European Space Agency