

VSEE - CDF Data Model Transfer and Modelling Guidelines – Final Review Meeting

Dr. Todor Stoitsev, Telespazio VEGA Deutschland GmbH Armin Müller, ScopeSET Technology Deutschland GmbH

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- 1. Introduction and Background
- 2. Meta-Model Mappings
- 3. Tooling Integration
- 4. Budgets & Reports
- 5. Component Libraries
- 6. Summary and Conclusions



1. Introduction & Background

Background

CDF OCDT

- ESA Concurrent Design Facility (CDF) using the Open Concurrent Design Tool (OCDT) for system engineering in early mission phases 0, A and B1
- OCDT provides environment for concurrent, collaborative and distributed engineering based on ECSS-E-TM-E-10-25A

VSEE

- Virtual Spacecraft Engineering Environment (VSEE) using the Space Systems Design Editor (SSDE) for system engineering in later mission phases (B, C, D, E)
- ⇒ VSEE framework and tooling based on ECSS-E-TM-10-23A



1. Introduction & Background

Objectives

- Analyse the compatibility between the 10-25 and 10-23 meta-models and specify model mappings and transformations
- Integrate the SSDE and OCDT tooling, enabling model exchange between both environments
- Develop guidelines and associated tooling for system technical budget dashboards and validate them with reference data sets to demonstrate the integration approach



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2. Meta-Model Mappings

Meta-Model Mappings

- ≱ Import:
 - Custom mappings based on OCDT Category
 - Default mappings for filling semantic gaps according to the target meta-model
 - Implicit mappings for closely related constructs
- - Implicit mappings from the semantically richer 10-23 to the more generic 10-25 allowing inversed mapping through custom import mappings

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 e categoryMapping	[1*]	categoryMapping

4	" 🕼 categoryMapping									
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"e typedReferenceMapping [0*] typedReferenceMapping	

1		🔚 referenceMapping			
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		e vseeClass	[11]	string	
		e vseeContainerReferenceName	[01]	string	
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3. Tooling Integration

Solution Overview

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- Reuse of the generic OCDT-EMF Connector from CESoS including:
 - OCDT model retrieval through OCDT Web Services Processor (WSP) JSON to EMF conversion
 - OCDT model creation/update through EMF to OCDT WSP JSON conversion
- OCDT VSEE Connector performs OCDT EMF to VSEE EMF conversion (and vise versa)



3. Tooling Integration

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Noteworthy

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- Import of OCDT 3 ParameterOverrides:
 - No overrides on 3 ElementUsage level in SSDE
 - 3 Occurrence tree generation
 - 3 ValuePropertyValue overrides for OCDT ParameterOverrides in ElementOccurrences and **DiscreteStateOccurrences**

- Import of OCDT state-dependent 3 Parameter(Overrides):
 - 3 ValuePropertyValues applied to DiscreteStateDefinitions and **DiscreteStateOccurrences**

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i Cati ⊳ 📂 Grav		Import/update model constraints Import/update Data Groups		1
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		Import Engineering Model Import Reference Library Export SSDE Model to OCDT		

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Ok	Cancel				
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3. Tooling Integration

DEMO

4. Budgets & Reports

Mass Budget - Modelling:

- Implicit product structure:
 - Modelling of ElementDefinitions, ElementUsages
 - ValuePropertyValues expected in 'leaf' elements
- Explicit product structure:
 - Overriding of ValuePropertyValue where needed in generated ElementOccurrences



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Mass Budget - Output:

- Value aggregation along occurrence tree
- Dynamic HTML tree-table:
 - Expand/Collapse all nodes
 - Errors visible for expanded nodes
 - Column filtering
- ➢ Fixed Layout (non-HTML):
 - Based on table
 - Hierarchy through: coloring, level, qualified name

Specified Computed Measured Required Computed Specified Measured Required Mass Mass Mass Mass Mass Margin Mass Margin Mass Margin Mass Margin Elemen (kilogram) (kilogram) (kilogram) (kilogram) (percentage) (percentage) (percentage) (percentage) Level Qualified Name 🕒 💼 PLM 590.22 20 LOFT Mission::Space Segment::Satellite::PLM • 🖬 20 1.1.1 O 🗂 LAD 563.4 LOFT Mission::Space 2 Segment::Satellite::PLM::instruments SS1::LAD 1.1.1.1 0 EÎ 93.9 20 LOFT Mission::Space Segment::Satellite::PLM::instruments Lad Detector Panel SS1::LAD::Lad Detector Panel 1.1.1.1.1 0 EÎ 20 20 LOFT Mission::Space 6 5 4 Segment::Satellite::PLM::instruments Harness

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(Instruments)

Modules (21

per panel)

79.4

79.4

0 E

←)(→) 🙋 Mass Budget

1.1.1.1.2

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	1	Element	Computed Mass (kilogram)	Specified Mass (kilogram)	Measured Mass (kilogram)	Required Mass (kilogram)	Computed Mass Margin (percentage)	Specified Mass Margin (percentage)	Measured Mass Margin (percentage)	Required Mass Margin (percentage)	Level	Element Qualified Name	Errors
	2	PLM	590.22				20.00				0	Segment::Satellite::PLM	
	3	instruments SS1	590.22	600.60			20.00	19.80				LOFT Mission::Space Segment::Satellite::PLM::Inst ruments S\$1	Mismatching computed and specified mass margin values!; Mismatching computed and specified mass values!
	4	LAD	563.40				20.00				2	LOFT Mission::Space Segment::Satellite::PLM::inst ruments SS1::LAD	
	5	Lad Detector Panel	93.90				20.00				3	LOFT Mission::Space Segment::Satellite::PLM::Inst ruments SS1::LAD::Lad	
	6	Hamess (Instruments)	5.00	5.00			20.00	20.00			4	LOFT Mission::Space Segment::Satellite::PLM::inst ruments SS1::LAD::Lad Detector Panel: Hamess	
	7	Modules (21 per panel)	79.40	79.40			20.00	20.00			4	LOFT Mission::Space Segment: Satellite::PLM::inst ruments SS1::LAD::Lad Detector Panel::Modules (21	
												LOFT Mission::Space Segment::Satellite::PLM::inst	

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4. Budgets & Reports

SS1::LAD::Lad Detector Panel::Harness (Instruments) LOFT Mission::Space

SS1::LAD::Lad Detector

Panel::Modules (21 per panel)

Segment::Satellite::PLM::instruments

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☆★ ☆

Error

4. Budgets & Reports

Power & Data Link Budget - Modelling:

- Implicit product structure:
 - Modelling of DiscreteStateDefinitions
 - ValuePropertyValues expected in 'leaf' states in a required states hierarhy
- Explicit product structure:
 - Explicit modelling of RequiredState relationships

 only possible on occurrence level with multiplication of efforts!



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4. Budgets & Reports

Power & Data Link Budget - Output:

- Value aggregation along required states tree for states of selected root element
- Chart of direct root child element contributions to root state values
- Dynamic HTML tree-table:
 - Expand/Collapse all nodes
 - Errors visible for expanded nodes
 - Column filtering
- ✤ Fixed Layout (non-HTML):
 - Based on cross-tab
 - Hierarchy through: coloring and level

Power Bu	dget (watt)								
Jopend Al	Element	Sat_Calibration_Mode	Set_Launch_Mode	Sat_Orbit_Meintenance_Mode specified: 300.00	Sat_Science_Mode required: 400.00, specified: 500.00	Sat_Survival_Mode	Level	Qualified Name	Errors
	 ní čistovstí 	387.80	190.00	279.80	337.00	199.00	0	Spacecraft	Manatching computed an specified values for state Sal, Onto, Manatonice, M Manatching computed an specified values for state Sal, Science, Model
1	• 👩 payload	200.00	0.00	50.00	150.00	50.00	1	Spacecraft payload	
2	• cd platform	187.80	100.00	229.80	187.80	140.00	1	Spacecraft platform	
21	o m accs	59.80	0.00	59.80	59.80	40.00	2	Spacecraft:platform:accs	
2.1.1	• cd gps	9.80	0.00	9.00	9.80	0.00	3	Spacecraft platform accs gps	
212	• cd mags	0.00	0.00	0.00	0.00	1.00	3	Spacecraft platform accs mags	
2.1.3	O [[] mitqs	10.00	0.00	10.00	10.00	10.00	3	Spacecraft platform aces intes	
2.1.4	• cd rws	28.00	0.00	28.00	28.00	28.00	3	Spacecraft platform accs rws	
215	O (c) star tracker	12.00	0.00	12.00	12.00	0.00	3	Spacecraft platform accs star tracker	
2.1.6	O [[] sun sensor	0.00	0.00	0.00	0.00	1.00	3	Spacecraft platform accarsun sensor	
2.2	• m propulsion	0.00		42.00	0.00	0.00	2	Spacecraft platform propulsion	
23	O [j] thermal control	128.00	100.00	128.00	128.00	100.00	2	Spacecraft platform thermal control	



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4. Budgets & Reports

Annotation Reports:

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- Supported for all kind of Annotations on: ElementDefinition, ElementUsage, ElementOccurrence
- Element-centric: show how many elements are annotated through a given kind of annotation, not how many annotations there are (single annotation assigned to 3 elements counted 3 times)
- Summary report for all annotations and all elements
- Detailed report for selected annotation kind(s)

Element Type	Element Qualified Name	Annotation	Annota	tion Annotation	Annotation	Annota
		Туре	Nam	e Title	Classification	Descrip
ElementDefinition						
1() layers MLI on tower					
		CR				
					minor	CR test
					major	CR test
	Total CR's:	2	major:	1	minor: 1	
		NCR				
					minor	NCR tes
					major	NCR tes
	Total NCR's:	2	major:	1	minor: 1	
		PR				
					minor	PR test
		_			major	PR test
	Total PR's:	2	major:	1	minor: 1	
		RFD	.			
					major	RFD tes
	T (1959)				minor	RFD tes
	Total RFD's:	2	major:	1	minor: 1	
		RFW	1			
					minor	RFW tes
	Tetal BEIM	0	L		major	RFW tes
	Total RFW's:	2	major:	1	minor: 1	
		SPR	1			long .
			L		major	SPR tes
	T-t-LODD'-	0	L		Iminor	SPR tes
	Total SPR's:	2	major:	1	minor: 1	
	Total element Annotations:	12	major:	5	minor: 6	

RID Statistics:

Element Type	Element Qualified Name	Total	Major	Minor
lementDefinition				
	Chemical Propulsion Subsystem	2	1	1
	Miscellaneous	1	1	0
	Piping (with fittings)	1	1	0
	Stand-Off	1	1	0
	Structures Subsystem	1	1	0
	WP on LAD box_radiators	1	1	0
	ElementDefinition Totals:	7	6	1
lementOccurrence				
	LOFT Mission::Space Segment::Satellite::SVM::attitude and Orbit Control SS1	1	0	1
	ElementOccurrence Totals:	1	0	1
lementUsage				
	Satellite::WP on LAD box_radiators	1	1	0
	Satellite::WP on SVM radiator	2	1	1
	Satellite::/WP on top box radiator	1	1	0
	ElementUsage Totals:	4	3	1
	Global Totals:	12	9	3







4. Budgets & Reports

DEMO

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Modelling for Component Libraries:

- Sample model based on SimVis, CDF models (LOFT), VSEE models (GravitySat_v12)
- Focus on implicit product structure including state definitions, categories and associated value properties
- Generic EngineeringDataCategory for (budget) computations:
 - Hardware: mass
 - Equipment (defines states): power, data link
 - Sensor (extends Equipment, defines pointing)





6. Summary and Conclusions

Summary

- Implementation of data exchange between OCDT and VSEE available in both directions
- Technical budgets developed and validated with a number of models from CDF and VSD
- Annotation reports developed for basic annotations reporting
- Component library prototype model developed to aid further development of library functionality in the SSDE



6. Summary and Conclusions

Next Steps

- Consolidate the system engineering meta-models and frameworks towards enabling end-to-end, model-based engineering approaches across all mission phases
- Develop consolidated tooling infrastructure, enabling seamless modelling, tailored to a given mission phase
- Focus on usability and usefulness to ensure adoption by system engineers without knowledge of formal modelling languages and frameworks

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Telespazio VEGA Deutschland GmbH, Europaplatz 5 64293 Darmstadt, Germany www.telespazio-vega.de