







Journée Thématique "Validation des architectures de Système via les modèles MBSE-MBSA"

« Intégration des approches MBSE/MBSA pour la prévision, le suivi et l'optimisation des performances de systèmes pendant leur cycle de vie: : couplage avec les Data Science » Présentateur ARBARETIER Emmanuel,







1st Part

- APSYS context
- APSYS at a glance
- Simulation Software
 Editor





2nd Part

- MBSA for Performance
 prediction
- MBSE/MBSA for Performance follow up
- And management
- MBSE/MBSA for Performance based architecture validation
- MBSE/MBSA for Performance Optimization
- Conclusion







APSYS secures digital transformation and assures safety



*since 2017 an APSYS company



MBSA in aeronautic Safety prediction

Evaluate an architecture and demonstrate compliance to safety requirements

→Model Based Safety Analysis Example: MBSA

MBSA application

- → MBSE/MBSA may also be the support for predictive or prescriptive maintenance
- MBSE/MBSA may highlight improvement leverages on OR / AOG indicators

MBSA for performance prediction







MBSA in Automotive industry Safety prediction



MBSA for performance prediction

SimfiaNeo



MBSA in Energy industry Safety and Operational Availability



MBSA for performance prediction

SimfiaNeo





MBSA in Railway industry Safety and Operational Availability



MBSA for performance prediction



MBSA for performance follow up and management





MBSA for performance follow up and management





MBSE / MBSA info and model collection during whole Life Cycle

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Development process additional functional hazard trouble shooting operators system design support analysis analysis testability users qualitative SAFETY specification RAMS SAFETY quantitative FAULT TREE demonstration information analysis analysis assessment **RAMS** tasks demonstration data sheet MBSA model & infos design information report Doc / Report Design process MODELS SAFETY FMECA SIMUL RELDIAG

MBSA for performance follow up and management



MBSA for performance follow up and management





Diagnosis / Troubleshooting enhancement

→ Reduce isolation time, Mean Down Tim

Prognosis → Improve Mean Up Time

Predictive Maintenance
→ Reduce Mean Down Time

Prescriptive Maintenance → Reduce Maintenance Cost







- ✓ Use for PSSA/SSA
- ✓ Alternative method





Association Française Système Architecture Validation: Collaborative sharing of content for more relevancy SimfiaNeo







Causal dependency chains for diagnosis efficiency and precision



Dysfunctional propagation chains

Through dependancy logical equations and discrete state automata



Step-by-step diagnosis for verification or discrimination





MBSA for architecture validation

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System



Model-checking: a new way to validate design contents



Classically, we compare MCS or FT to our understanding of the system.

Now, we can directly check the behavior of the system Constraints verification

- Reachability of dangerous states from the initial state
- Is this state reachable from any other state?
- Can the system be locked in a state?
- Without step limit, without maximal order



Architecture Model Validation and Qualification **SimflaNeo**

Requirement

 Can be linked to any element in the model

- Is defined by a Status
- Modifications are kept

Editing of the	properties of an object Requirement		A ▼ → ▼ A ♥ B E C 2
Requirement	Advanced		
Туре:	functional Subtype:		
Id :	REQ_001		
Name :	Requirement about engine		
Status :			
Statement :	Statement of what the requirement is, including a definition of wether the requirement shall be met, should be met or may be met.	, ,	Engine
Modified On:	2019-01-31 14:58:26 Created On: 2019-01-31 14:57:	45	
?	< Back Next > Finish Ca	incel	
roperties 🔳 I	mages 🛚 🗄 Model Explorer 🔒 AltaRica 🛭 😔 Linked Req	uirement	ts 🕱 🕹 🍫 🕱 🌫 🗸
ent : Engine			
	Name		ategory
2_001	Requirement about engine	Fu	unctional requirements

MBSA for architecture validation

Ouick Access



INCOSE architecture validation through FMECA Simila Neo

Event	Probability	Local effect	Local effect val	Intermediate	Intermediate	Final effect	Final effect
Ø	-	-	-	-	-	-	-
	Exp(1.0E-6)	PowerSupply.o1	failed	PowerSupply.o1	failed	Alarm1	loss
PowerSupply.failure				Alarm1	loss	Alarm2	loss
				Alarm2	loss		
				sensor1.o2	loss		
				relay1.outPower	loss		
				buzzer1.o2	loss		
				sensor2.o2	loss		
				relay2.outPower	loss		
				buzzer2.o2	loss		
	Exp(1.0E-6)	sensor1.o2	loss	sensor1.o2	loss	Alarm1	loss
concort totall acc				Alarm1	loss		
sensorr.totalcoss				relay1.outPower	loss		
				buzzer1.o2	loss		
	Exp(1.0E-6)	sensor1.o2	erroneous	sensor1.o2	erroneous	Alarm1	erroneous
concort orronoousEvent				Alarm1	erroneous		
sensori.enoneousevent				relay1.outPower	erroneous		
				buzzer1.o2	erroneous		



Other relevant extensions of models for validation

- Different type of models functional, physical logical,
- Several viewpoints
- Stored in one model
- Cross viewpoints and cut set
- Express cut set in the viewpoint you want

Generator1 Generator2 GeneratorAux Distribution AC1 Distribution_AC_EMER Distribution_AC2 AC2 Distribution EMER Distribution Distribution Converter1 Converter_EMER Converter2 Distribution_DC1 Distribution_DC_EMER Distribution_DC2 Distribution C2 Distribut EMER Distributio Battery_EMER Battery_Normal Generator2



- New version of model Re-check cutsets through your different viewpoints
- Gain efficiency in cutsets analysis during development iterations and field feedback processing









MBSA for architecture validation

Process Map Bricks design FHA PSSA SSA

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Sce

- Functional breakdown
- Classification
- Effects, detection means, flight crew actions...
- Safety parameters

MBSA for architecture validation



[🔲] Properties 🔀 🔚 Images

📱 01.01.01.A.02 - ETOPS flight with diversion beyond 180 min in polar regic

ntification	▼ Scenario	
enario	Classification	MAJ
	Effects	Depressurization of fuselage (cabin altitude stays below 25000 See <ref sc="">118960</ref> .
		Loss of cabin and F/D temperature control. See <ref sc="">119083</ref> , <ref sc="">119086</ref> .
	Detection Mean	
	Flight Crew Actions	
	Failure Conditions	01.200 - Both packs shut-down (ETOPS flight with diversion
		01.300 - Aircraft depressurization caused by Air Generation S

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Share objects between FHA and SSA for multi criteria architecture validation Similare



Association Française d'Ingénierie Système Operational Performance Simulation Simila Neo

MBSA can be enriched by stochastic simulation

Sophisticated results need the iteration of numerous sequential simulations Events are triggered randomly (depending on their laws)

An event with a high probability is more frequently triggered

Compute the value of one Observer at the end of one simulation

Depending of its type (weighted value, count, date, final value) Depending on the expressions and evolutions of all the variables of the system

Compute a mean value of Observer during all simulations





Spare Part Optimization Flow





MBSA for logistic optimization



Human Ressource Optimization Flow SimilaNeo

Maintenance levels **Operational maintenance :** ML1 User site and its staff (operators) Specialized maintenance : ML2 Intermediate workshops (specialized staff and tools) Industrial maintenance : ML3 Depot or factory of the civil sector

MBSA for logistic optimization

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languages

irlus

ipse

MBSE/MBSA for more added value SIMIC contents supporting performance based architecture validation MBSE / MBSA

- MBSA
 - Altarica
 - Petri networks
 - StateFlow StateCharts
 - ...
- ✓ MBSE
 - ✓ 3DExperience[®],
 - MagicDraw
 - Modelica
 - ••••
- Working on methods to synchronize the different contents

As a conclusion...

pella





Content repository for performance prediction and follow up and management

- Innovative required by performance simulation
 - Capability to produce models of a system and its support system
 - Capability to manage as many mission profile(s) as required
 - Capability to integrate functional / dysfunctional system behavior in every performance production context
- ✓ Support to results analysis, content **document generation**
 - Capability to perform failure simulations
 - Capability to generate FMEA / Fault Tree Analysis / Cut Sets / Sequences
- Customizable and configurable for every performance

As a conclusion...





MBSE / MBSA approach for **SIMI** performance based architecture validation



- Models: functional, dysfunctional, physical...
- RAMS content: FMEA / Fault Tree Analysis / Reliability Diagrams /Cut Sets
- Dedicated Safety content: FHA, SHA, PSSA
- RAMS KPI and other performance KPI
- Documentary contents

As a conclusion...

Behavior

Structure

Requirements