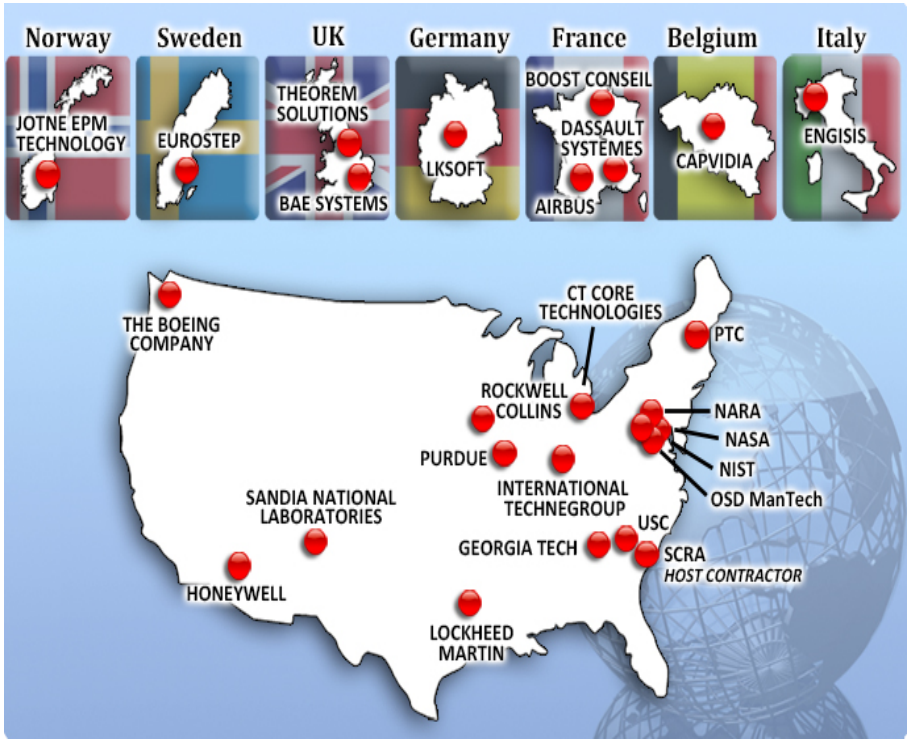
Multi-Domain Systems Engineering Interoperability

INCOSE TIIWG

16 May 2014

Greg Pollari, Rockwell Collins
John Russell, Honeywell
PDES Systems Engineering Project Leads

Joint PDES – SAVI Presentation



PDES, Inc. is an international industry/government/university consortium committed to accelerating the development and implementation of standards enabling enterprise integration and PLM interoperability for its member companies.

Systems Engineering Interoperability

www.pdesinc.org/

The AVSI SAVI Program is a collaboration between aerospace system development stakeholders that aims to advance the state of the art of technologies that enable virtual integration of complex systems.

"Integrate, Analyze, then Build"

http://savi.avsi.aero/

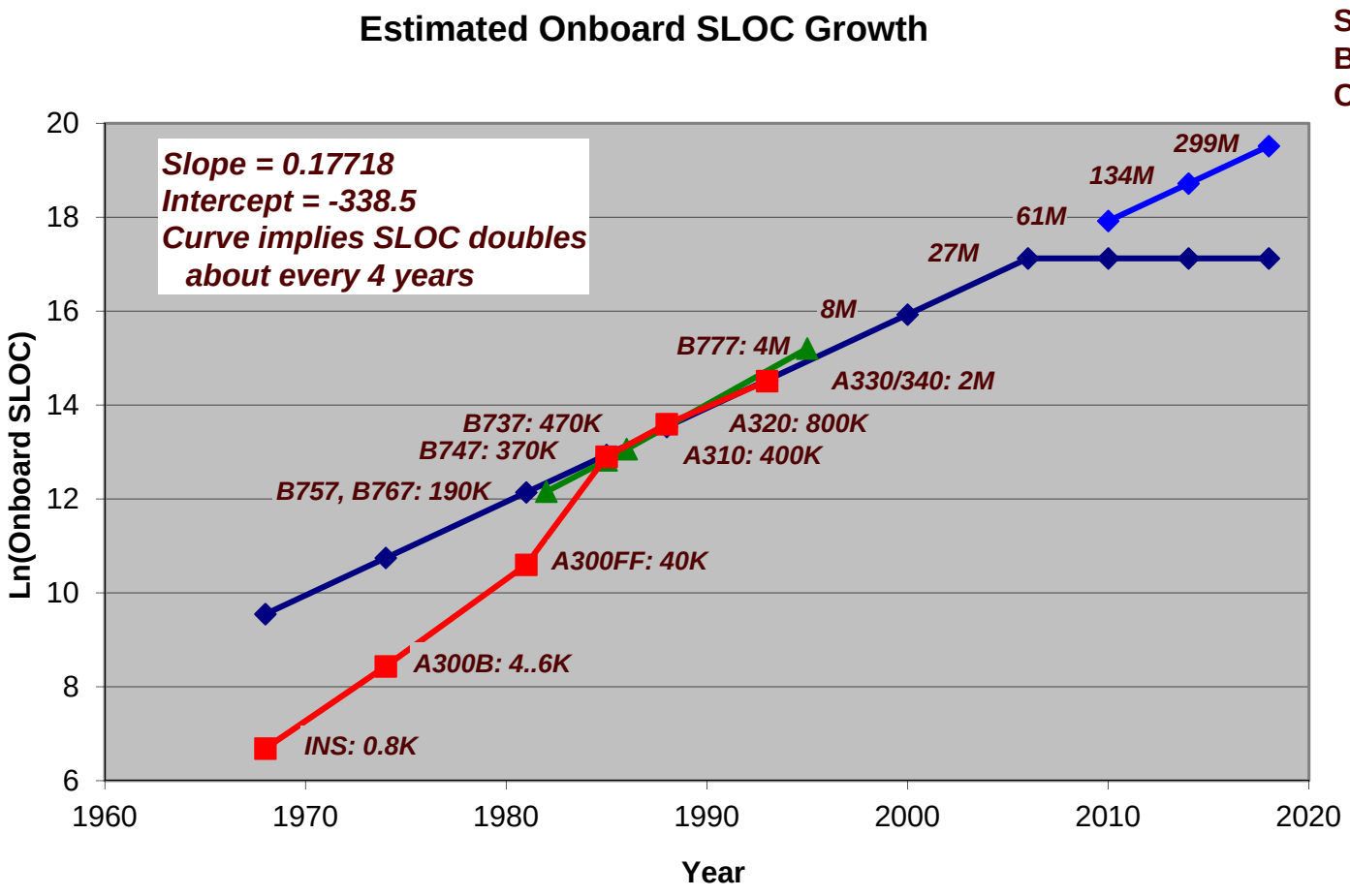
Supply Chain Tiers

Multiple Data Formats

Multiple Data Repositories

THE SITUATION

Systems Are Becoming More Complex



Software Base Cost COCOMO II

$160 B

$7.8 B ← Assumed Affordability Limit

$290 M

$81 M

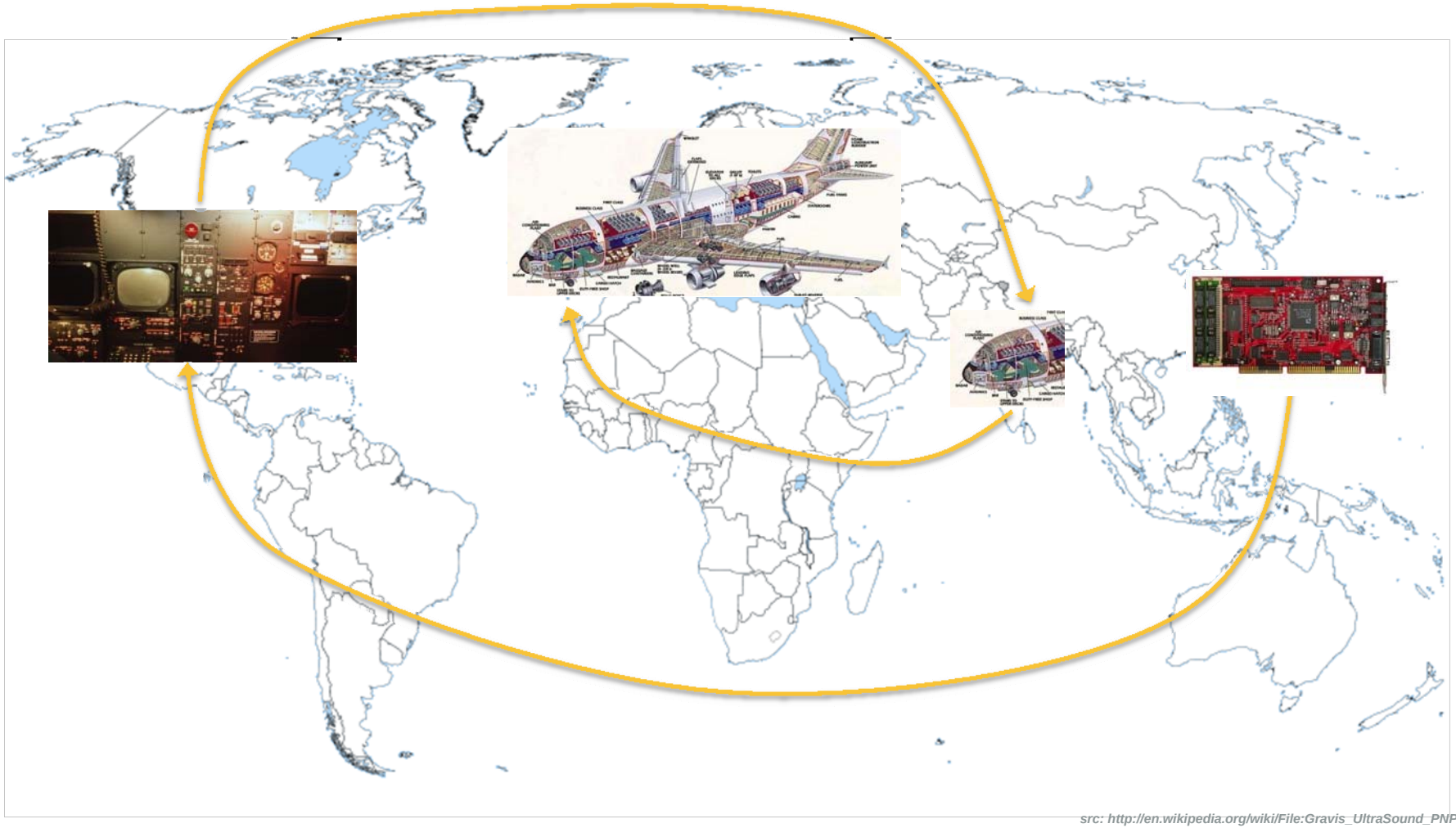
$38 M

Line Fit
Boeing
Airbus
Unaffordable

The line fit is pegged at 27M SLOC because the projected SLOC sizes for 2010 through 2020 are unaffordable. The COCOMO II estimated costs to develop that much software are in excess of $10B.

Airbus data source: J.P. Potocki De Montalk, Computer Software in Civil Aircraft, Sixth Annual Conference on Computer Assurance (COMPASS '91), Gaithersburg, MD, June 24-27, 1991.
Boeing data source: John J. Chilenski. 2009. Private email.

...with complex Development Ecosystems



src: http://en.wikipedia.org/wiki/File:Gravis_UltraSound_PNP.jpg

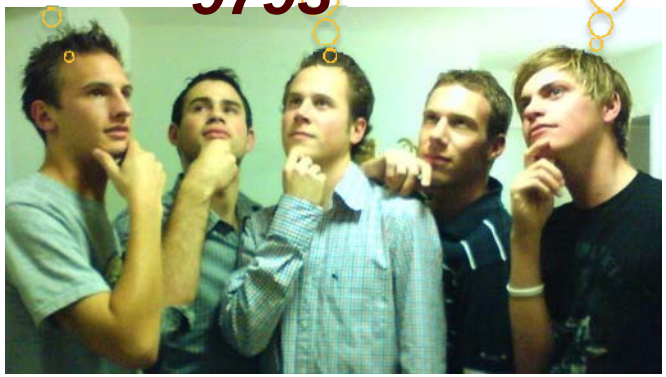
… using dated SE methods

Silo'ed Organizations

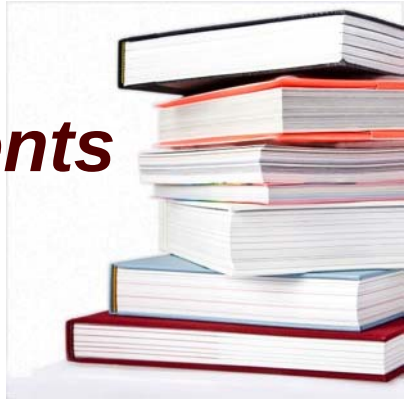
"pi"

3.14

3.14159 265358 9793



Written Requirements



Mismatched Assumptions

Current means of managing complexity have issues

- Operational Models
- [illegible]ls
- [illegible]avior Mo
- Performance Model
- Structural/Component M
- Cost Model
- Safety Model
- Security Model
- Reliability Model
- Maintainability Model
- S[illegible]
- [illegible]odel
- [illegible]ssembly) Models

Indeterminate Change Impact

Incompatible Abstractions

MODEL EXPLOSION

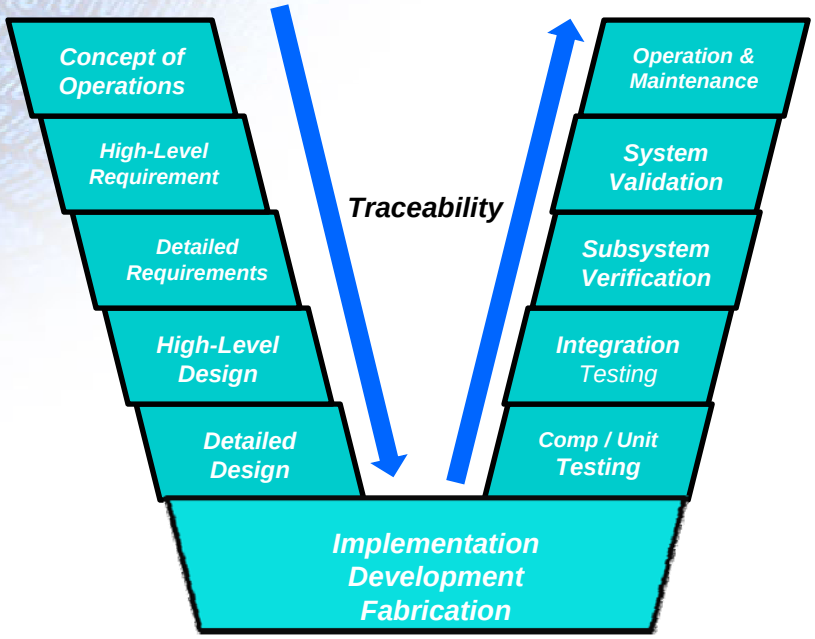
- Modeling Domains
  - Ops/Mission Analysis
  - Syste[illegible]
  - Alg[illegible]
  - Hardw[illegible]
  - Software
  - Logistics Su[illegible]or
  - Manufacturing
  - [illegible]egration & Test
  - Performance Simulation
  - [illegible]gineering Analysis
  - Human System Integration
- System Architecture Model (Integration Framework)
  - Analysis Models
  - Hardware Models
  - Software Models
  - Verification Models

Multiple Truths

Product Development SE Data Exchanges

PDES, Inc.®

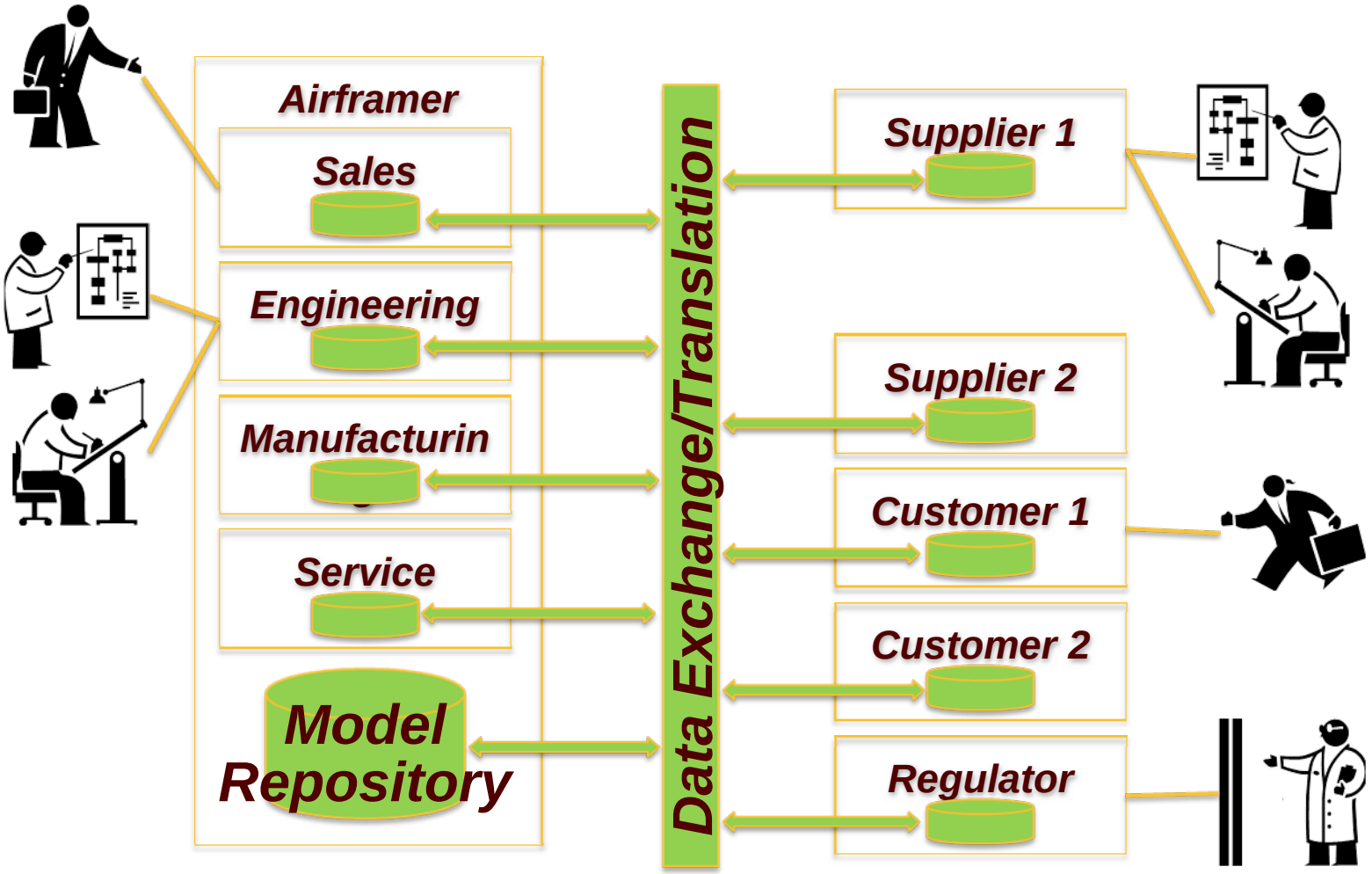
Text	Trend	Models & DB's	Trend	Diagrams	Trend
80%	↓	10%	↑	10%	↑
60%	↓	10%	↑	30%	↑
50%	↓	20%	↑	30%	↑
10%	–	30%	↑	60%	↓
10%	–	40%	↑	50%	↓
20%	↓	40%	↑	40%	↓



Text	Trend	Models & DB's	Trend	Diagrams	Trend
40%	↓	40%	↑	20%	↑
30%	↓	60%	↑	10%	↑
30%	↓	60%	↑	10%	↑
30%	–	65%	↑	5%	↓
20%	–	75%	↑	5%	↓
20%	↓	40%	↑	40%	↓

- MBD / MBE Impacting Systems Engineering Processes
- Percentages Driven by an Organization's MBE Adoption & Maturity
  - **Models exchanges increasing**
  - **Text based requirements will not go away**

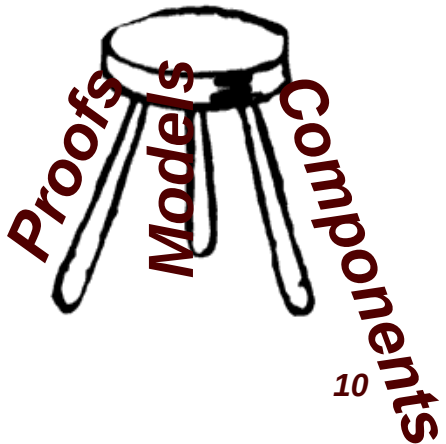
Multiple Groups/Tools/Repositories



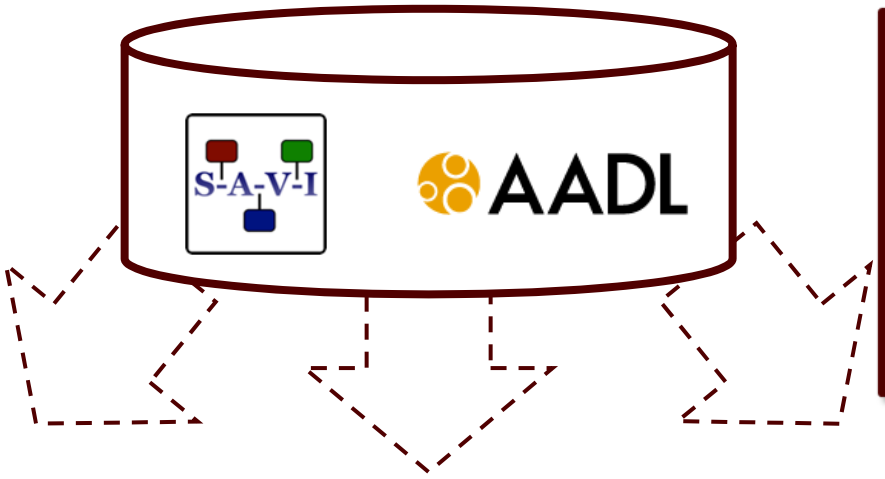
SAVI Objective and Themes

- ***Reduce costs/development time through early and continuous model-based virtual integration***
  - ***Shift to new paradigm** – integrated models rather than documents*
    - *Systems engineering in cross-domain context*
    - *Models provide basis for improvements*
    - *Models promote consistency – "absence of contradictions"*
  - ***Architecture-centric approach** – start with models, but more*
    - *Meld with requirements for traceability*
    - *Facilitate trade studies*
  - ***Virtual Integration** – early and continuous integrated analysis*
    - *Proof-based (consistency checked – but not all with formal models)*
    - *Component-based (hierarchical models)*
    - *Model-based (annotated models)*

Integrate, analyze … then build"



A Rich Architectural Model is Key



Architecture centricity enables generative technologies to support analyses

FHA	FTA	Markov Chain	SPN/SANs	FMEA
• Spreadsheet • Use error propagations	• CAFTA OpenFTA • Use composite behavior • Error flows	• PRISM • Use error flow • Error behavior	• Stochastic Petri Nets and Activity Nets • Use error flow • Error behavior	• Spreadsheet • Error behavior • Propagations

Cross-Domain Linking

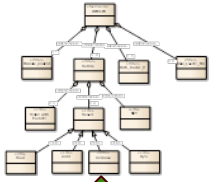
Model Explosion

Increasing Complexity

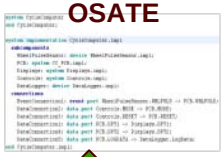
THE MODEL ENVIRONMENT

Models Across the Supply Chain

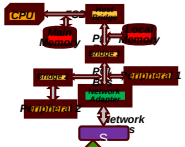
SysML
Enterprise Architect



AADL
OSATE

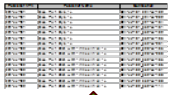


RTES Analysis
ASIIST

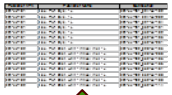


3D Solid Geometry
SolidWorks, NX

Correspondence Pub-Sub
Excel



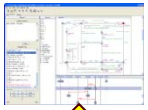
Requirements
DOORS, Excel



Fault Tree
CAFTA

Constraint Analysis
LUTE

Behavior
UPPAAL



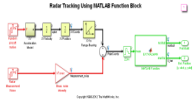
Hazard Table
Excel

FMEA
Excel

Markov Chains
PRISM

SAVI MR/DEL
Standards: PLCS/DEX, STEP, ReqIF, XMI, OSLC, Eclipse
Proprietary: Intentional SW, The Mathworks

Simulink



SCADE

Behavior
Modelica

Proprietary

PDM/PLM
TeamCenter, Enovia, Windchill

ERP

SVN

Eurostep *Share-A-space*®

Requirements Model

A/C Reqts (excerpt)

Requirement	Description	Derived	Traced From
S18-ACFT-R-0009	Aircraft shall have a means to decelerate on the ground in accordance with 14CFR 25.735	14 CFR Part 25.735	Minimum standard required for aircraft certification
S18-ACFT-R-0110	Aircraft shall have autobrake function	Derived	Technological improvements in CAT IIIb auto-landing capability and market research, (report MRS18- XXX) about the customer needs
S18-ACFT-R-0135	Aircraft shall provide an anti-skid function.	Derived	All weather operation and stability of the aircraft during runway
S18-ACFT-R-0184	Aircraft shall have hydraulically-driven brake function	Derived	
S18-ACFT-R-0185	The pilot shall be allowed to override the autobrake function.	14CFR 25.735(c)(2)	

A/C FHA (excerpt)

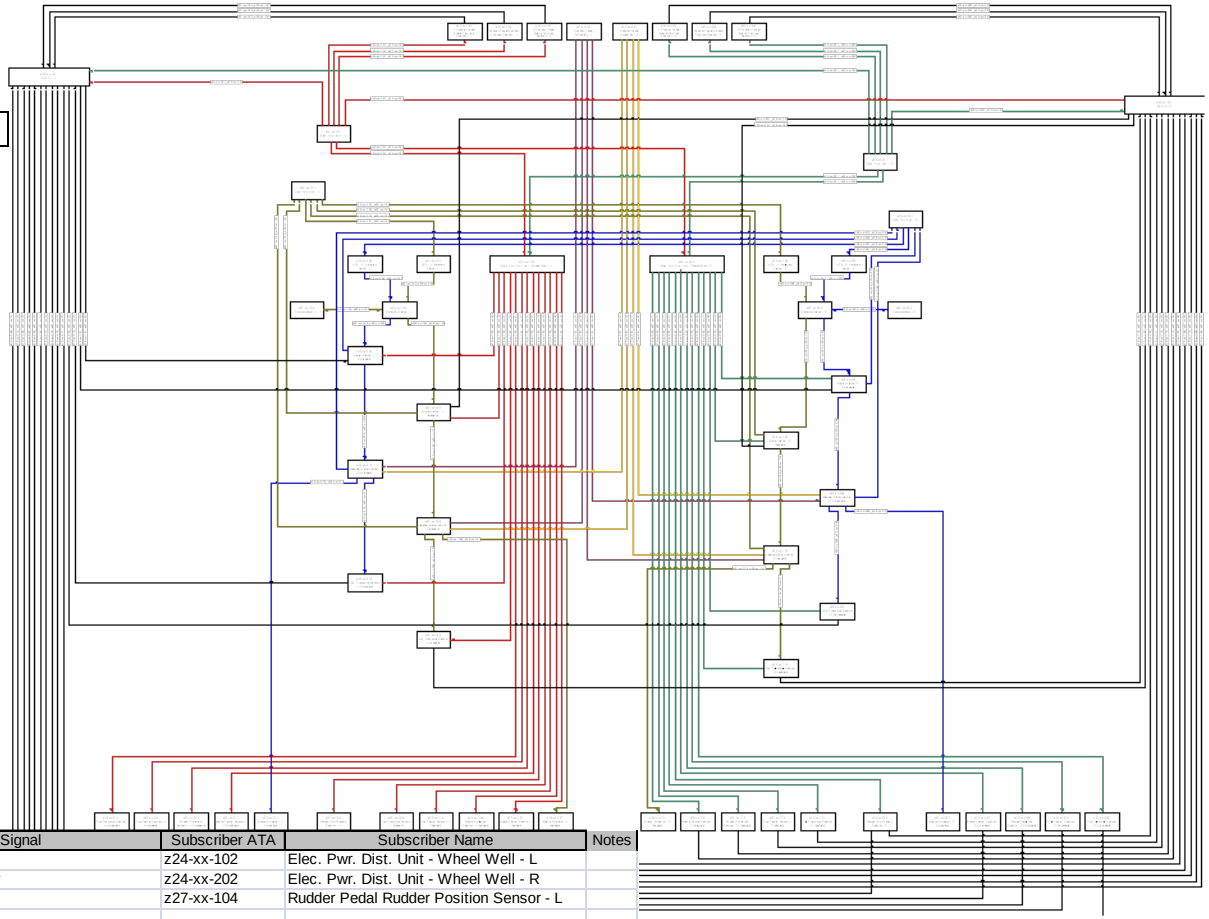
Failure Condition (Hazard Description)	Phase	Effect of Failure Condition on Aircraft/Crew	Classification
Loss of Deceleration Capability	Landing, RTO, Taxi	See Below	See Below
a. Unannunciated loss of Deceleration Capability	Landing, RTO	Catastrophic	Crew is unable to decelerate the aircraft,resulting in a high speed overrun
b. Annunciated loss of Deceleration Capability	Landing	Hazardous	Crew selects a more suitable runway,notifies emergency ground support, and prepares occupants for runway overrun.
c. Unannunciated loss of Deceleration Capability	Taxi	Major	Crew is unable to stop the aircraft on the taxi way or gate resulting in low speed contact with terminal, aircraft, or vehicles.
d. Annunciated loss of Deceleration Capability	Taxi	No Safety Effect	Crew steers the aircraft clear of any obstacles and calls for a tug or portable stairs.

WBS FHA (excerpt)

Function	Failure Condition (Hazard Description)	Phase	Effect of Failure Condition on Aircraft/Crew	Classification	Reference to Supporting Material	Verification
Decelerate Aircraft using Wheel Braking	Total Loss of wheel braking	Landing or RTO	See Below			
	a. Unannunciated loss of wheel braking	Landing or RTO	Crew detects the failure when the brakes are operated. The crew uses spoilers and thrust reversers to the maximum extent possible. This may result in a runway overrun.	Hazardous		S18 Aircraft FTA
	b. Annunciated loss of wheel braking	Landing	Crew selects a more suitable airport, notifies emergency ground support, and prepares occupants for runway overrun. The crew uses spoilers and thrust reversers to the maximum extent possible.	Hazardous	Crew procedures for loss of normal and reserve modes	S18 Aircraft FTA
	Partial Symmetrical Loss of Wheel Braking	Landing or RTO	See below			
	a. Unannunciated partial symmetrical loss of wheel braking	Landing or RTO	The crew detects the failure when the brakes are used. Crew uses available wheel braking, spoilers and thrust reversers available to maximum extent to decelerate the aircraft. The temperature on wheels of the loaded brakes increases and could reach point where wheel/fire failure occurs. Depending on number of brakes lost result could be an overrun.	Major to Hazardous	Additional study required to determine classification	Potentially catastrophic â€" to be confirmed by analysis
	b. Annunciated partial symmetrical loss of wheel braking	Landing	The crew is aware that there is a partial loss of braking before landing. Crew uses wheel braking, spoilers and thrust reversers available to maximum extent to decelerate the aircraft. The temperature on wheels of the loaded brakes increases and could reach point where wheel/fire failure occurs. Depending on number of brakes lost result could be an overrun.	Major		
	Asymmetrical Loss of Wheel Braking	Landing or RTO	See below			
	a. Asymmetrical loss of wheel braking â€" brake system failure only	Landing or RTO	Decrease in braking performance. Tendency to veer off the runway. For braking performance and brake temperature the effects are the same as partial brake loss above. The crew keeps the aircraft on the runway by using rudder at high speed and nose wheel steering at low speed. Consequences are TBD pending results of the justification studies.	Potentially catastrophic â€" to be confirmed by analysis	Additional studies required to determine classification.	
	b. Asymmetrical loss of wheel braking and loss of rudder or nose wheel steering	Landing or RTO	Decrease in braking performance. Tendency to veer off the runway. For braking performance and brake temperature the effects are the same as partial brake loss above. The crew cannot maintain runway centerline and results in an offside excursion.	Hazardous		S18 Aircraft FTA
	Inadvertent wheel brake application		See below			

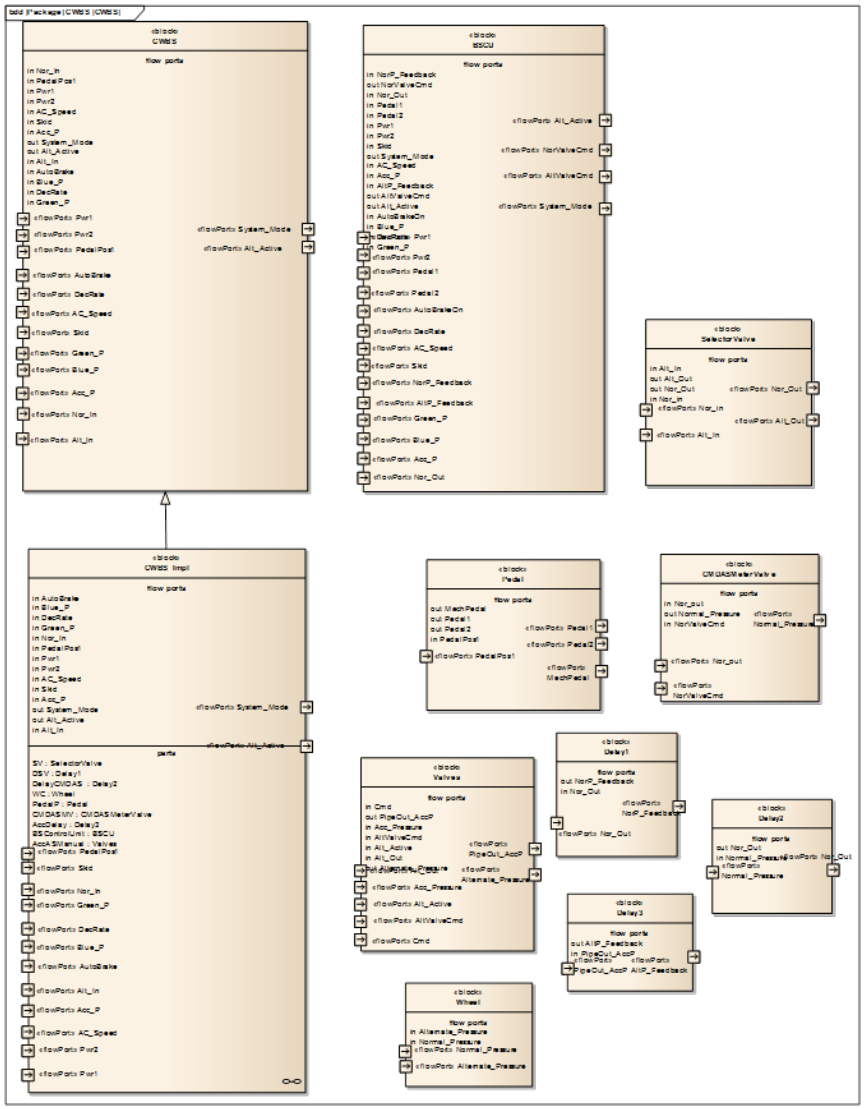
Publisher/Subscriber Model

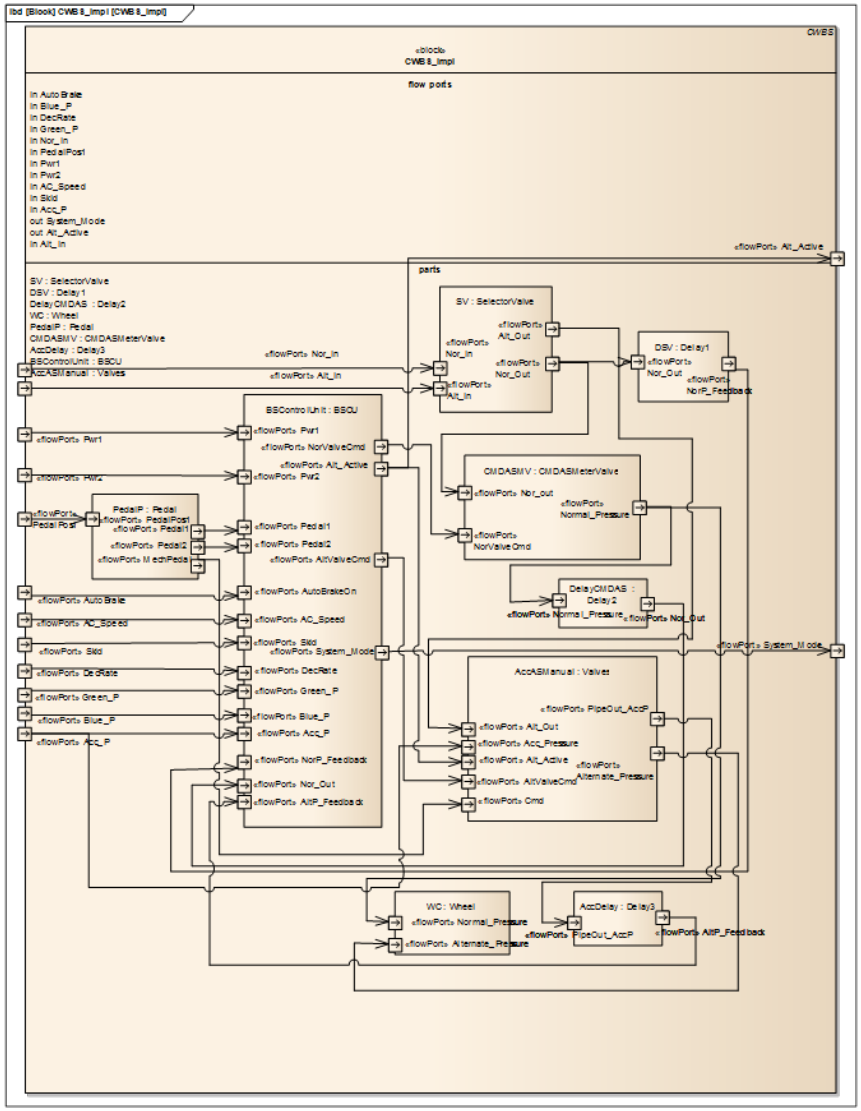
ATA	Name
z24-xx-101	Elec. Pwr. Sys. - L
z24-xx-102	Elec. Pwr. Dist. Unit - Wheel Well - L
z24-xx-201	Elec. Pwr. Sys. - R
z24-xx-202	Elec. Pwr. Dist. Unit - Wheel Well - R
z27-xx-101	Rudder Pedal Assembly - L
z27-xx-104	Rudder Pedal Rudder Position Sensor - L
z27-xx-201	Rudder Pedal Assembly - R
z27-xx-204	Rudder Pedal Rudder Position Sensor - R
z29-xx-101	Hyd. Pwr. Sys. - L
z29-xx-102	HPS - L Isolation Valve - L
z29-xx-103	Selector Valve - L
z29-xx-104	Accumulator - L



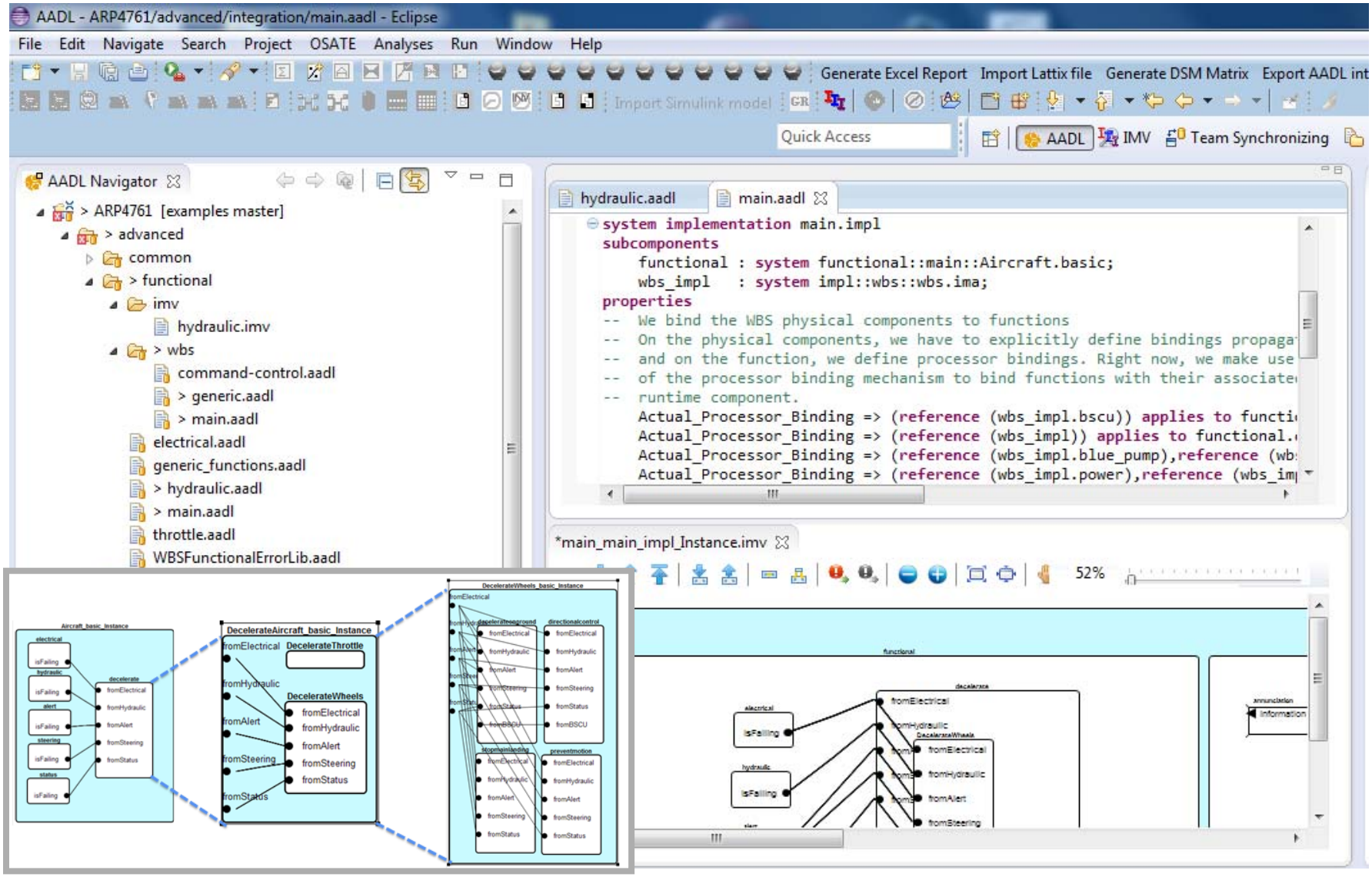
Publisher ATA	Publisher Name	Connection	Signal	Subscriber ATA	Subscriber Name	Notes
z24-xx-101	Elec. Pwr. Sys. - L	z24-xx-101_z24-xx-102	Primary Power	z24-xx-102	Elec. Pwr. Dist. Unit - Wheel Well - L	
z24-xx-101	Elec. Pwr. Sys. - L	z24-xx-101_z24-xx-202	Secondary Power	z24-xx-202	Elec. Pwr. Dist. Unit - Wheel Well - R	
z24-xx-101	Elec. Pwr. Sys. - L	z24-xx-101_z27-xx-104	Main Power	z27-xx-104	Rudder Pedal Rudder Position Sensor - L	
z27-xx-101	Rudder Pedal Assembly - L	z27-xx-101_z29-xx-110	Mechanical Power	z29-xx-110	Manual Meter Valve - R Inboard	
z27-xx-101	Rudder Pedal Assembly - L	z27-xx-101_z29-xx-206	Mechanical Power	z29-xx-206	Manual Meter Valve - R Outboard	
z29-xx-101	Hyd. Pwr. Sys. - L	z29-xx-101_z29-xx-102	Hyd. Power (Pressure)	z29-xx-102	HPS - L Isolation Valve - L	
z29-xx-103	Selector Valve - L	z29-xx-103_z29-xx-104	Hyd. Power (Pressure)	z29-xx-104	Accumulator - L	Bi
z29-xx-105	Meter Valve - L Inboard	z29-xx-105_z29-xx-101	Hyd. Power (Return)	z29-xx-101	Hyd. Pwr. Sys. - L	
z32-xx-101	BSCU - L	z32-xx-101_z29-xx-205	Meter Valve – R Outboard Command	z29-xx-205	Meter Valve - R Outboard	
z32-xx-101	BSCU - L	z32-xx-101_z29-xx-209	Meter Valve – L Outboard Command	z29-xx-209	Meter Valve - L Outboard	
z32-xx-109	Weight-On-Wheels Sensor - L	z32-xx-109_z32-xx-101	Weight-On-Weels Sensor – L Reading	z32-xx-101	BSCU - L	
z32-xx-109	Weight-On-Wheels Sensor - L	z32-xx-109_z32-xx-201	Weight-On-Weels Sensor – L Reading	z32-xx-201	BSCU - R	

SysML Model

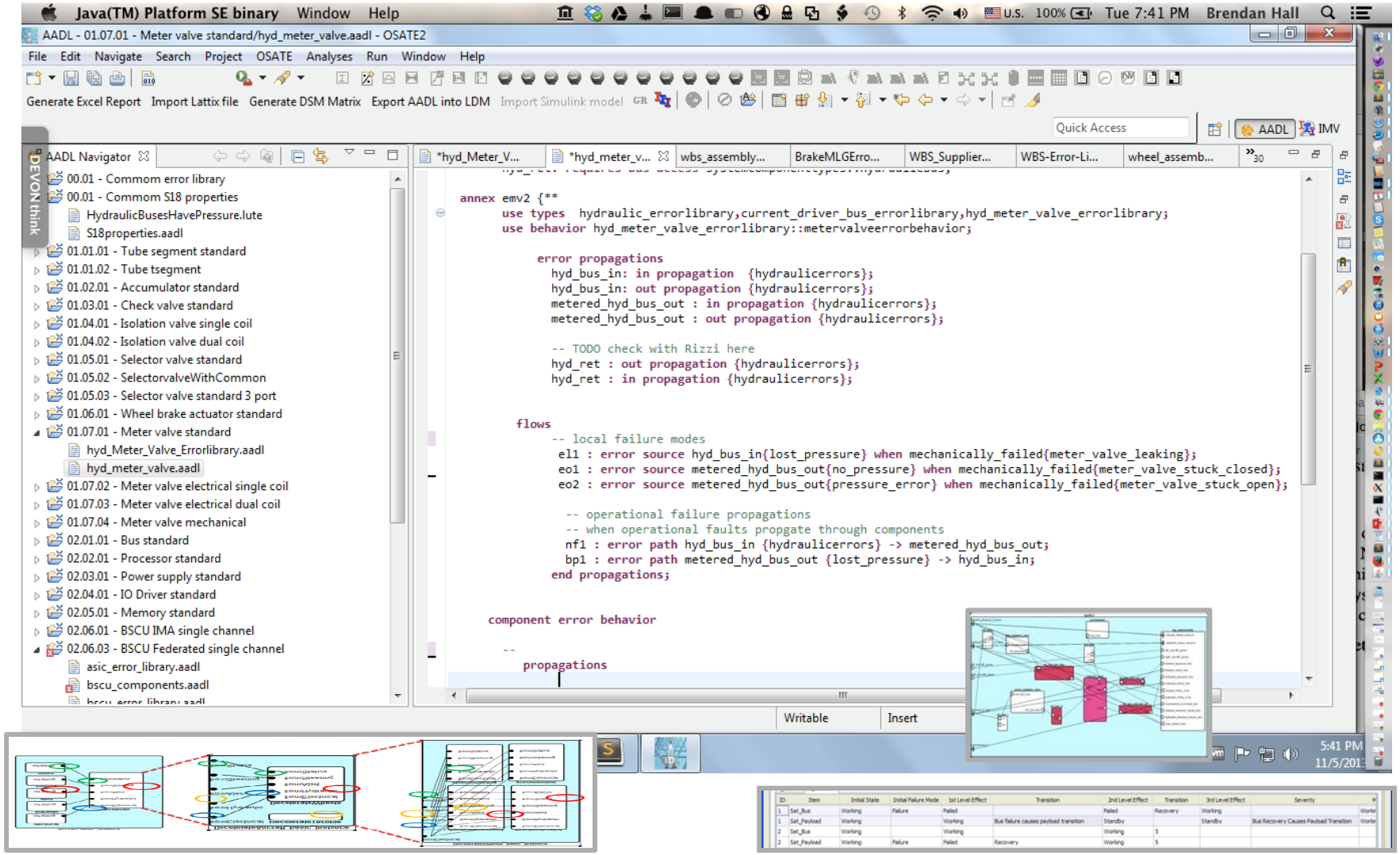




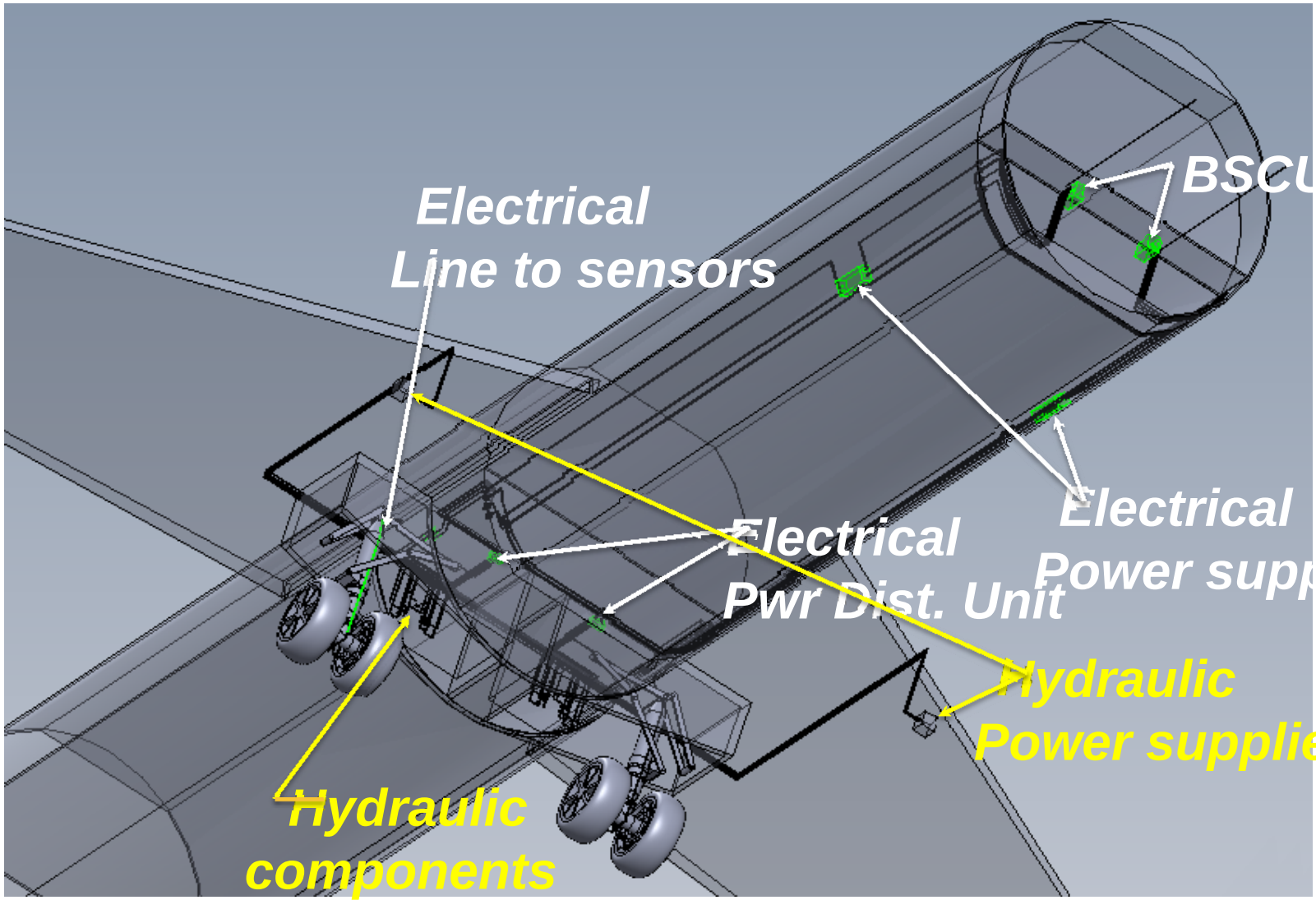
System & SW Architecture with AADL



Architecture Fault Model



Solid Geometry Model



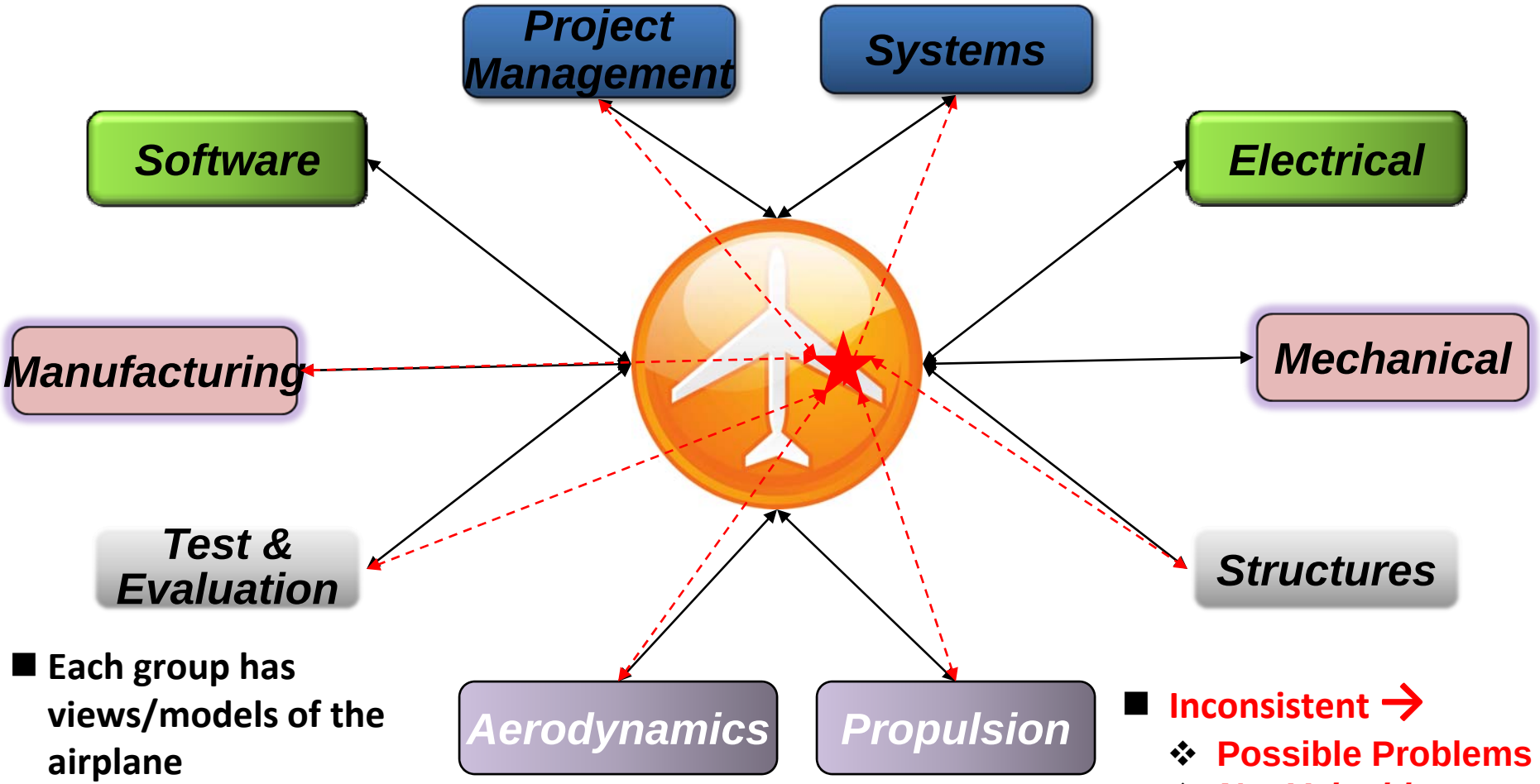
Requirements Exchange

Inter-Model Dependencies

Inter-Model Consistency Checks

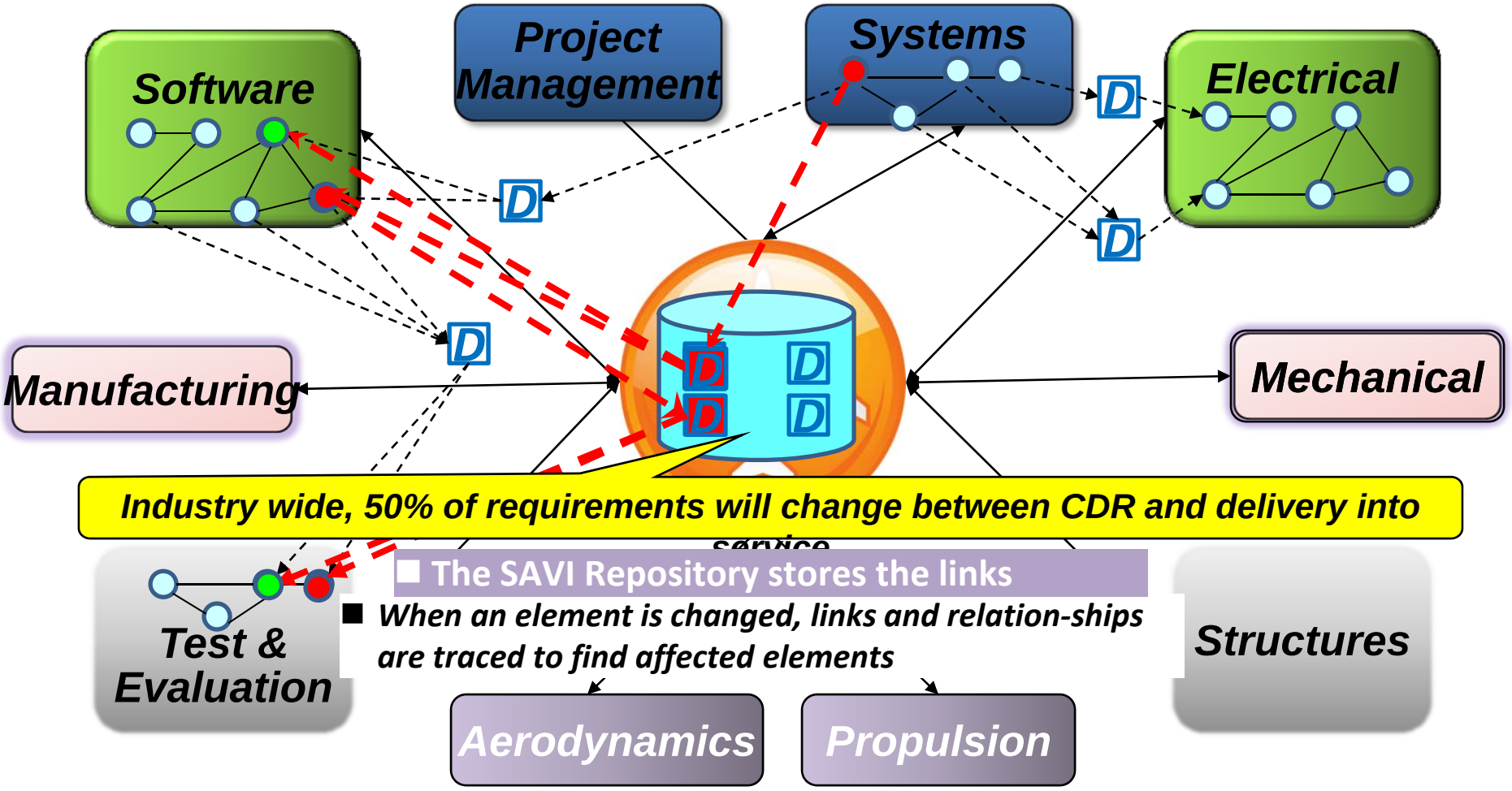
USE CASES

Inter-Model Consistency



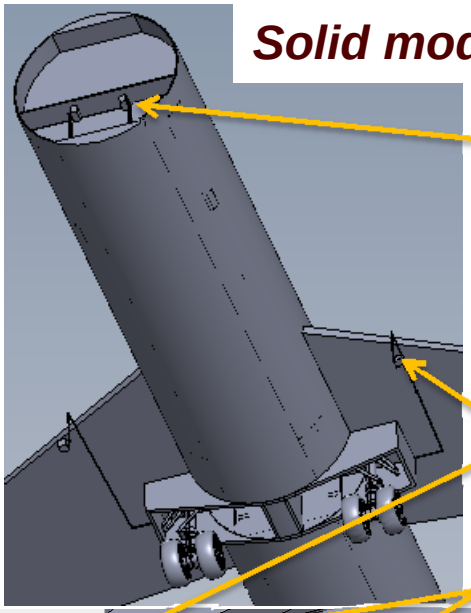
- Each group has views/models of the airplane
- Relations/Dependencies exist between the views/models used
- Inconsistent →
  - Possible Problems
  - *Not Valuable*

Dependencies Are Key



- Each dependency must be identified, *tracked and checked throughout the life cycle*

Inter-Model Consistency Checks

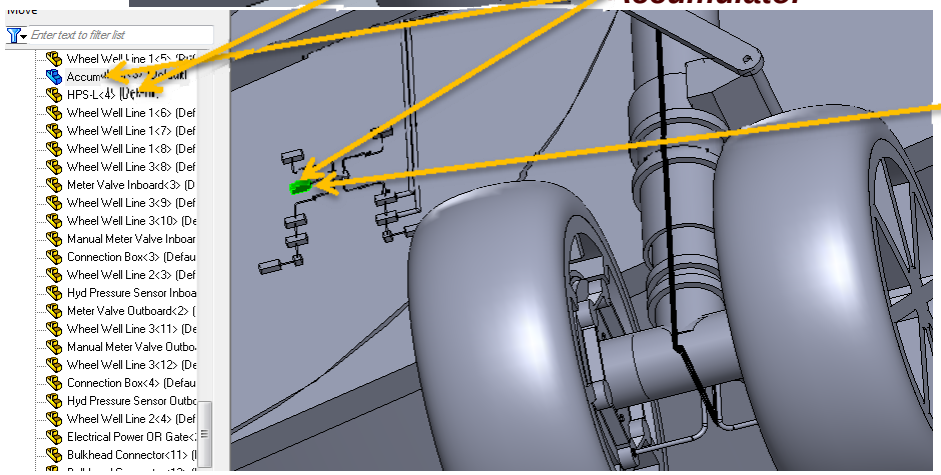


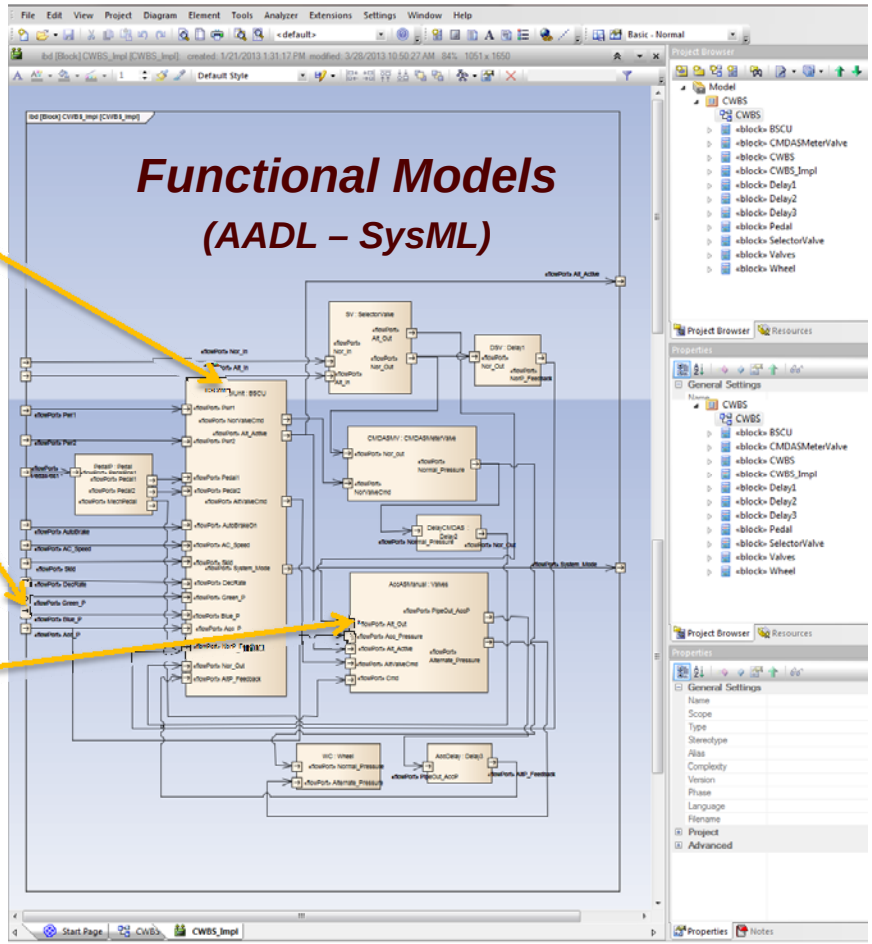
Solid models

BSCU

Hyd power supply

Accumulator





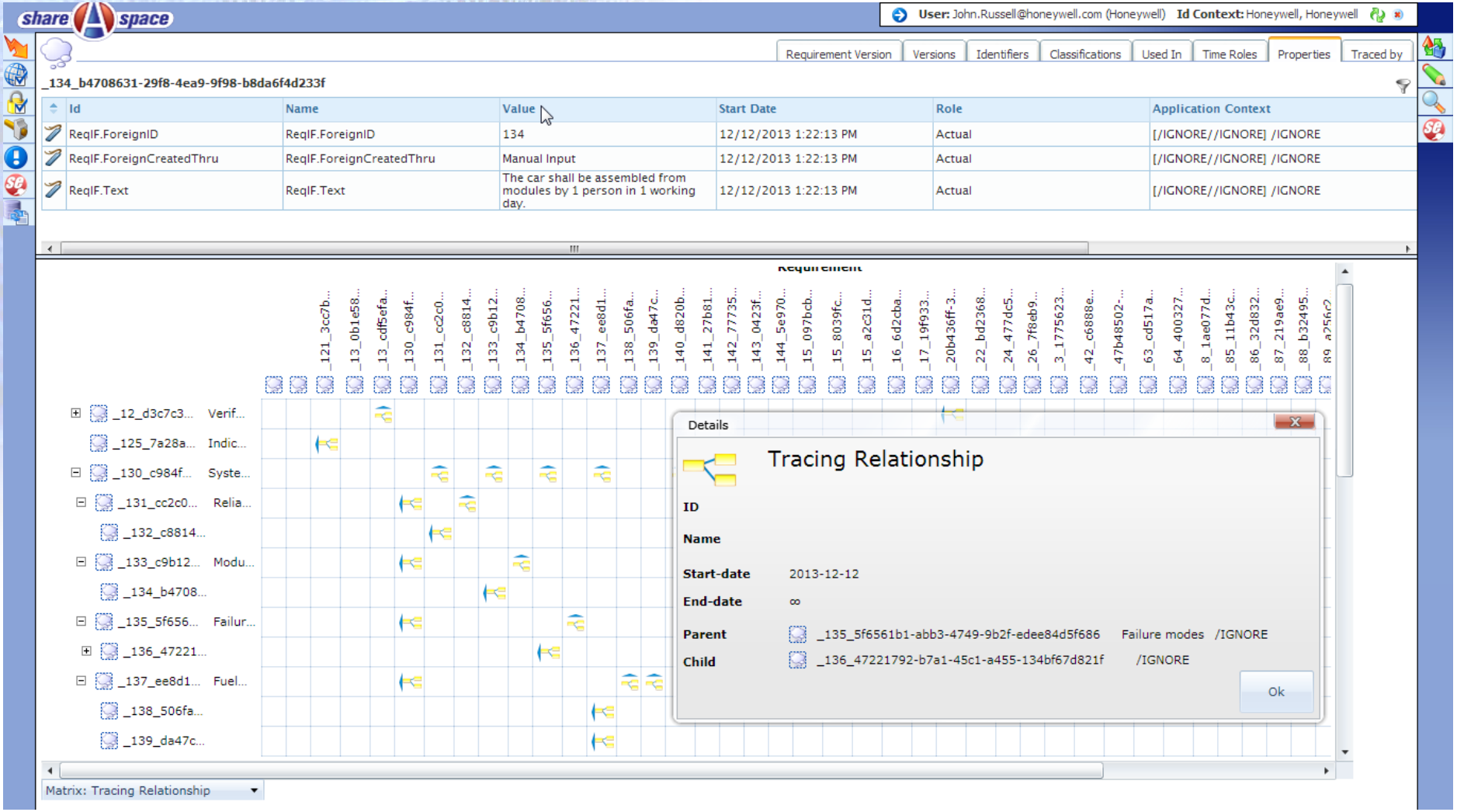
Functional Models

(AADL – SysML)

DEMONSTRATIONS

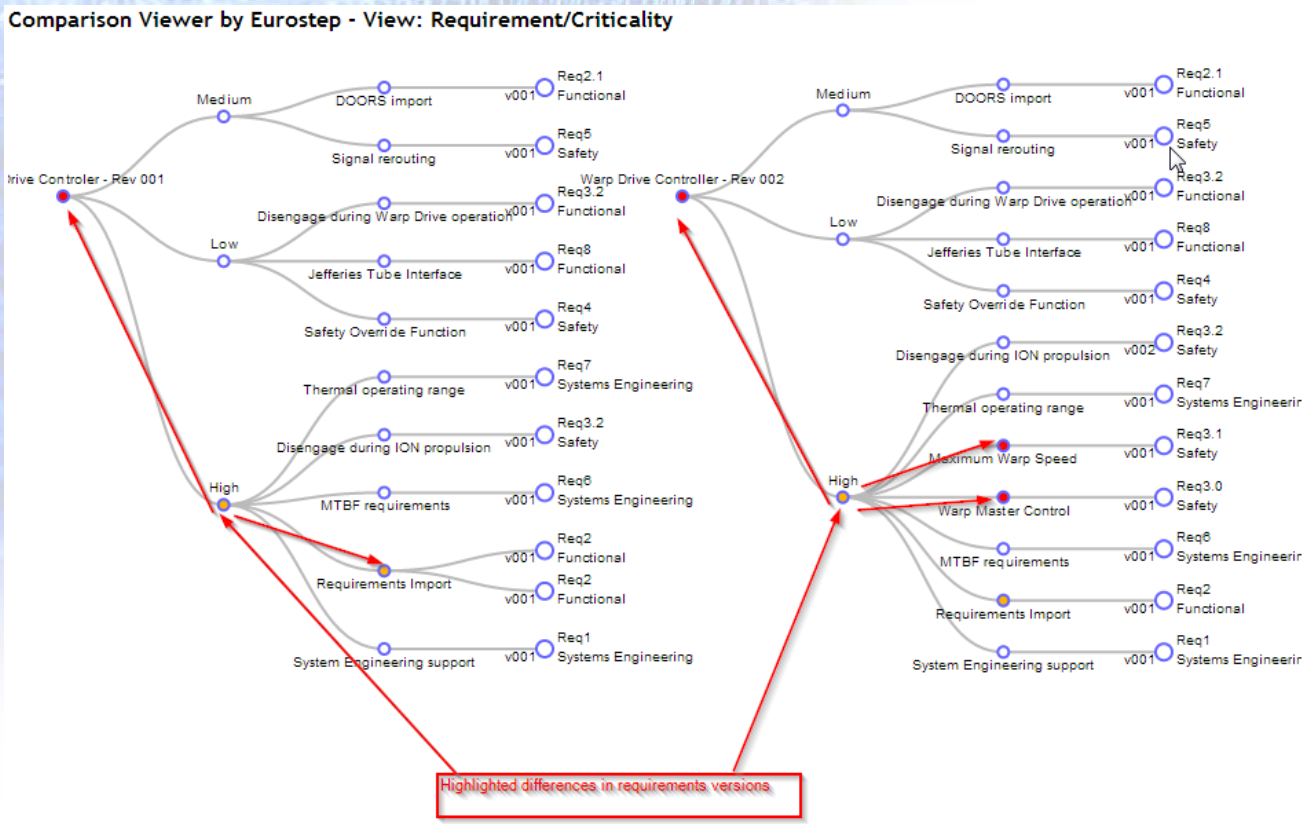
DOORS ReqIF 9.5 Import to Share-A-Space 7.7

PDES, Inc.®



PDES, Inc.®

POC Comparison Tool



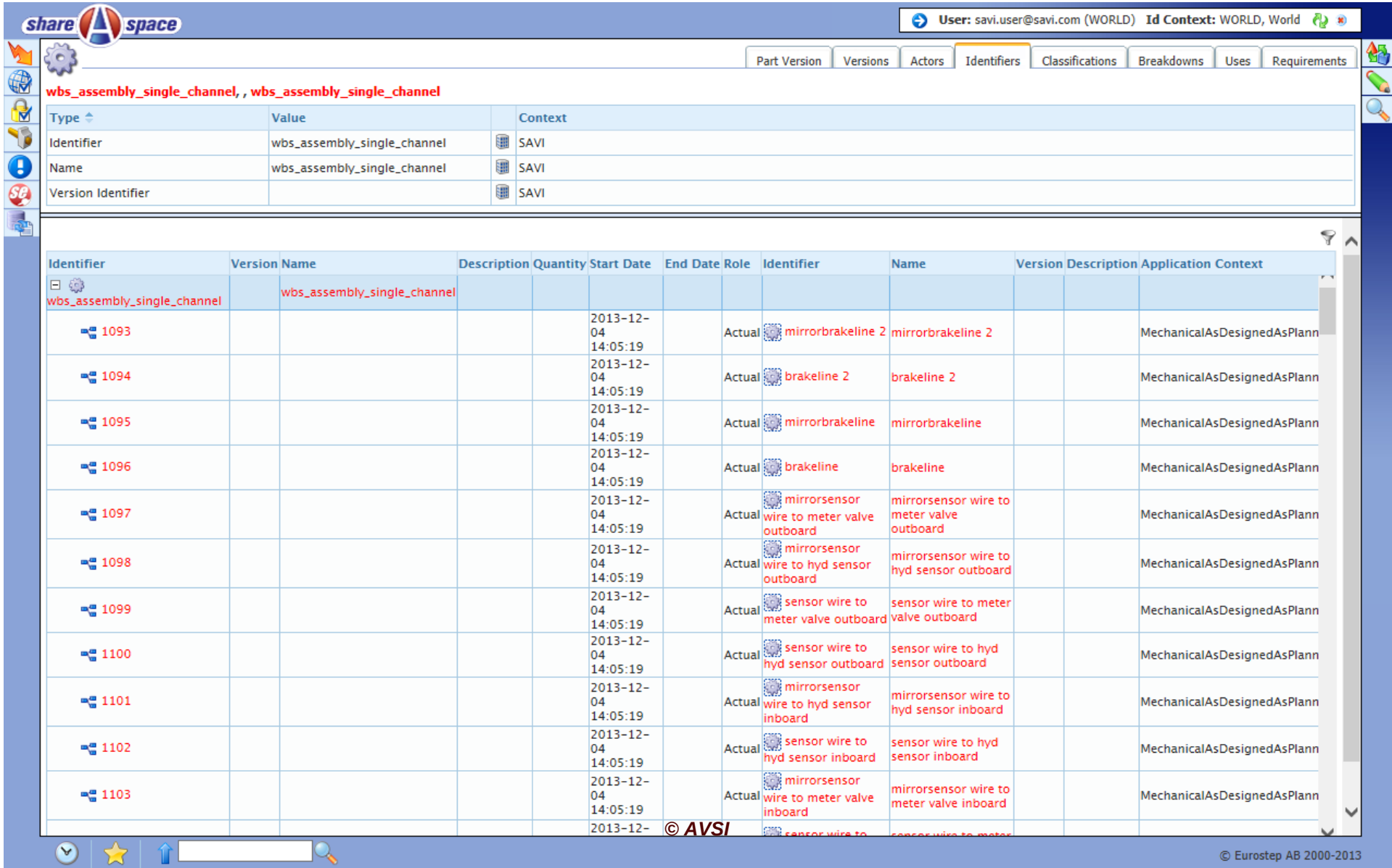
ReqID/Requirement Name/Criticality
Requirement Name/ReqID
Line/Requirement Name
ReqID/Requirement Name/Version
Traced From/Source Document/Requirement Name
Requirement - sorted by name
Requirement/Criticality

Line: 9
name: Signal rerouting
Version: v001
ReqID: Req5
ParentID: 0
Description: The solution shall provide easy physical and logical access to anyone named Scotty to reroute output signals to be used for or controlled by other ship functions
Criticality: Medium
Release: undefined
TracedFrom:
SourceDocument: Script Guidelines
Type: Safety

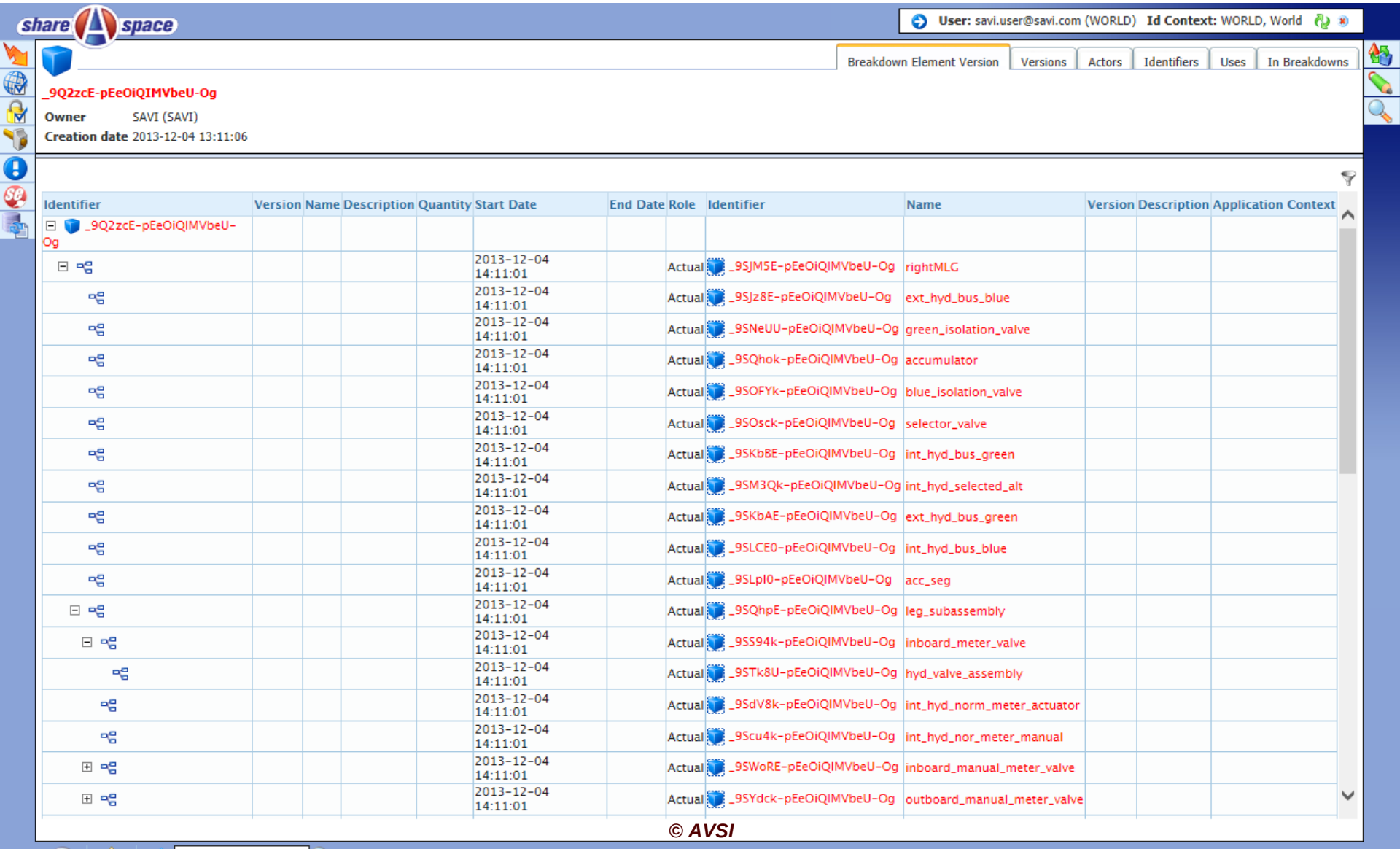
General Need for Comparisons of Versions – POC Discussion Topics

- ***What are the use cases?***
- ***What input formats should be supported?***
- ***How will this approach fit for large datasets? – human factors will be a major consideration***
- ***Are there better approaches?***

Structure imported from STEP files



Structure imported from AADL file



Identifier	Version	Name	Description	Quantity	Start Date	End Date	Role	Identifier	Name	Version	Description	Application Context
_9Q2zcE-pEeOiQIMVbeU-Og												
					2013-12-04 14:11:01		Actual	_9SJM5E-pEeOiQIMVbeU-Og	rightMLG			
					2013-12-04 14:11:01		Actual	_9SJz8E-pEeOiQIMVbeU-Og	ext_hyd_bus_blue			
					2013-12-04 14:11:01		Actual	_9SNeUU-pEeOiQIMVbeU-Og	green_isolation_valve			
					2013-12-04 14:11:01		Actual	_9SQhok-pEeOiQIMVbeU-Og	accumulator			
					2013-12-04 14:11:01		Actual	_9SOFYk-pEeOiQIMVbeU-Og	blue_isolation_valve			
					2013-12-04 14:11:01		Actual	_9SOsck-pEeOiQIMVbeU-Og	selector_valve			
					2013-12-04 14:11:01		Actual	_9SKbBE-pEeOiQIMVbeU-Og	int_hyd_bus_green			
					2013-12-04 14:11:01		Actual	_9SM3Qk-pEeOiQIMVbeU-Og	int_hyd_selected_alt			
					2013-12-04 14:11:01		Actual	_9SKbAE-pEeOiQIMVbeU-Og	ext_hyd_bus_green			
					2013-12-04 14:11:01		Actual	_9SLCE0-pEeOiQIMVbeU-Og	int_hyd_bus_blue			
					2013-12-04 14:11:01		Actual	_9SLpI0-pEeOiQIMVbeU-Og	acc_seg			
					2013-12-04 14:11:01		Actual	_9SQhpE-pEeOiQIMVbeU-Og	leg_subassembly			
					2013-12-04 14:11:01		Actual	_9SS94k-pEeOiQIMVbeU-Og	inboard_meter_valve			
					2013-12-04 14:11:01		Actual	_9STk8U-pEeOiQIMVbeU-Og	hyd_valve_assembly			
					2013-12-04 14:11:01		Actual	_9SdV8k-pEeOiQIMVbeU-Og	int_hyd_norm_meter_actuator			
					2013-12-04 14:11:01		Actual	_9Scu4k-pEeOiQIMVbeU-Og	int_hyd_nor_meter_manual			
					2013-12-04 14:11:01		Actual	_9SWoRE-pEeOiQIMVbeU-Og	inboard_manual_meter_valve			
					2013-12-04 14:11:01		Actual	_9SYdck-pEeOiQIMVbeU-Og	outboard_manual_meter_valve			

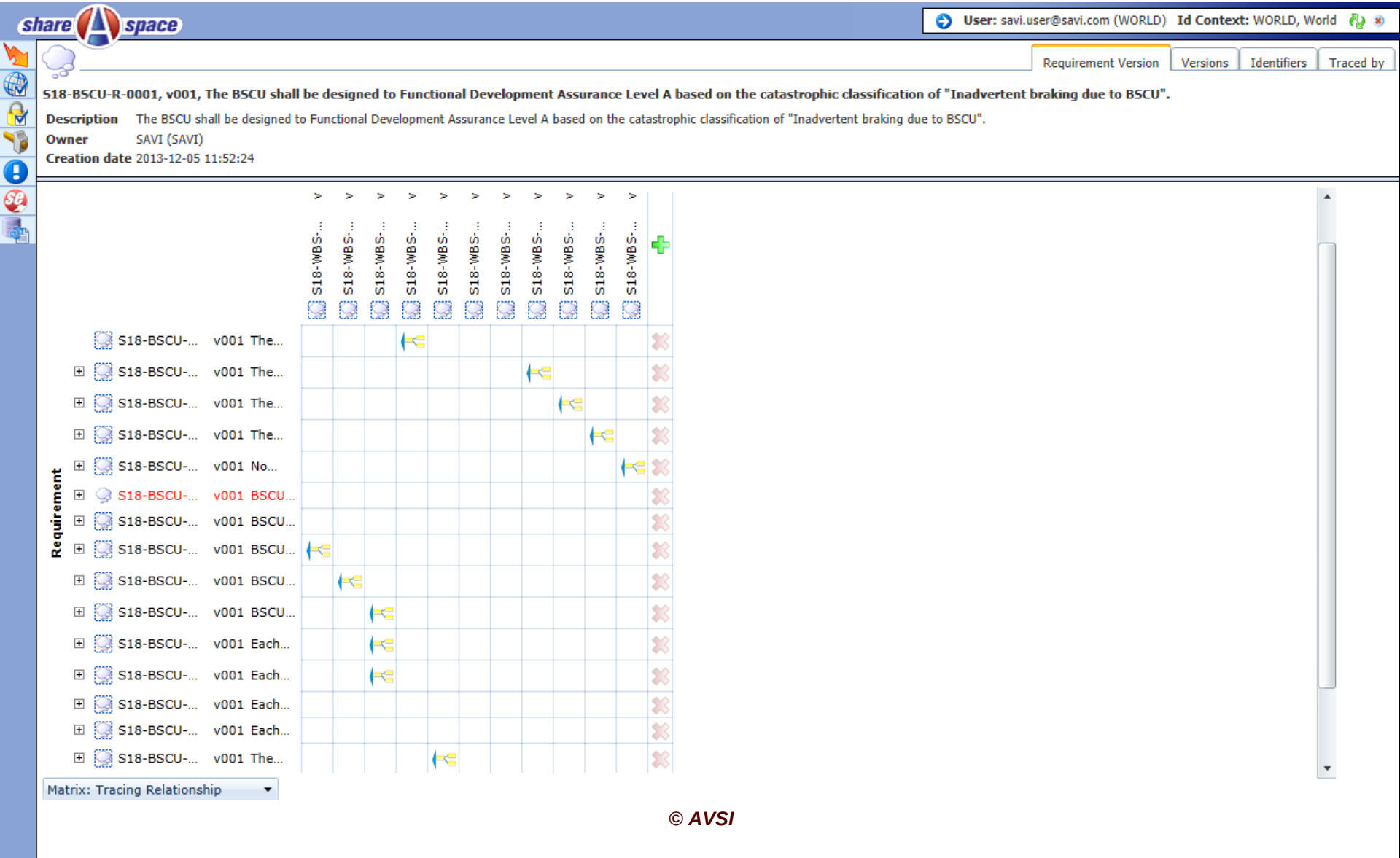
Requirements imported from Excel

Share-A-space 1.7.0.25668 - Internet Explorer

http://savi.share-a-space.com/Share-A-space/browse/ExternalWindow?externalTargetAction=TreeTable/InitLegacy&selectedObjectId=abf7d743-9f93-4f92-862b-4064637bfda9_3113&ParamNames=[0]=EXTERNALROUTE&ParamValues=[

Identifier	Version	Name	Description	Quantity	Start Date	End Date	Role	Identifier	Name	Version	Description	Application Context
6110-0	v001	Aircraft Level Functions	Aircraft Level Functions									
					2013-12-05 00:00:00		Actual	6110-0.8	Provide Control on the Ground	v001	Provide Control on the Ground	
					2013-12-05 00:00:00		Actual	6110-0.8.2	Control Direction	v001	Control Direction	
					2013-12-05 00:00:00		Actual	6110-0.8.3	Landing Gear Extension & Retraction	v001	Landing Gear Extension & Retraction	
					2013-12-05 00:00:00		Actual	6110-0.8.1	Control Speed	v001	Control Speed	
					2013-12-05 00:00:00		Actual	6110-0.8.1.1	Decelerate aircraft on the ground (stopping on the runway)	v001	Decelerate aircraft on the ground (stopping on the runway)	
					2013-12-05 00:00:00		Actual	6110-0.8.1.1.4	Remove Forward Thrust	v001	Remove Forward Thrust	
					2013-12-05 00:00:00		Actual	6110-0.8.1.1.1	Provide Primary Stopping Force	v001	Provide Primary Stopping Force	
					2013-12-05 00:00:00		Actual	6110-0.8.1.1.3	Decrease Lift/ Create Drag/ Enhance Braking Effectiveness	v001	Decrease Lift/ Create Drag/ Enhance Braking Effectiveness	
					2013-12-05 00:00:00		Actual	6110-0.8.1.1.5	Transfer Stopping Forces to Structural Integrity Components (i.e. Landing Gear)	v001	Transfer Stopping Forces to Structural Integrity Components (i.e. Landing Gear)	
					2013-12-05 00:00:00		Actual	6110-0.8.1.1.2	Provide Secondary Stopping Force	v001	Provide Secondary Stopping Force	
					2013-12-05 00:00:00		Actual	6110-0.1	Provide Structural Integrity	v001	Provide Structural Integrity	
					2013-12-05 00:00:00		Actual	6110-0.2	Provide Stability & Control	v001	Provide Stability & Control	
					2013-12-05 00:00:00		Actual	6110-0.2.2	Control Roll	v001	Control Roll	
					2013-12-05 00:00:00		Actual	6110-0.2.5	Automatic Flight Control & Guidance	v001	Automatic Flight Control & Guidance	
					2013-12-05 00:00:00		Actual	6110-0.2.4	Flight Control Augmentation	v001	Flight Control Augmentation	
					2013-12-05 00:00:00		Actual	6110-0.2.3	Control Yaw	v001	Control Yaw	
					2013-12-05 00:00:00		Actual	6110-0.2.1	Control Pitch	v001	Control Pitch	
					2013-12-05 00:00:00		Actual	6110-0.3	Provide Control of Energy	v001	Provide Control of Energy	
					2013-12-05 00:00:00		Actual	6110-0.3.2	Control Lift & Drag	v001	Control Lift & Drag	
					2013-12-05 00:00:00		Actual	6110-0.3.1	Control Thrust	v001	Control Thrust	

Requirements tracing relationships



PDES, Inc.®

TEES AVSI AEROSPACE VEHICLE SYSTEMS INSTITUTE TEXAS A&M ENGINEERING EXPERIMENT STATION

S-A-V-I

"This Ain't Your CAD Model Data Exchange"

THE CONCLUSIONS

PDES, Inc.®

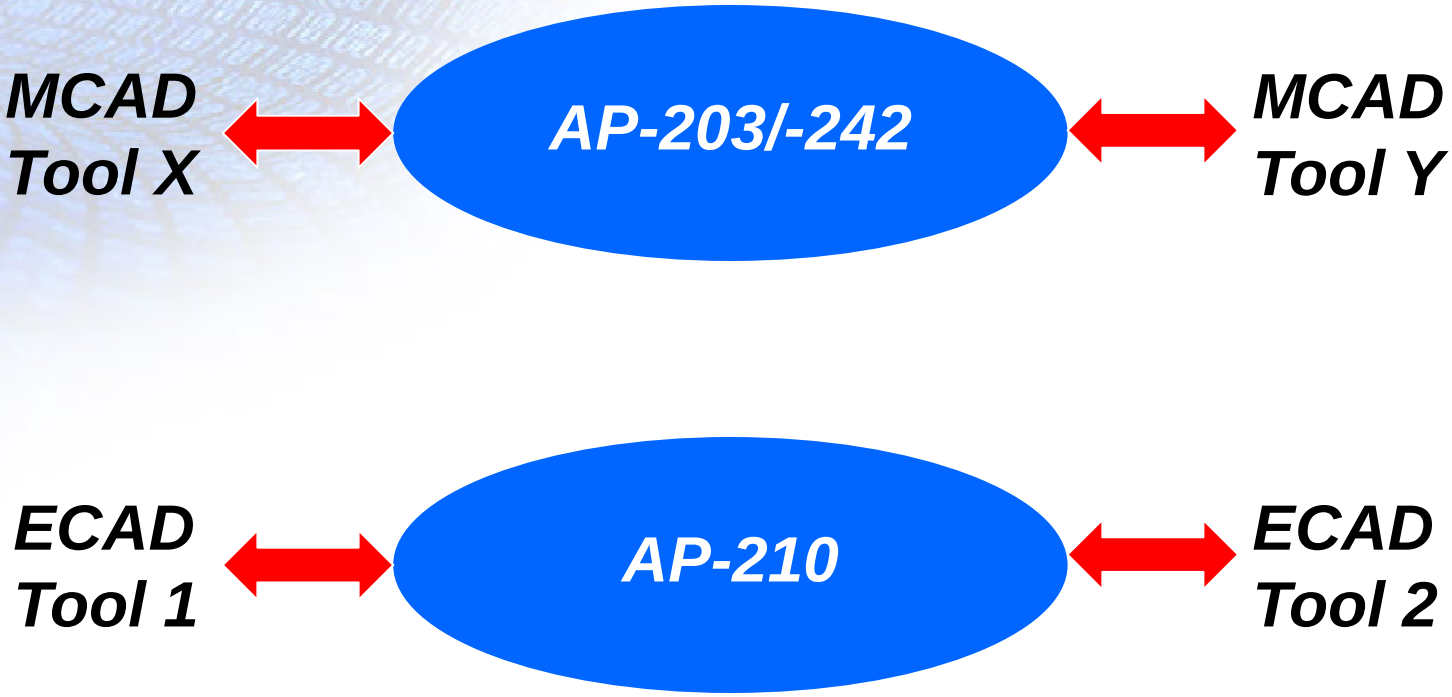
Key Takeaways

- Systems Engineering use cases expose a new layer of complex interoperability requirements
  - Multi-domain
  - Subsets of shared properties data exchange
  - Relationships (not exchange) of dissimilar properties
    - » Consistency
    - » Traceability
    - » Dependency
    - » Association
- Not a “zero sum game” for tool providers
  - Interoperability is the opportunity to participate

PDES, Inc.®

Intra-Domain Interoperability

- File exchange/translation example



PDES, Inc.®

Inter-Domain Interoperability

Requirements

Environmental

LVCS

SysML

AADL

MCAD

Simulink

Security

MODAF

EMI

ECAD

Scenario

Mgmt

CAFTA

FEA

Model

DFD

Modelica

Checkers

Interoperability Standards

AP-233/-239

Model Repository/Data Exchange Layer

Leverage

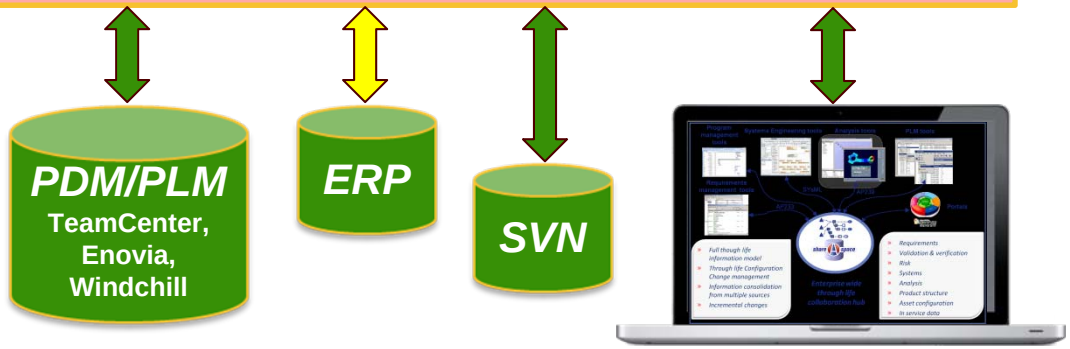
- Architecture models
- Existing tools
- Existing IT systems
- Existing repositories

Most Important Requirements

- Protect IP
- Process Neutral
- IT Independent
- Standards Based
- Clear Ownership
- Auditable
- Secure Access
- Flexible Content

SAVI MR/DEL

Standards: PLCS/DEX, STEP, ReqIF, XMI, OSLC, Eclipse
Proprietary: Intentional SW, The Mathworks



Eurostep *Share-A-space*®

Inter-Model Consistency Checking

- Consistency between two models exists when the dependence relations between those two models are satisfied
  - Some dependence relations can be detected automatically
    - Some tools are using patterns to assist
  - Some dependence relations will (always) require manual identification
  - Fidelity of consistency is proportional to the effort put into consistency modeling

- Dependence relations exist between entities and attributes
  - The output of one parameter in a model is the input for another model
    - IEEE floating point radar altitude in feet
    - NOT radar altitude on one side and barometric altitude on the other
    - NOT feet on one side and meters on the other

SAVI Version 1.0B - Objectives

- Mature and extend SAVI VIP capabilities to include initial fit and behavioral capabilities
  - Extend WBS example system to include behavioral and fit characteristics (add antiskid and autobraking)
  - Exercise fit and behavioral aspects of the WBS model-based example
  - Carry out consistency checking for the expanded WBS Model
- Implement an ISO10303-239 (PLCS) DEX (or DEXes) into the SAVI Model Repository/Data Exchange Layer (MR/DEL)

CONCLUSION

Summary

- Systems Engineering Model Set
  - High complexity
  - Cross domain
  - Linking subsets of model properties
- Standards based
  - Process and tool independent
  - Protect Intellectual Property
- PDES & SAVI research and demonstrations

Contacts

John Russel,
Honeywell
john.russell@honeywell.com

Don Ward,
AVSI
savipgm@gmail.com

Greg Pollari,
Rockwell Collins
gmpollar@rockwellcollins.com

Dave Redman,
AVSI
dredman@tamu.edu

BACKUP

PDES, Inc.®

Next Steps

- Prepare results for INCOSE discussions
- Coordinate with vendors
- Integrate SAVI use and test cases
- Install and Test Eurostep AP239 e1&e2 import / export functions in 2014
- Develop smaller, more targeted test cases with diagrams and hardware references
- Test larger datasets with more tools
- Coordinate industry XMI test cases
- Expand white paper on TDP use & interoperability in Systems Engineering
- Seek funding for more complete project

Proposed Demonstration – Phase 1

PDES, Inc.®

Tier 1

REQUIREMENTS
•CM / PLM: export / import; status, version, effectivity
•Safety / hazard,
•Locking (?) – investigation
•Linking Requirements with Different Names
- Requirement with 2 names
•Grouping of requirements (both scenarios)
•Issue tracking (observation – AP233/239)

PRIME
Requirements Management System
(AP233)

REGULATOR
-How could they use this?
-Is there a report we could produce?
- Military / Civilian Airworthiness considerations?

Tier 2

ORG 1
Requirements Management System
(DOORS - ReqIF)

INDEPENDENT VERIFICATION
•Metadata on verification
•Artifacts
•Electrical, Mechanical, Software
•Certification Metadata
•Separation of OEM and derivative requirement data

ORG 2
Requirements Management System
(TcSE - AP233 / ReqIF)

Tier 3

ORG 3
Requirements Management System
(PTC - ReqIF)

ORG 3
SysML Tool
(Magic Draw – XMI)

ORG 4
Simulation
(Open Modelica – FMI)