

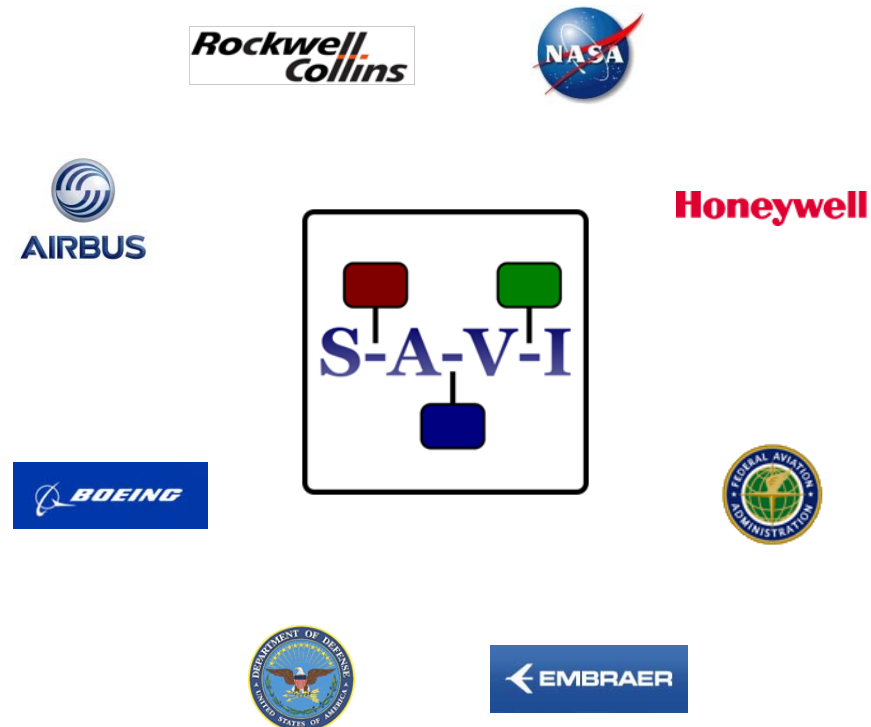
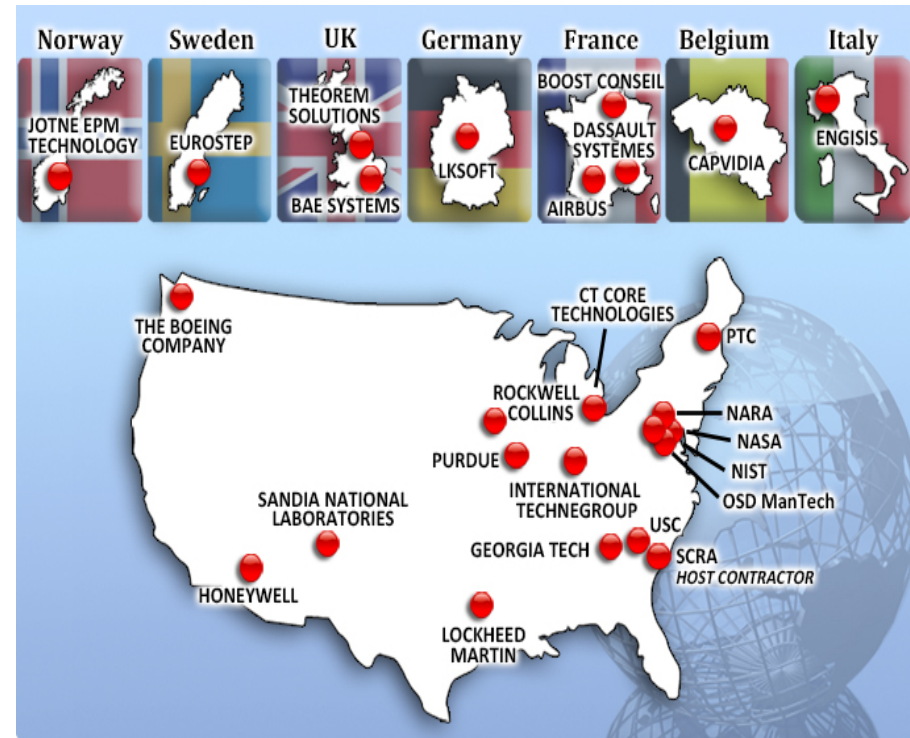
Multi-Domain Systems Engineering Interoperability

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/>

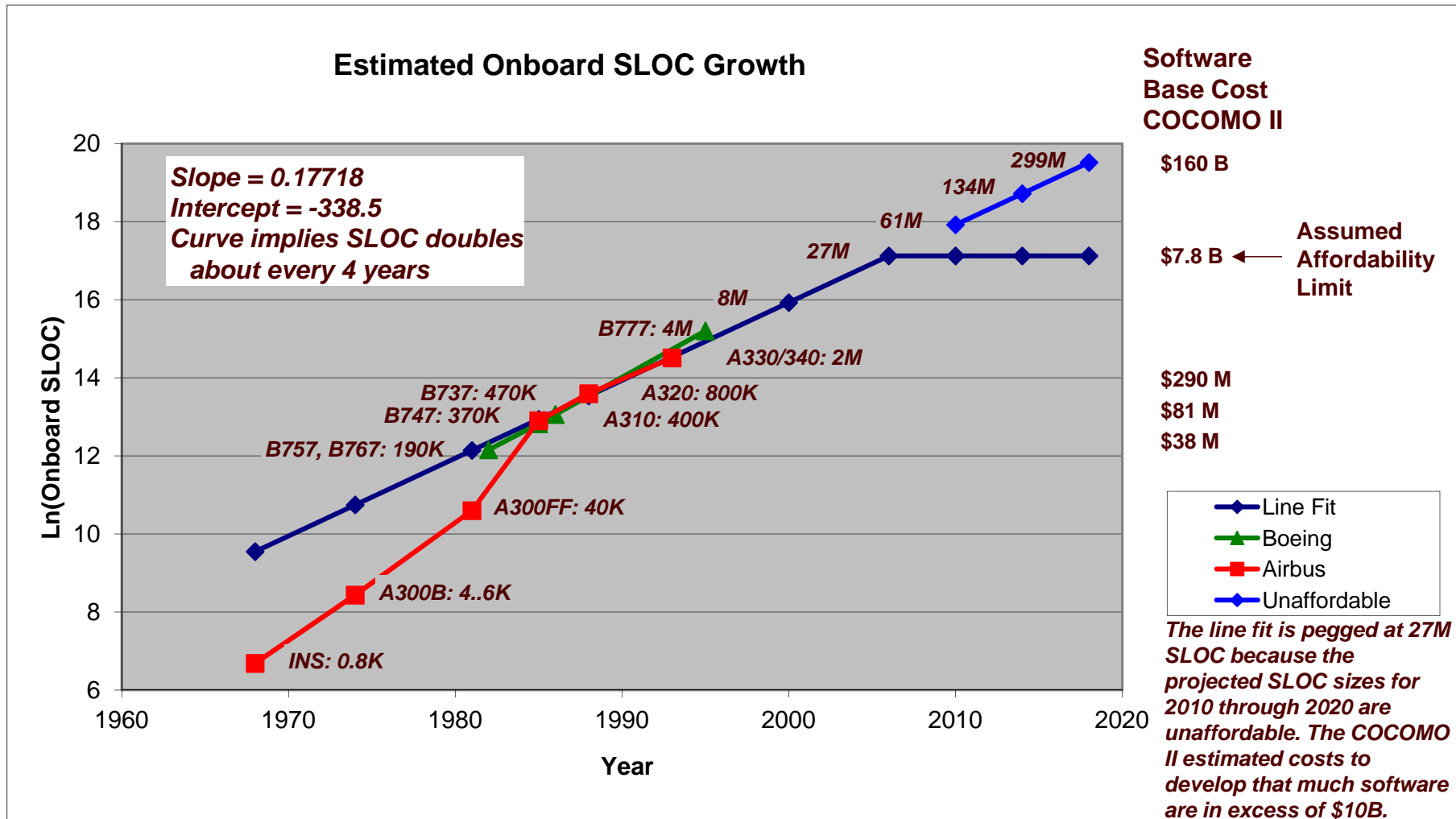
Supply Chain Tiers

Multiple Data Formats

Multiple Data Repositories

THE SITUATION

Systems Are Becoming More Complex



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



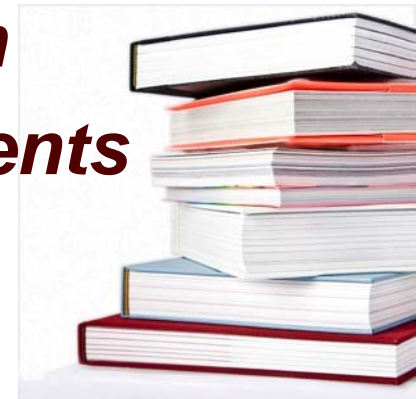
src: http://en.wikipedia.org/wiki/File:Gravis_UltraSound_PNP.jpg

... using dated SE methods

Silo'ed Organizations



Written Requirements



Mismatched Assumptions

Current means of managing complexity have issues

Operational Models

*Indeterminate
Change Impact*

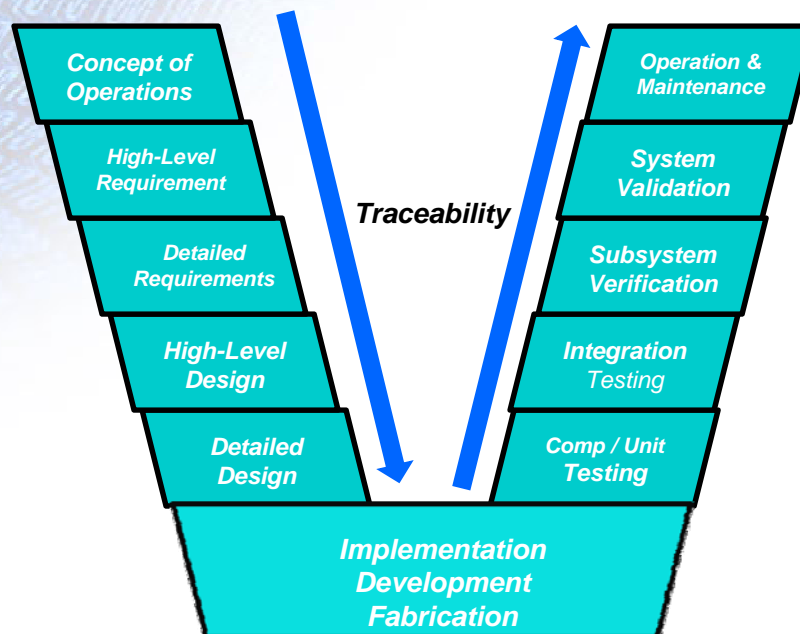
- Performance Model
- Structural/Component Model
- Cost Model
- Safety Model
- Security Model
- Reliability Model
- Maintainability Model
- Supportability Model
- Incompatible Abstractions
- (Assembly) Models

- Modeling Domains
 - Ops/Mission Analysis
 - System Analysis
 - Algorithms
 - Hardware
 - Software
 - Logistics Support
 - Manufacturing
 - Integration & Test
 - Performance Simulation
 - Engineering Analysis
 - Human System Integration
- Multiple Truths
- System Architecture Model (Integration Framework)
 - Analysis Models
 - Hardware Models
 - Software Models
 - Verification Models

**MODEL
EXPLOSION**

Product Development SE Data Exchanges

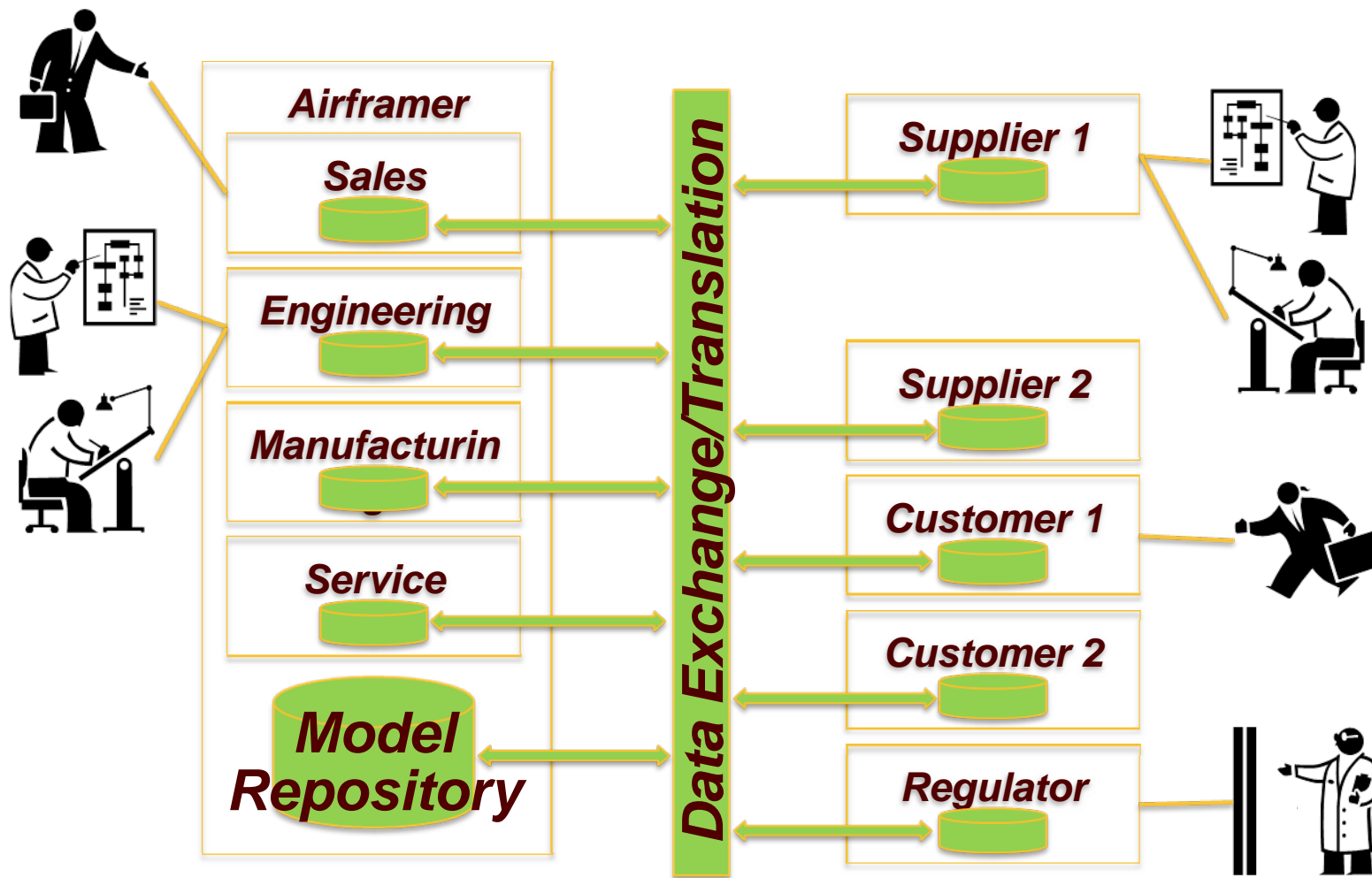
Text	Trend	Models & DB's	Trend	Diagrams	Trend
80%	↓	10%	↑	10%	↑
60%	↓	10%	↑	30%	↑
50%	↓	20%	↑	30%	↑
10%	—	30%	↑	60%	↓
10%	—	40%	↑	50%	↓
20%	↓	40%	↑	40%	↓



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**

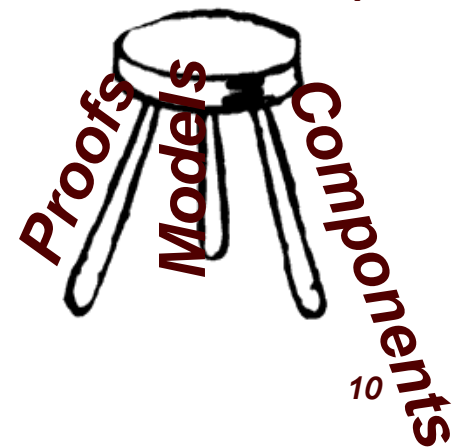
Multiple Groups/Tools/Repositories



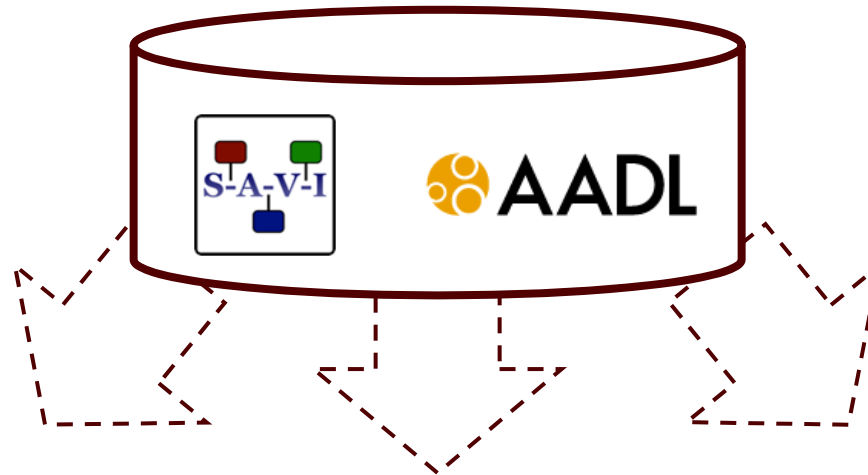
SAVI Objective and Themes

- ***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

- Spreadsheet
- Use error propagations

FTA

- CAFTA
- OpenFTA
- Use composite behavior
- Error flows

Markov Chain

- PRISM
- Use error flow
- Error behavior

SPN/SANs

- Stochastic Petri Nets and Activity Nets
- Use error flow
- Error behavior

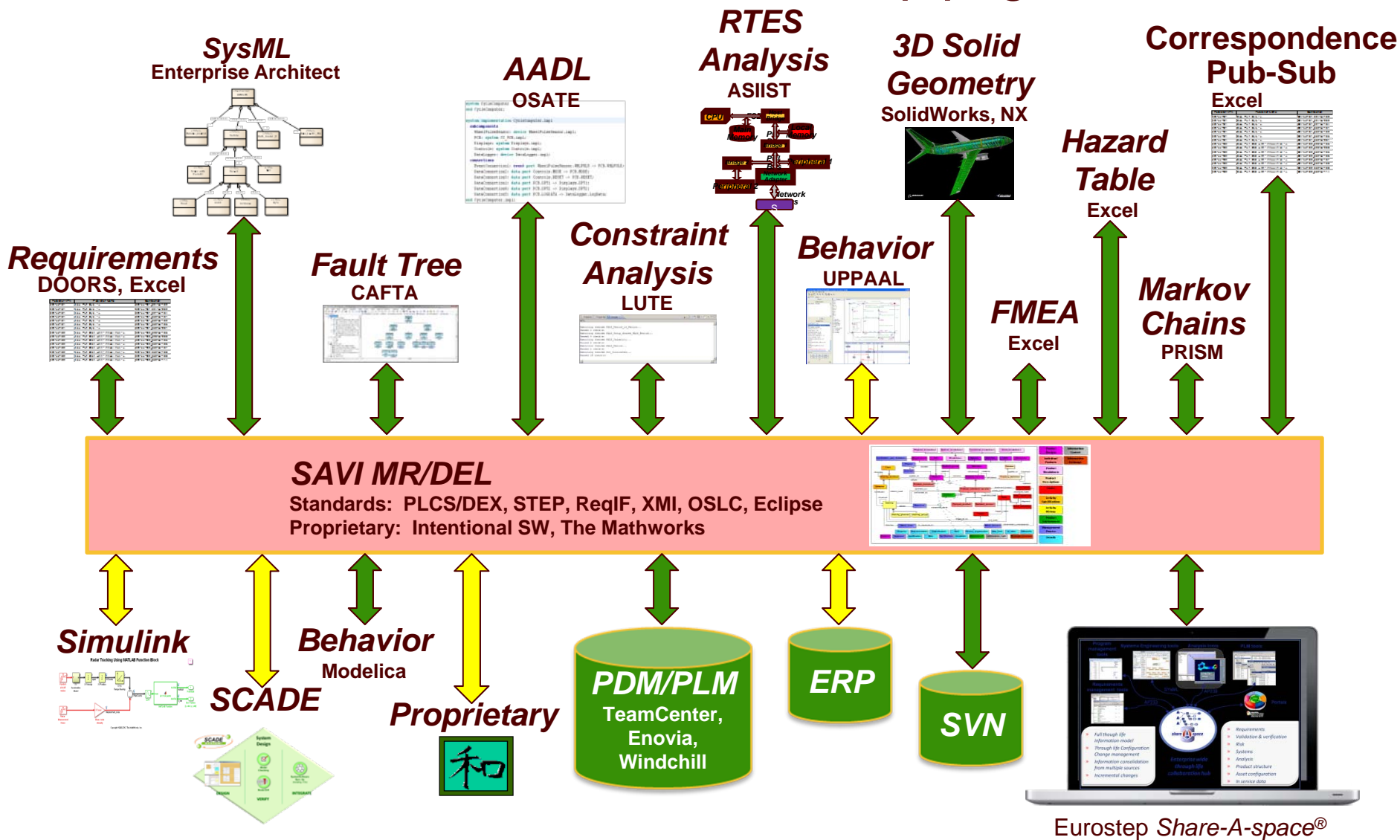
FMEA

- Spreadsheet
- Error behavior
- Propagations

Cross-Domain Linking
Model Explosion
Increasing Complexity

THE MODEL ENVIRONMENT

Models Across the Supply Chain



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 if 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 if 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 if 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			

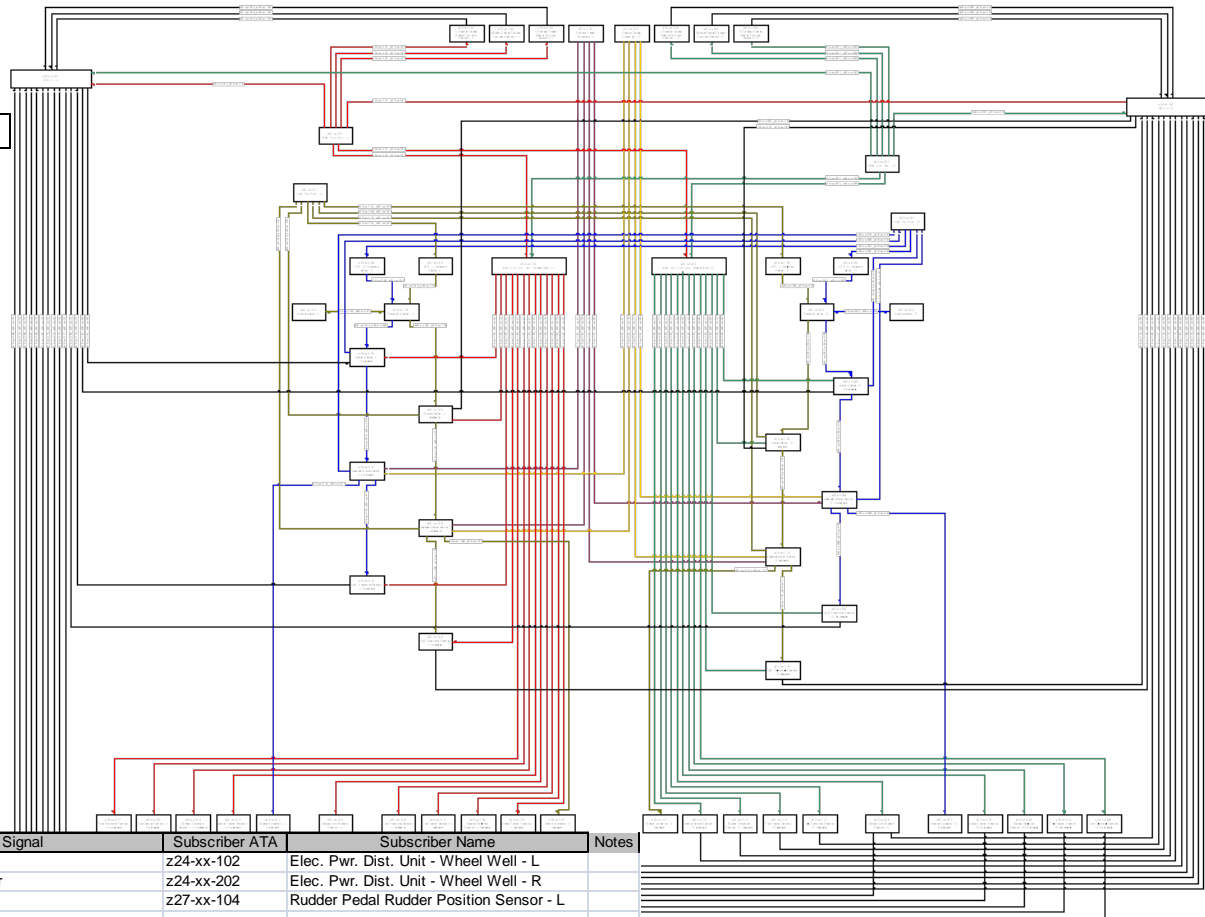
Publisher/Subscriber Model

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-Wheels Sensor - L Reading	z32-xx-101	BSCU - L	
z32-xx-109	Weight-On-Wheels Sensor - L	z32-xx-109_z32-xx-201	Weight-On-Wheels Sensor - L Reading	z32-xx-201	BSCU - R	

System & SW Architecture with AADL

AADL - ARP4761/advanced/integration/main.aadl - Eclipse

File Edit Navigate Search Project OSATE Analyses Run Window Help

Generate Excel Report Import Lattix file Generate DSM Matrix Export AADL int

Quick Access AADL IMV Team Synchronizing

AADL Navigator

- ARP4761 [examples master]
 - advanced
 - common
 - functional
 - imv
 - hydraulic.imv
 - wbs
 - command-control.aadl
 - generic.aadl
 - main.aadl
 - electrical.aadl
 - generic_functions.aadl
 - hydraulic.aadl
 - main.aadl
 - throttle.aadl
 - WBSFunctionalErrorLib.aadl

hydraulic.aadl **main.aadl**

```

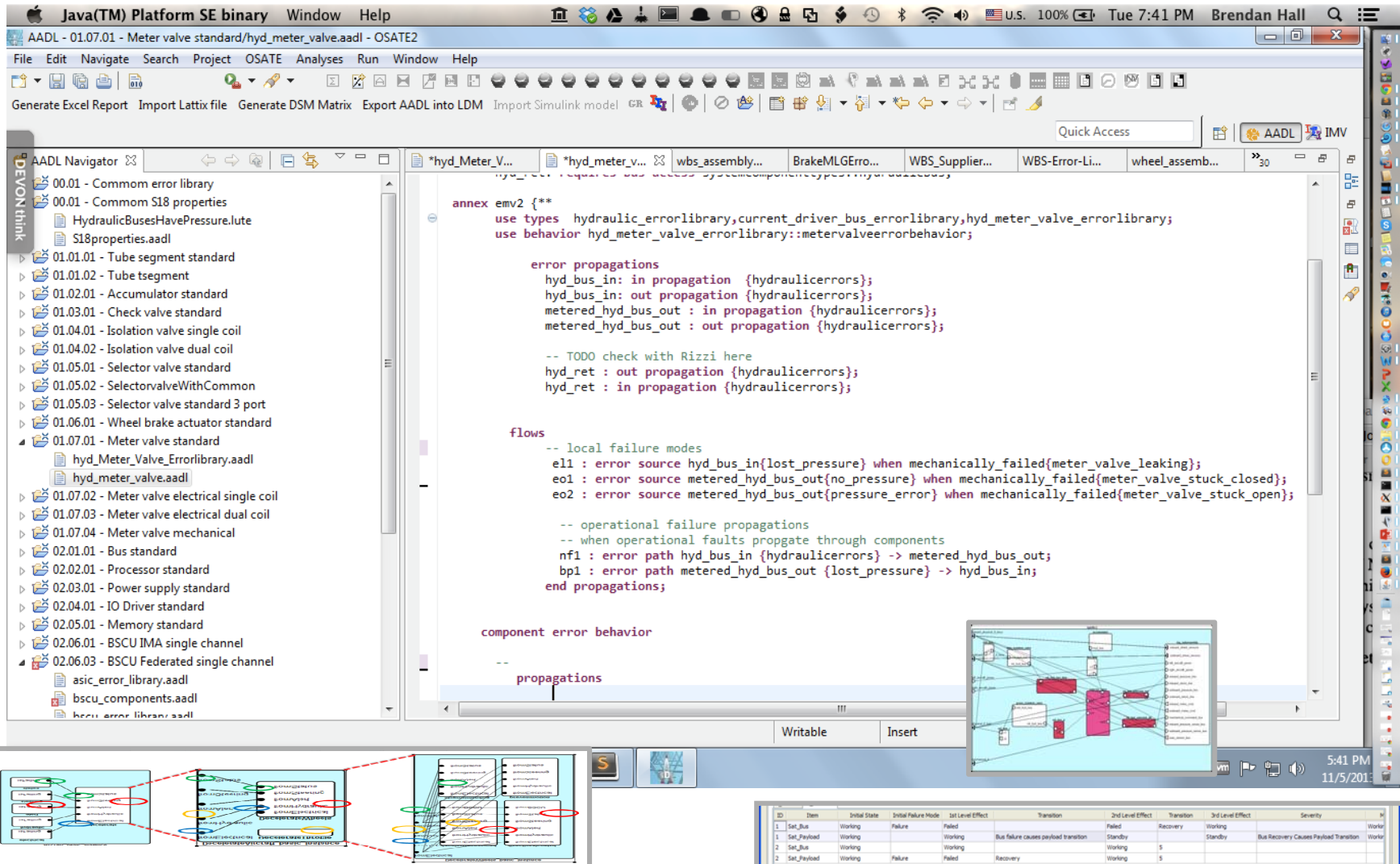
system implementation main.impl
subcomponents
    functional : system functional::main::Aircraft.basic;
    wbs_impl : system impl::wbs::wbs.ima;
properties
    -- We bind the WBS physical components to functions
    -- On the physical components, we have to explicitly define bindings propagat
    -- and on the function, we define processor bindings. Right now, we make use
    -- of the processor binding mechanism to bind functions with their associat
    -- runtime component.
    Actual_Processor_Binding => (reference (wbs_impl.bscu)) applies to functi
    Actual_Processor_Binding => (reference (wbs_impl)) applies to functional.
    Actual_Processor_Binding => (reference (wbs_impl.blue_pump),reference (wb
    Actual_Processor_Binding => (reference (wbs_impl.power),reference (wbs_
  
```

***main_main_impl_Instance.imv**

52%

The diagram illustrates the system architecture and its implementation. It shows the hierarchy of components and their interactions. The top-level component is 'Aircraft basic_instance', which is implemented by 'DecelerateAircraft basic_instance'. This component is further decomposed into 'DecelerateThrottle' and 'DecelerateWheels'. The 'DecelerateWheels' component is further decomposed into 'fromElectrical', 'fromHydraulic', 'fromAlert', 'fromSteering', and 'fromStatus'. The 'fromElectrical' component is further decomposed into 'fromElectrical', 'fromHydraulic', 'fromAlert', 'fromSteering', and 'fromStatus'. The 'fromHydraulic' component is further decomposed into 'fromHydraulic', 'fromAlert', 'fromSteering', and 'fromStatus'. The 'fromAlert' component is further decomposed into 'fromAlert', 'fromSteering', and 'fromStatus'. The 'fromSteering' component is further decomposed into 'fromSteering' and 'fromStatus'. The 'fromStatus' component is further decomposed into 'fromStatus'.

Architecture Fault Model



AADL Navigator

- 00.01 - Common error library
- 00.01 - Common S18 properties
 - HydraulicBusesHavePressure.lute
 - S18properties.aadl
- 01.01.01 - Tube segment standard
 - 01.01.02 - Tube tsegment
- 01.02.01 - Accumulator standard
- 01.03.01 - Check valve standard
- 01.04.01 - Isolation valve single coil
 - 01.04.02 - Isolation valve dual coil
- 01.05.01 - Selector valve standard
 - 01.05.02 - Selector valve With Common
- 01.05.03 - Selector valve standard 3 port
- 01.06.01 - Wheel brake actuator standard
- 01.07.01 - Meter valve standard
 - hyd_meter_valve_errorlibrary.aadl
 - hyd_meter_valve.aadl
- 01.07.02 - Meter valve electrical single coil
- 01.07.03 - Meter valve electrical dual coil
- 01.07.04 - Meter valve mechanical
- 02.01.01 - Bus standard
 - 02.02.01 - Processor standard
 - 02.03.01 - Power supply standard
 - 02.04.01 - IO Driver standard
 - 02.05.01 - Memory standard
- 02.06.01 - BSCU IMA single channel
 - 02.06.03 - BSCU Federated single channel
 - asic_error_library.aadl
 - bscu_components.aadl
 - bscu_error_library.aadl

AADL Editor

```

annex emv2 {**
use types hydraulic_errorlibrary,current_driver_bus_errorlibrary,hyd_meter_valve_errorlibrary;
use behavior hyd_meter_valve_errorlibrary::metervalueerrorbehavior;

error propagations
hyd_bus_in: in propagation {hydraulicerrors};
hyd_bus_in: out propagation {hydraulicerrors};
metered_hyd_bus_out: in propagation {hydraulicerrors};
metered_hyd_bus_out: out propagation {hydraulicerrors};

-- TODO check with Rizzi here
hyd_ret: out propagation {hydraulicerrors};
hyd_ret: in propagation {hydraulicerrors};

flows
-- local failure modes
e11: error source hyd_bus_in{lost_pressure} when mechanically_failed{meter_valve_leaking};
e01: error source metered_hyd_bus_out{no_pressure} when mechanically_failed{meter_valve_stuck_closed};
e02: error source metered_hyd_bus_out{pressure_error} when mechanically_failed{meter_valve_stuck_open};

-- operational failure propagations
-- when operational faults propagate through components
nf1: error path hyd_bus_in {hydraulicerrors} -> metered_hyd_bus_out;
bp1: error path metered_hyd_bus_out {lost_pressure} -> hyd_bus_in;
end propagations;

component error behavior
-- propagations
    
```

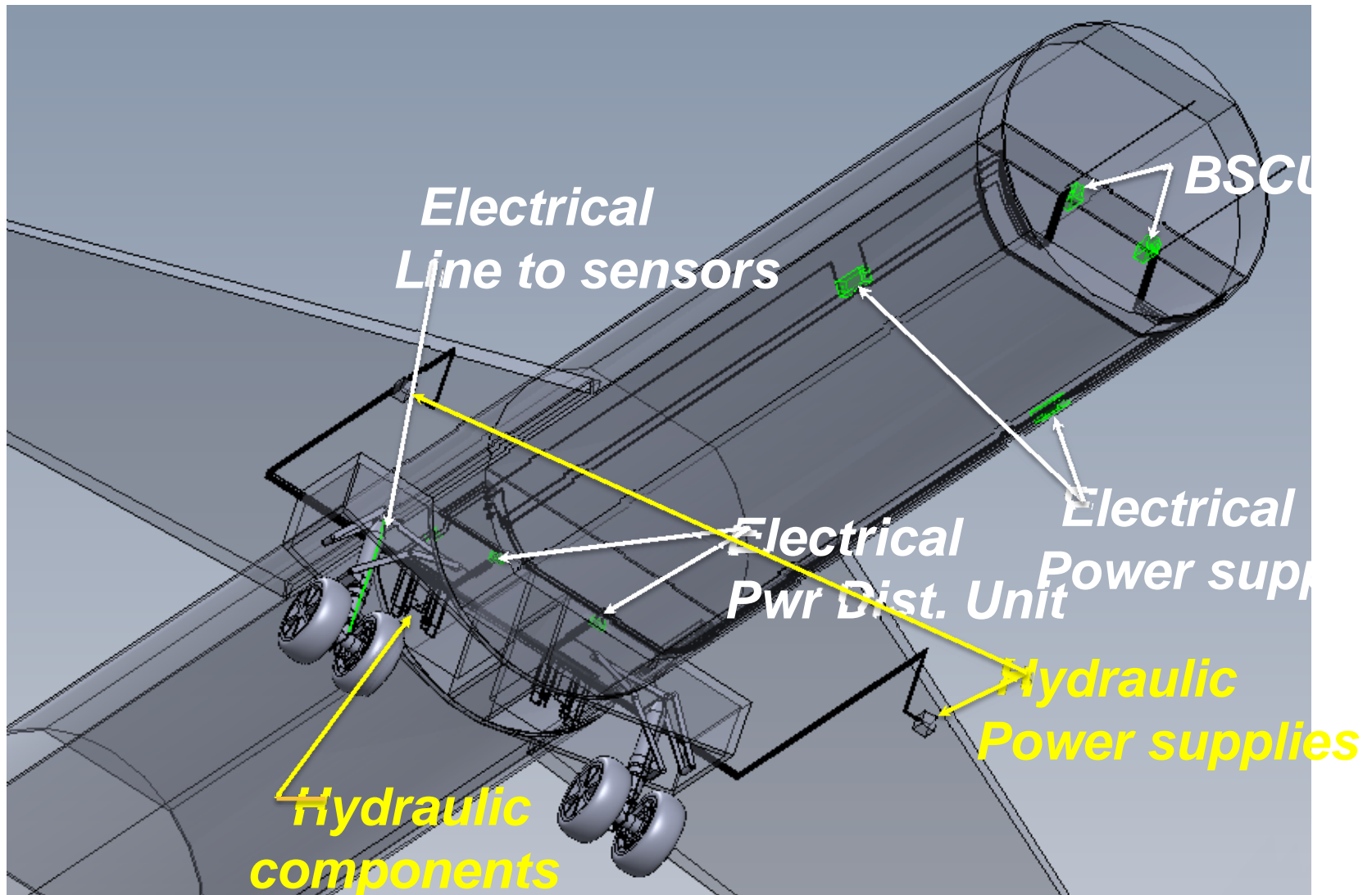
System Architecture Diagram

The diagram shows a network of components connected by lines representing data or control flow. Components are represented by boxes with labels, and the connections form a complex web of interactions.

Table: System State and Transitions

ID	Item	Initial State	Initial Failure Mode	1st Level Effect	Transition	2nd Level Effect	Transition	3rd Level Effect	Severity
1	Set_Bus	Working	Failure	Failed	Bus failure causes payload transition	Failed	Recovery	Standby	Worker
1	Set_Payload	Working	Working	Working	Standby	Standby	Standby	Bus Recovery Causes Payload Transition	Worker
2	Set_Bus	Working	Working	Working	Standby	Standby	Standby	Standby	Worker
2	Set_Payload	Working	Failure	Failed	Recovery	Working	S		

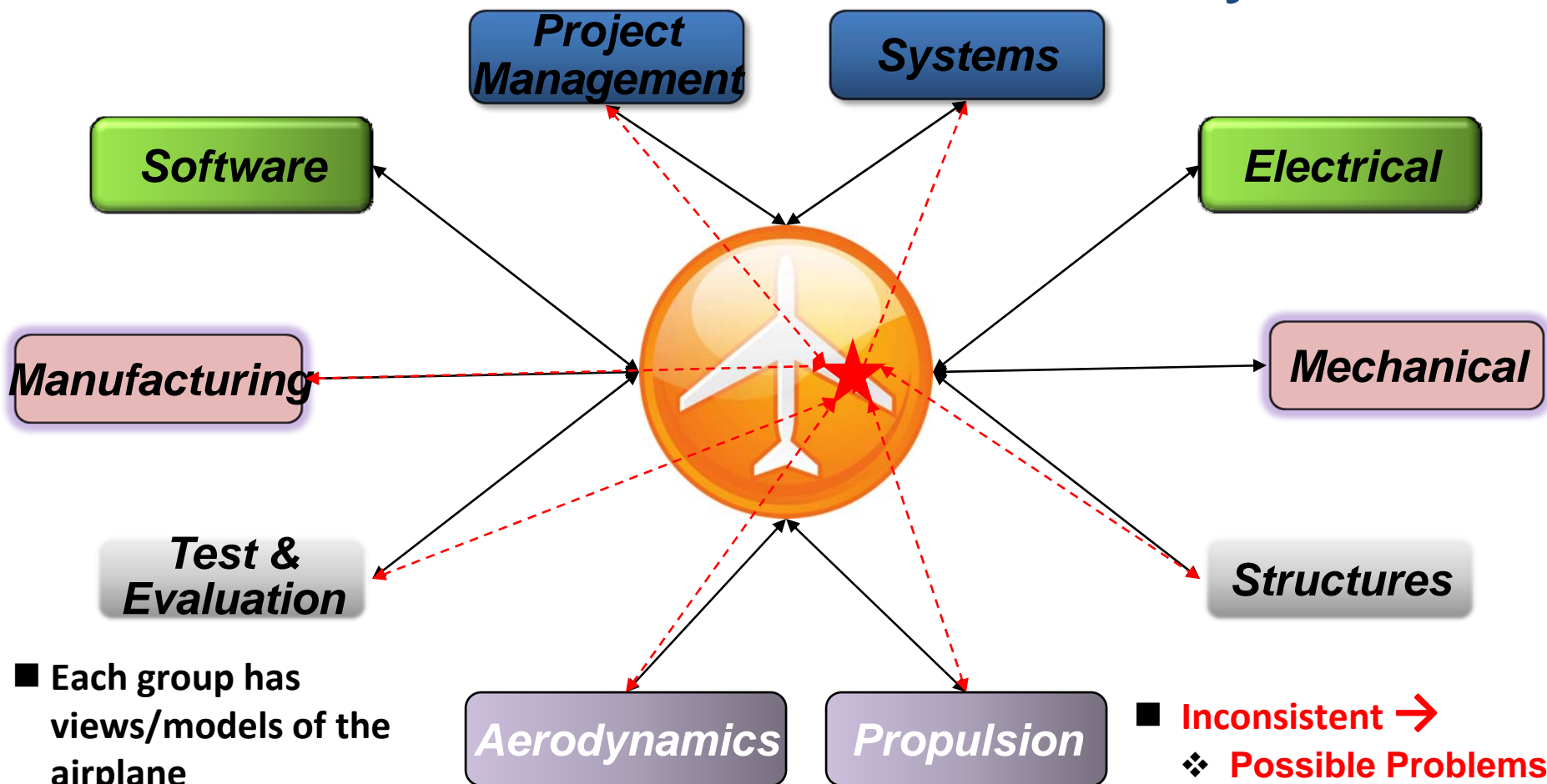
Solid Geometry Model



Requirements Exchange
Inter-Model Dependencies
Inter-Model Consistency Checks

USE CASES

Inter-Model Consistency

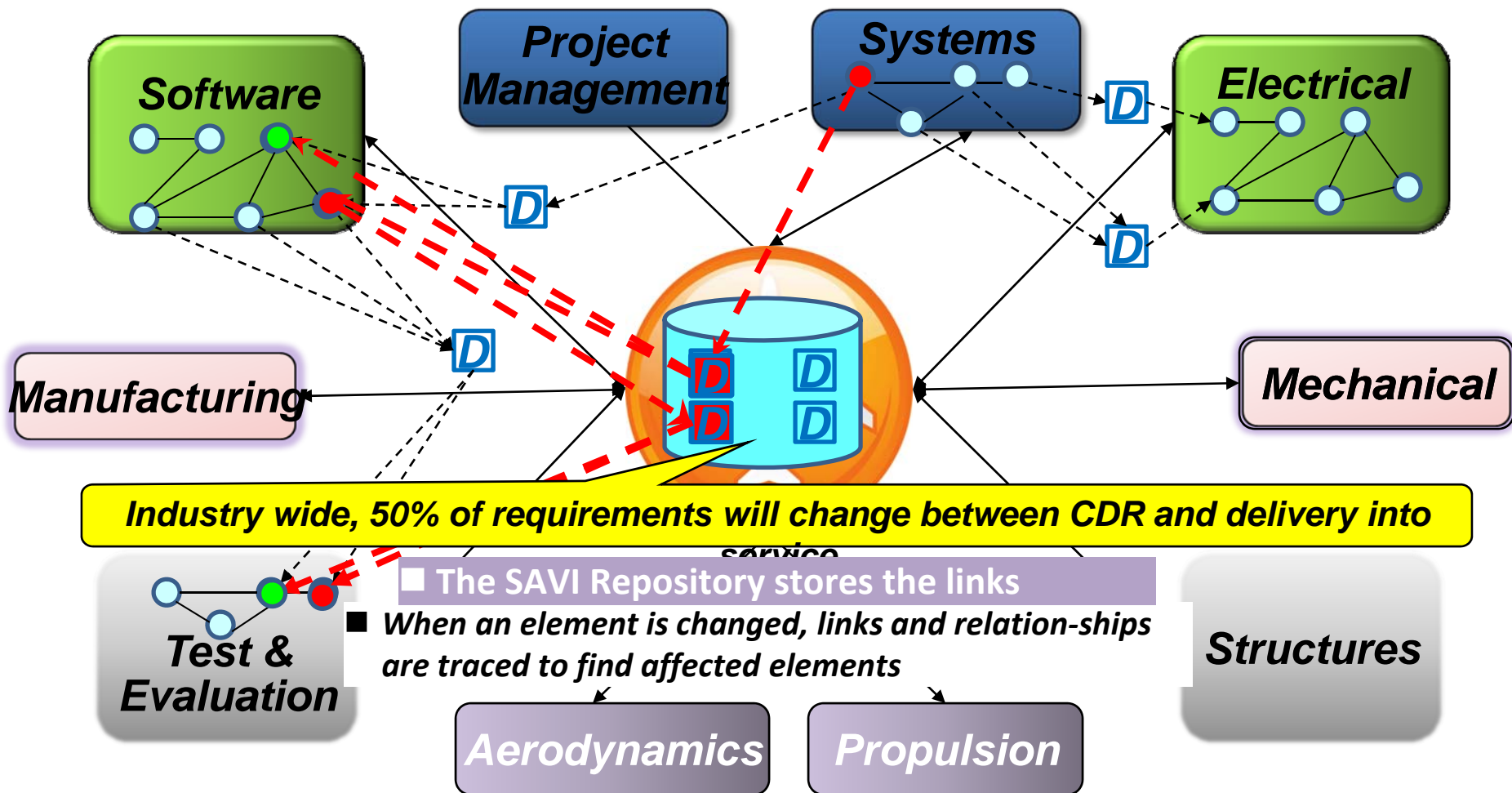


- Each group has views/models of the airplane

- 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

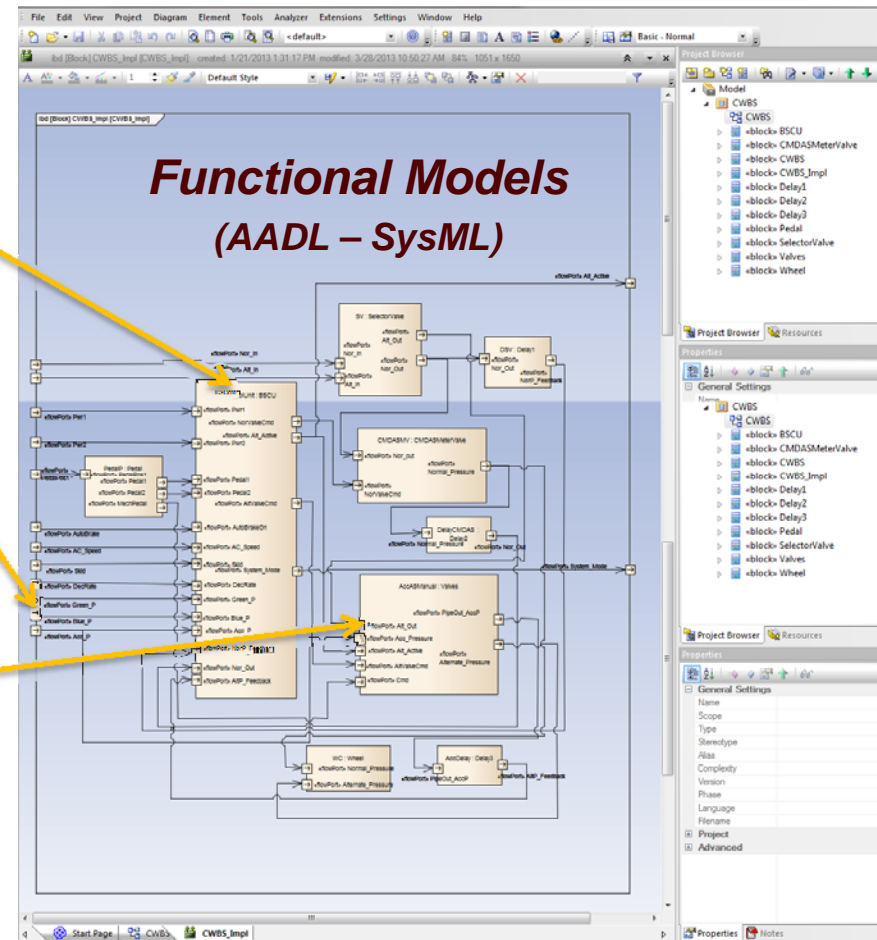
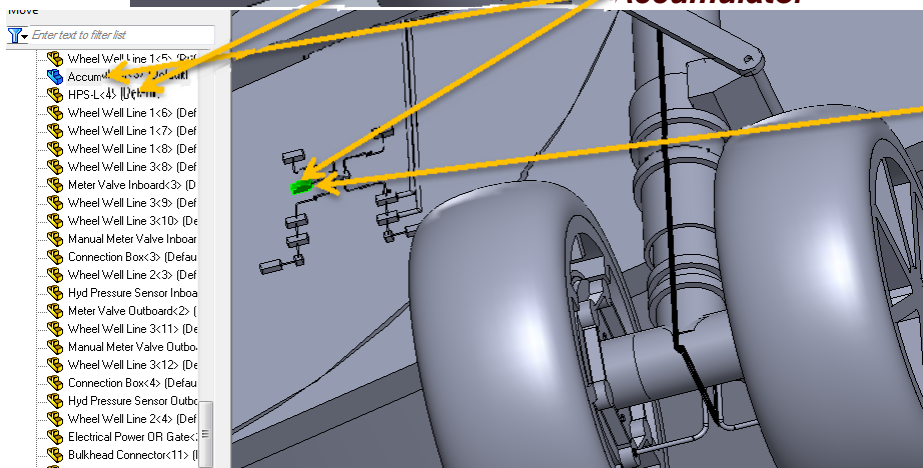
Solid models

BSCU

Hyd power supply

Accumulator

**Functional Models
(AADL – SysML)**



DEMONSTRATIONS

DOORS ReqIF 9.5 Import to Share-A-Space 7.7

share space

User: John.Russell@honeywell.com (Honeywell) Id Context: Honeywell, Honeywell

Requirement Version Versions Identifiers Classifications Used In Time Roles Properties Traced by

134_b4708631-29f8-4ea9-9f98-b8da6f4d233f

Id	Name	Value	Start Date	Role	Application Context
ReqIF.ForeignID	ReqIF.ForeignID	134	12/12/2013 1:22:13 PM	Actual	[[IGNORE//IGNORE] /IGNORE
ReqIF.ForeignCreatedThru	ReqIF.ForeignCreatedThru	Manual Input	12/12/2013 1:22:13 PM	Actual	[[IGNORE//IGNORE] /IGNORE
ReqIF.Text	ReqIF.Text	The car shall be assembled from modules by 1 person in 1 working day.	12/12/2013 1:22:13 PM	Actual	[[IGNORE//IGNORE] /IGNORE

Requirement

Matrix: Tracing Relationship

Details

Tracing Relationship

ID

Name

Start-date 2013-12-12

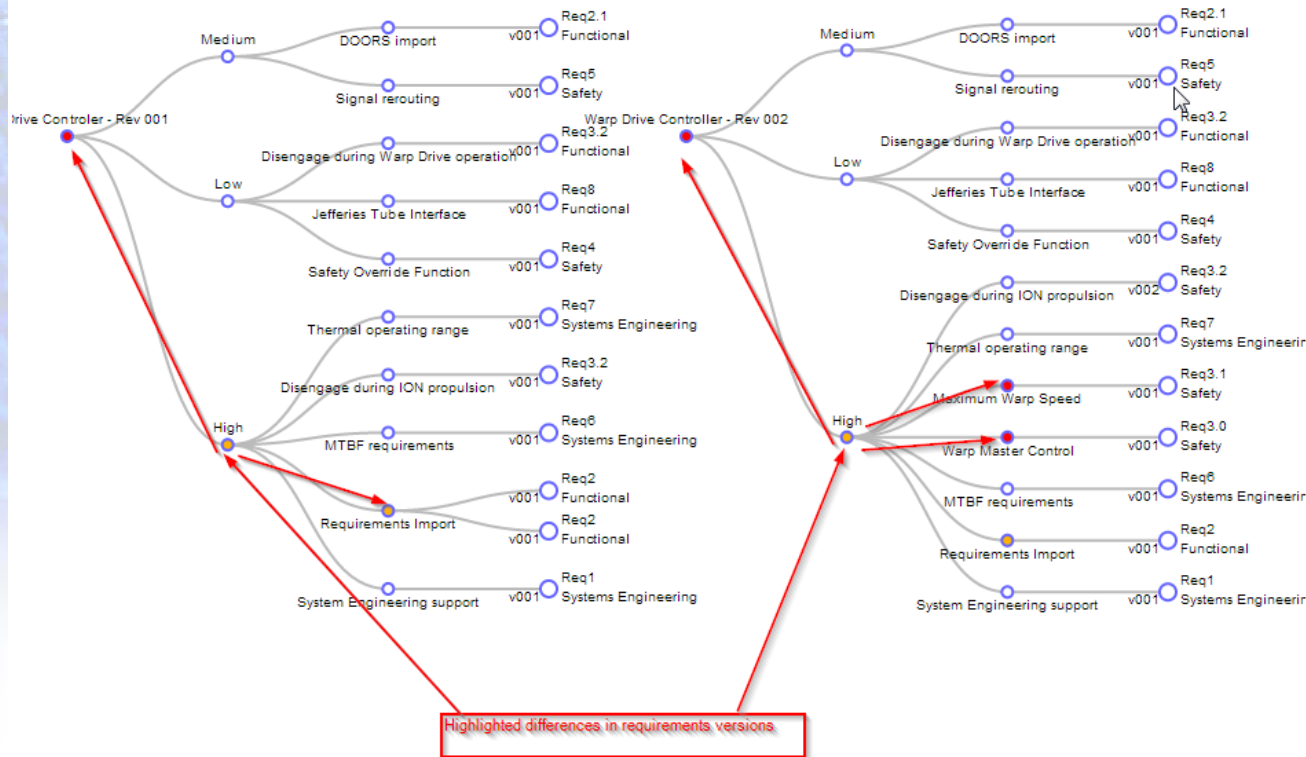
End-date ∞

Parent _135_5f6561b1-abb3-4749-9b2f-edee84d5f686 Failure modes /IGNORE

Child _136_47221792-b7a1-45c1-a455-134bf67d821f /IGNORE

Ok

Comparison Viewer by Eurostep - View: Requirement/Criticality




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

share  User: savi.user@savi.com (WORLD) Id Context: WORLD, World

Part Version Versions Actors Identifiers Classifications Breakdowns Uses Requirements

wbs_assembly_single_channel, wbs_assembly_single_channel

Type	Value	Context
Identifier	wbs_assembly_single_channel	SAVI
Name	wbs_assembly_single_channel	SAVI
Version Identifier		SAVI

Identifier	Version	Name	Description	Quantity	Start Date	End Date	Role	Identifier	Name	Version	Description	Application Context
wbs_assembly_single_channel		wbs_assembly_single_channel										
1093					2013-12-04 14:05:19		Actual	mirrorbrakeline 2	mirrorbrakeline 2			MechanicalAsDesignedAsPlann
1094					2013-12-04 14:05:19		Actual	brakeline 2	brakeline 2			MechanicalAsDesignedAsPlann
1095					2013-12-04 14:05:19		Actual	mirrorbrakeline	mirrorbrakeline			MechanicalAsDesignedAsPlann
1096					2013-12-04 14:05:19		Actual	brakeline	brakeline			MechanicalAsDesignedAsPlann
1097					2013-12-04 14:05:19		Actual	mirrorsensor wire to meter valve outboard	mirrorsensor wire to meter valve outboard			MechanicalAsDesignedAsPlann
1098					2013-12-04 14:05:19		Actual	mirrorsensor wire to hyd sensor outboard	mirrorsensor wire to hyd sensor outboard			MechanicalAsDesignedAsPlann
1099					2013-12-04 14:05:19		Actual	sensor wire to meter valve outboard	sensor wire to meter valve outboard			MechanicalAsDesignedAsPlann
1100					2013-12-04 14:05:19		Actual	sensor wire to hyd sensor outboard	sensor wire to hyd sensor outboard			MechanicalAsDesignedAsPlann
1101					2013-12-04 14:05:19		Actual	mirrorsensor wire to hyd sensor inboard	mirrorsensor wire to hyd sensor inboard			MechanicalAsDesignedAsPlann
1102					2013-12-04 14:05:19		Actual	sensor wire to hyd sensor inboard	sensor wire to hyd sensor inboard			MechanicalAsDesignedAsPlann
1103					2013-12-04 14:05:19		Actual	mirrorsensor wire to meter valve inboard	mirrorsensor wire to meter valve inboard			MechanicalAsDesignedAsPlann

© AVSI

© Eurostep AB 2000-2013

Structure imported from AADL file

share space User: savi.user@savi.com (WORLD) Id Context: WORLD, World

Breakdown Element Version Versions Actors Identifiers Uses In Breakdowns

_9Q2zcE-pEeOiQIMVbeU-Og
Owner SAVI (SAVI)
Creation date 2013-12-04 13:11:06

Identifier	Version	Name	Description	Application Context
_9Q2zcE-pEeOiQIMVbeU-Og				
_9SJM5E-pEeOiQIMVbeU-Og		rightMLG		
_9Sjz8E-pEeOiQIMVbeU-Og		ext_hyd_bus_blue		
_9SNeUU-pEeOiQIMVbeU-Og		green_isolation_valve		
_9SQhok-pEeOiQIMVbeU-Og		accumulator		
_9SOFYk-pEeOiQIMVbeU-Og		blue_isolation_valve		
_9SOsck-pEeOiQIMVbeU-Og		selector_valve		
_9SKb8E-pEeOiQIMVbeU-Og		int_hyd_bus_green		
_9SM3Qk-pEeOiQIMVbeU-Og		int_hyd_selected_alt		
_9SKbAE-pEeOiQIMVbeU-Og		ext_hyd_bus_green		
_9SLCE0-pEeOiQIMVbeU-Og		int_hyd_bus_blue		
_9SLpI0-pEeOiQIMVbeU-Og		acc_seg		
_9SQhpE-pEeOiQIMVbeU-Og		leg_subassembly		
_9SS94k-pEeOiQIMVbeU-Og		inboard_meter_valve		
_9STk8U-pEeOiQIMVbeU-Og		hyd_valve_assembly		
_9SdV8k-pEeOiQIMVbeU-Og		int_hyd_norm_meter_actuator		
_9Scu4k-pEeOiQIMVbeU-Og		int_hyd_nor_meter_manual		
_9SWoRE-pEeOiQIMVbeU-Og		inboard_manual_meter_valve		
_9SYdck-pEeOiQIMVbeU-Og		outboard_manual_meter_valve		


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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=[0]=EXTERNALROUTE

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



User: savi.user@savi.com (WORLD) Id Context: WORLD, World

Requirement Version Versions Identifiers Traced by

S18-BSCU-R-0001, v001, The BSCU shall be designed to Functional Development Assurance Level A based on the catastrophic classification of "Inadvertent braking due to BSCU".

Description The BSCU shall be designed to Functional Development Assurance Level A based on the catastrophic classification of "Inadvertent braking due to BSCU".

Owner SAVI (SAVI)

Creation date 2013-12-05 11:52:24

Requirement	S18-WBS-...	S18-WBS-...	S18-WBS-...	S18-WBS-...	S18-WBS-...	S18-WBS-...	S18-WBS-...	S18-WBS-...	S18-WBS-...	S18-WBS-...	S18-WBS-...	
S18-BSCU-... v001 The...												
S18-BSCU-... v001 The...												
S18-BSCU-... v001 The...												
S18-BSCU-... v001 The...												
S18-BSCU-... v001 No...												
S18-BSCU-... v001 BSCU...												
S18-BSCU-... v001 BSCU...												
S18-BSCU-... v001 BSCU...												
S18-BSCU-... v001 Each...												
S18-BSCU-... v001 Each...												
S18-BSCU-... v001 Each...												
S18-BSCU-... v001 Each...												
S18-BSCU-... v001 The...												

Matrix: Tracing Relationship

“This Ain’t Your CAD Model Data Exchange”

THE CONCLUSIONS



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



- File exchange/translation example





PDES, Inc.®

Inter-Domain Interoperability

Interoperability Standards AP-233/-239

Environmental

Requirements

LVCS

SysML

AADL

MCAD

Simulink

Security

EMI

ECAD

Scenario

Mgmt

CAFTA

FEA

DFD

Model

Modelica

Checkers

Model Repository/Data Exchange Layer

Leverage

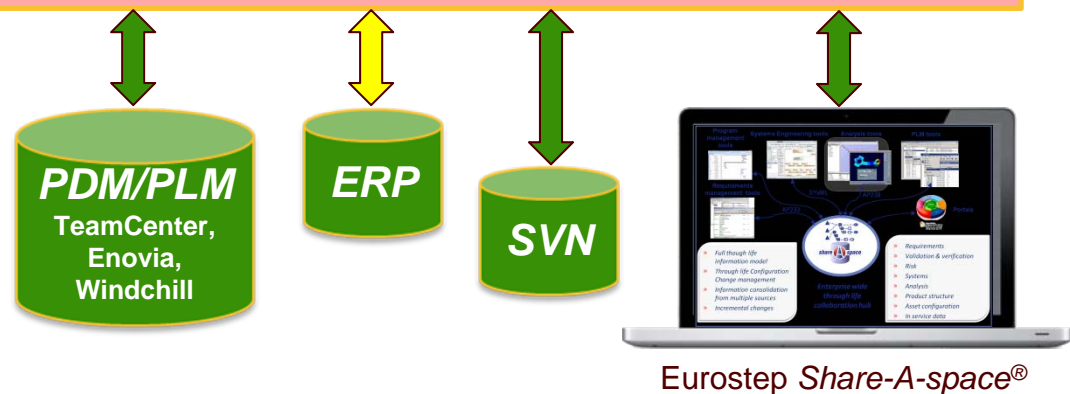
- Architecture models
- Existing tools
- Existing IT systems
- Existing repositories

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



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

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BACKUP

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 XML test cases
- Expand white paper on TDP use & interoperability in Systems Engineering
- Seek funding for more complete project

Proposed Demonstration – Phase 1

