

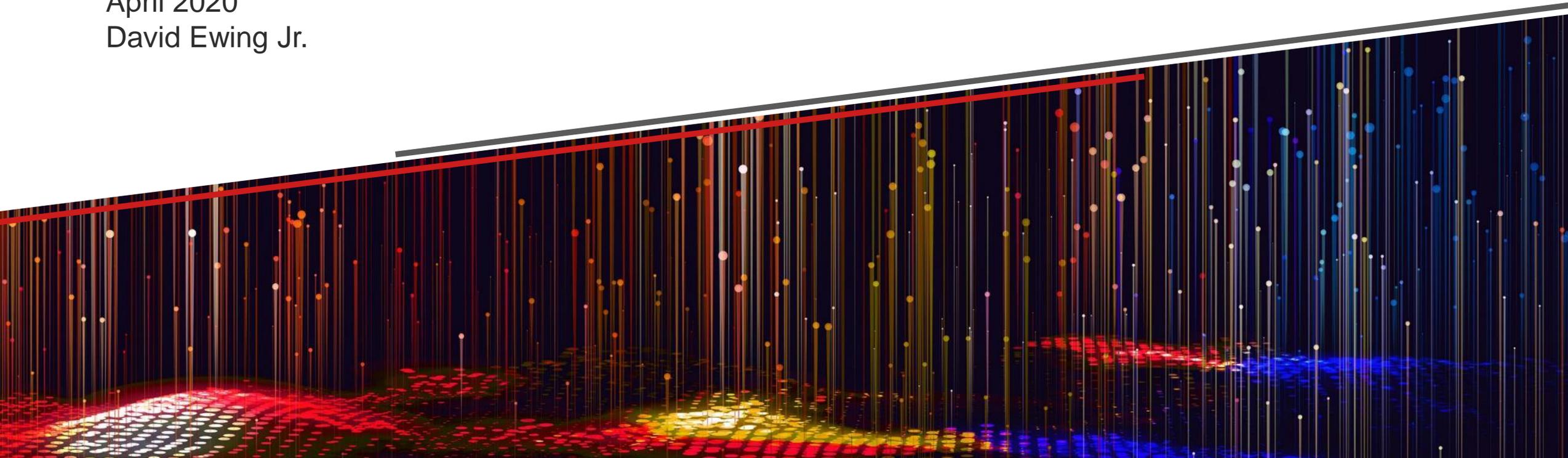


Enabling The Source of Truth

For Model Based System Development

April 2020

David Ewing Jr.



A&D Challenges Today

Weapon system and C5I complexity is accelerating

Lack of a digital thread or twin

Inability to access information for innovation

Designing weapon systems to meet unique & evolving missions

Supporting new business models

84% of digital transformations fail.
- Forbes, 2016

14% say their (Digital Transformation) efforts have made and sustained performance improvements.
- McKinsey 2018

50% of digital transformation efforts stalled out completely.
- Forrester, 2018

3% report complete success at sustaining their (Digital Transformation) change.
- McKinsey 2018

18% of companies rate their use of digital technology as very effective.
- Harvey-Nash-KPMG COI Survey, 2017

5% of those companies involved in digital transformation had achieved or exceeded the expectations
- Bain, 2017

FRAGMENTED PROCESSES

Disconnected
Overlapping
Tribal Knowledge

Hidden Factories

INCOMPATIBLE TOOLS

Silos
Increasing effort
Hardcoded

Technical Debt



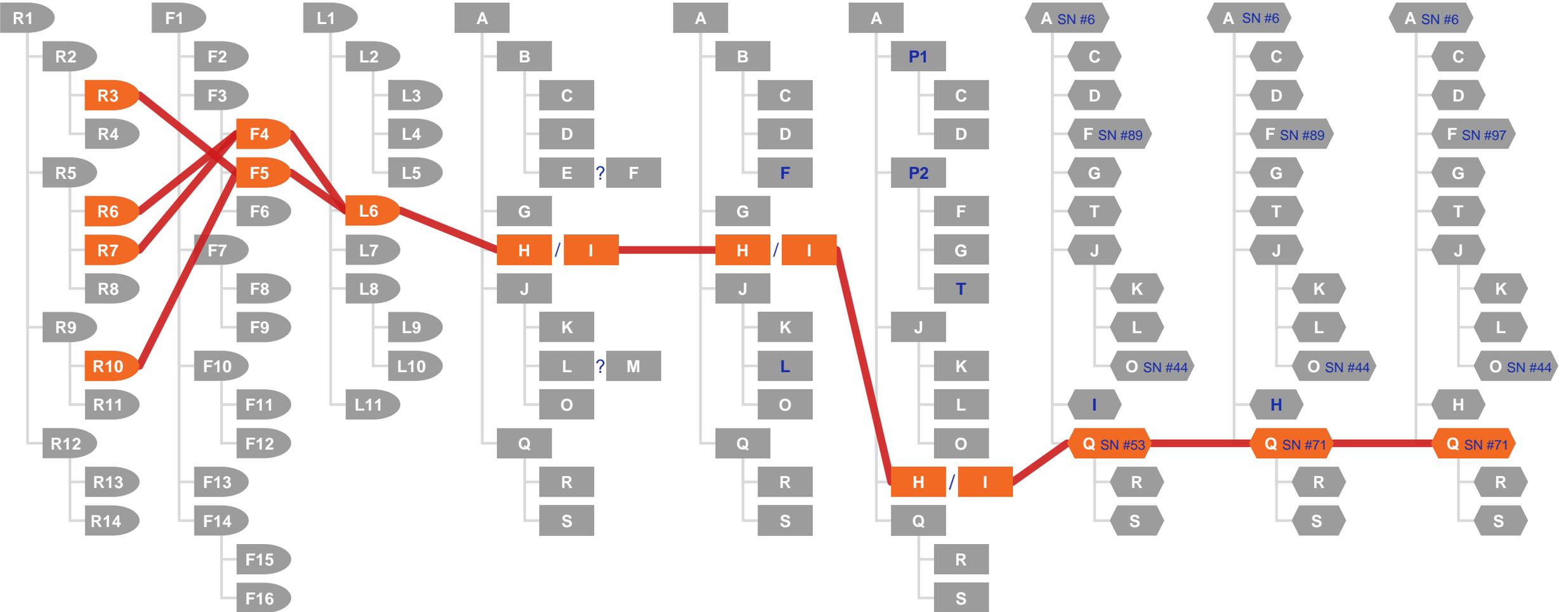


Digital Engineering Core Tenets

- 1 Model Based Enterprise**
Enterprise Configuration Management
Platform Overlay,
Holistic, Tool Agnostic Approach
- 2 Authoritative Source of Truth**
Platform Overlay:
Connect PDM environments & Tool agnostic
Open - data model & API
- 3 Technological Innovation**
Holistic approach – all domains
Tool agnostic approach
Open – data model & API
- 4 Infrastructure Environments**
Agile methodology
Greenhouse, Cloud, Virtualization
Open – data model & API
- 5 Transform Culture**
KAIZEN 101 > BY THE PEOPLE
Commander's Intent > Empower

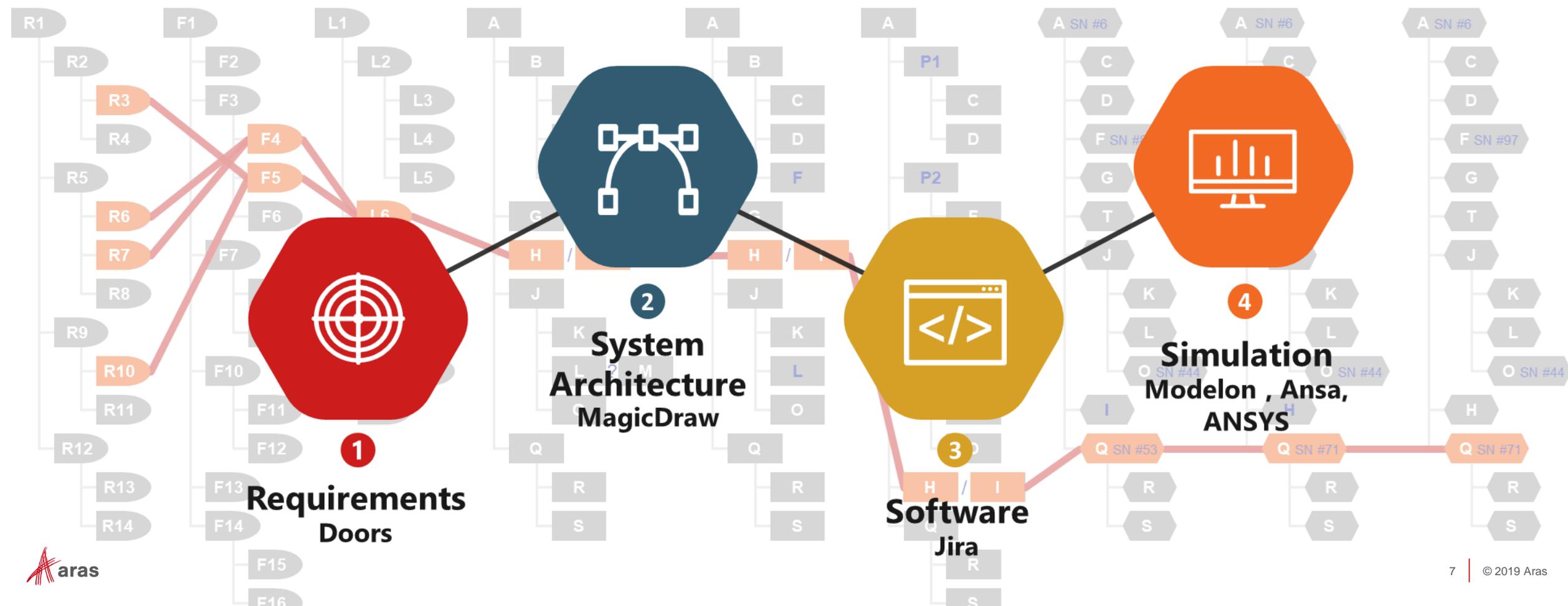


Full Lifecycle Digital Thread

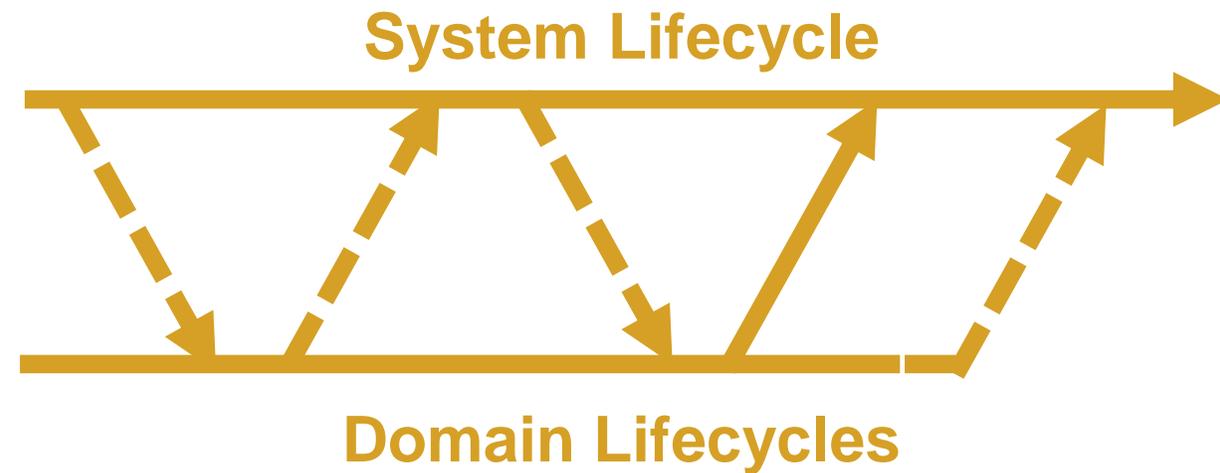
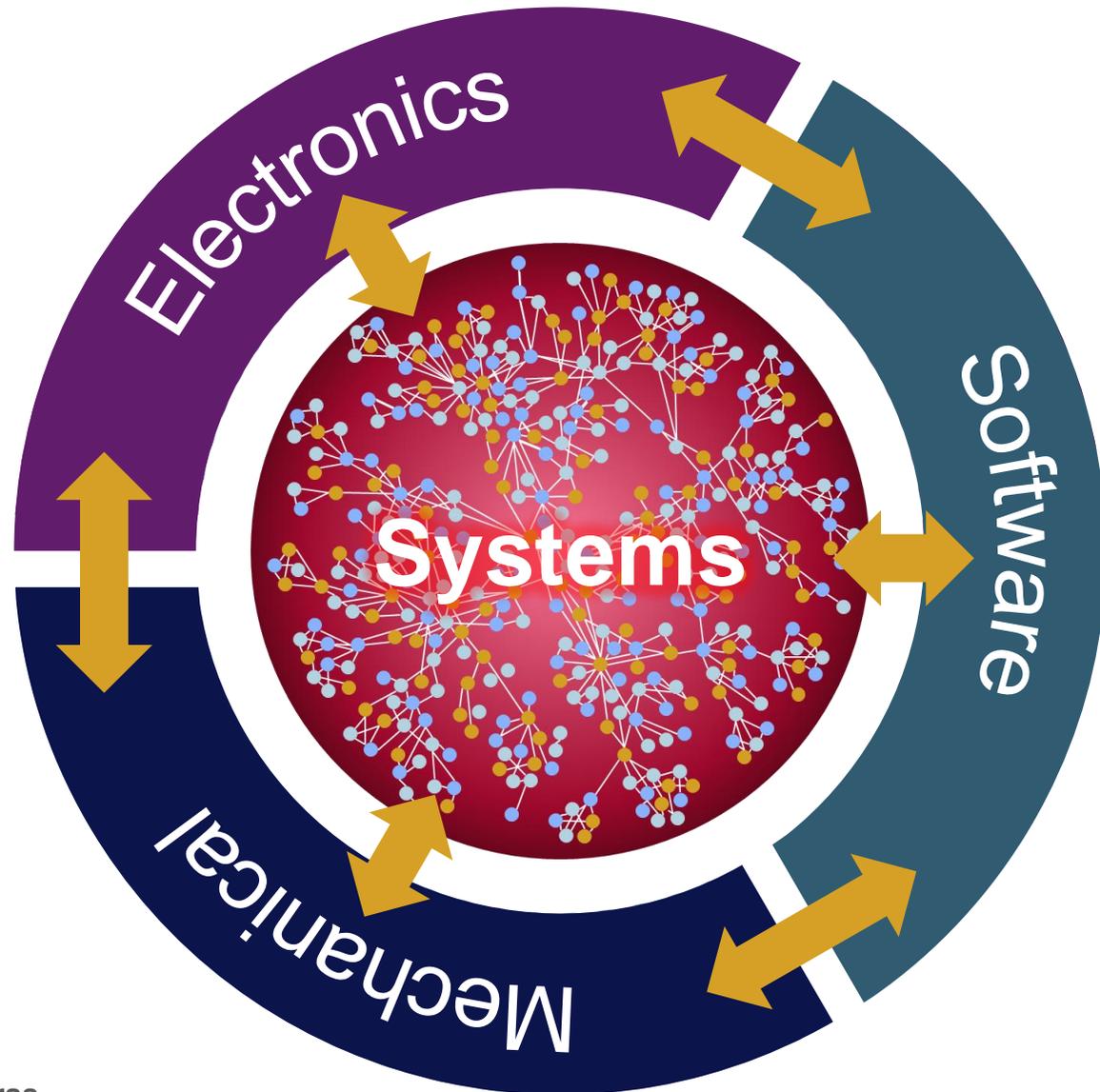


Integrated Product Development

- ~~Rip & Replace~~ | Platform overlay
- Enterprise Configuration Management

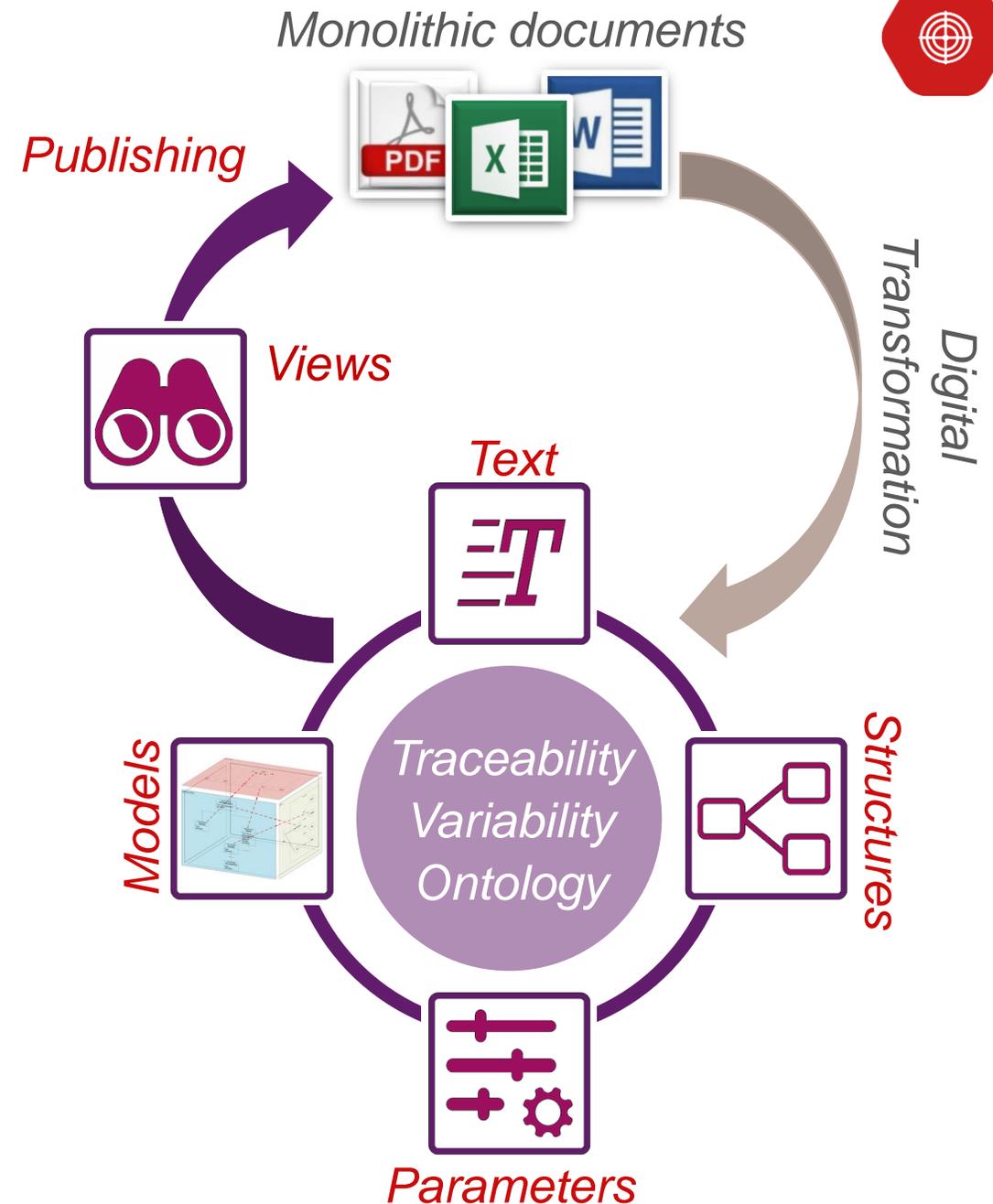


Interdisciplinary Collaboration – Systems Focus



Requirements Engineering

- Move beyond traditional methodology
 - Monolithic, disconnected documents
- Ontologies – meaning & purpose
- Stand alone controlled & reusable items
- Structured, shareable, reusable content
 - Text, Equations, Graph, parameter
- Relatable – RFLP, internal/external
- Requirements Documents allow grouping & reuse





Requirements Engineering

Req - 001

File Edit View Search Actions Reports Tools Help

Requirement

Requirement Number: 0001-00-002 Revision: State: Managed By: ...

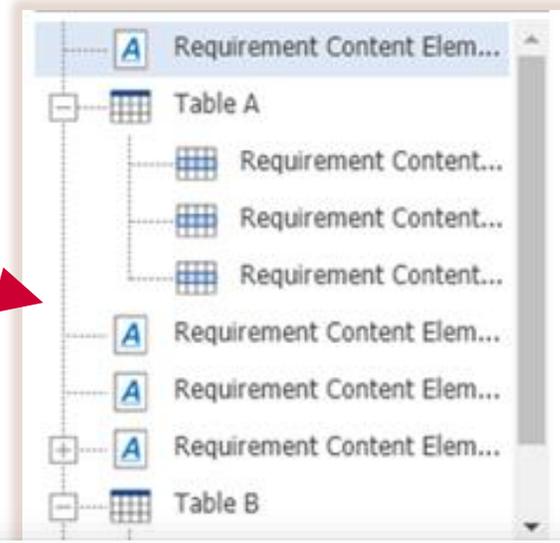
Title: Req - 001 Owned By: ...

Type: Category: Group: Tier: ...

Complexity: Priority: Risk: ...

External Links Outgoing Links Incoming Links

- Requirement
- Use case
- Test
- Verification
- Validation
- Text
- Structure



Requirement Title

Requirement Number

Lorem ipsum dolor sit amet, consectetur adipisicing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

REQ-000004

Create Related

Extruder Head Requirement

- 1 - Printing Technology
- 2 - Print Volume
- 3 - Layer Resolution
- 4 - Nozzle Diameter
- 5 - Extrusion Temperature
- 6 - Filament Diameter
- 7 - Filament Compatibility
- Extruder Compatibility

1 - Printing technology
REQ-000000032
Printing technology shall be Fused Deposition Modeling.

2 - Print volume
REQ-000000025
Print volume for printing parts shall be 573 in³.

- L29.5cm X W19.5cm X H16.5cm
- L11.6in x W7.6in x H6.5in

3 - Layer resolution
REQ-000000033
Each printed layer resolution shall resolve to

- 100 microns
- 0.0039 in

4 - Nozzle Diameter
REQ-000000035
Nozzle diameter shall be:

- 0.4 mm
- 0.015 in

5 - Extrusion temperature

Discussion

Enter a comment... Use @ to mention people

Attach World Comment

Diane Prescott August 28 at 7:11 AM REQ-000004 A-1 - Draft

@Dan Parks should we add REQ-000000007 to this document?

Flag Reply

Brian Cox August 27 at 12:52 PM REQ-000000035 A-2 - Draft

@Diane Prescott, should this requirement be related to the new Extruder assembly we created?

Flag Reply Hide replies

Diane Prescott August 27 at 1:12 PM REQ-000004 A-1 - Draft

You are absolutely right. I will take care of that.

Flag Reply

Brian Cox August 26 at 9:44 AM REQ-000000035 A-2 - Draft

@Terry Adams would it be possible to move to a smaller filament diameter?

Flag Reply Hide replies

Terry Adams August 26 at 10:44 AM REQ-000004 A-1 - Draft

We could try, but we would have to adjust the temperature. Do you think its worthwhile?

Flag Reply

Brian Cox August 26 at 11:11 AM REQ-000004 A-1 - Draft



DOORS Integration: Use Cases

- Select and link requirement to part or other item
- Create and update requirement in Innovator
- Create backlink in Doors to requirement/part
- Identify and visualize suspect state: “Has something changed in Doors?”
- Create/update requirements in Doors
- Revise part and requirement
- Navigate to Doors requirement
- Delete part/requirement link
- Display live Doors data

Synchronize title and description

Doors link as external link

Link requirement

Backlink part/requirement

DOORS Integration

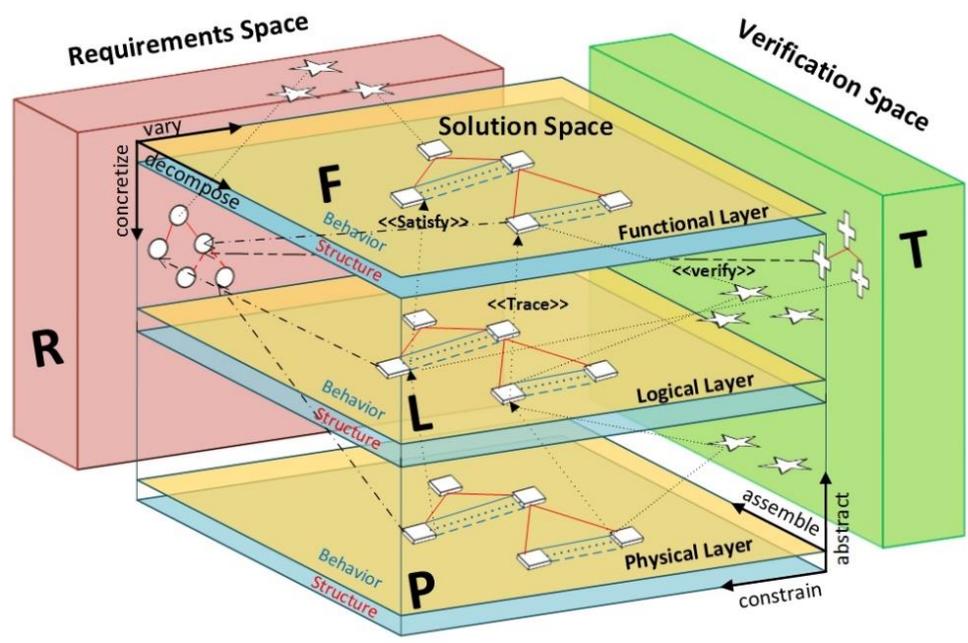
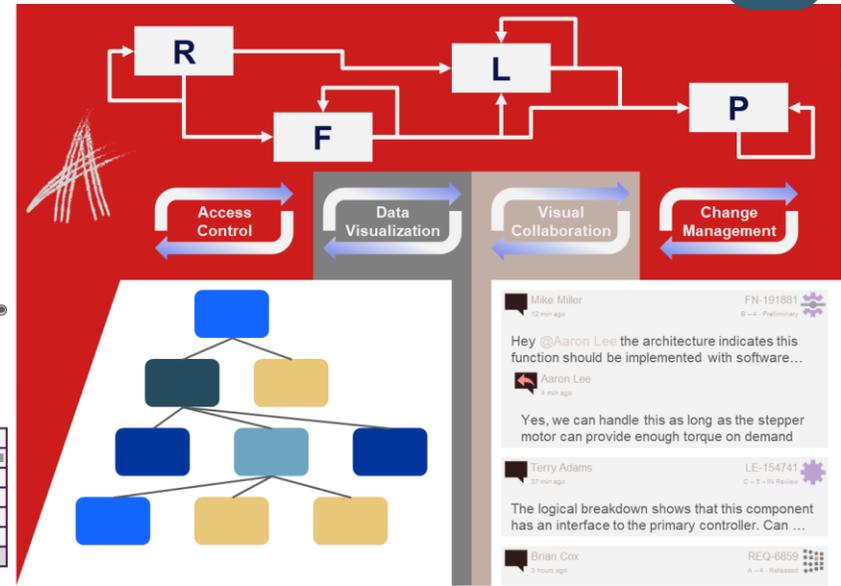
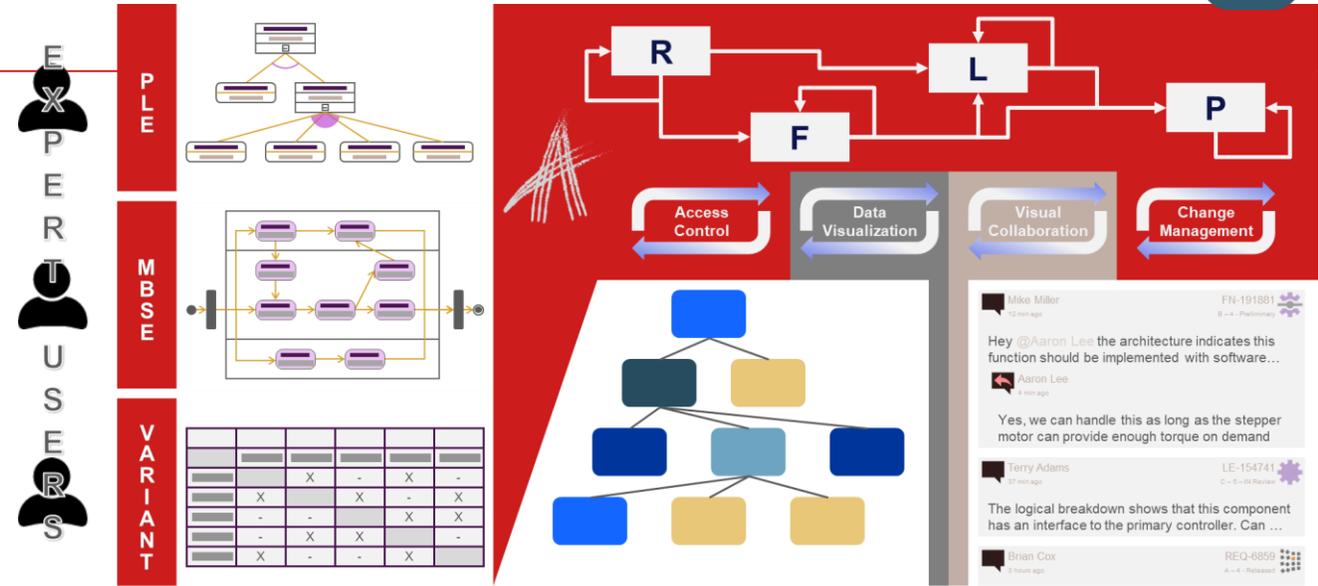
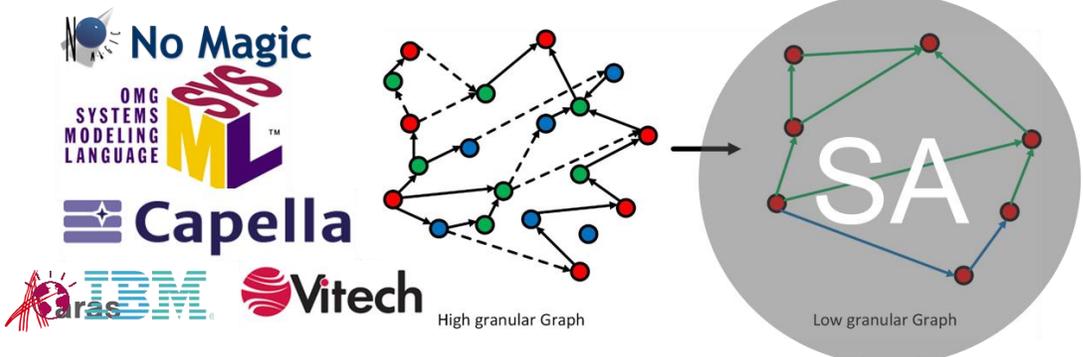
Full video online:
<https://youtu.be/JIQKevkfRel>

- Link DOORS requirement
- DOORS UI from Aras
- Aras Requirement in DOORS
- Multiple links
- Requirement change



Systems Architecture

- Central System Architecture & Ontology
- Enterprise Configuration Management & traceability
- Model variants and PLE configurability as early as possible
- Enables cross-discipline collaboration with downstream/supplier specialists
- MBSE Integration
 - Model object abstraction - granularity
 - Configuration control of abstraction and models
 - Dynamic data exchange



- Solution Elements
- Requirements
- Intermediate Artifacts
- Test Cases

Systems Architecture



Properties

System Model

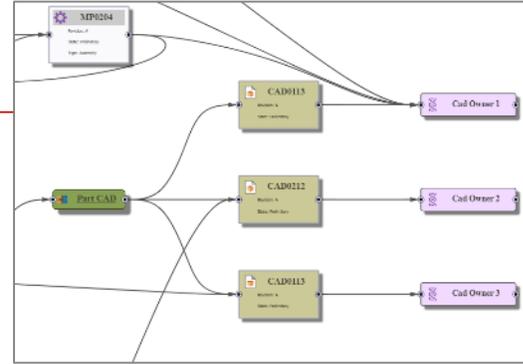


Created By: Innovator Admin
 Created On: 5/19/2017
 Modified By: Innovator Admin
 Modified On: 5/25/2017
 Locked By:
 Major Rev: A
 Release Date:
 Effective Date:
 Generation: 2
 State:

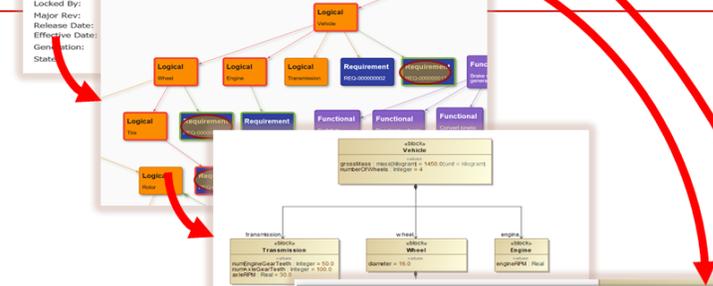
Name	Version
Vehicle Model LX	2

Function Name	Version	Status
Brake	2	Preliminary
Brake with generator	2	Preliminary
Charge battery	1	Preliminary
Convert kinetic energy into electrical energy	1	Preliminary

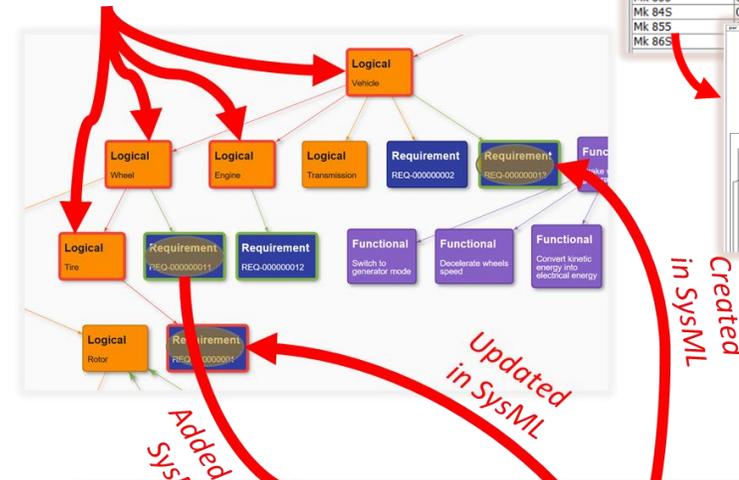
Function Name	Logical Name	Version	state
Decelerate wheels speed			
Engage friction brake			
Force brake pads to move inwards	Brake	2	Preliminary
Generate friction brake contacting brake pads	Caliper	1	Preliminary
Move piston inside master cylinder	Engine	1	Preliminary
Push Brake Pedal	Pad	2	Preliminary
	Rotor	2	Preliminary
	Tire	2	Preliminary
	Transmission	1	Preliminary
	Vehicle	2	Preliminary
	Wheel	2	Preliminary



state	Version	in...
Preliminary	1	Brake
Preliminary	1	Caliper
Preliminary	2	Engine
Preliminary	1	Pad
Preliminary	1	Rotor



Flagged as affected

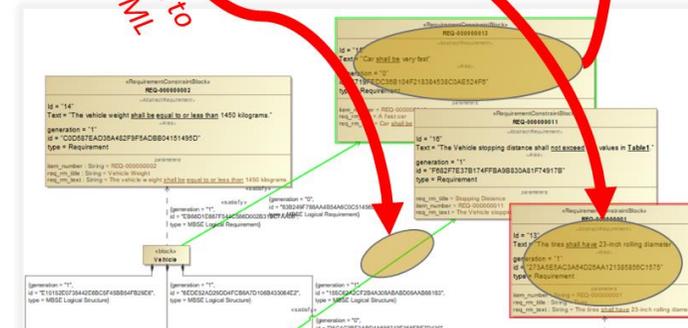


Created in SysML

Added to SysML

Updated in SysML

item_number	sys_width	sys_thickness	sys_centerlength
Mk 825	0.04	0.0084	0.076
Mk 835	0.042	0.0084	0.076
Mk 845	0.046	0.0088	0.076
Mk 855			
Mk 865			





MagicDraw Integration

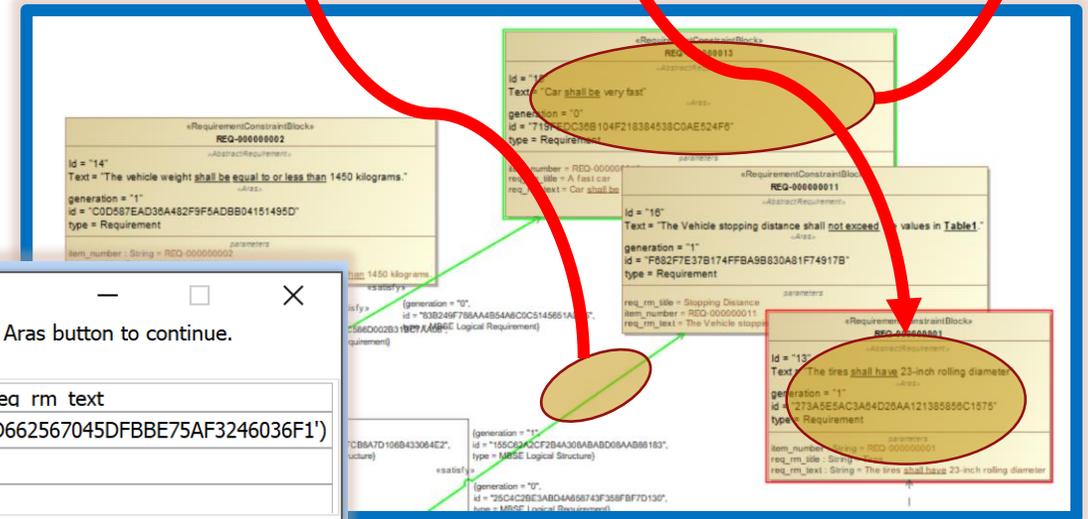
- SysML user manipulates parametrically-driven requirements at will
- Integration provides visual feedback regarding Platform status of SysML changes
 - Red -> modified from Platform (change)
 - Green -> not in Platform (create)
 - No color -> query from Platform (add)

Properties

Requirement

Created By: Innovator Admin
Created On: 4/19/2018
Modified By: Innovator Admin
Modified On: 4/19/2018
Locked By:
Major Rev: A
Release Date:
Effective Date:
Generation:
State: Draft

Requirement Number	Title	State	Rev
REQ-000000001	Tires	Draft	A
REQ-000000002	Vehicle Weight	Draft	A
REQ-000000003	Pad Width	Draft	A
REQ-000000004	Stopping Distance	Draft	A
REQ-000000005	Table1	Draft	A
REQ-000000006	Pad Center Thickness	Draft	A
REQ-000000007	Brake Heating	Draft	A
REQ-000000008	Rotor Diameter	Draft	A
REQ-000000009	Brake Pad Life	Draft	A



Aras

Please enter item attributes! Press the Query Aras button to continue.

+ Requirement

Select: item number,req rm title,req rm text

Where: NT where source_id='FB49D662567045DFBBE75AF3246036F1')

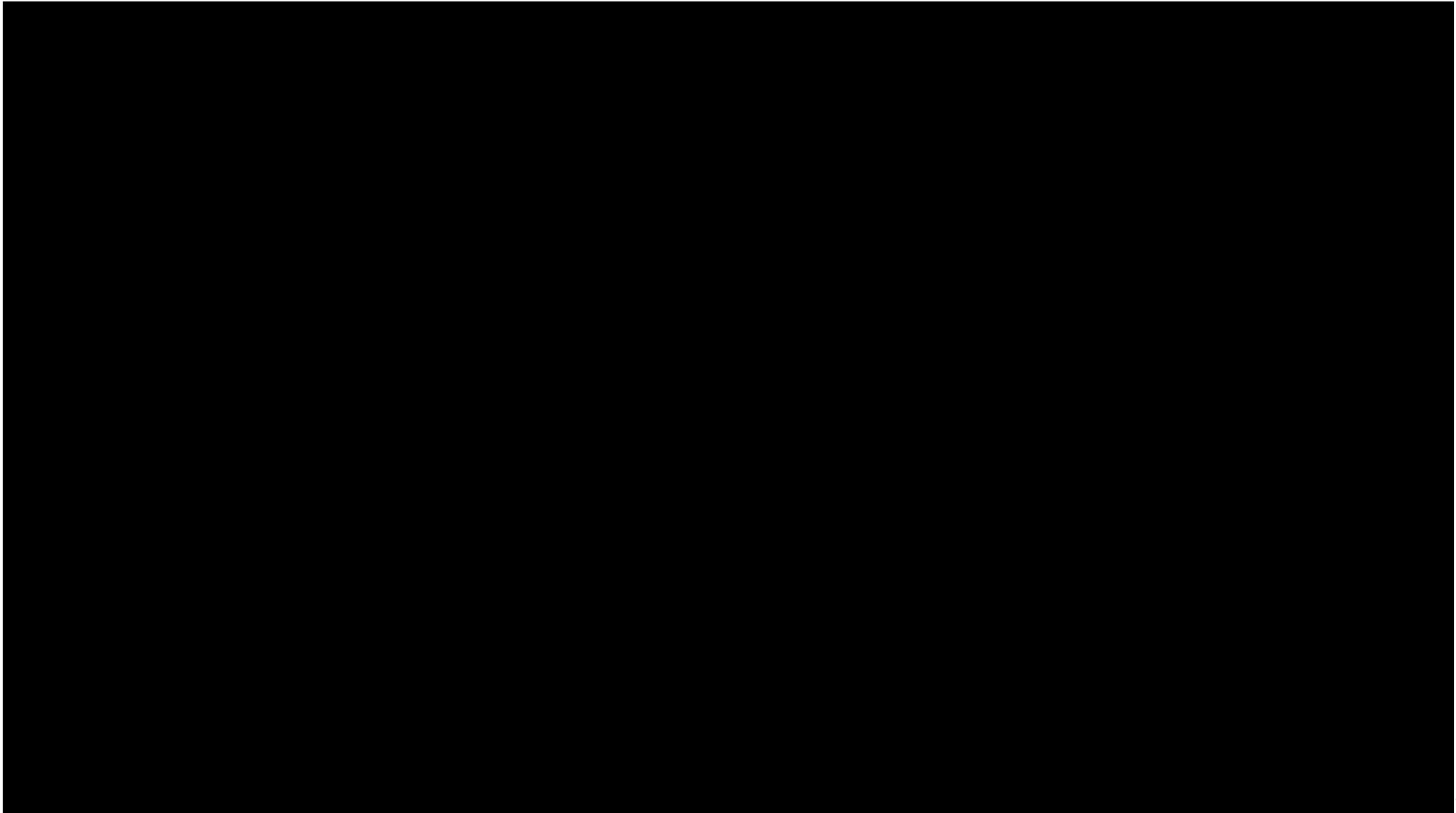
Classifier Name: Requirement

Action: get

Query Aras Load Query Save Query Cancel

MagicDraw Integration

Full video online:
<https://youtu.be/HPIWyS0vgr0>



Embedded Software

- Integrated Software and Hardware development and operation processes(DevOps)
- Support domain differences
- Tool agnostic approach
- Synchronize master with other systems for visibility and integrity
- Single, cross-discipline problem reporting and change process

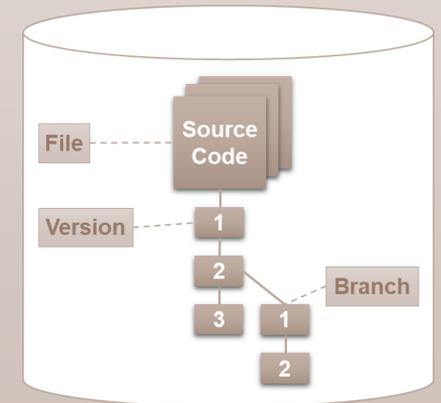
JIRA

Issue tracking, change management, agile planning



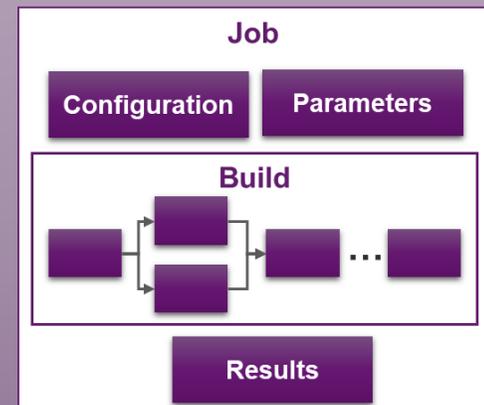
Git

Software configuration management

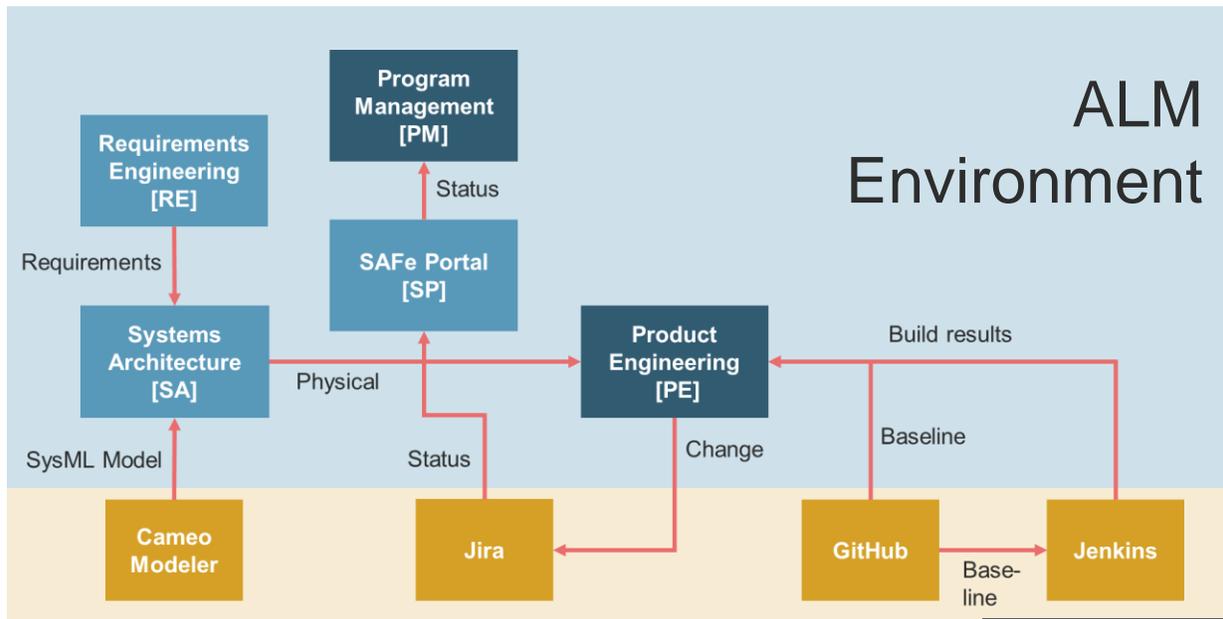


Jenkins

Automated build –
Creating software binaries
from source code



Embedded Software



Jira

ADP-359

Changes to: MP2988 revision: A

Reason for change: because

Description of changes to make: do it

Affected Repository: <https://github.com/ajsebastian/jenkins-example>

Branch for changes: ECO-00001020

(Task created from Aras Innovator ECO number: ECO-00001020)

Link: <http://araslabs/ALMLABS-development/?StartItem=ExpressECO>

Buttons: Save, Cancel

Git

ajsebastian / jenkins-example

Example project with Groovy based Jenkins Pipeline (Jenkinsfile)

30 commits, 3 branches, 1 release, 2 contributors

Branches: master, ECO-00001019, ECO-00001020, testBranch

Buttons: Find or create a branch...

Part

Part Number: MP2988

Revision: A

Name: Makerbot Mig

Type: Software

State: Released

Cost: 114.0000

Changes: []

Last Build: mbp_master 11

Last Failed Build: mbp_master 3

Last Successful Build: mbp_master 11

Release: V1.0

Release URL: <https://github.com/ajset>

Software Build

Build Result: SUCCESS

Parameterized: []

SCM: Github

GitHub Repo: <https://github.com/ajsebastian/jenkins-example.git>

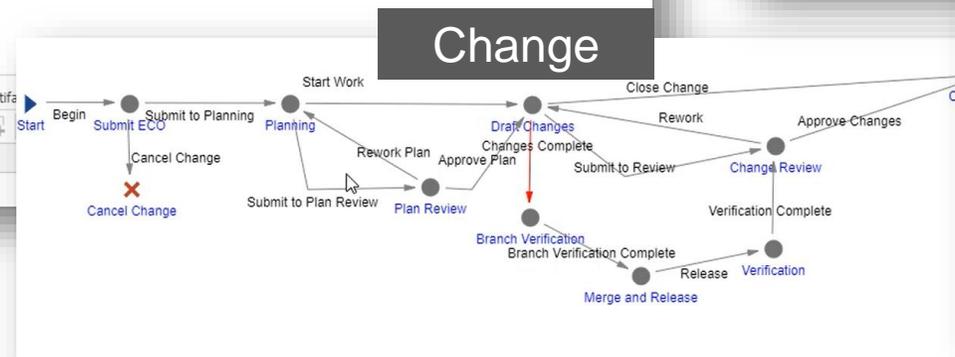
Build Number: 11

Duration: 24951

Branch Name: master

Tests Passed: 8/8

Software Revision: E2C5021A3FAD497288E57D8820D59452



Jenkins

Branch ECO

Full project name: mbp

Recent Changes

Stage	Time
Declarative: Checkout SCM	1s
Compile Stage	6s
Testing Stage	703ms

Average stage times: 1s, 6s, 703ms

Permalinks: Last build (#1) 15 sec ago



Jira & Git Integration: Aras ECO

ECO

Number: Server Assigned

Title: Bug Fix

Change Reason: beacuse

Change Description: do it

Priority:

- 1 - High
- 2 - Normal
- 3 - Low

Change Coordinator: Innovator Admin

Team: Software Team

Release Date: [Calendar]

Effective Date: [Calendar]

Impact Matrix | Attachments | EDRs | SignOffs | Related Jira Links

Item Number	Name	Revision	State	Sequence	Quantity	Unit	Item Action
MP2988	Makerbot MightyBoard Sof...	A	Released			EA	Revise
MP2988 Software	Makerbot Software	A	Preliminary	10			

Workflow Activity Completion

Workflow: ECO-00001020
Activity: Planning

Sequence	Required	Description	Complete
1	<input type="checkbox"/>	Perform an impact analysis and ensure that each change action is set	<input type="checkbox"/>
2	<input type="checkbox"/>	Set the effective date for the ECO	<input type="checkbox"/>

Vote: [Dropdown] Delegate to: [User]

Comments: [Text Area]

Authentication: Password: [Field] E-Signature: [Field]

Buttons: Complete, Save Changes, Cancel

Activity	State	Assigned To	Completed By	How Voted	When
Submit ECO	Closed	Innovator Admin	Innovator Admin	Submit to Planning	4/24/2019 2:29:17 P
Planning	Active	Product Owner		VOTE NOW	



Jira & Git Integration

Contact us for full video



- Kanban ticket from Innovator ECO - Aras info on Card, Jira info on ECO
- New Git branch auto created
- Software engineer takes Jira task/ ticket
- Perform work (code)

The screenshot displays the Aras Innovator web interface. At the top, the browser address bar shows the URL: `araslabs/ALMLABS-development/Client/X-salt=2_11.0.0.7181-X/scripts/Innovator.aspx`. The page header includes the Aras INNOVATOR logo, a user profile for 'Innovator Admin', and the local time 'Wednesday, April 24, 2019 2:29 PM'. Below the header, there are navigation tabs for 'EDRs', 'Impact Matrix', 'Attachments', 'SignOffs', and 'Related Jira Links'. The main content area is titled 'Workflow History Report' for item 'ECO-00001020'. It shows the workflow status as 'Active' and provides a table of activities.

Activity	State	Assigned To	Completed By	How Voted	When	Comments
Submit ECO	Closed	Innovator Admin	Innovator Admin	Submit to Planning	4/24/2019 2:29:17 PM	
Planning	Closed	Product Owner	Innovator Admin	Start Work	4/24/2019 2:29:26 PM	
Draft Changes	Active	System Engineer		VOTE NOW		

Simulation: Drive From Requirements



RD-00002

Edit

Requirements Document

Requirements Document Number: RD-00002
Revision: A
State: Draft
Managed by: World

Title: TC Curb Collision Requirements
Owned by:

Description:

Category: Group: Tier:

Content Documents Related Parts External Links Outgoing Links Incoming Links

Requirements

Chapter	Requirement Number	Title	State
1	REQ-000000001	Max Force - r0CL1_left in collision with 200mm curb ...	Draft
2	REQ-000000002	Max Force - r0CL2_left in collision with 200mm curb ...	Draft
3	REQ-000000003	Max Stress- Left Front LCA in collision with 200mm c...	Draft

REQ-000000001

Edit

Requirement

Requirement Number: REQ-000000001
Revision: A
State: Draft
Managed by: World

Title: Max Force - r0CL1_left in collision with 200mm curb at 20m/s and 28deg
Owned By:

Type: Requirement
Category: Group: Tier:

Complexity: Low
Priority: Low
Risk: Low

Documents Related Parts External Links Outgoing Links Incoming Links Condition Expression

Condition Expressions

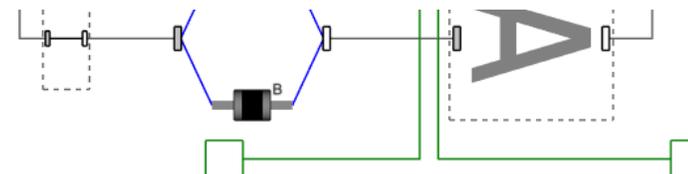
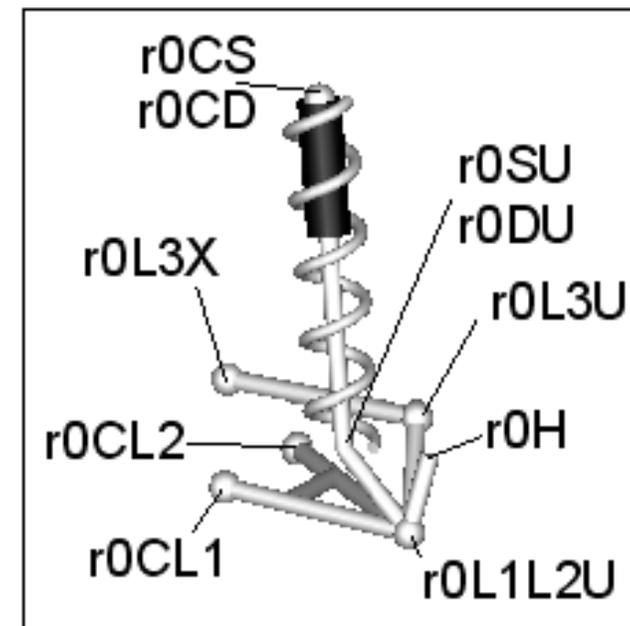
Order	Conditional O...	Parameter [...]	Logical Opera...
	<=	100000 N	



Simulation: Modelica Integration

Hard points

r0H	$\{0.0, 0.7, 0.0\}$	m	Position of hub center, resolved in vehicle frame
r0A	r0H	m	Position of origin of stabilizerFrame, resolved in vehicleFrame
r0X	steering.r0R_1	m	Position of origin of steerLinkFrame, resolved in vehicleFrame
r0CL1	$\{-0.008, 0.375, -0.051\}$	m	Position of front link mount in chassis, resolved in vehicleFrame
r0CL2	$\{-0.318, 0.354, -0.035\}$	m	Position of rear link mount in chassis, resolved in vehicleFrame
r0CS	$\{0.025, 0.541, 0.4\}$	m	Position of spring mount in chassis, resolved in vehicleFrame
r0CD	r0CS	m	Position of strut/damper mount in chassis, resolved in vehicleFrame
r0SU	$\{0, 0.579, 0.042\}$	m	Position of spring mount in upright, resolved in vehicleFrame
r0DU	r0SU	m	Position of damper mount in upright, resolved in vehicleFrame
r0L1L2U	$\{0.015, 0.675, -0.072\}$	m	Position of upright-strut joint, resolved in vehicleFrame
r0L3X	r0X	m	Position of steer link inner joint, resolved in vehicleFrame
r0L3U	$\{-0.128, 0.643, 0.073\}$	m	Position of steer link outer joint, resolved in vehicleFrame



Simulation: Manage Simulation Process



aras INNOVATOR®

gearbox_demo_v09_... SIM000053

File Edit Views Search Actions Reports Tools Help

Simulation ID: SIM000053 State: Completed

Name: Gearbox Simulation 001C

Description: 001C: 001B + new bearings

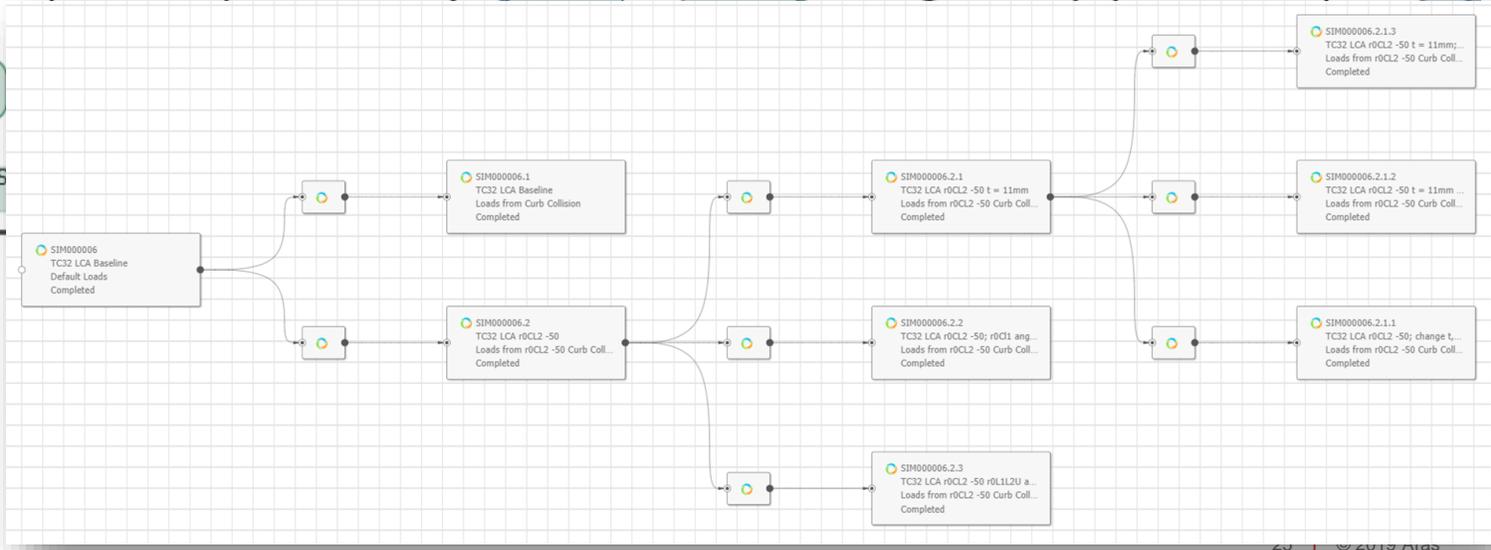
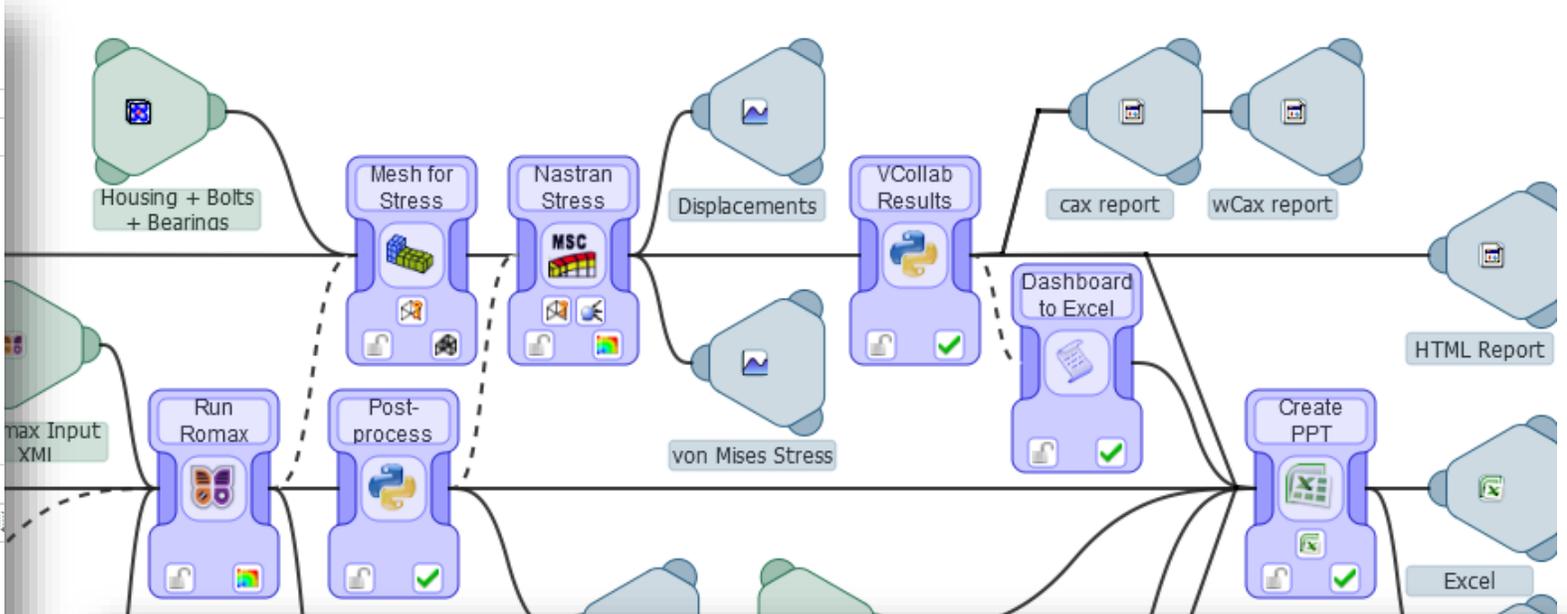
Simulation Template: gearbox_demo_v09_RUN

Created By: Innovator Admin
Created On: 4/25/2019
Modified By: Innovator Admin
Modified On: 4/25/2019
Locked By:
Major Rev: A
Release Date:
Effective Date:
Generation: 2
State: Completed

Simulation Items Structure Simulation Variables Simulation FMI Variables Simulation Results Simulation Result Files

Actions: Pick Related

File Type [...]	Comments	Indexed On [...]	related_id [...]
Microsoft PowerPoint			automatic_report.pptx
ASCII Text			logfile.txt
HTML Web Page			results_3D.html
XML Data			System_Metrics.xml
HTML Web Page			updated_CAD_3D.html



Simulation: Integrated Demo

Full video online:
<https://youtu.be/SaY2NdJrjJ4>





Simulation Studies Correlate Testing

STUDY000001

Study

Study

Name: STUDY000001

Description: TC32 Milestone 3

State: WIP

Design: [TC32_Vehicle_Des](#)

Environment: [TC32_Vehicle_Env](#)

Simulation Instruction: [TC32_Vehicle_SimInstr](#)

Requirement: [TC32_Requirements](#)

Design Name: TC32 Full Vehicle Model

Environment Name: TC32 Full Vehicle Envir

Instruction Name: TC32 Full Vehicle Simul

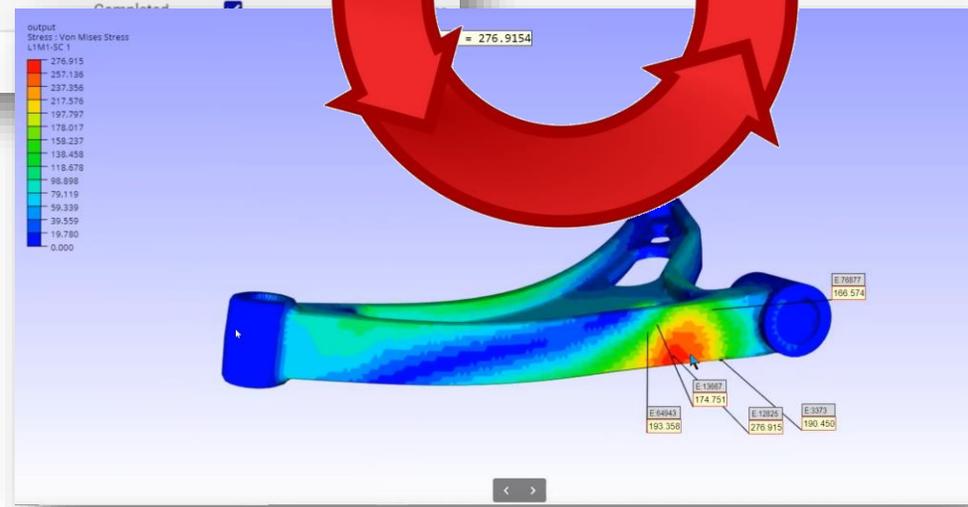
Requirement Name: TC32 Requirements

Created By: Innovator Admin
Created On: 10/5/2019
Modified By: Innovator Admin
Modified On: 10/6/2019
Locked By: Major Des

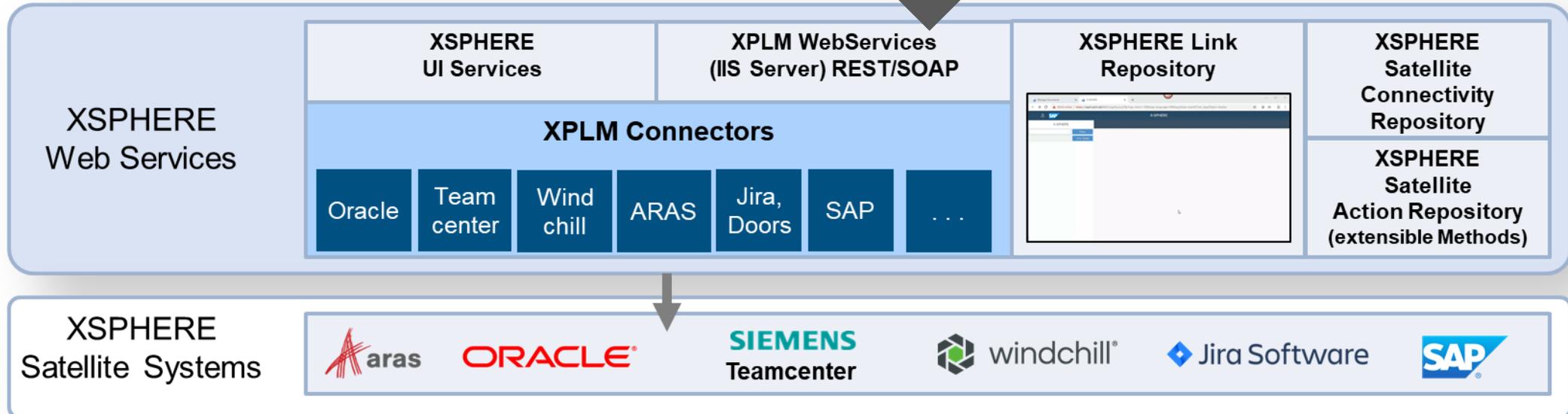
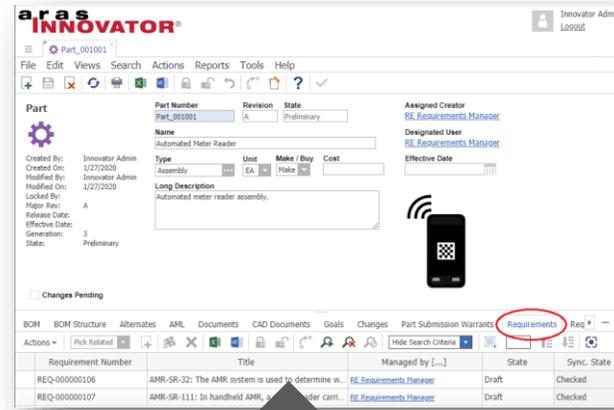
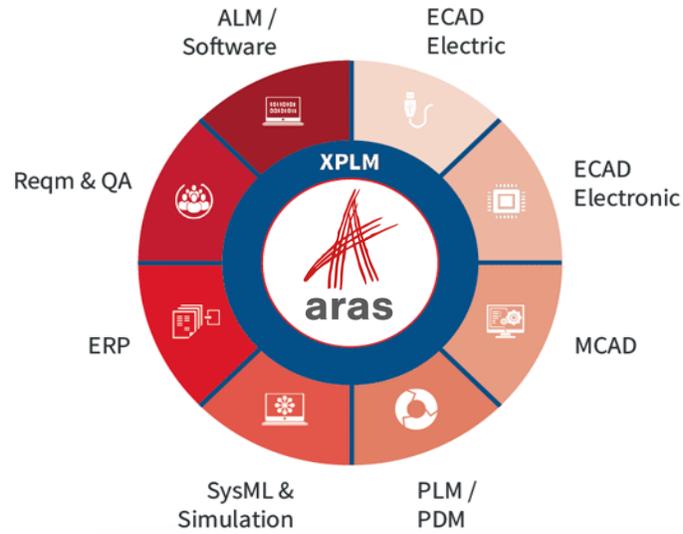
Simulation

Simulations

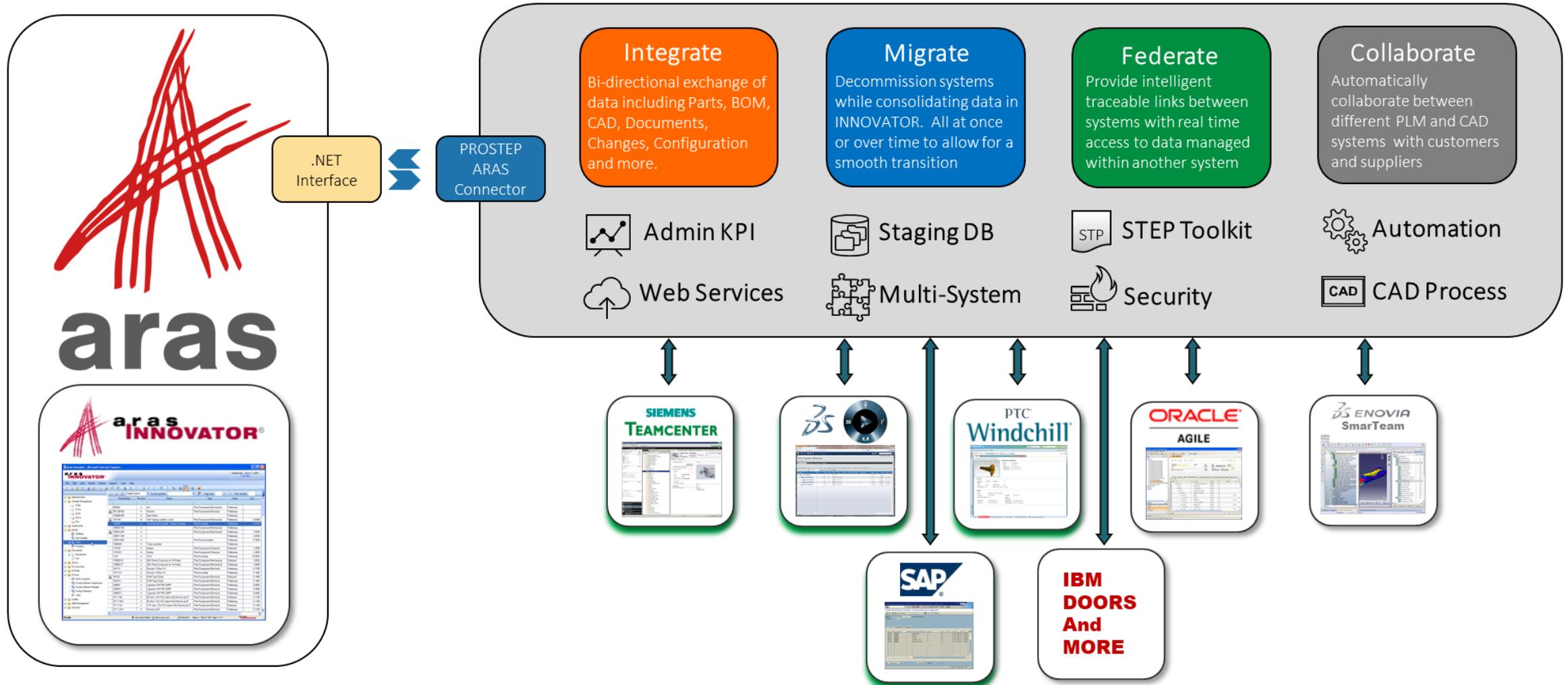
Simulation ID	Name	Description	Simulation Template [...]	state	Use template
SIM000005	TC32 Curb Collision Baseline	Baseline Design	Vehicle_Simulation_FMI_Project_Run3	Completed	<input checked="" type="checkbox"/>
SIM000006	TC32 LCA Baseline	Default Loads	lca_02_run	Completed	<input checked="" type="checkbox"/>



Aras | XPLM Integrations



Aras | Prostep Integrations



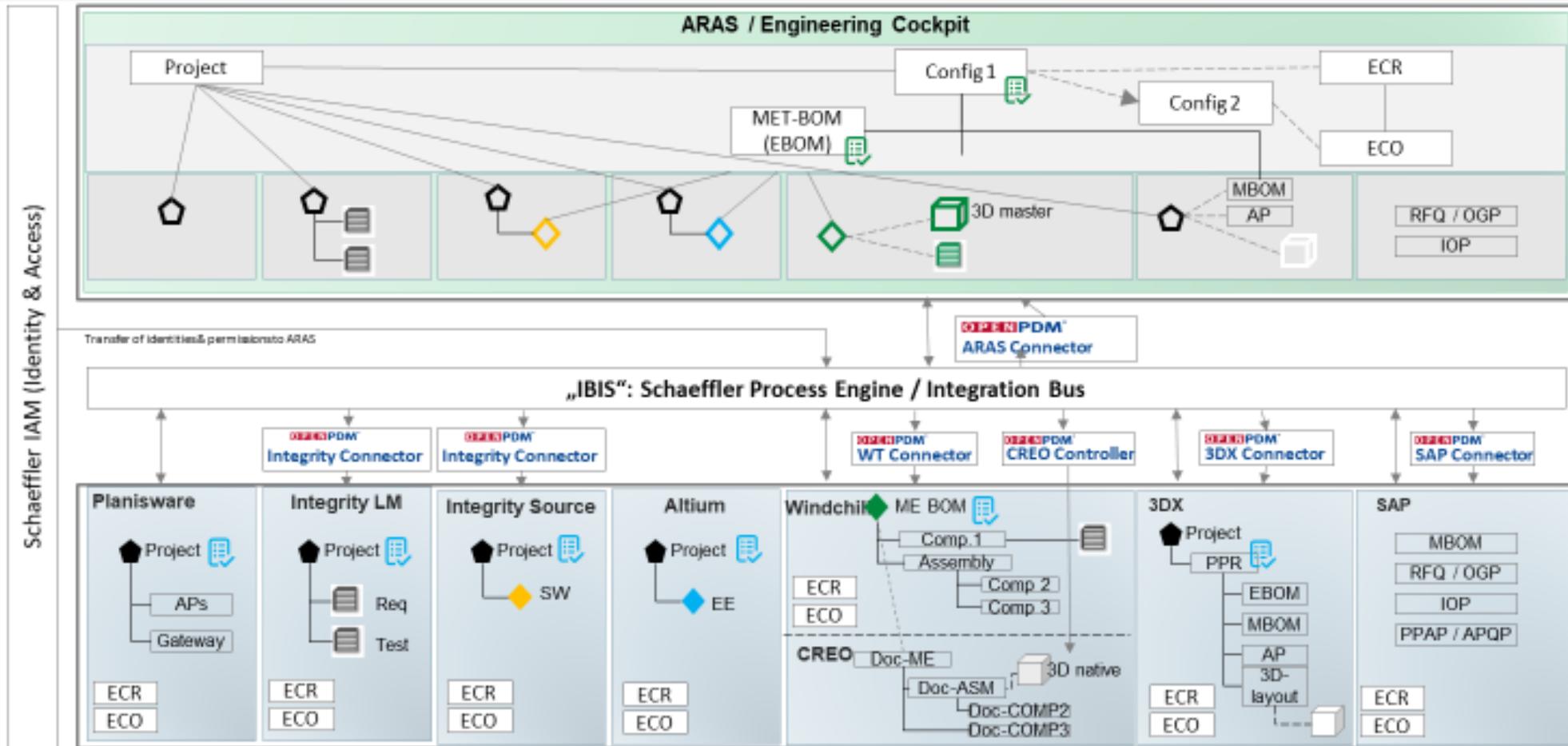
Aras | Prostep Integrations

Interaction between the PLM systems and ARAS Innovator (data view)

Middleware Architecture IBIS with OpenPDM Connectors



Caption: → Trigger (not data flow)





Thank You

David Ewing Jr. | dewing@aras.com | 978.806.9504

Detailed demos/examples call or email

