

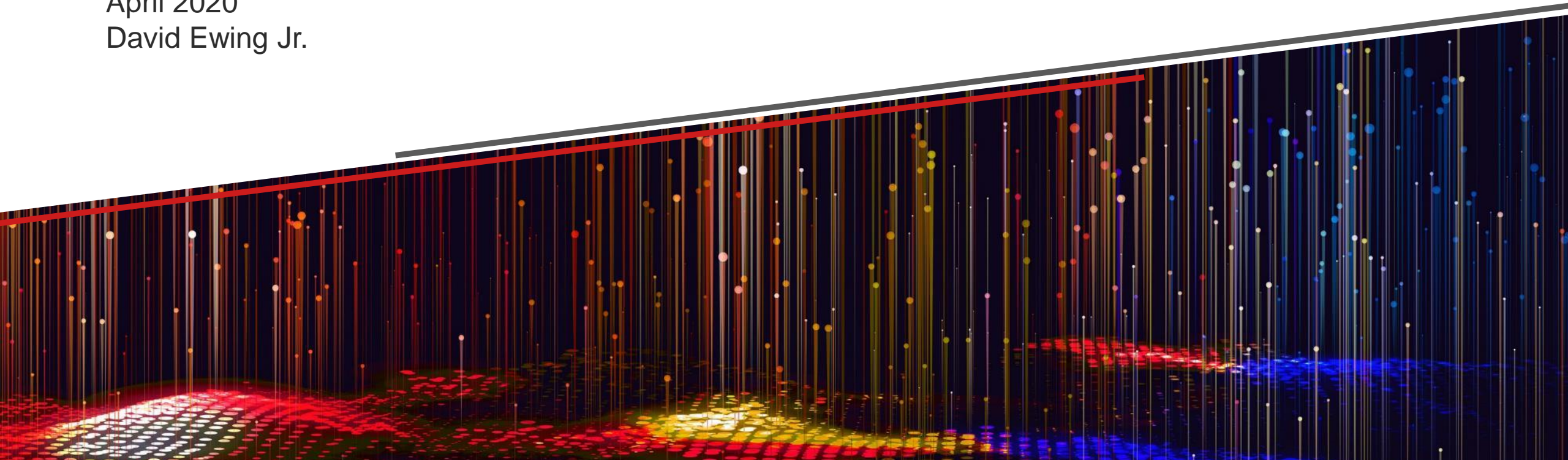


Enabling The Source of Truth

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

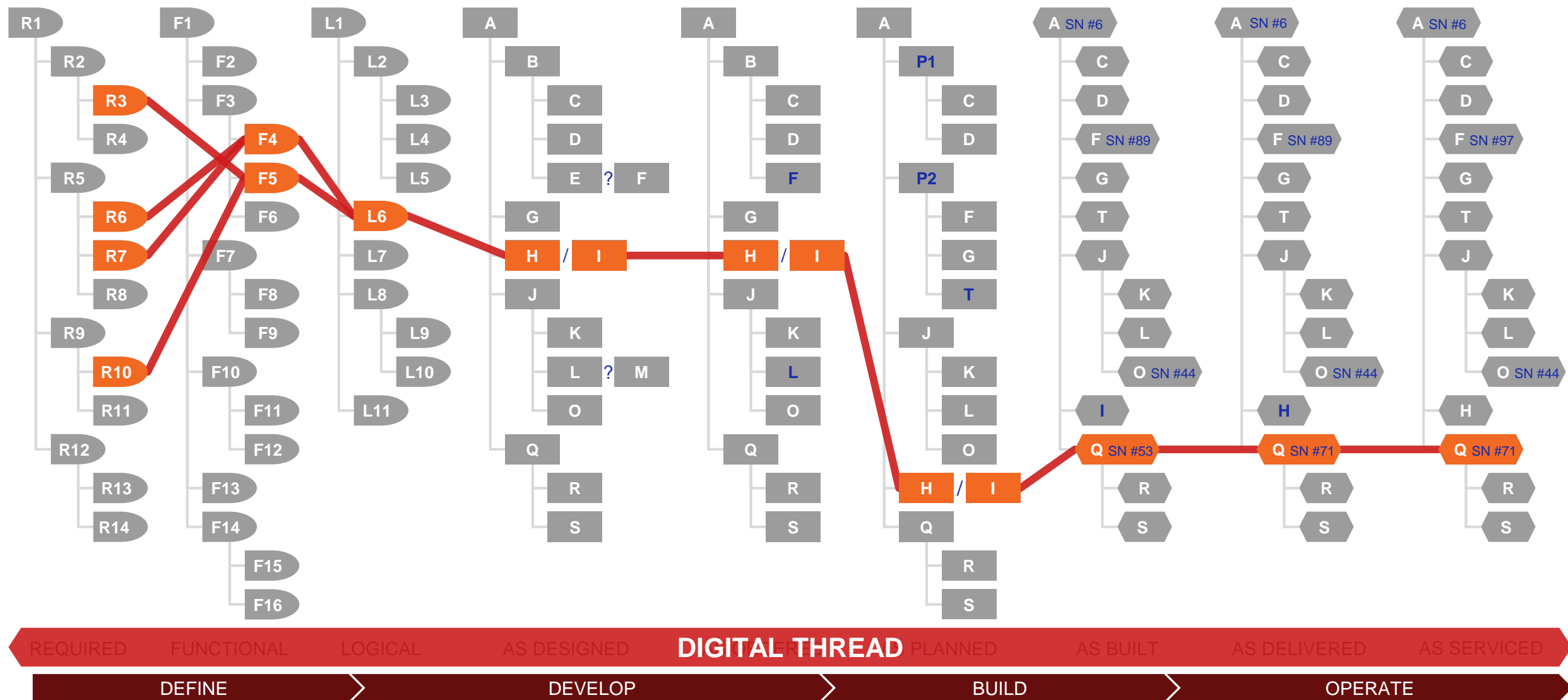
5

Transform Culture

KAIZEN 101 > BY THE PEOPLE
Commander's Intent > Empower

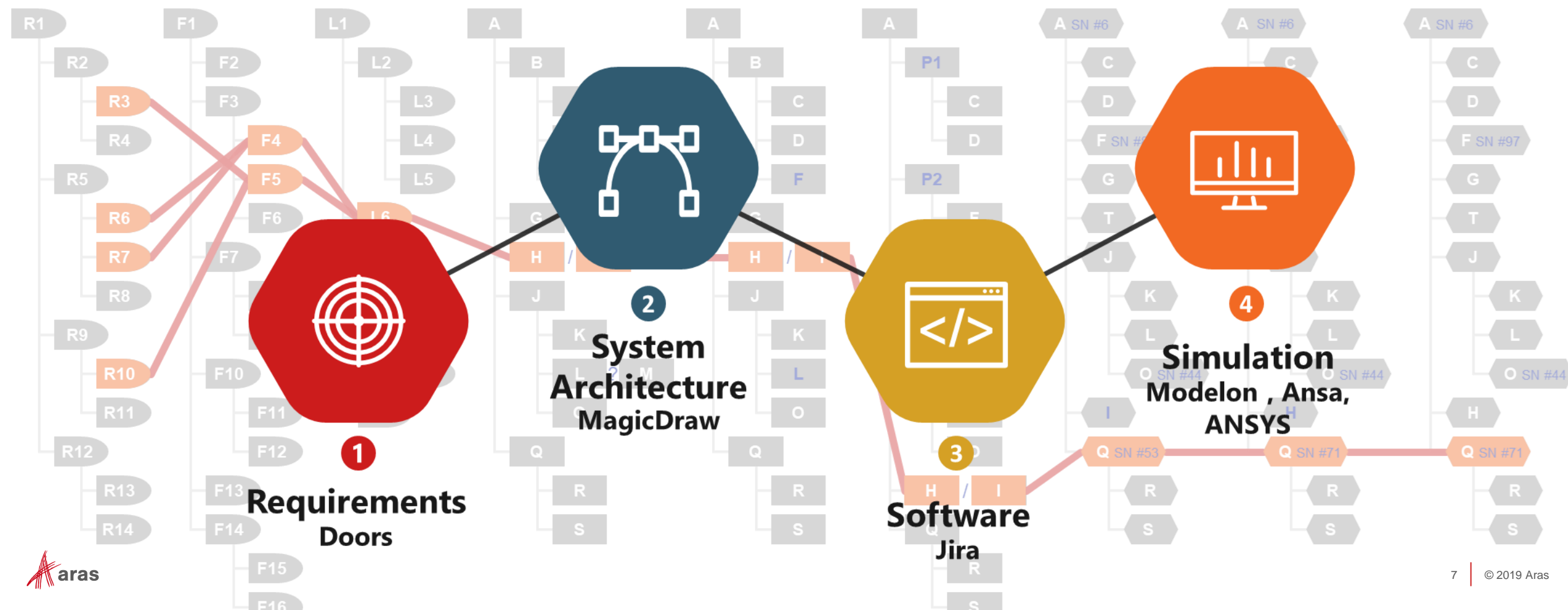


Full Lifecycle Digital Thread

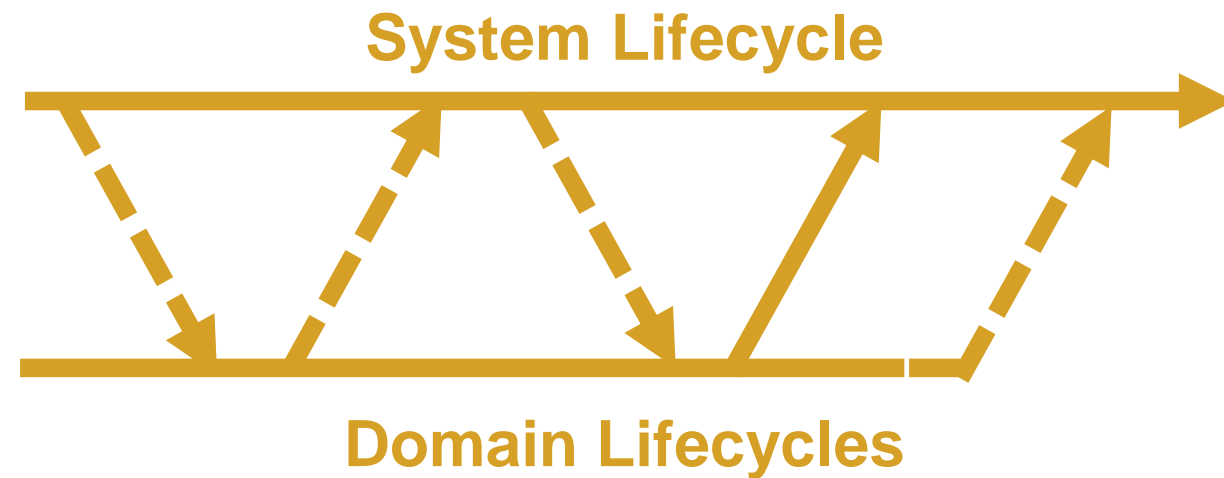
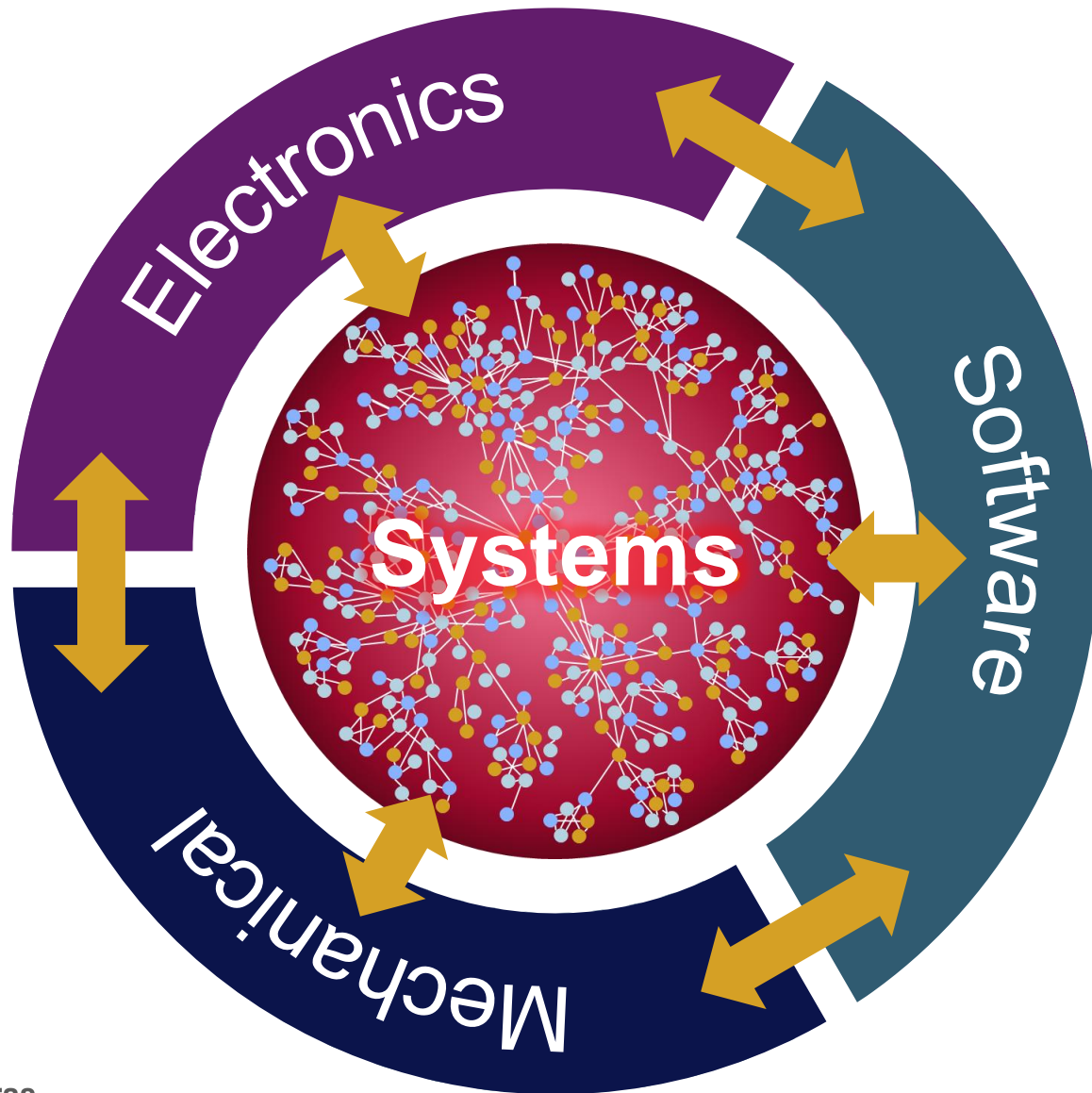


Integrated Product Development

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

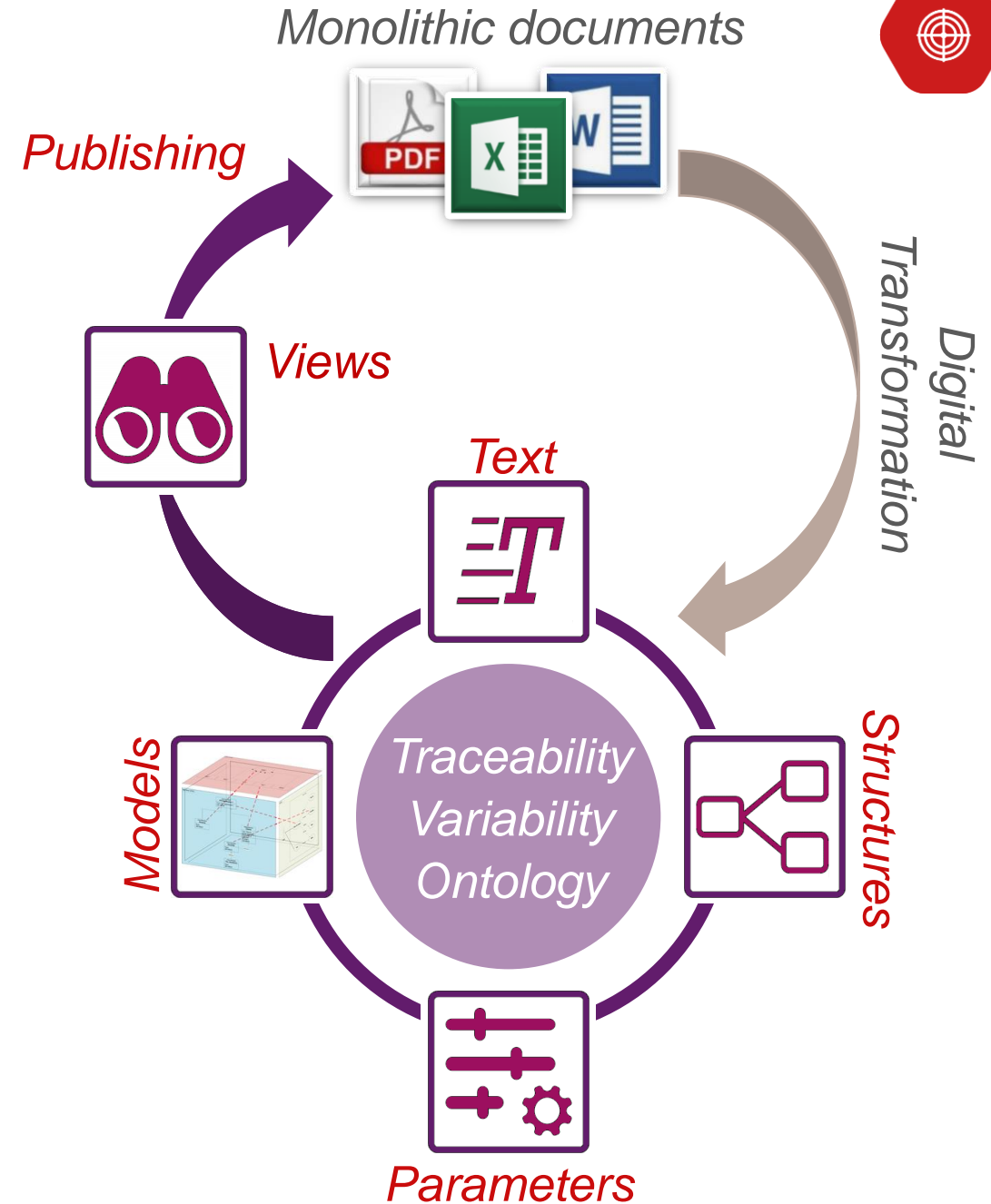


Interdisciplinary Collaboration – Systems Focus



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

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

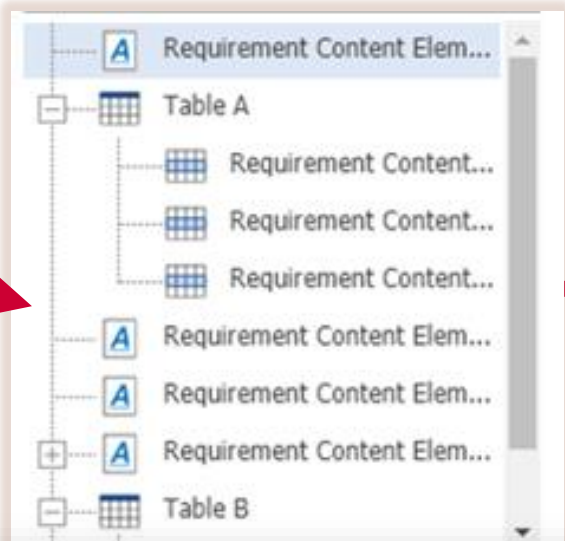
Risk

External Link

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.

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. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Req - 00004

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
- 7.1 - 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

Search messages...

Enter a comment...

Use @ to mention people

Attach World Comment

Diane Prescott

August 28 at 7:11 AM

REQ-00004

A-1 - Draft

@Dane Park, 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-00000

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-00000

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 11:14 AM

REQ-00000

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

The image displays two software interfaces side-by-side. The top interface is 'Rational DOORS Web Access' showing a project tree on the left with 'AMR_Sample' expanded. The main area shows a document titled 'Automated Meter Reader System' with sections like '1 Introduction' and '2 General Description'. The bottom interface is 'Aras INNOVATOR' showing a 'Requirement' form for 'REQ-00000106'. A red dashed box highlights the 'Requirement' form in Innovator. A red arrow points from the 'Requirement' form in Innovator to the 'DOORS External Links (2)' section in DOORS, labeled 'Link requirement'. A green arrow points from the 'DOORS External Links (2)' section in DOORS to the 'Requirement' form in Innovator, labeled 'Backlink part/requirement'. A blue arrow points from the 'Requirement' form in Innovator to the 'DOORS External Links (2)' section in DOORS, labeled 'Doors link as external link'. A red arrow points from the 'Requirement' form in Innovator to the 'Requirement' form in DOORS, labeled 'Synchronize title and description'.

Synchronize title and description

Doors link as external link

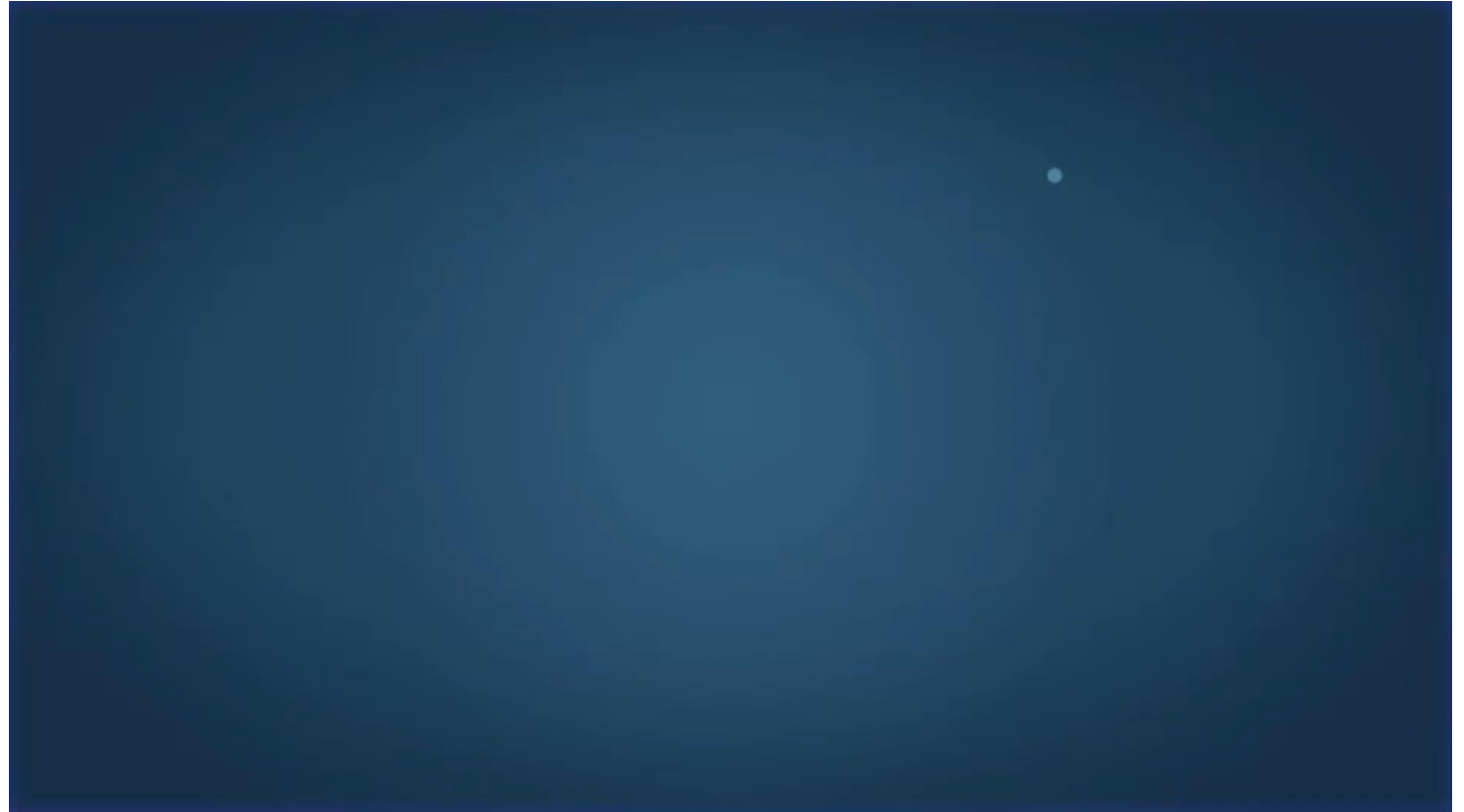
Link requirement

Backlink part/requirement

DOORS Integration

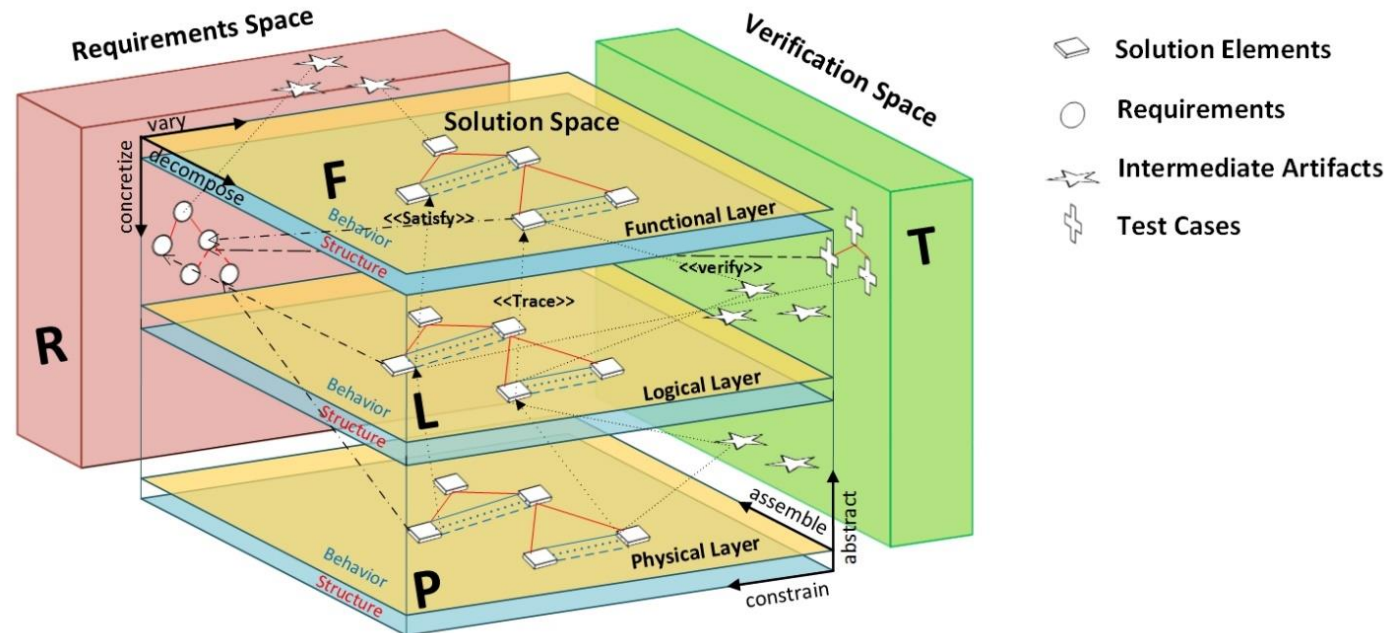
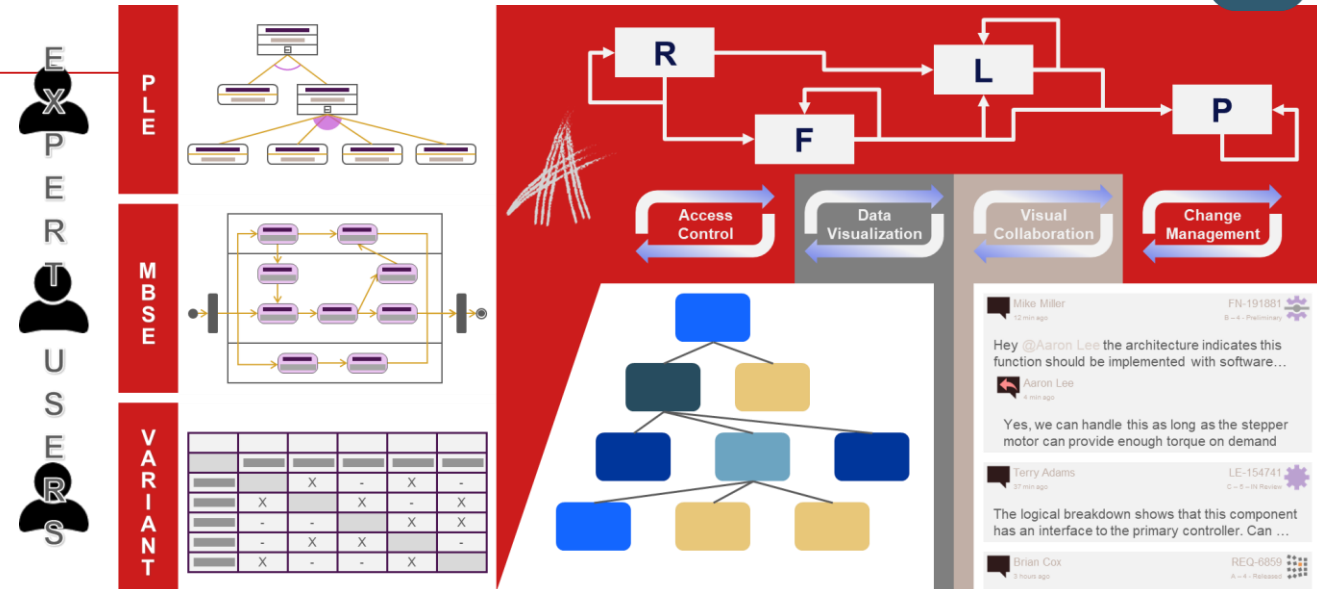
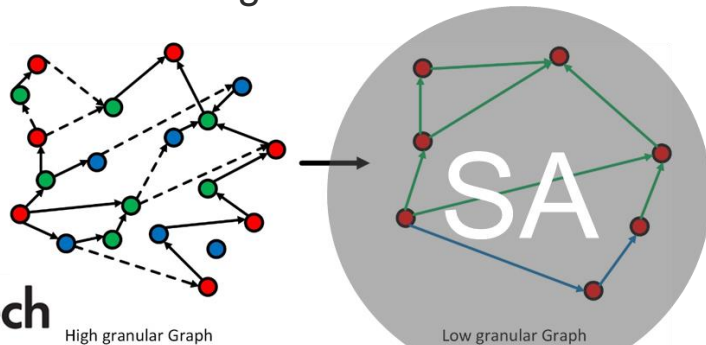
Full video online:
<https://youtu.be/JIQKevkfRel>

- 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



Systems Architecture

Properties

System Model

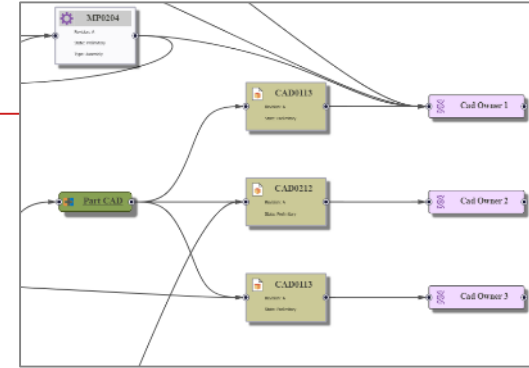


Created By: Innovator Admin
 Created On: 5/19/2017
 Modified By: Innovator Admin
 Modified On: 5/25/2017
 Locked By:
 Major Rev: A
 Release Date:
 Effective Date:
 Generation: 2
 State:

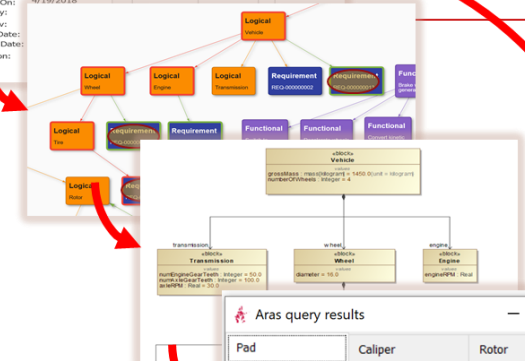
Name	Version
Vehicle Model LX	2

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

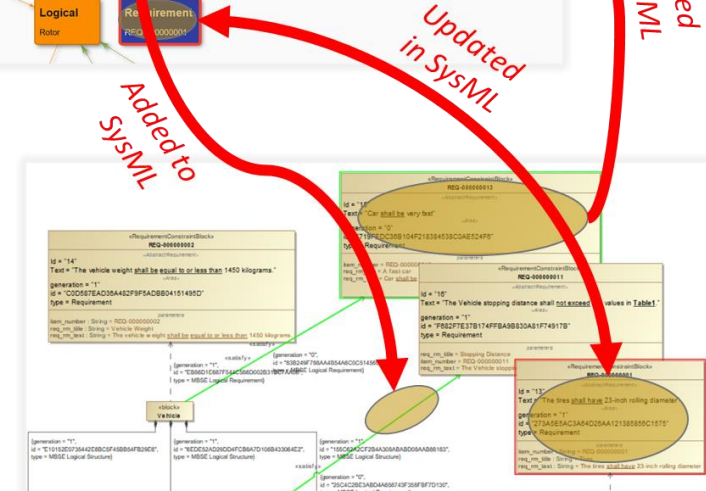
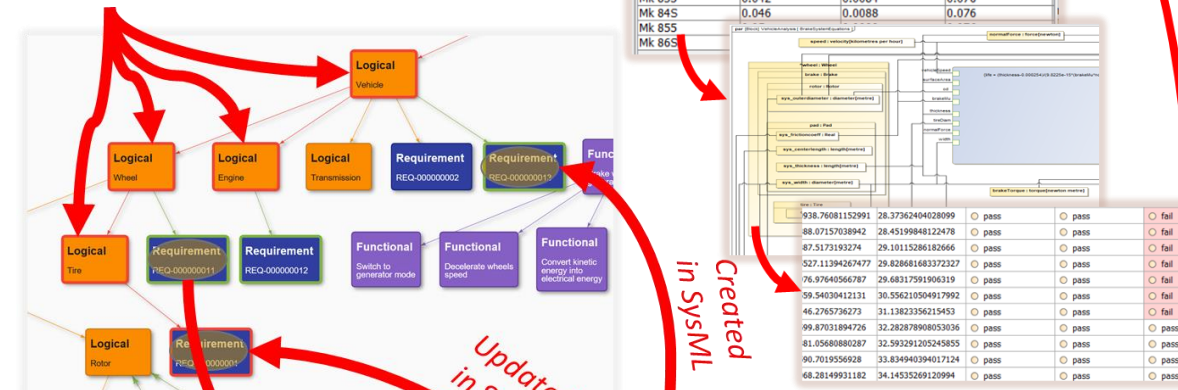


state	Version	in...
Preliminary	1	Brake
Preliminary	1	Caliper
Preliminary	2	Engine
Preliminary	1	Pad
Preliminary	1	Rotor



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			

Flagged as affected





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

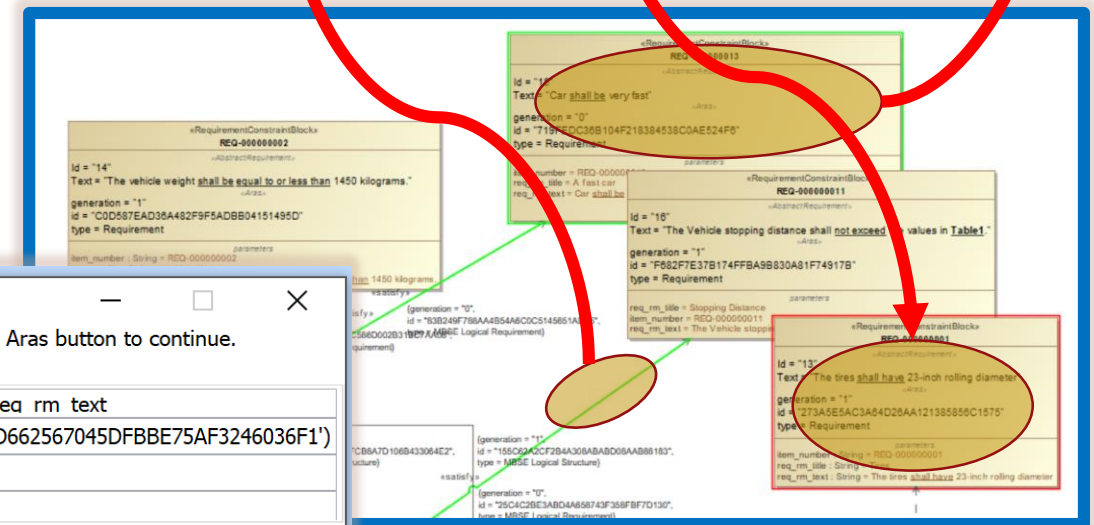
Select: item number,req rm title,req rm text

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

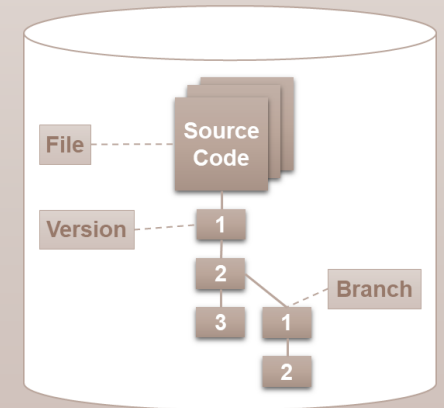
JIRA

Issue tracking, change management, agile planning



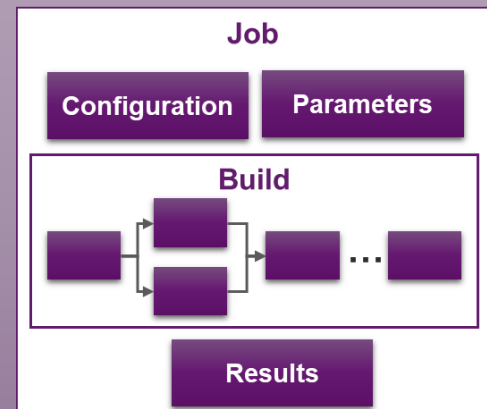
Git

Software configuration management

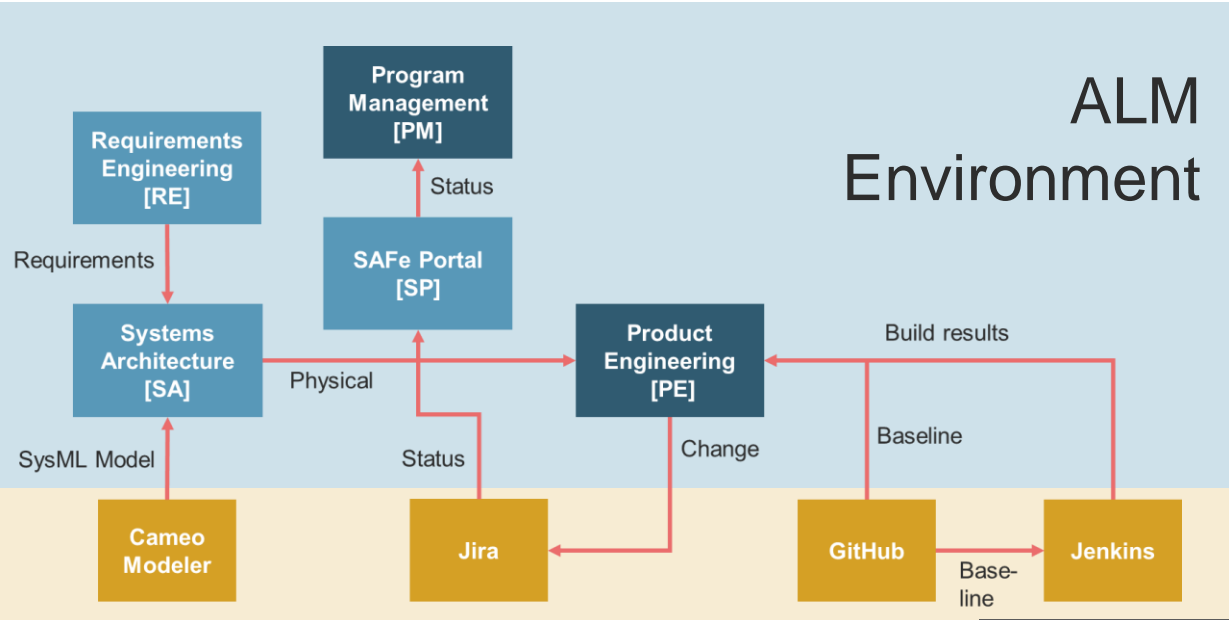


Jenkins

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>

Save Cancel

Git

ajsebastian / jenkins-example

Example project with Groovy based Jenkins Pipeline (Jenkinsfile)

30 commits 3 branches 1 release 2 contributors

Branch: master New pull request

Switch branches/tags

Find or create a branch...

Branches Tags

ECO-00001019

ECO-00001020

master

testBranch

README.md

Jenkins

Branch ECO

Full project name: mbp

Recent Changes

Stage View

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

Average stage times:

Apr 24 14:32 No Changes

Permalinks

Last build (#1) 15 sec ago

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

Branch Name: master

Duration: 24951

Tests Passed: 8/8

Software Revision: E2C5021A3FAD497288E57D8820D59452

Change

Begin

Submit ECO

Cancel Change

Submit to Planning

Planing

Start Work

Plan Review

Submit to Plan Review

Approve Plan

Changes Complete

Submit to Review

Change Review

Approve Changes

Close Change

Rework

Verification Complete

Branch Verification

Branch Verification Complete

Release

Verification

Merge and Release

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:

Effective Date:

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-0001020
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: Delegate to:

Comments:

Authentication: Password: E-Signature:

Complete Save Changes Cancel

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 a URL with a security warning. The application 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, a navigation bar contains tabs for 'File', 'Edit', 'Views', 'Search', 'Actions', 'Reports', 'Tools', and 'Help'. The main content area is divided into several sections. On the left, there's a sidebar with 'ECO' and 'In Work' sections. The central part features a form for 'ECO-00001020' with fields for 'Change Reason', 'Change Description', 'Change Coordinator', 'Team', 'Release Date', and 'Effective Date'. Below this, there's a 'Workflow History Report' section. The report includes a table with columns: Activity, State, Assigned To, Completed By, How Voted, When, and Comments. The table shows a sequence of activities: 'Submit ECO' (Closed, Assigned To: Innovator Admin, Completed By: Innovator Admin), 'Planning' (Closed, Assigned To: Product Owner, Completed By: Innovator Admin), and 'Draft Changes' (Active, Assigned To: System Engineer, Completed By: System Engineer). The 'When' column shows timestamps for each activity. The 'Comments' column contains a 'VOTE NOW' link. At the bottom of the page, a status bar indicates 'Ready' and 'Aras Innovator'.

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	System Engineer	VOTE NOW		

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



- The diagram illustrates the PLM Platform Server architecture, organized into several functional layers and components:

 - Client Types:** Web Client and Workstation Client.
 - Scripting & Process Definition:** A layer for defining processes and scripts.
 - Process Execution:** A layer for executing processes, including High Performance Open APIs and Remote Execution.
 - Scalable Back End:** A layer for managing the back end of the system.
 - Unified Data Model:** A layer for managing data across the system.
 - Persistent & Transient Data:** A layer for managing data that is persistent or transient.
 - PLM Platform Server:** The central server component, which includes:
 - Temp Files:** Temporary files used during the process.
 - File Vaults:** A repository for storing files.
 - Metadata Repository:** A repository for storing metadata.
 - Workflow and Modeling:**
 - CAD Model:** The initial design model, showing various components like Main bearing, Planet gear, Cylindrical roller bearing, Taper roller bearing set, High speed shaft, Intermediate gear, Intermediate pinion, Ring gear, Half shaft, Planetary carrier, Evaporator mount, and Planetary carrier.
 - Mesh Model:** A discretized model of the CAD model.
 - System Model:** A model of the system, showing various components like Main bearing, Planet gear, Cylindrical roller bearing, Taper roller bearing set, High speed shaft, Intermediate gear, Intermediate pinion, Ring gear, Half shaft, Planetary carrier, Evaporator mount, and Planetary carrier.
 - FEA Results:** The results of a Finite Element Analysis (FEA) simulation, showing stress distribution on the system model.
 - PROCESS MANAGEMENT:** A section detailing the process flow, including steps like CAD Model, Mesh Model, System Model, and FEA Results, with associated tools and data.
 - JOB & FILE SERVICES:** A section detailing the services for managing jobs and files, including Input Files, Output Files, Metadata, and Viewable Files.
 - DATA & CONFIGURATION MANAGEMENT:** A section detailing the services for managing data and configuration, including Study, Scenario, and Scenario.

Simulation: Drive From Requirements



RD-00002

Edit

Requirements Document

Requirements Document Number: RD-00002
Revision: A
State: Draft
Managed by: World
Owned by:
Title: TC Curb Collision Requirements
Description:
Category:
Group:
Tier:

Content Documents Related Parts External Links Outgoing Links Incoming Links

Requirements

Hidden

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
Owned By:
Title: Max Force - r0CL1_left in collision with 200mm curb at 20m/s and 28deg
Type: Requirement
Category:
Group:
Tier:
Complexity: Low
Priority: Low
Risk: Low

Documents Related Parts External Links Outgoing Links Incoming Links Condition Expression

Condition Expressions

Hidden

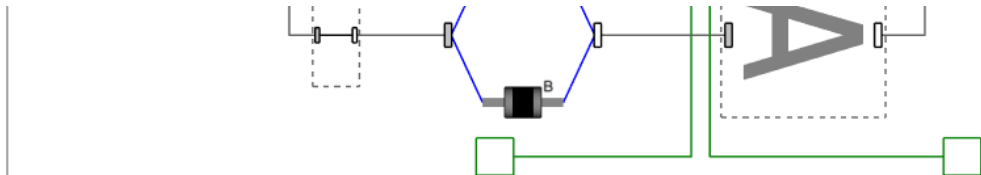
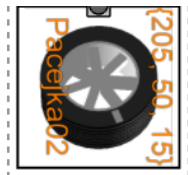
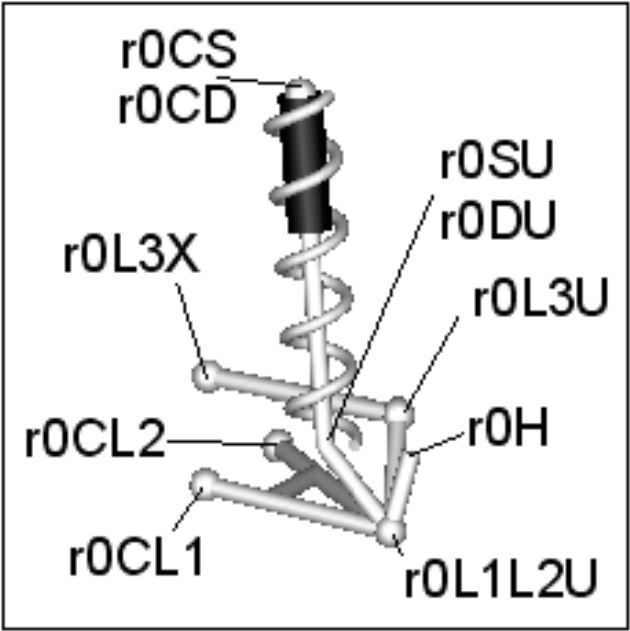
Order	Conditional O...	Parameter [...]	Logical Opera...
	<=	100000 N	



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

Simulation ID: SIM000053 State: Completed

Name: Gearbox Simulation 001C

Description: 001C: 001B + new bearings

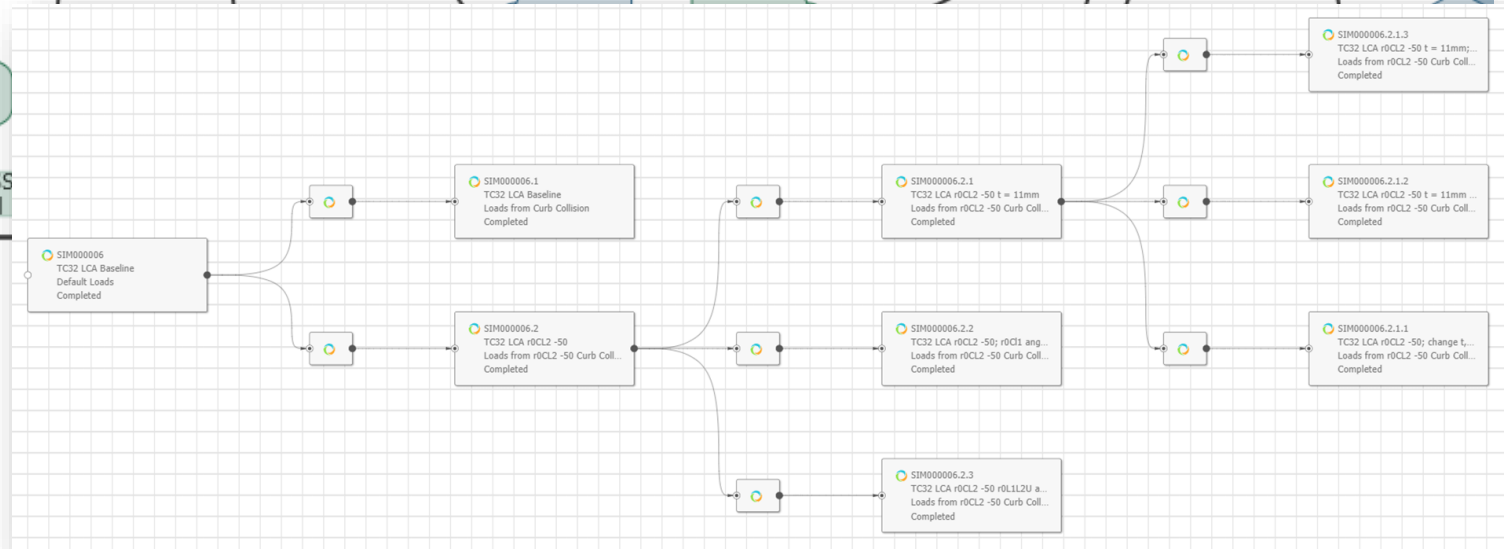
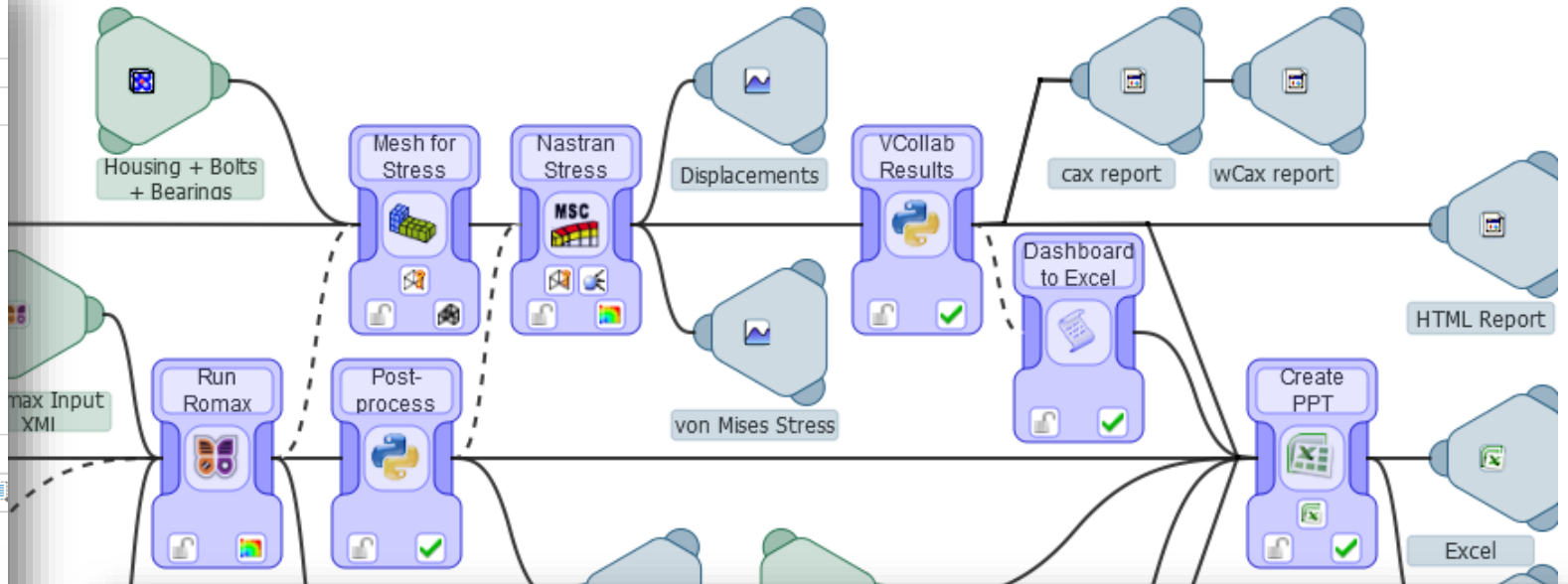
Simulation Template: gearbox_demo_v09_RUN

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

Edit

Refresh

Undo

Share

Print

More

Study

Study

Created By: Innovator Admin

Created On: 10/5/2019

Modified By: Innovator Admin

Modified On: 10/6/2019

Locked By: Minor Dev

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 Envirc

Instruction Name

TC32 Full Vehicle Simul

Requirement Name

TC32 Requirements

Simulation

Simulations

+

-

Q

Hidden

Camera

Monitor

Share

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"/>

output
Stress : Von Mises Stress
L1M1-SC 1

276.915
257.136
237.356
217.576
197.797
178.017
158.237
138.458
118.678
98.898
79.119
59.339
39.559
19.780
0.000

276.9154

E:78877
166.574

E:13687
174.751

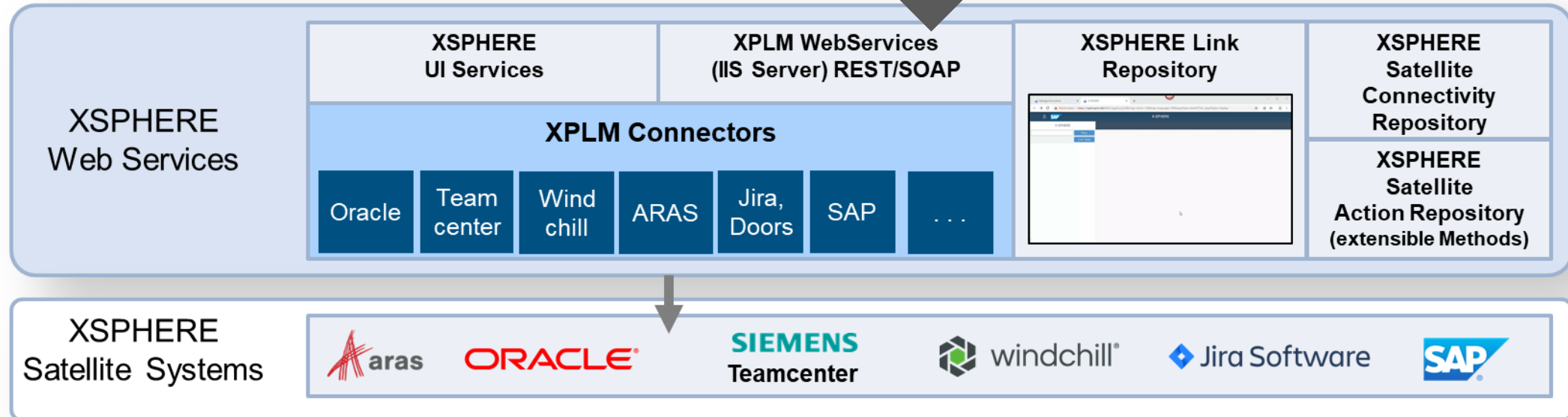
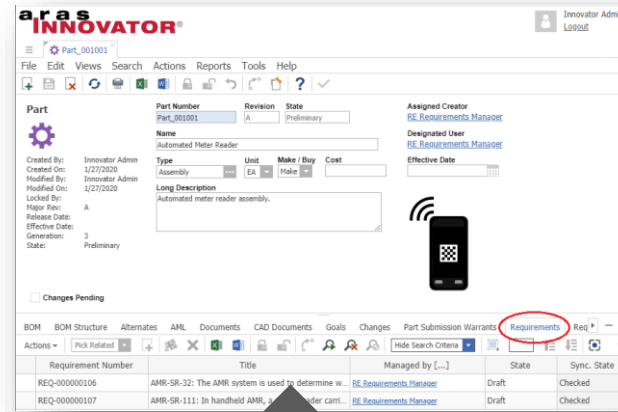
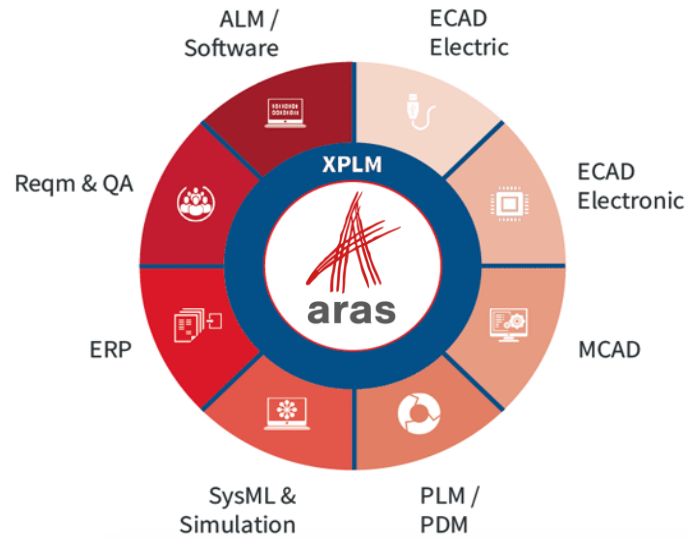
E:84043
193.358

E:12025
276.915

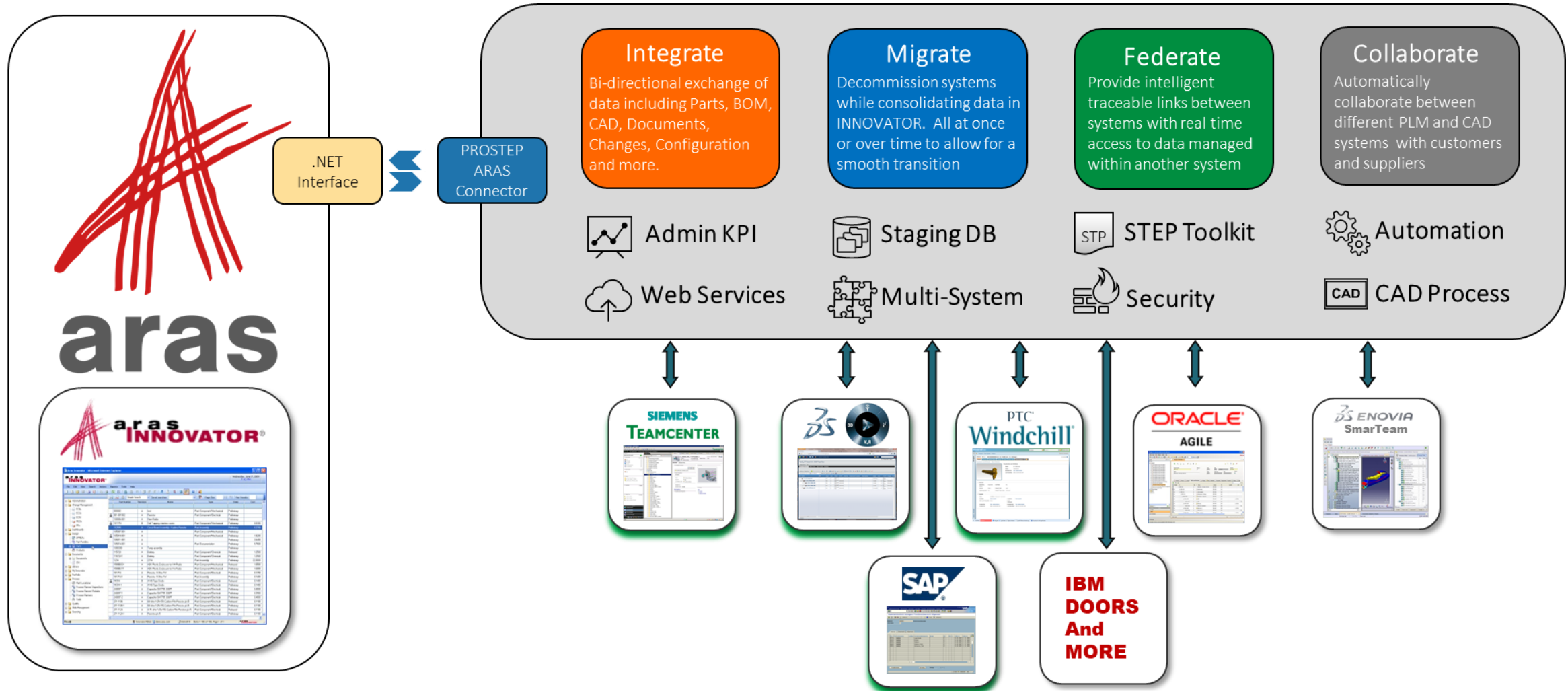
E:3373
190.450

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Aras | XPLM Integrations



Aras | Prostep Integrations



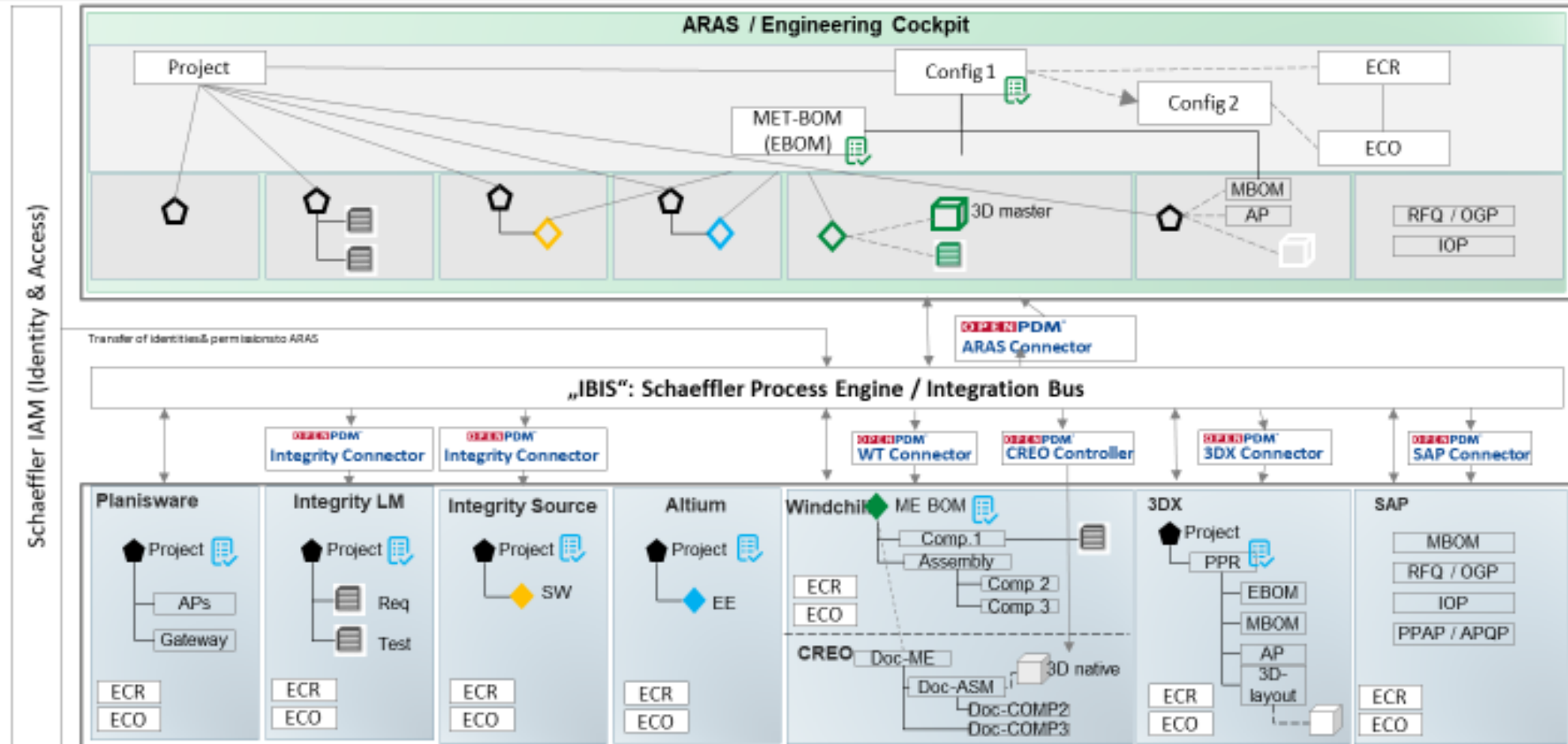
Aras | Prostep Integrations

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

Middleware Architecture IBIS with OpenPDM Connectors

PROSTEP

Caption: → Trigger (not data flow)





Thank You

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Detailed demos/examples call or email

