WEBINAR

Best Practices for Data Migration Towards MBSE

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Our Speaker

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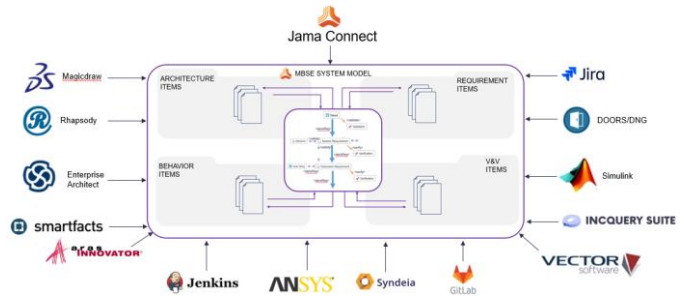
Best Practices for Data Migration Towards MBSE



We measure the money we spend on tools, but do we know the cost of data?

- Are we giving data enough attention?

Model-Based Systems Engineering (MBSE) is tantalizing

- But seems out of reach given current tools and data shape

In my session we discuss

- What is MBSE and how does it differ from SysML
- The benefits of building a common engineering data model
- How to approach moving data towards MBSE
- Best practices for migration when moving away from legacy tools

animated time bar (duration 60 sec.)

REConf® 2022

What is MBSE?

MODEL BASED SYSTEMS ENGINEERING

OMG (MBSE WiKi):

“The formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases.”

Reading between the lines:

MBSE is the elimination of documents to then combine requirements, architecture, behavior and V&V into a single data-driven “model” tied together with relationships.

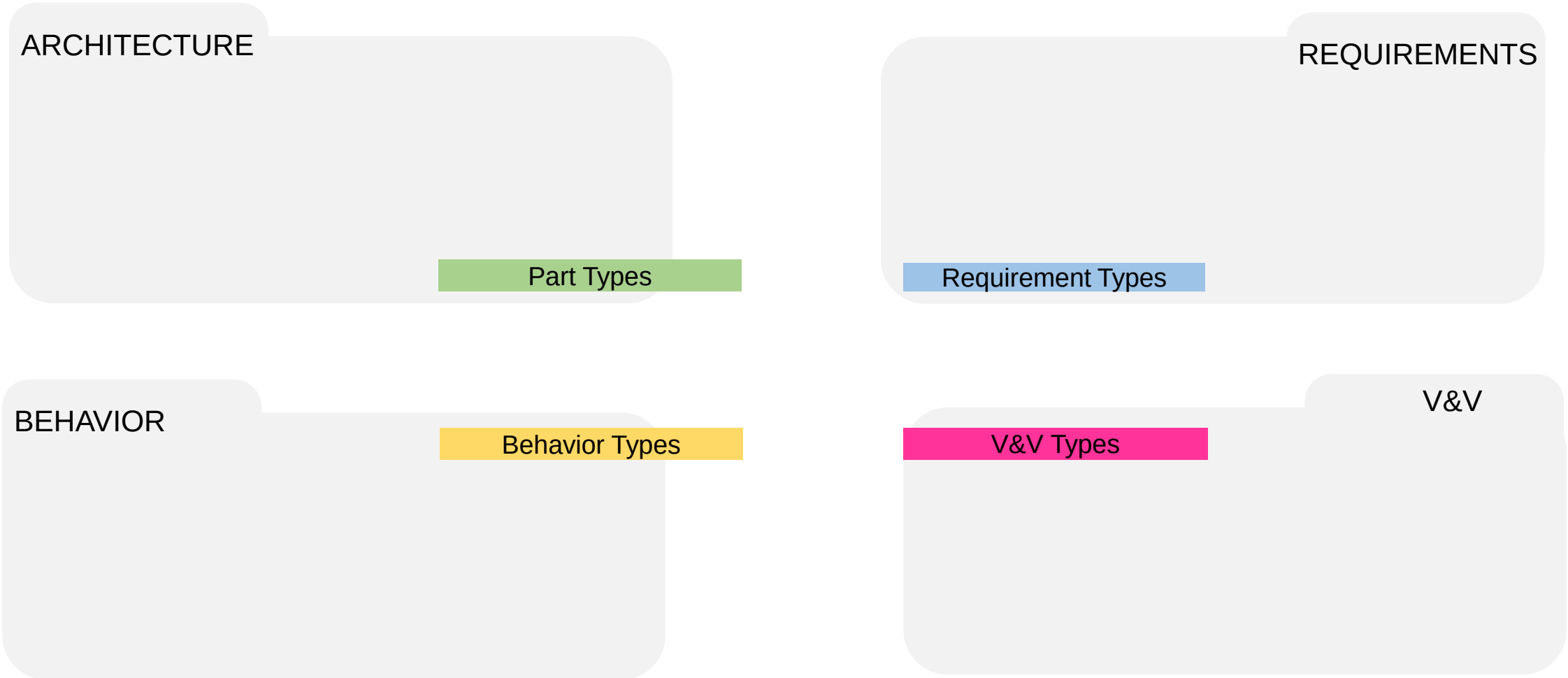
MBSE cannot be effectively practiced when viewed from just one perspective (requirements, models, patterns, standards, industry specific application, etc.). To successfully practice MBSE, wise systems engineers recognize and use each perspective as appropriate to their specific needs. Based on these needs, they choose the appropriate capabilities, tools, and visualizations that will meet their needs.

One size doesn't fit all."

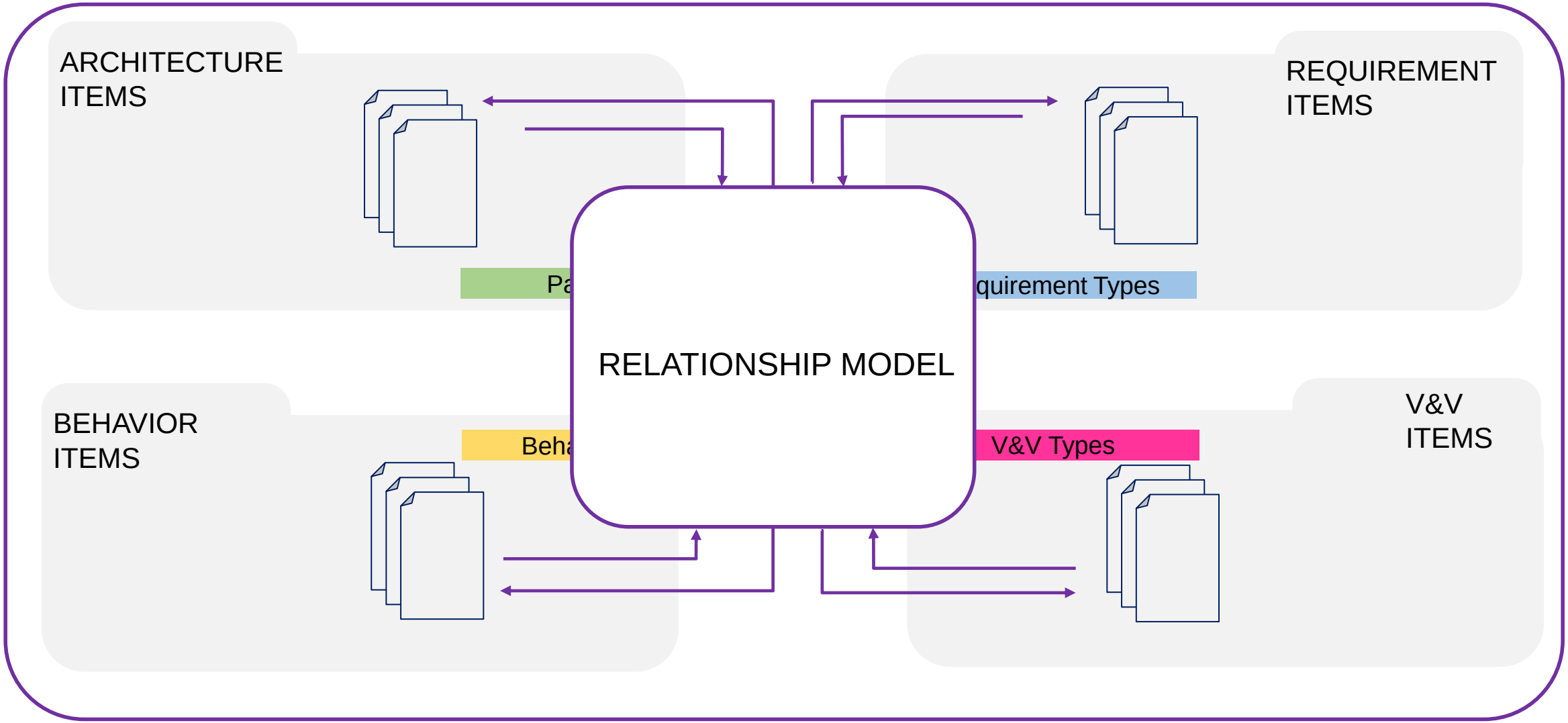
Lou Wheatcraft

Co-Chair INCOSE Requirements Working Group & Wheatland Consulting LLC

What is MBSE? It is not just SysML



What is MBSE? It is not just SysML



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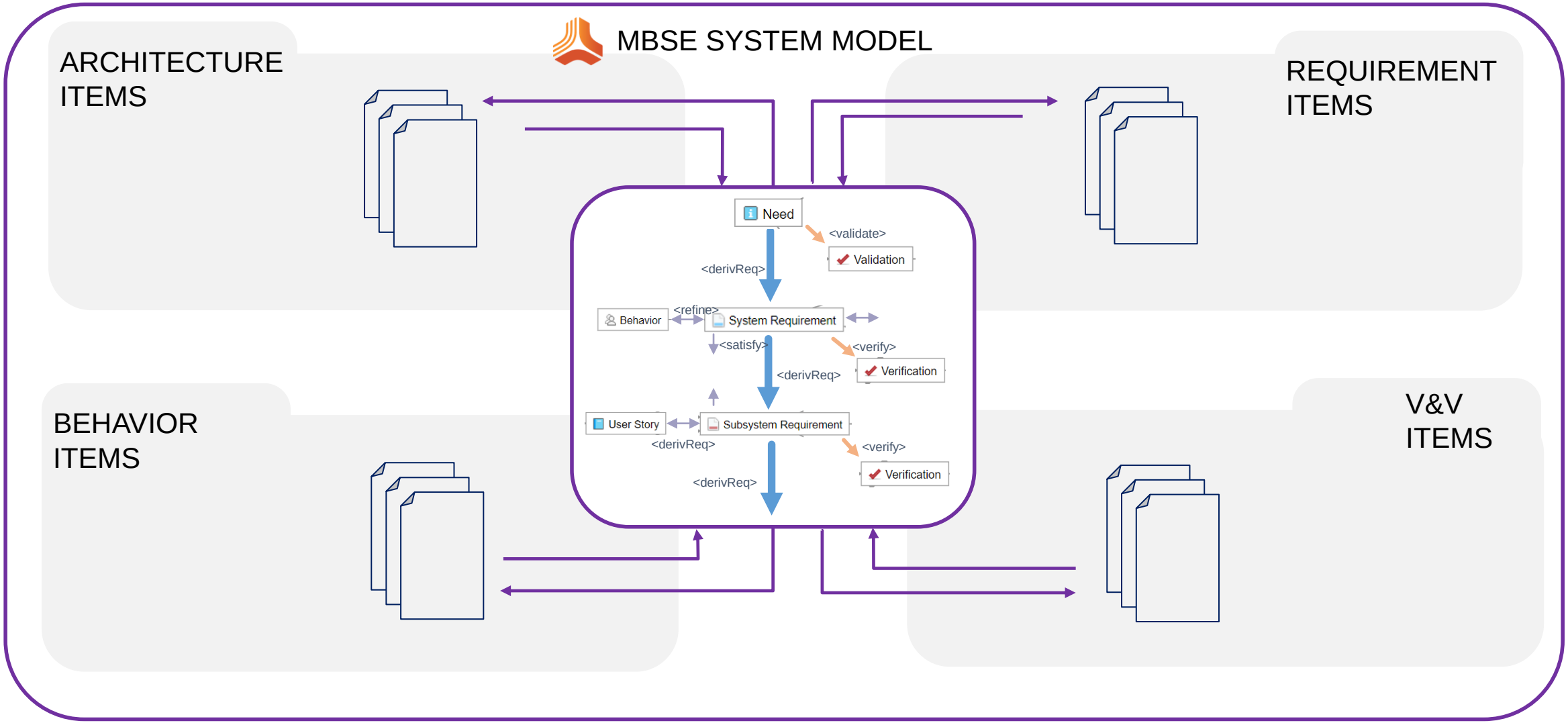
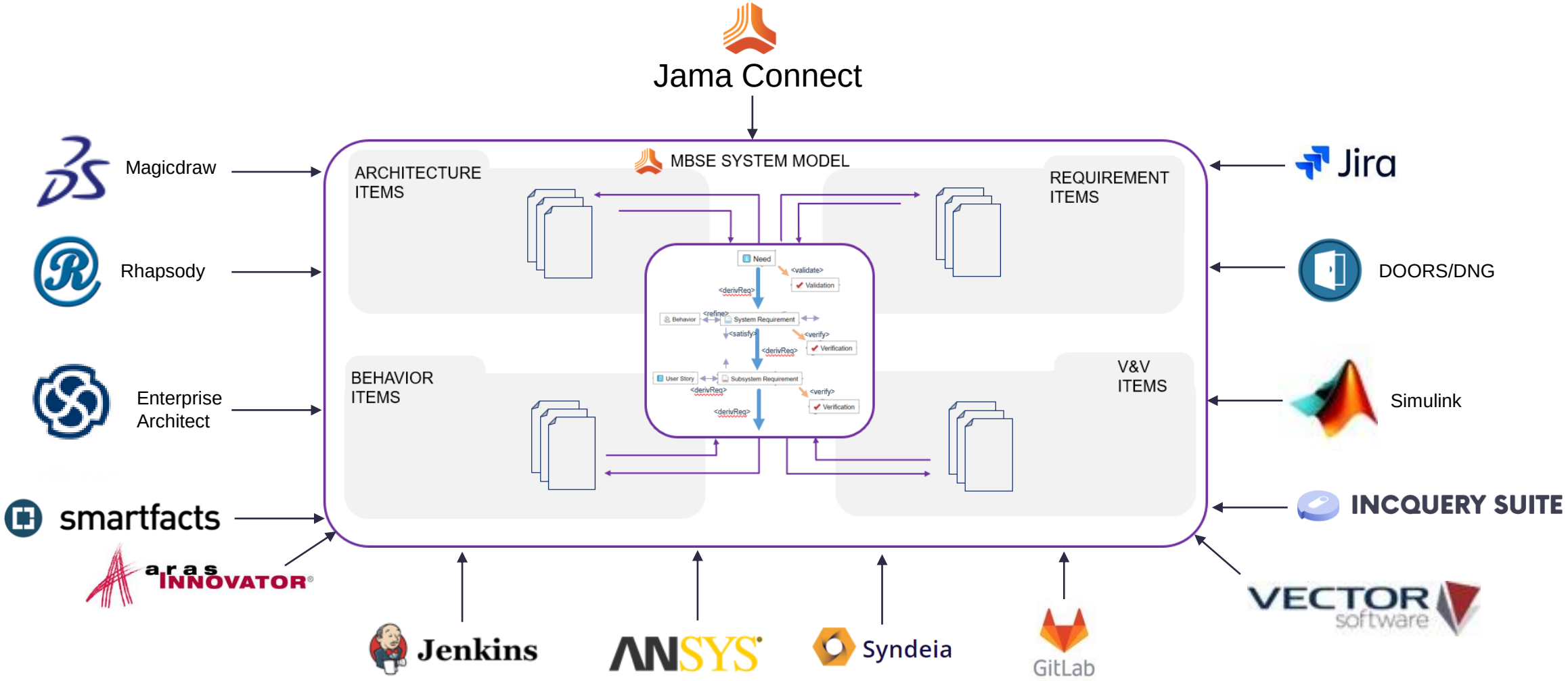


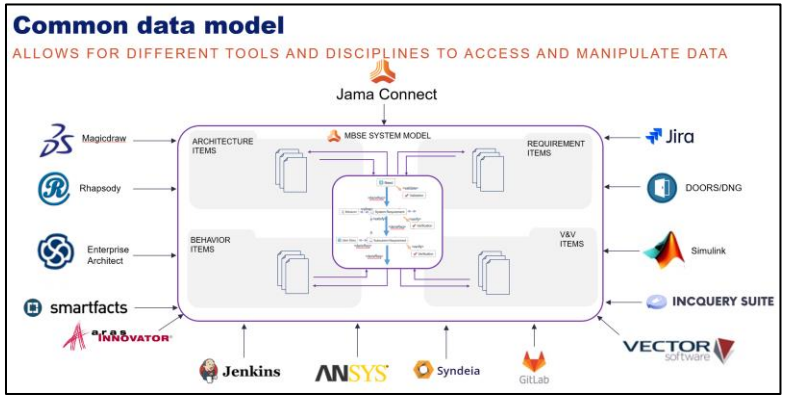
Common Data Model

ALLOWS FOR DIFFERENT TOOLS AND DISCIPLINES TO ACCESS AND MANIPULATE DATA



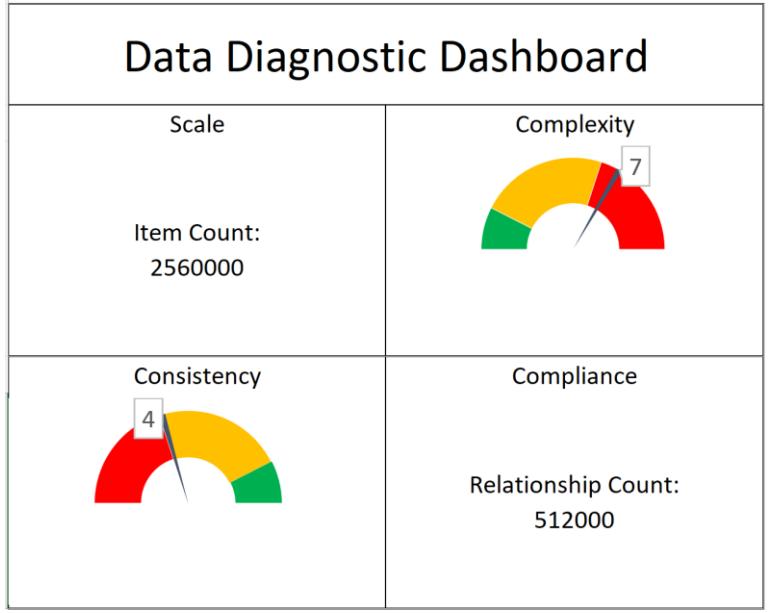
Reasons for Common Data Model

MAKING YOUR DATA WORK FOR YOU



- Your data model describes the structure you enforce throughout your development process
  - Using the same data model in an organization is like a common language
    - Reduces training costs to move engineers between teams
    - Reduces costs to integrate requirements data with other disciplines
    - Improves collaboration and quality

- Understanding your engineering data is the first step towards moving to a common data model
  - Truly see your data structure for the first time
  - Establish integrations with other disciplines using Live Traceability
  - Enable all stakeholders to gain direct access to engineering data to influence business decisions



Reality | V is Broken into Siloed Tools & Spreadsheets

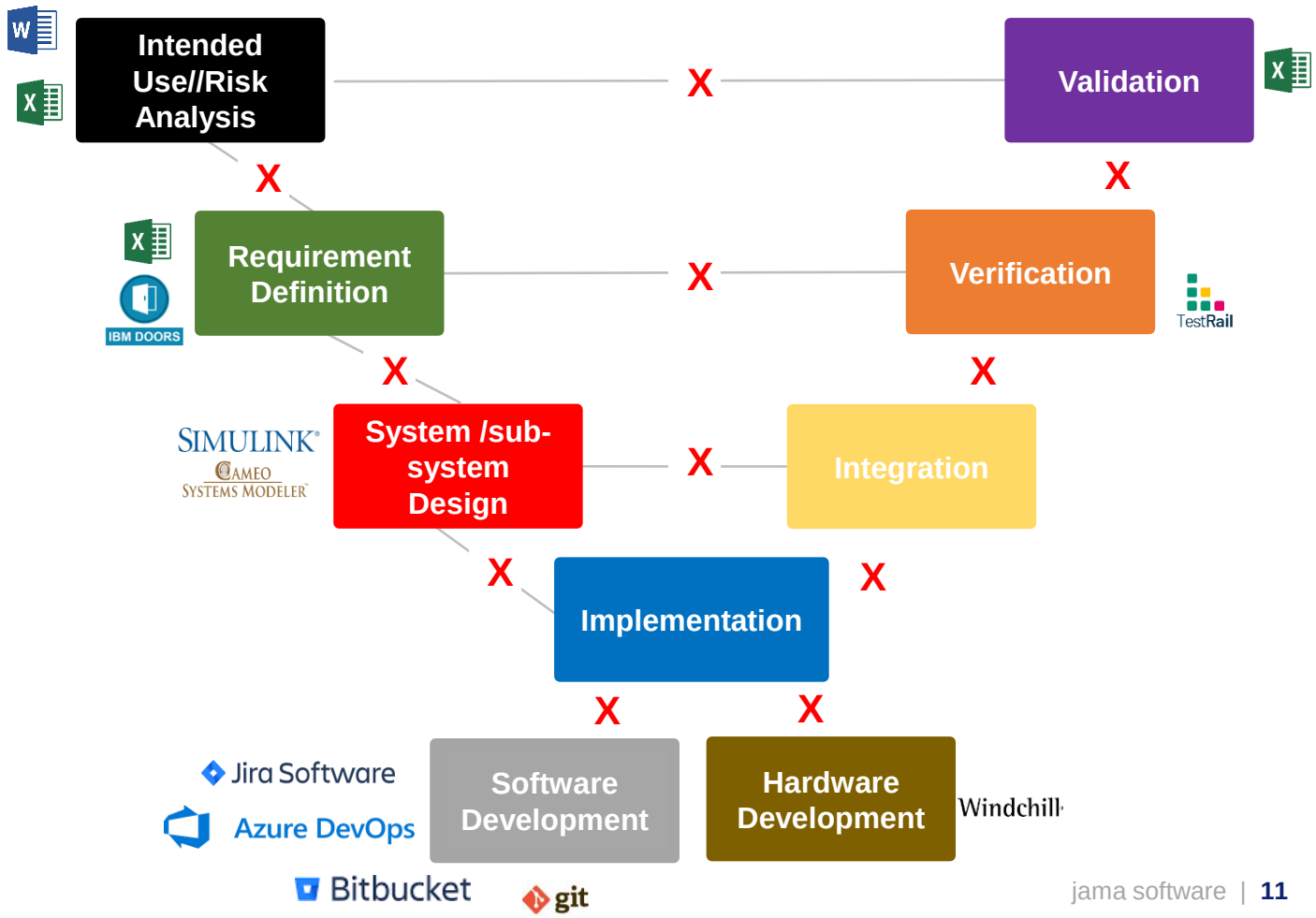
#1 CAUSE OF NEGATIVE PRODUCT OUTCOMES & DESIGN CONTROL ISSUES

#1 Cause of inspectional observations, product recalls & delays, increased CAPAs, and cost overruns

- Late identification of defects/coverage gaps due to lack of visibility through development process
- Lack of requirement coordination and change management between hardware/software/product
- Lack of ongoing risk assessment and change management
- Cumbersome and risky effort to produce trace report and other DHF artifacts

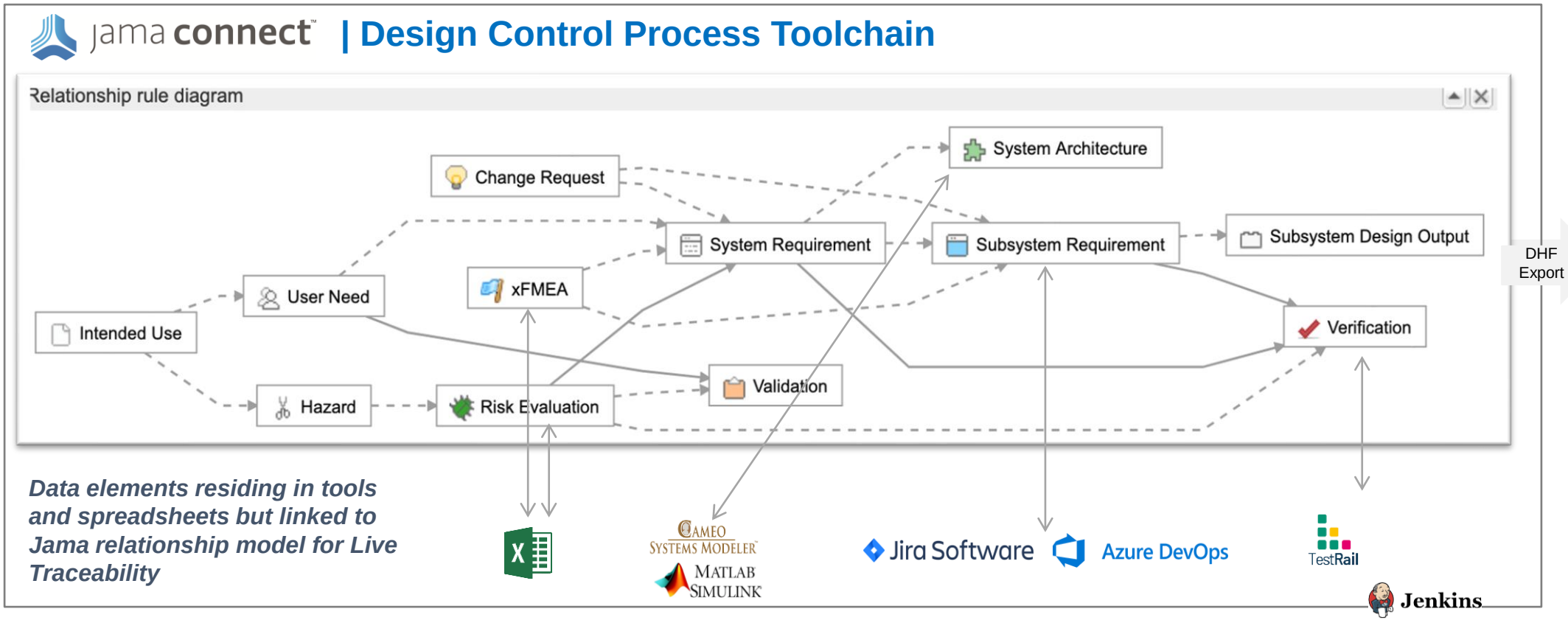
No solution to the Problem

- No single platform to support entire process
- No way to integrate desktop tools and Excel files
- Highly manual, after the fact traceability effort to hopefully satisfy standards including ISO 13485:2016, 21 CFR 820.30, ISO 14971:2019, IEC 62304 and more



What We Need

LIVE TRACE ACROSS BEST-OF-BREED TOOLS



Making the Switch

BACKGROUND

Why is Migration Expensive and Most often Fails to Leave Users Satisfied?

- Organizations have approached migration with a “give it a go” attitude
  - Migrate until something goes wrong, then fix it
  - In this situation, how can you predict how long migration will take?
- Even with a perfect migration, unless you can demonstrate to users that their data has been protected there will always be distrust
  - How can you reassure users that their data is protected, and migration worked?

The problem is not about a single vendor

- The process for migration from any legacy system is largely generic
  - The migration tools will be specific
- Jama Software provide migration tools towards an MBSE framework

Making the Switch - Migration Approach

MIGRATING TO MBSE

Steps:

1. Pre-assess
2. Plan
3. Discover
4. Export
5. Import
6. Clean
7. Verify

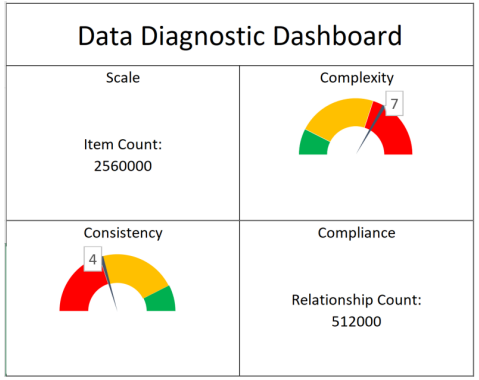
{repeat}

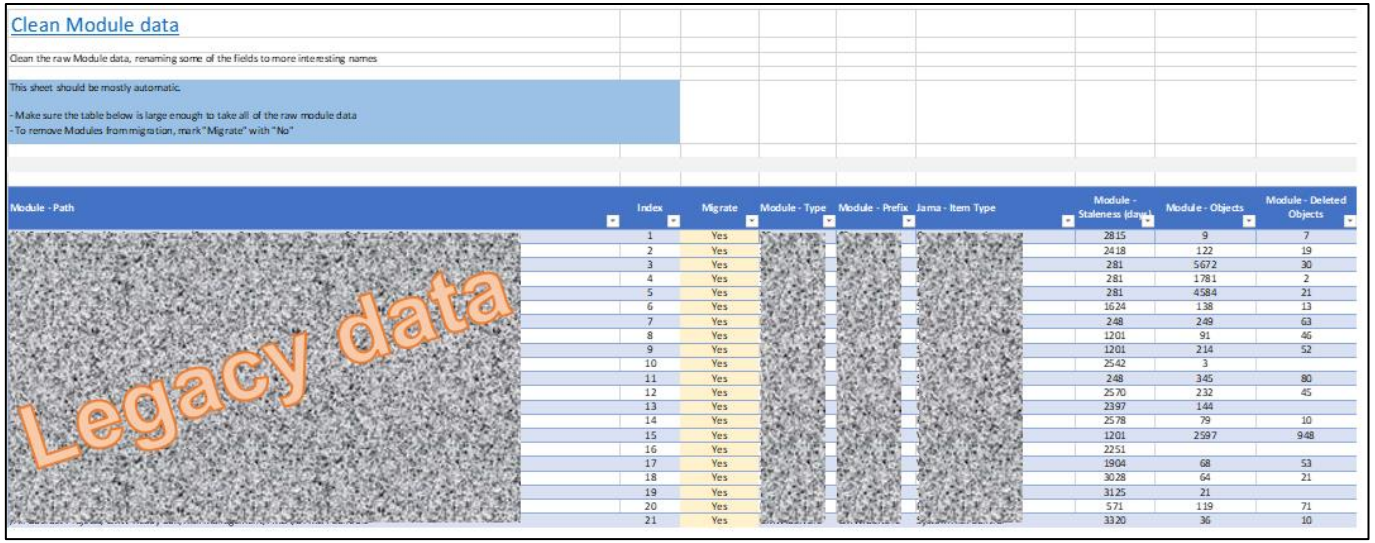
1) Pre-assess

ASSESS DATA COMPLEXITY

Some Legacy Systems Provide Analysis Functions Giving Metrics over Data

- If no built-in tool exists, you might have to create one
  - Don’t go into data migration blind
  - Understand the scale and complexity of the problem before you export data
- Migration needs to be predictable and repeatable
- Best practice to run in a Sandbox environment
  - Reduces the risk to ongoing project works





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Migration Iterations

OVERVIEW

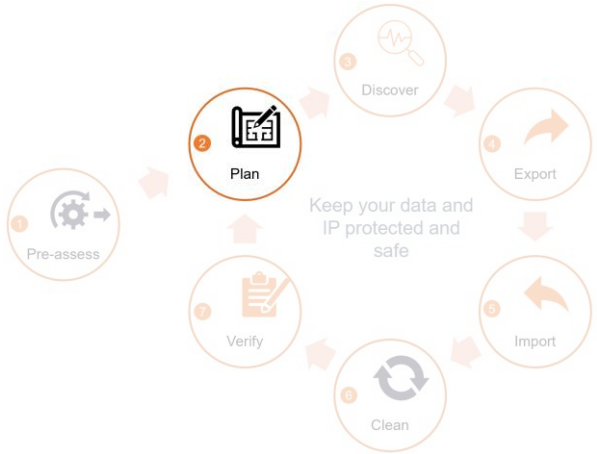
Two Reasons Migration Might Take Multiple Iterations:

- **Groups require their own extensions to a common MBSE model**
  (information architecture)
  - Planning and discovery could be needed for each group
  - Most likely for Enterprise migrations

- **Individual projects contain a lot of data**
  - We might require more iterations around Export, Import, Clean and Verify
  - Most likely for Complex migrations

2) Plan

OVERVIEW



In Order to Reduce Risk, Write a Plan and Execute it:

- Predictable outcomes
- Predictable risks
- Predictable estimates

A Plan will Consist of:

- Statement of work, defining migration tasks
- Roles and names of people involved in migration
- Assessment of data conditioning

Ask Vendors for Help

- Services are cheap in comparison to the value of your data

2) Plan

ASSESSMENT OF DATA CONDITIONING

Metric Gathering:

- Take a detailed measure of your legacy
- Assess data scale
- Assess conditioning required – cleaning your data in the migration process
- Analyze for tool specific data and form a migration plan
- Don’t migrate dead wood unless it contains knowledge
- It’s as important to know what not to migrate as to what is needed
  - Organizations can drown if they don’t have an understanding of the data they attempt to maintain
  - Partly due to a legacy “clone-and-own” process
  - Copy-paste, copy-paste , copy-paste , copy-paste , copy-paste

	Name	Current	Target for ROI	Data model relevancy
Scale	Modules	84	43	Number of requirements documents
	Stale Modules	98%	49%	Stale information could be an indication that project data should be removed as it is no longer viable. Too much stale information will bog engineers down and distract them from the answers they need. A Stale module is defined to be modules not changed in at least 365 days
	Objects	36147	18435	Individually management statements within documents. This count includes all table information.
	Stale Objects	99%	49%	Items that reside in stale Modules
	Soft deleted objects	0	0	Soft deleted objects have been marked as obsolete. Keeping soft deleted data can distract an Engineer from their core job.
	Out-links	12286		Used to manage compliance and dependencies. We count "out links" only so as not to count links twice.
	DOORS Tables	54		DOORS support for Tables is unique to DOORS. Too high a volume for DOORS table usage could indicate that requirements are being hidden inside other data structures
	DOORS Table rows	485		Each DOORS table row could indicate a new section of requirements
	DOORS Table cells	1723		Each DOORS table cell is mapped to a full object in DOORS and should likely be counted as a requirement in its own right
	OLE Objects	1333		Complex data structures can be hidden inside OLE data.

	Name	Current	Target for ROI	Data model relevancy
Complexity	Largest module	5273		If this is too large the management of the document becomes difficult
	Unique items types	11		Item types are an indication of the diversity of data model (language) being used. Too many item types provide the systems Engineer with too arduous a choice for what to use when managing requirements.
	Unique Module Type Systems	55	11	We clean all Module data to conform to a standard set of Item Types
	Unique attribute definitions distributed over all item types	132	66	We reduce complexity by cleaning attributes on Objects
	Relationship types	3		Traceability is key. It’s important to have just enough relationship types in order to facilitate traceability reporting. Too many relationship types provide the systems Engineer with too much of a choice and leads to human error.
	Unique enumerated lists	36	28	Consistent enumerated types are a huge influence to having consistent engineering. This number could reduce further after migration analysis

	Name	Current	Target for ROI	Data model relevancy
Consistency	Conflicting module type systems	44	0	Each conflicting Module Type indicates two or more modules are identified to cary the same type of information but do not. This introduced confusion to teams and akes it difficult to achieve a Model Based objective.
	Conflicting attribute definitions	0	0	This is a count of duplicated attribute definitions allocated to item types when the definitions are different
	Conflicting enumerated lists	8	0	Count of enumerated lists that would conflict with each other when migrating
	Objects with Heading and Object T	0	0	It's widely accepted in the DOORS community to split traceable requirements from their "heading" structure. These elements should be broken into parts.
	Picture count	0	0	Pictures can not be edited or maintained and should be translated to OLE objects.

	Name	Current	Target for ROI	Data model relevancy
Not Migrated	Module Baseline count	375		It is difficult to migrate baselines to any tool, including IBM DOORS Next. Where found and required a bespoke solution will be needed. Baselines will not normally be migrated.
	Modules with Module Discussions	0		Module discussions are bespoke to DOORS and will not be migrated.
	Modules with Object Discussions	0		Object discussions are bespoke to DOORS and will not be migrated.
	Public views	0		Views will be considered in the Discovery and Administration training
	Private views	0		Views will be considered in the Discovery and Administration training
	Custom views	836		Views will be considered in the Discovery and Administration training

3) Discover

OVERVIEW

MBSE Data Model

- Interview stakeholders
- Define your Information Architecture, data shape and engineering process – your MBSE meta-model
  - Make your MBSE data-model in your own language. Exploit the best out of the tools you use and don't constrain them with old data shapes

Legacy-MBSE Data Mapping

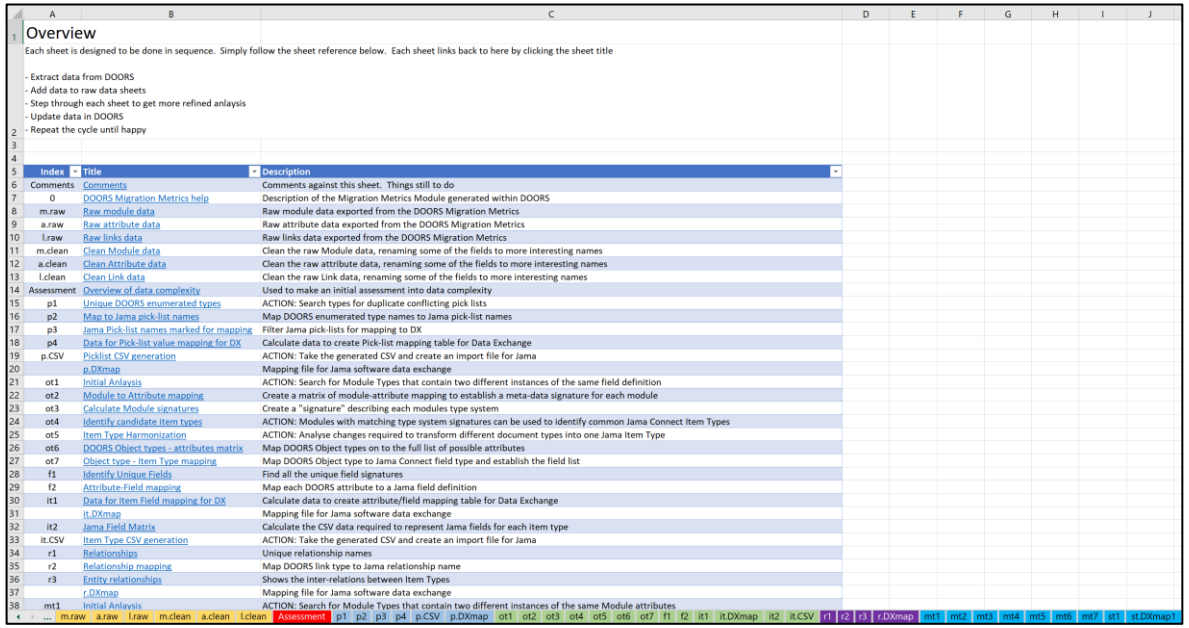
- Legacy data analysis
- Associate legacy meta-data to MBSE data model

Test Migration

- Migration tools come in different shapes, for requirements data, ReqIF might be sufficient
- User verification of a small amount of data to verify migration works as expected and your new MBSE data model is acceptable

3) Discover

DOORS DATA ANALYSIS



Overview

Each sheet is designed to be done in sequence. Simply follow the sheet reference below. Each sheet links back to here by clicking the sheet title

- Extract data from DOORS
- Add data to raw data sheets
- Step through each sheet to get more refined anlaysis
- Update data in DOORS
- Repeat the cycle until happy

Index	Title	Description
Comments	Comments	Comments against this sheet. Things still to do
0	DOORS Migration Metrics help	Description of the Migration Metrics Module generated within DOORS
m.raw	Raw module data	Raw module data exported from the DOORS Migration Metrics
a.raw	Raw attribute data	Raw attribute data exported from the DOORS Migration Metrics
l.raw	Raw links data	Raw links data exported from the DOORS Migration Metrics
m.clean	Clean Module data	Clean the raw Module data, renaming some of the fields to more interesting names
a.clean	Clean Attribute data	Clean the raw attribute data, renaming some of the fields to more interesting names
l.clean	Clean Link data	Clean the raw Link data, renaming some of the fields to more interesting names
Assessment	Overview of data complexity	Used to make an initial assessment into data complexity
p1	Unique DOORS enumerated types	ACTION: Search types for duplicate conflicting pick lists
p2	Map to Jama pick-list names	Map DOORS enumerated type names to Jama pick-list names
p3	Jama Pick-list names marked for mapping	Filter Jama pick-lists for mapping to DX
p4	Data for Pick-list value mapping for DX	Calculate data to create Pick-list mapping table for Data Exchange
p.CSV	Picklist CSV generation	ACTION: Take the generated CSV and create an import file for Jama
	p.DXmap	Mapping file for Jama software data exchange
ot1	Initial Anlaysis	ACTION: Search for Module Types that contain two different instances of the same field definition
ot2	Module to Attribute mapping	Create a matrix of module-attribute mapping to establish a meta-data signature for each module
ot3	Calculate Module signatures	Create a "signature" describing each modules type system
ot4	Identify candidate Item types	ACTION: Modules with matching type system signatures can be used to identify common Jama Connect Item Types
ot5	Item Type Harmonization	ACTION: Analyse changes required to transform different document types into one Jama Item Type
ot6	DOORS Object types - attributes matrix	Map DOORS Object types on to the full list of possible attributes
ot7	Object type - Item Type mapping	Map DOORS Object type to Jama Connect field type and establish the field list
f1	Identify Unique Fields	Find all the unique field signatures
f2	Attribute-Field mapping	Map each DOORS attribute to a Jama field definition
it1	Data for Item Field mapping for DX	Calculate data to create attribute/field mapping table for Data Exchange
	it.DXmap	Mapping file for Jama software data exchange
it2	Jama Field Matrix	Calculate the CSV data required to represent Jama fields for each item type
it.CSV	Item Type CSV generation	ACTION: Take the generated CSV and create an import file for Jama
r1	Relationships	Unique relationship names
r2	Relationship mapping	Map DOORS link type to Jama relationship name
r3	Entity relationships	Shows the inter-relations between Item Types
	r.DXmap	Mapping file for Jama software data exchange
mt1	Initial Anlaysis	ACTION: Search for Module Types that contain two different instances of the same Module attributes

... | m.raw | a.raw | l.raw | m.clean | a.clean | l.clean | Assessment | p1 | p2 | p3 | p4 | p.CSV | p.DXmap | ot1 | ot2 | ot3 | ot4 | ot5 | ot6 | ot7 | f1 | f2 | it1 | it.DXmap | it2 | it.CSV | r1 | r2 | r3 | r.DXmap | mt1 | mt2 | mt3 | mt4 | mt5 | mt6 | mt7 | st1 | st.DXmap1

Data Analysis:

- Now we must do a more detailed data analysis
- We don't just look at meta-data but we also assess for data cleaning
- We understand and resolve migration issues prior to actual migration

Example - Pick lists:

- Many organizations use enumerated types or pick-lists, do you know they are consistently used to move into a common MBSE data model?
- Are you happy with literal names or do you want them to change in the migration process?

Example - Item Types:

- MBSE will encourage your data to be more strongly typed: User Requirements, System Design, Integration test etc
- Like minded legacy data must be consistent to move into a common notation

Example - "What if" Scenarios for Data Migration:

- The ability to remove attributes & modules from migration to see how this impacts data cleanliness

DOORS Data Analysis

JAMA SOFTWARE DOORS MIGRATION METRICS TOOLKIT

We use the Module Signatures to Collect Modules that Share the Same Type System

- Here we see a collection of 4 modules sharing 3 different type systems
- 2 Modules share the same type system (i.e. have the same Module Signature) which would imply they carry the same type of data and should probably be mapped on to the same Jama Connect Item Type
- Mapping all these modules to the same data type causes conflict and needs mapping rules

Module Type	Module	Module Path
Verification	1,1,0,1	/My Project/User Requirements
	1,0,0,1	/My Project/System Requirements
		/My Project/Test Approach
	1,1,1,1	/My Project/Meeting Minutes

DOORS Data analysis

JAMA SOFTWARE DOORS MIGRATION METRICS TOOLKIT

Resolve Differences Between Information Types

- Now we have a better understanding of module types, we need to perform some more contextual analysis
- Take a set of Module paths that you would wish to map to a Jama Connect and perform some analysis:

Module Type	Module	Module Path
Verification	1,1,0,1	/My Project/User Requirements
	1,0,0,1	/My Project/System Requirements
		/My Project/Test Approach
	1,1,1,1	/My Project/Meeting Minutes

Module Path	Module Type	Module Pre	Absolute N	Actual Res	Affected Iten	Back Trace	Comments,	Complexity	Cost,0, Inte	Created By,
/My Project/User Requirements	Verification		1	0	1	0	1	0	0	1
/My Project/System Requirements	Verification		1	0	1	0	1	0	0	1
/My Project/Test Approach	Verification		1	0	0	0	0	0	0	1
/My Project/Meeting Minutes	Verification		1	1	0	0	1	0	0	1
Proposed Jama Item type:	Verification		Absolute N	Actual Res	Affected Iten		Comments,		Cost,0, Inte	Created By,

- If we leave the data alone we see a list of attributes that would be needed to migrate this data to the same Jama Connect Item Type
- Attributes marked in RED are included in some Modules but not others
- Attributes marked in GREEN are missing from some modules

Item Types

- DOORS Modules mapped to Jama Item types
- Attributes are harmonized between modules mapped to the same item type
- And a summary report produced

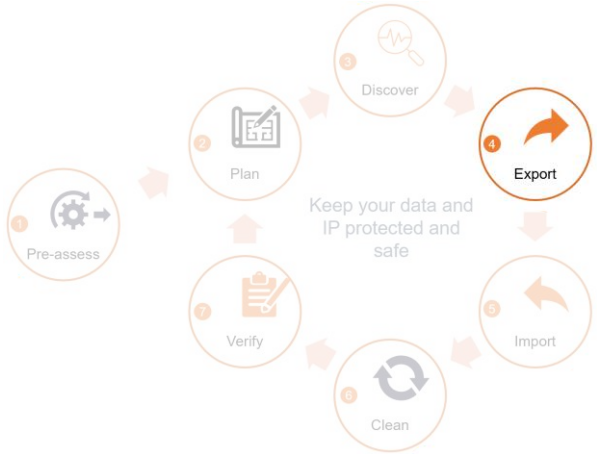
Item Type	Jama Item Type	Draft Field Name	AD Name	Migrate	Comments
Design	Design	Absolute Number	Absolute Number	Yes	
		Arch_Old_ID	Arch_Old_ID	Yes	
		Arch_Old_InLinks	Arch_Old_InLinks	Yes	
		Arch_Old_OutLinks	Arch_Old_OutLinks	Yes	
		Created By	Created By	Yes	
		Created On	Created On	Yes	
		Created Thru	Created Thru	~~No~~	Remove most of system attributes
		Design risk	Design risk	Yes	
		Last Modified By	Last Modified By	Yes	
		Last Modified On	Last Modified On	Yes	
		Object Heading	Object Heading	Yes	
		Object Short Text	Object Short Text	Yes	
		Object Text	Object Text	Yes	
CI Structure	CI Structure	Absolute Number	Absolute Number	Yes	
		CI_Old_OutLinks	CI_Old_OutLinks	Yes	
		CI_OldID	CI_OldID	Yes	
		Created By	Created By	Yes	
		Created On	Created On	Yes	
		Created Thru	Created Thru	~~No~~	Remove most of system attributes
		Last Modified By	Last Modified By	Yes	
		Last Modified On	Last Modified On	Yes	
		Object Heading	Object Heading	Yes	
		Object Short Text	Object Short Text	Yes	
		Object Text	Object Text	Yes	
		Priority	Prioritie	Yes	Correcting spelling
			Priority	Yes	
		Test	Test	~~No~~	Not needed, temporary data

Note

- attributes have been selected for migration, or not
- we clean data types for a harmonized type system in Jama Connect

4) Export

OVERVIEW



Preparation

- Data conditioning required to ensure data is mapped to the expected structures in Jama connect
- We use an Extended Migration Metrics Report to control the migration process

Data Conditioning

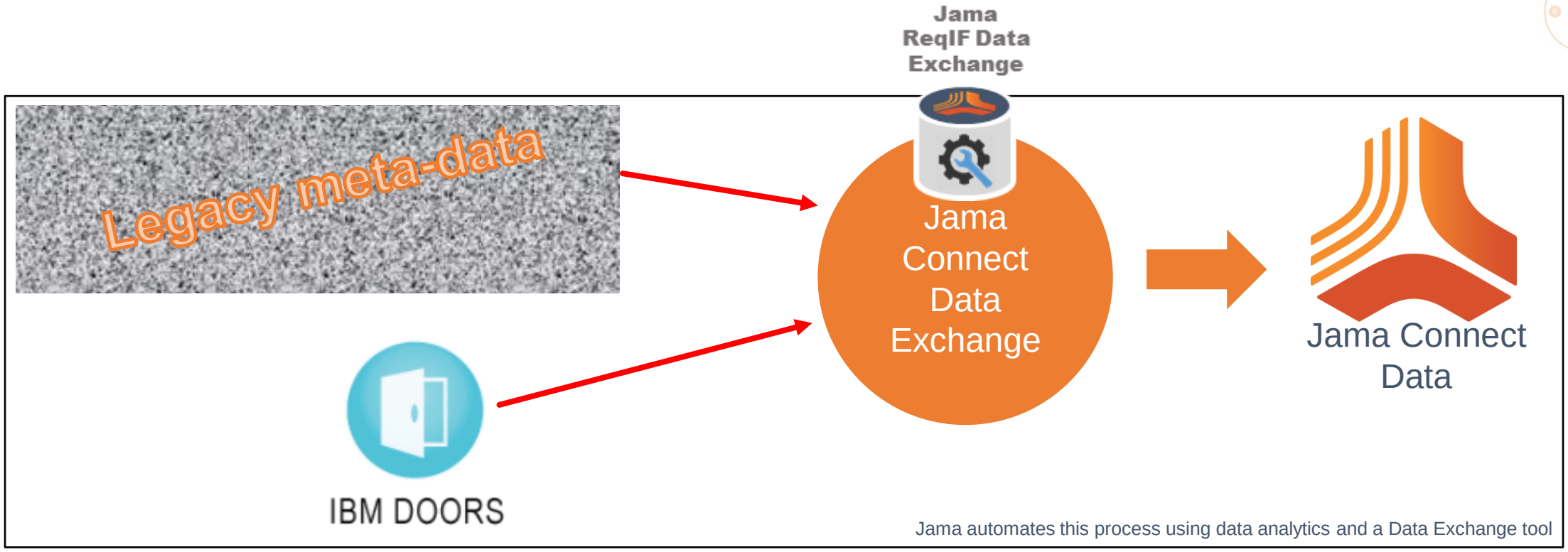
- Jama Software provided DXL scripts to
  - Report on inconsistencies
  - Fix inconsistencies

Export Automation

- Jama Provided scripts to create ReqIF definitions for data export
- A report will be run prior to each migration to detail data to be expected in this iteration
- Preserve requirement links before migration
- Perform migration tasks

5) Import

CLEAN LEGACY DATA EXPORTED FROM THE OLD SYSTEM AND IMPORT YOUR MBSE DATA-MODEL



6) Clean

OVERVIEW

- **Often Data Cleaning is Required in the Target Tool**
- **Reduce the Amount of Cleaning by Reshaping Data in the Export/Import Process**

7) Verify

ESSENTIAL TO DEMONSTRATE TO USERS THEIR DATA IS PROTECTED

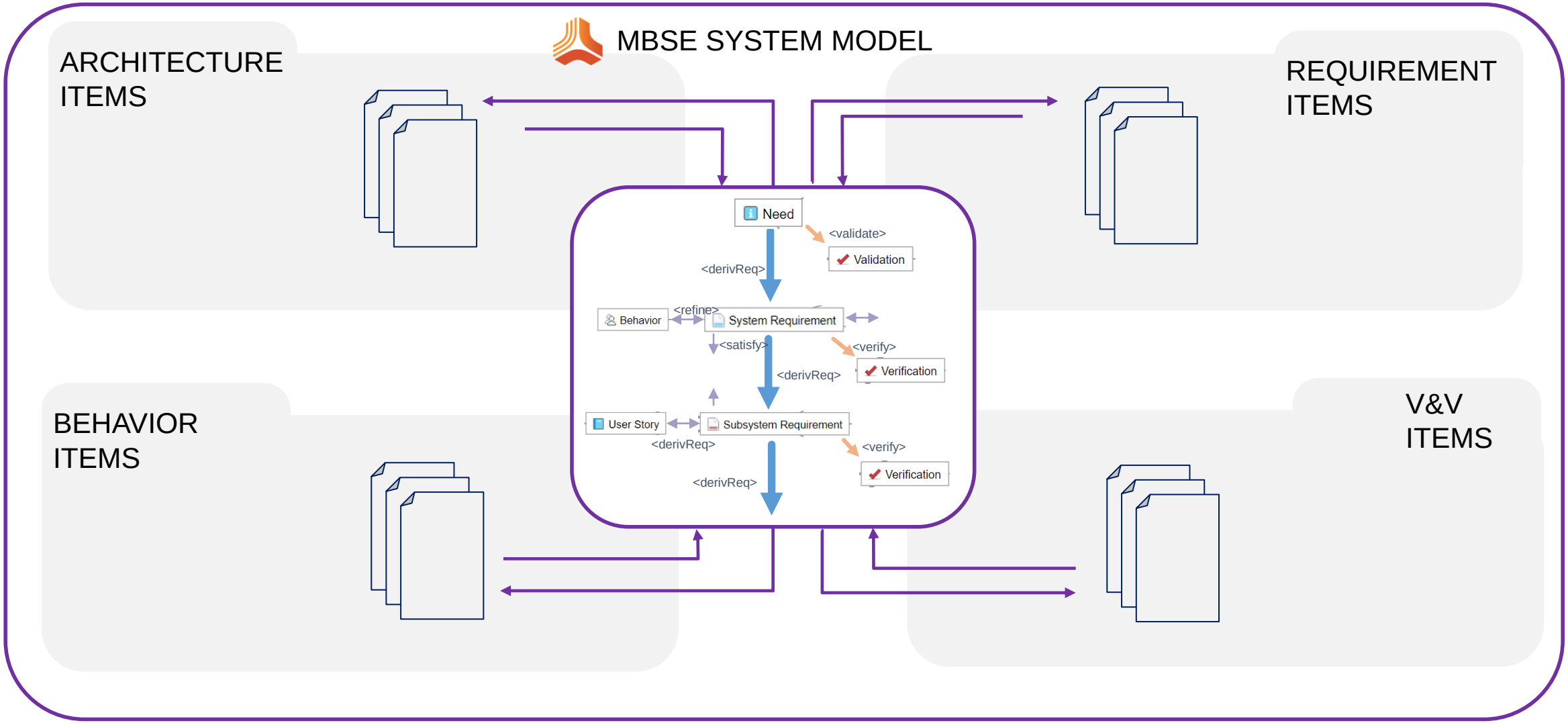
Compare Import Summary to the Data Measurements Taken Before Export

- Some “translation” will be required
- Source tool concepts might differ to target tools
- e.g. DOORS tables or DOORS embedded Pictures might be massaged into a different presentation

If tools do not exist, don’t be afraid to create them for yourself.

DOORS Validation by Module Path														Jama		
Totals for validation																
Module Path	Total objects to migrate	Module - Objects	Module Out-Links	Module - OLEs	Module - Pictures	Module - Tables	Module - Rows	Module - Cells	Objects with both heading and object text	Deleted Objects	Objects with short text	Max heading size		Count of Items (total)	Count upstream relationships	Count of migrated OLEs
User Requirements	123	123	0	7	0	0	0	0	0	0	0	0		1190		
System Requirements	789	789	0	0	3	0	0	0	0	0	0	0				
Drive train component requirements	12345	12345	90	8	0	3	60	1200	3	0	0	0			90	
Entertainment system component requirer	36	36	0	0	0	0	0	0	0	35	0	0				
Interface definitions	24	24	0	0	0	0	0	0	0	0	0	0				
Design Rationale	77	77	91	0	0	0	0	0	0	0	0	0				

What is MBSE? It is not just SysML



Questions

Thank You!

For more information: visit www.jamasoftware.com/platform