CAASE18
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Custom Integration Framework for MBSE and CAE using Open Standards

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- 8 years with John Deere
- Focused on intersection of Simulation & Systems Engineering
  - Front line experience conducting physical systems modeling for construction equipment design
  - Graduate research in model based systems engineering

Key Takeaways

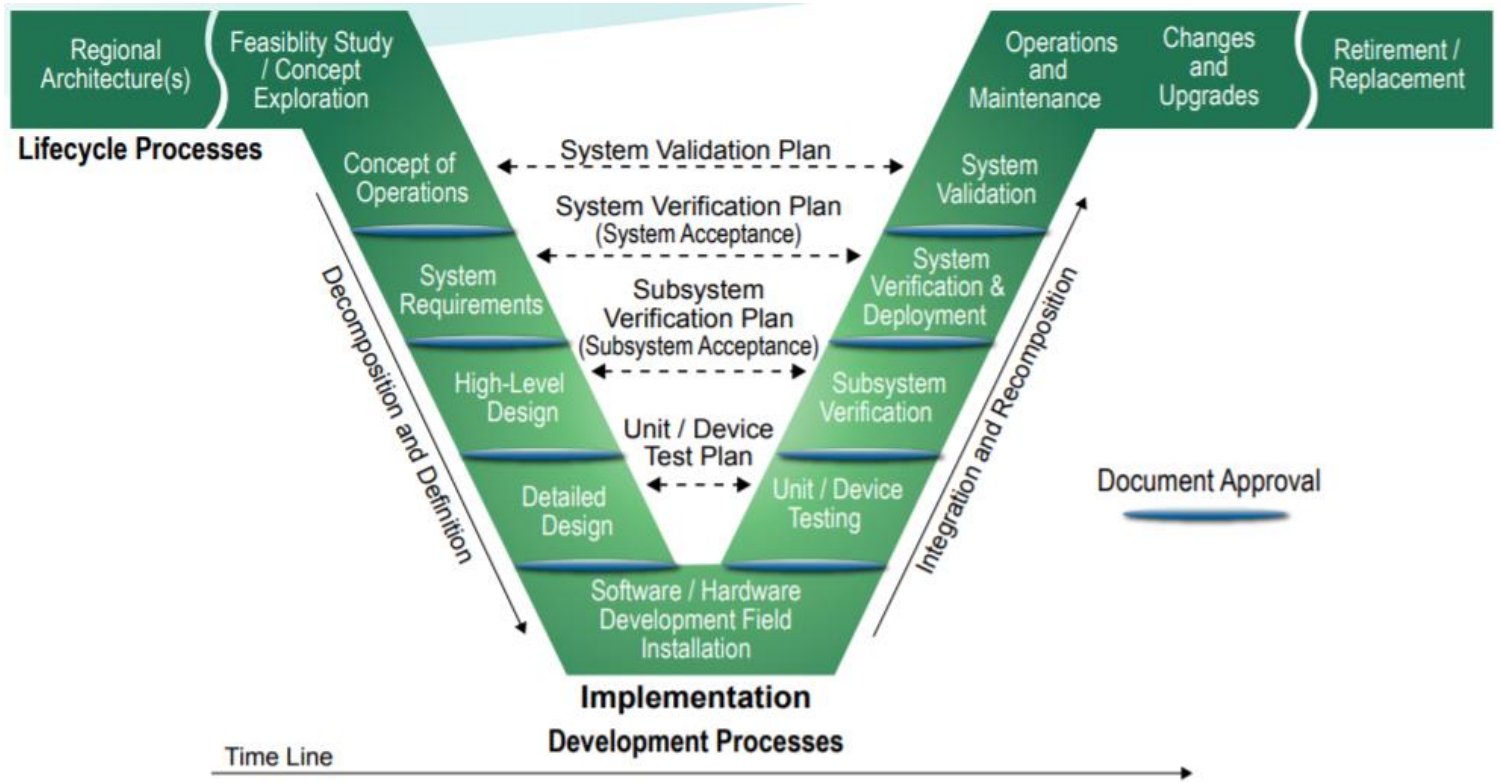
- Integration challenges will continue to increase within CAE and MBSE
- It is advantageous for users and vendors both to embrace deeper API access and develop (common) neutral data models
- Interest in collaboration
  - NAFEMS-INCOSE Systems Modeling and Simulation WG (SMSWG)?
    - https://www.nafems.org/about/technical-working-groups/systems_modeling/

Agenda

- Introduction: Need for integration in CAE and MBSE
- Problem: Traditional integration methods not practical
- Proposed: Custom workflows using APIs, OSLC and neutral data models
- Summary

Similar trends in CAE and MBSE

Less detail



More detail

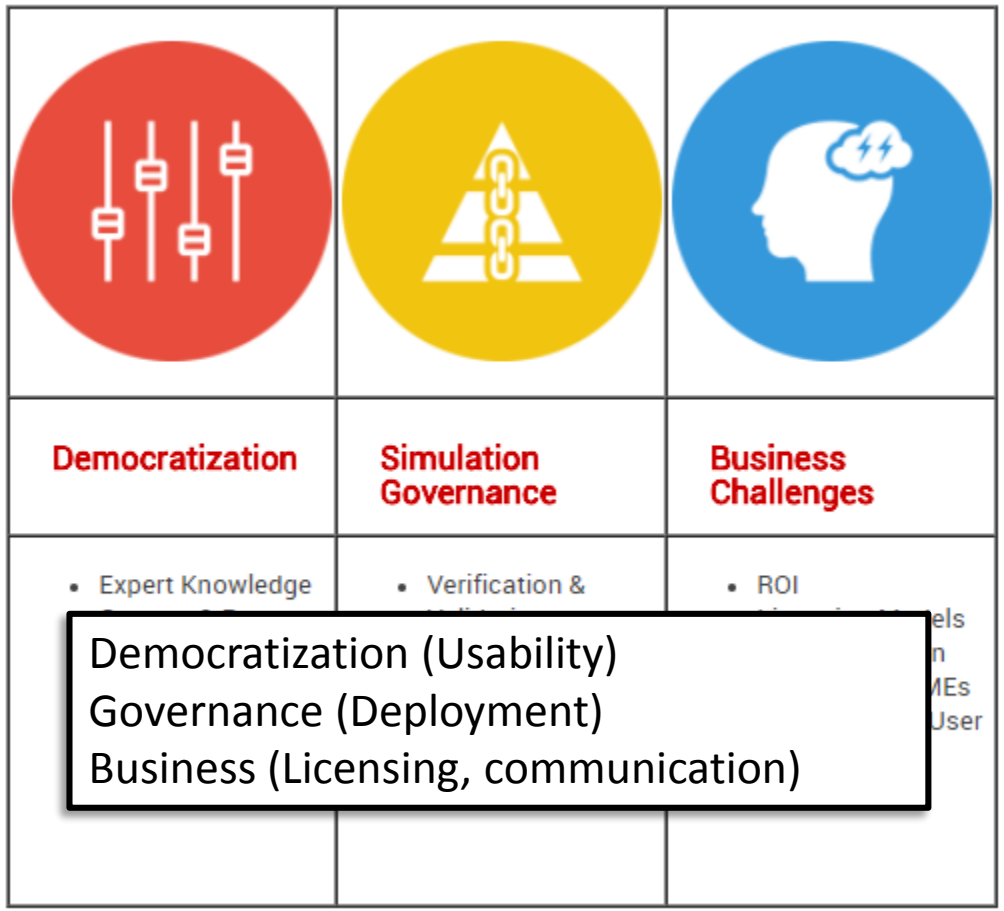
Designing for Transportation Management and Operations: A Primer [1]
(https://ops.fhwa.dot.gov/publications/fhwahop13013/ch2.htm#s25)

Initial concept → Production intent

More upfront modeling, integrated analysis… more, more, more!

CAE and MBSE Initiatives

Simulation 20/20



[2] https://www.nafems.org/about/regional/americas/events/2020vision/

Systems Engineering Vision 2025

Leveraging Technology for Systems Engineering Tools

FROM

Current systems
degree, and mak
limited integrati

From
… tools have limited integration with other engineering tools

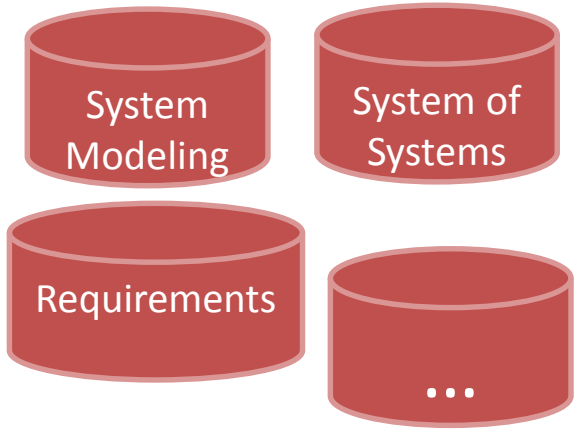
TO

The systems engineering tools of 2025 will facilitate systems engineering practices as part of a fully integrated engineering environment. Systems engineering tools will support high fidelity simulation, immersive
technolo
and reas
benefit f
with rela
agemen
environr
tools.

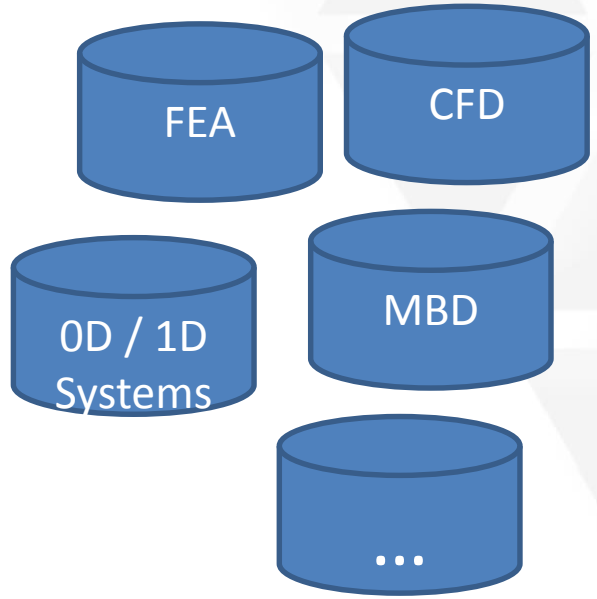
To
… SE tools will integrate with CAE tools, workflow tools as part of a broader engineering and enterprise management environment

[3] https://www.incose.org/docs/default-source/aboutse/se-vision-2025.pdf

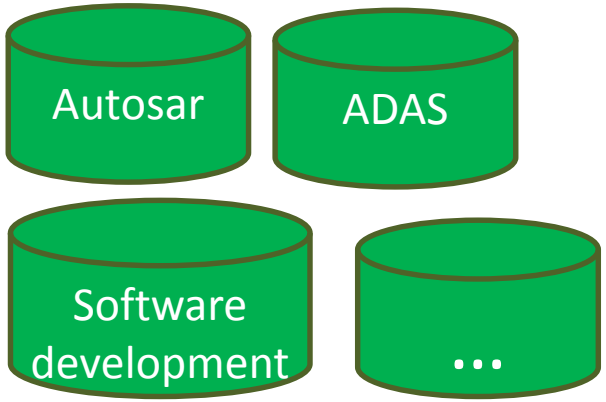
Number of tools and workflows will explode

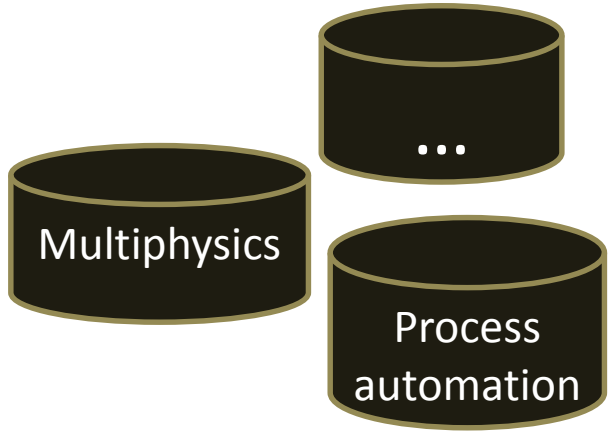


- More compute
- New CAE technologies
- New applications

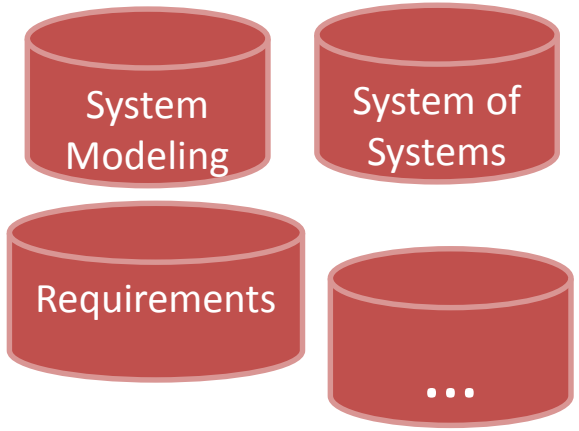


- Examples
  - FEA + CFD
  - FEA + 1D Systems + MBD + …
  - 1D Systems + Requirements
  - 1D Systems + System of System + ADAS + Software +…





Number of tools and workflows will explode



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- New CAE technologies
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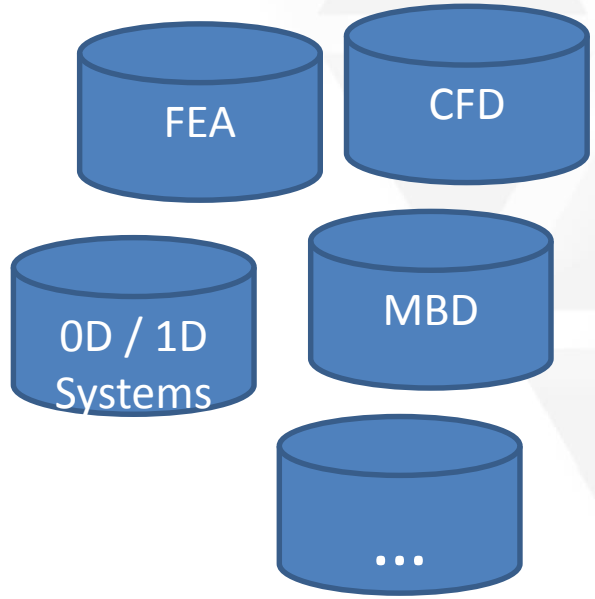
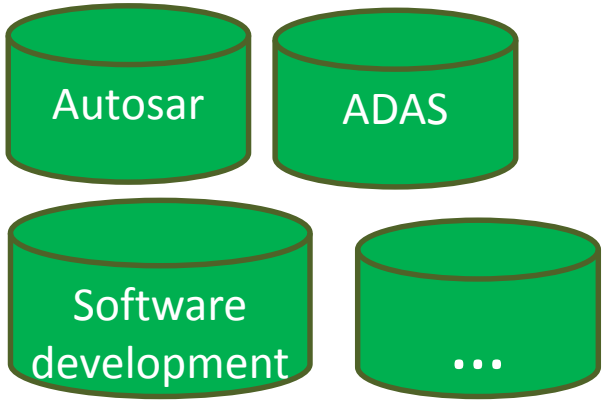
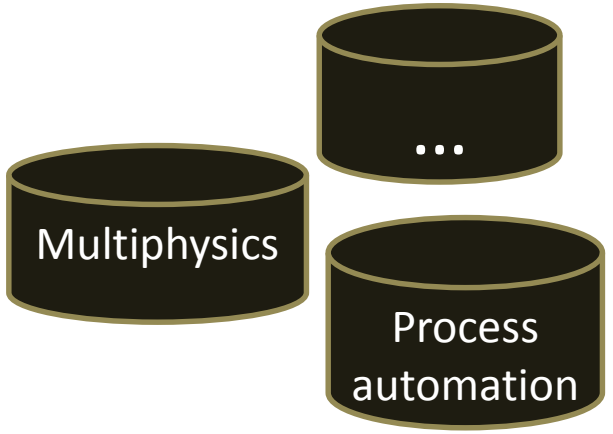
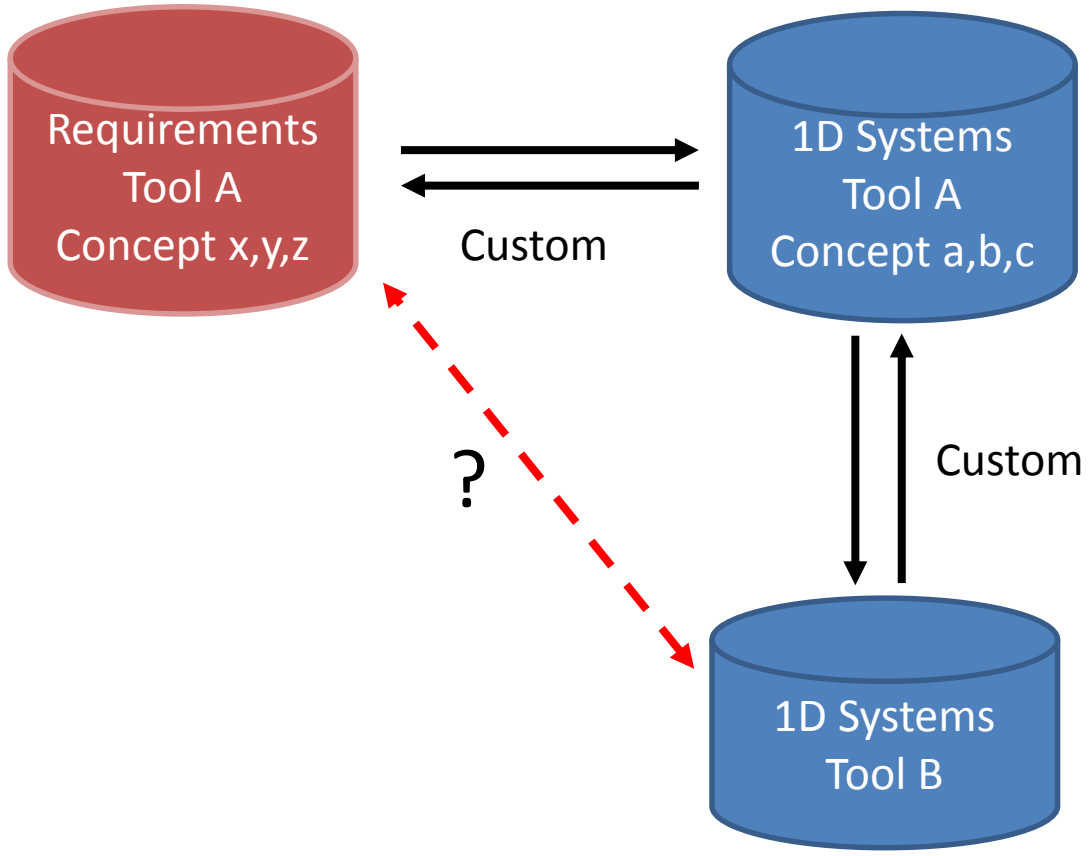




How do we bring these models and data together sustainably?

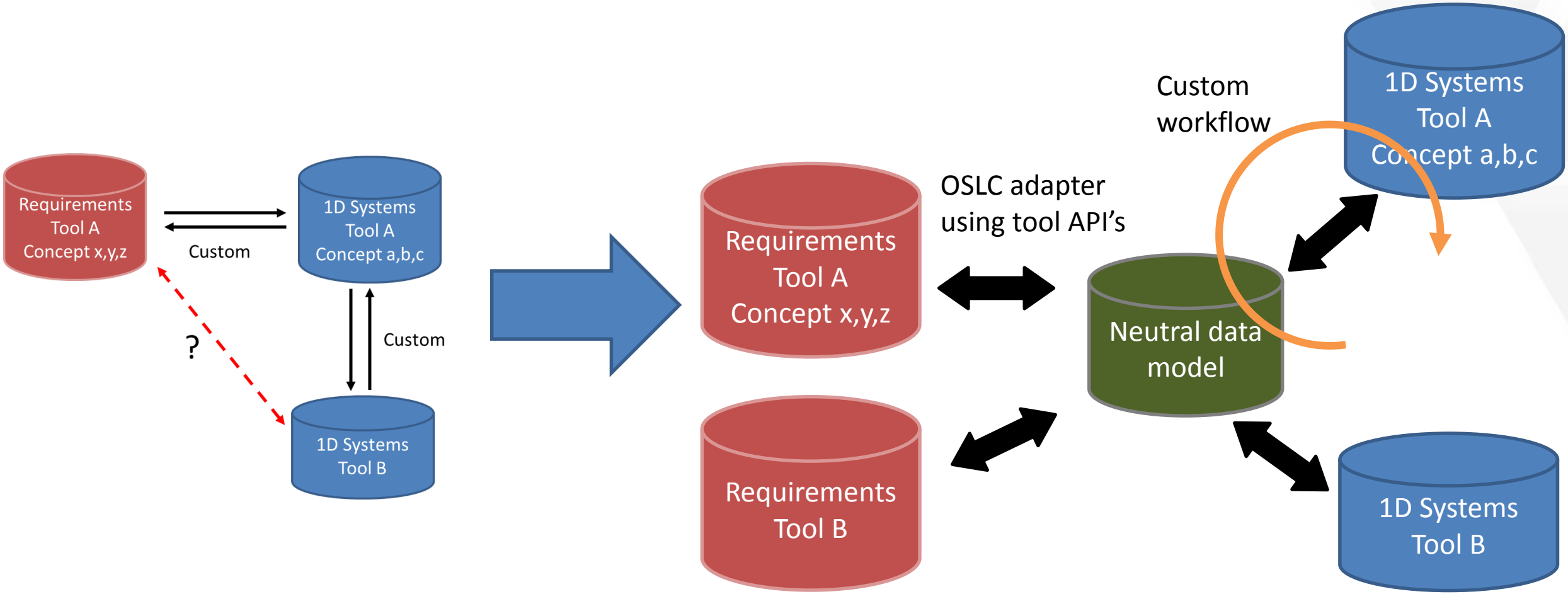


Traditional integration methods not practical



- Challenging for both users and vendors
- Integration workflows evolve over time
  - More tools to support
  - Different elements to connect
- Who maintains the integrations?

Alternative approach:
Custom workflows using OSLC and neutral data models



Example workflow
Integrating requirements with systems simulation
Proof of concept

Requirement Modeling Tool:

Custom systems engineering workflow

OSLC style adapter

Neutral data model:

Linked Data database

Systems simulation model:

Custom simulation workflow

"The mass of 317G Compact Track Loader shall be less than 5000 kg"

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<requirement>
    <project>/Skid Steer Requirements to DSM Evaluation</proje
    <category>Requirement</category>
    <id>243828</id>
    <name>The mass for 317G shall be less than 5000 kg</name>
    <text>The mass for 317G shall be between {{lower_limit}} a
    <parameterValues>
        <unit>kg</unit>
        <upperLimit>5000</upperLimit>
        <lowerLimit>0</lowerLimit>
    </parameterValues>
    <productConfiguration>317G for Mass</productConfiguration>
    <simulationName>Mass Test, EAP ###</simulationName>
</requirement>
```

XML representation of database

Benefits of this approach for Users and Vendors

- Increased flexibility
  - Users can define multiple workflows depending on need
  - Data from different sources can be mixed as needed
  - Vendors can shift focus away from specific integration workflows

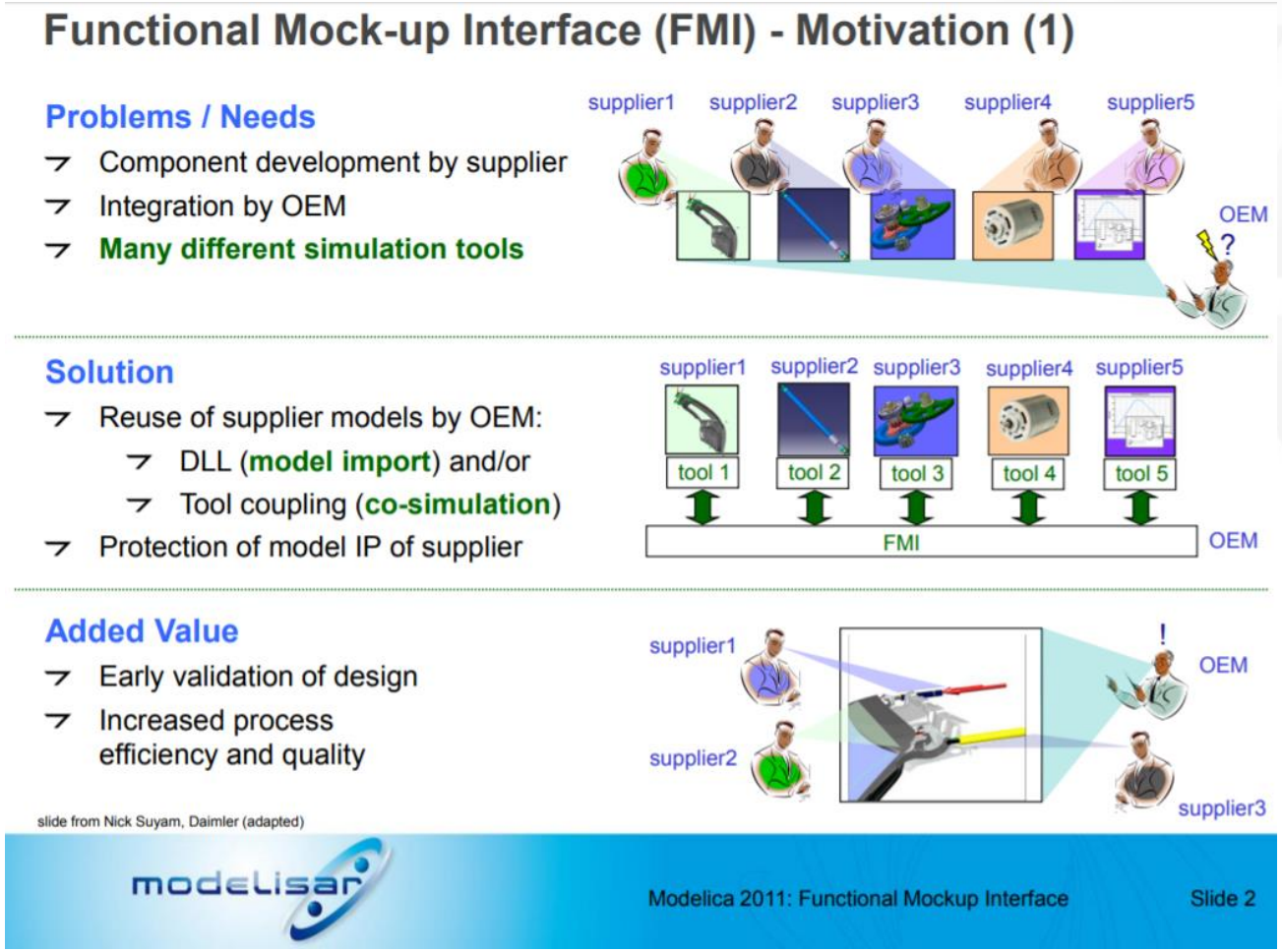
- More emphasis on user experience
  - Simulation and model use will increase (democratization)
  - Easier to compete on specific application performance

Challenges

- Developing data model
  - Interface management is part of Systems Engineering
  - Who does this? Can it be common?
- Tool vendors
  - API access, OSLC connectivity
  - Reluctance to change based on historic business model
- Users
  - Technical competencies required
  - Cultural change necessary; internally and externally with vendors

In spite of these challenges, why is now the right time for this?
FMI for co-simulation

- FMI is supported by <u>over 108 tools</u>
  - Used by automotive and non-automotive organizations throughout Europe, Asia and North America.



[4] https://trac.fmi-standard.org/export/700/branches/public/docs/Modelica2011/The_Functional_Mockup_Interface.pdf

Favorable trends in broader software community

- Rise of open source software

[5]

Linked Data for MBSE GitHub project [6]
https://github.com/ld4mbse

oslc-adapter-magicdraw-sysml
Java-based Implementation of OSLC MagicDraw SysML Adapter
Java 2 Updated on Apr 3

lyo.core
Forked from eclipse/lyo.core
Lyo project repository (lyo.core)
Java 6 Updated on Jan 19

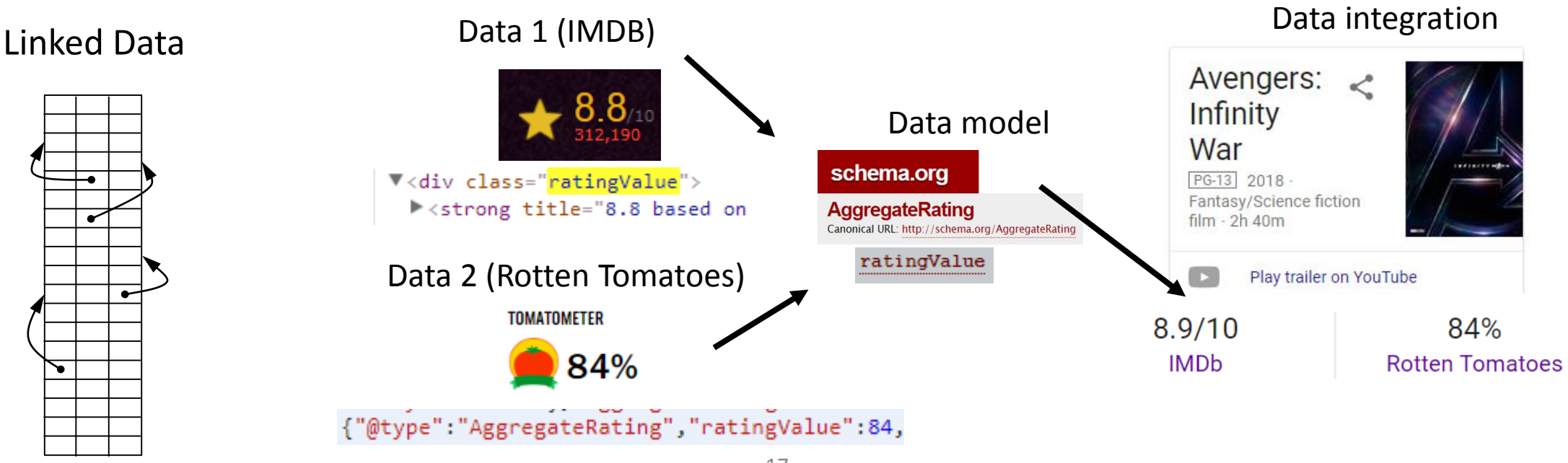
oslc-adapter-simulink
Java-based Implementation of OSLC Simulink Adapter
Java 4 Updated on Nov 8, 2017

oslc4j
OSLC4J library of Eclipse Lyo for Java-based implementation of OSLC adapters
HTML 1 3 Updated on Nov 8, 2017

magicdrawsysml2rdf

Favorable trends in broader software community

- Neutral data models are already in use on the web
  - Known as semantic web technologies
  - Web for Humans and Machines [7]



Favorable trends in broader software community

- Rise of specialized cloud software, focused on user experience and specific needs [8]
  - Enabled by providing full API access
  - New business models are possible
- Industry support for OSLC [9]
  - OSLC (Open Services for Lifecycle Collaboration)

[10] http://oslc.co/about/#supporters

Summary

- Favorable conditions for success of custom workflows using OSLC and neutral data models:
  - Interest from community (e.g. ST4SE at INCOSE IW 2018 [11])
  - Technologies are maturing (data models, OSLC, etc.)
  - User expectations (democratization)
  - Business environment (tool vendors and users work together)

- How best to continue this discussion externally?
  - NAFEMS-INCOSE Systems Modeling and Simulation WG (SMSWG) https://www.nafems.org/about/technical-working-groups/systems_modeling/

References

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Thank You!