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INCOSE International Symposium
Philadelphia, PA
June 24-27, 2013

Model Integration
Extracting Value from MBSE

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Agenda

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- Information integration overview
  - Definitions - Use cases and workflows
  - State-of-the-art
- Creating and leveraging linked data – from chaos to order
- Beyond linked data – model based development leveraging ontologies
- Getting the right data to the right place the right way – analytics integration platform
- Summary

Use cases of data integration

- Engineering data management: Interlink elements from various sources
  - Traceability
  - Impact analysis
  - Management
  - Process compliance
  - …..
- Co-development: Reuse data and models between tools and developers
  - Synergy and synchronization in development
  - Earlier discovery of issues
  - Less error prone document based processes
  - …..
- Analytics data integration: Facilitate seamless data flow to the analytics engines
  - Streamline analytics processes
  - Minimize analytics setup overheads
  - Guarantee data integrity, validity and currency
  - …..

Current Situation

- Trends
  - Engineering processes use more and more data
    - Trial data
    - Usage (lifecycle) data
  - Users want traceability, transparency, flexibility
    - Wider adoption of OSLC
    - Exploration into ontologies and semantic web
  - Information alignment and synchronization is key to efficiency
- State-of-the-art
  - Point to point integrations per tool per domain
  - Multi-point integrations (RELM) emerged, but the end points are still manually aligned
  - Any engineering analysis requires lengthy stage of input preparation and its subsequent management (change, versioning, etc.)

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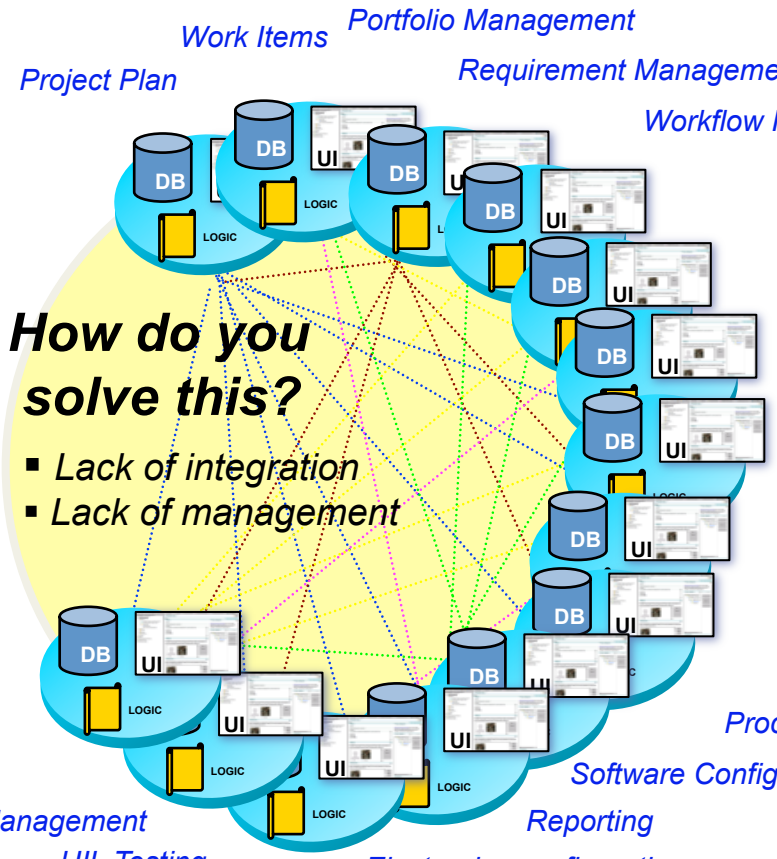
From Chaos to Order

Fragmented Environments

- **Traditionally, each tool came with its own**
  - **UI –** Web and desktop presentations of views and tasks
  - **Logic** – Workflow, process, search, query, scale, security and collaboration
  - **Storage** – Individual files on workstation or servers: How to ensure availability and traceability?
- **Resulting in...**
  - Brittle/poor integrations
  - Silos everywhere
  - High cost to maintain and administer
  - Low re-use

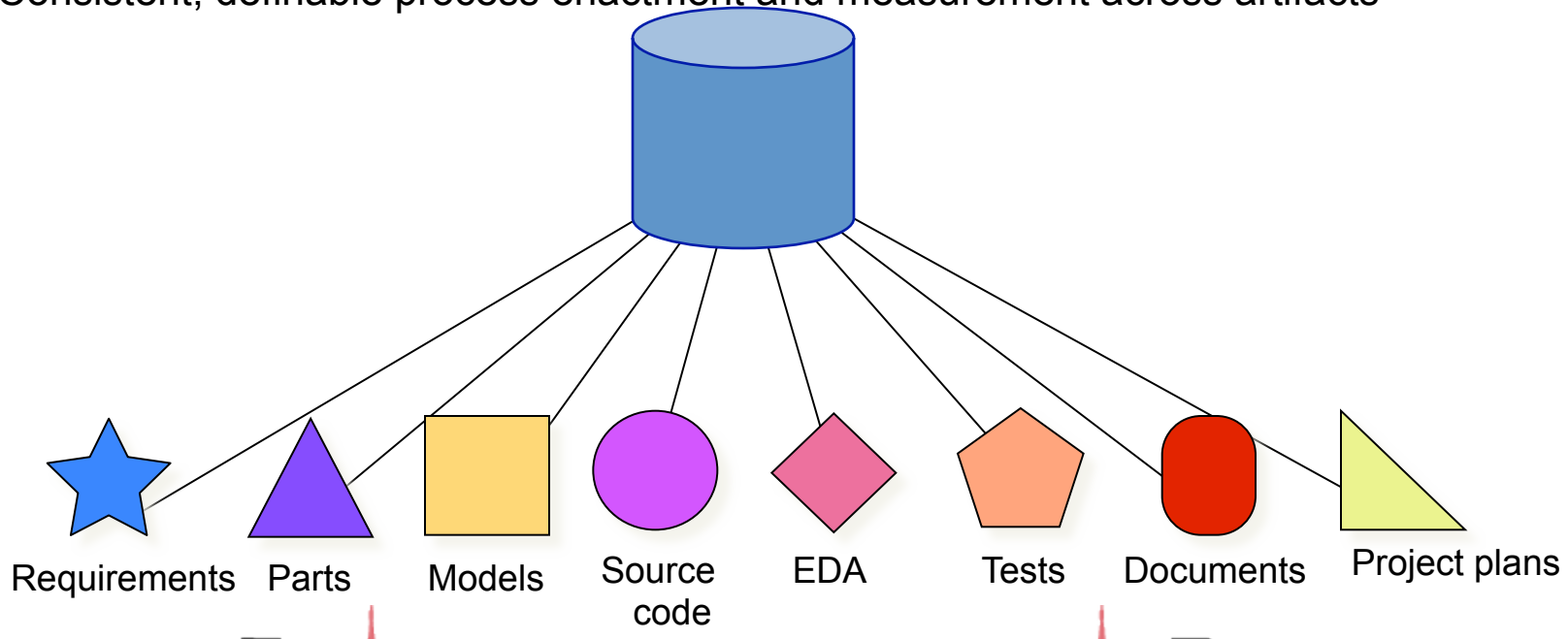


Work Items
Portfolio Management
Project Plan
Requirement Management
Workflow Management
FMEA
E/E Architecture
Simulation Modeling
SW Design
SW Coding
Verification
Control Loop Models
Complier/Debugger
Emulators
Change Management
SW Unit Test
Process Management
Software Configuration Mgmt
Reporting
Electronics configuration
SILTesting
MIL Testing
HIL Testing
Quality Management

Desired end-user view: A common repository

Desired traits

- **Common repository for all engineering data** – a "single source of truth"
  - Easy traceability and query across artifacts
  - Consistent, definable process enactment and measurement across artifacts



Desired end-user view not practical

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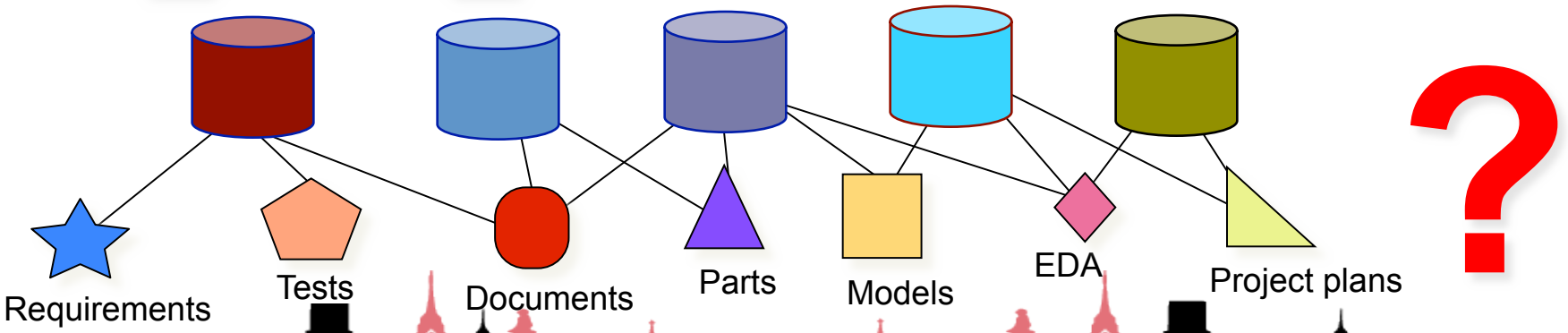
Desired traits

- **Common repository for all engine ing data**
  a "single urce truth"
  - Easy trace and query across artifacts
  - Consister efi le process enactm and m urement acros ifacts

Issues

- **Not practical** to move all applications to a common repository
- Common, consistent schema for all apps requires big tradeoffs (performance, size, upgrade, backup, etc.)
- Must have a strategy to deal with integrating heterogeneous data sources



An open platform for a loosely coupled "web" of engineering data

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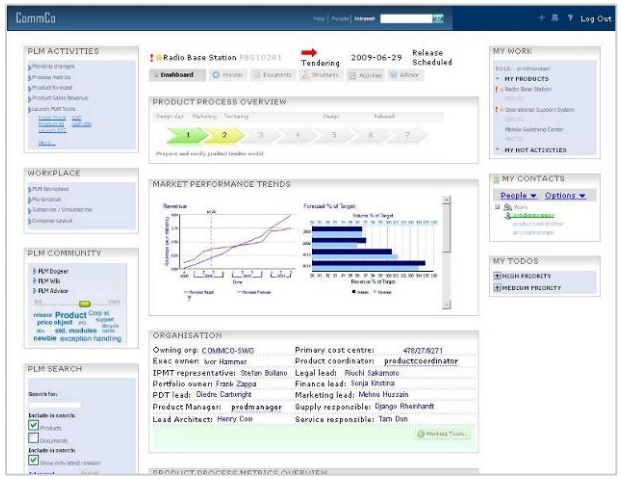
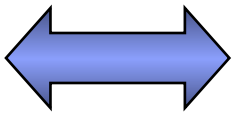
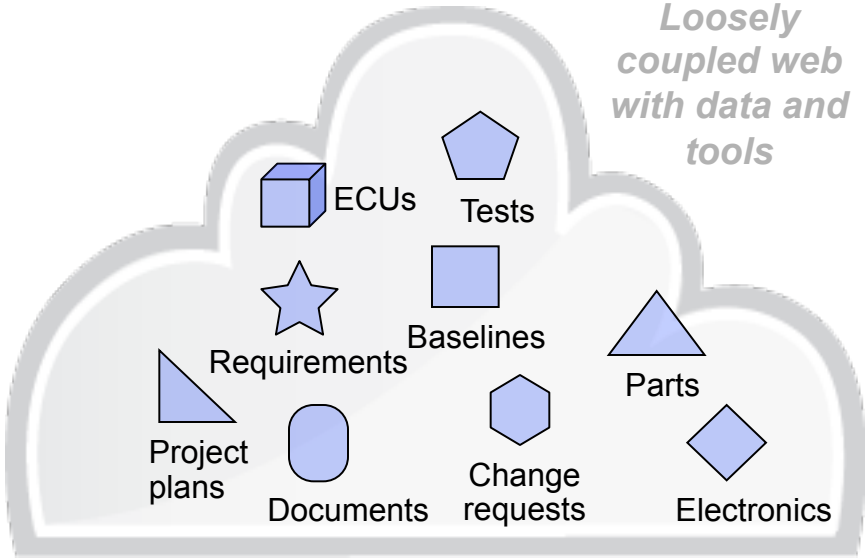
Single point of truth ≠ **Single repository**







Aggregate data from many sources into custom web UI mashup for each role

User sees data and operations, not products

Federated integration architecture

Enables easy upgrade

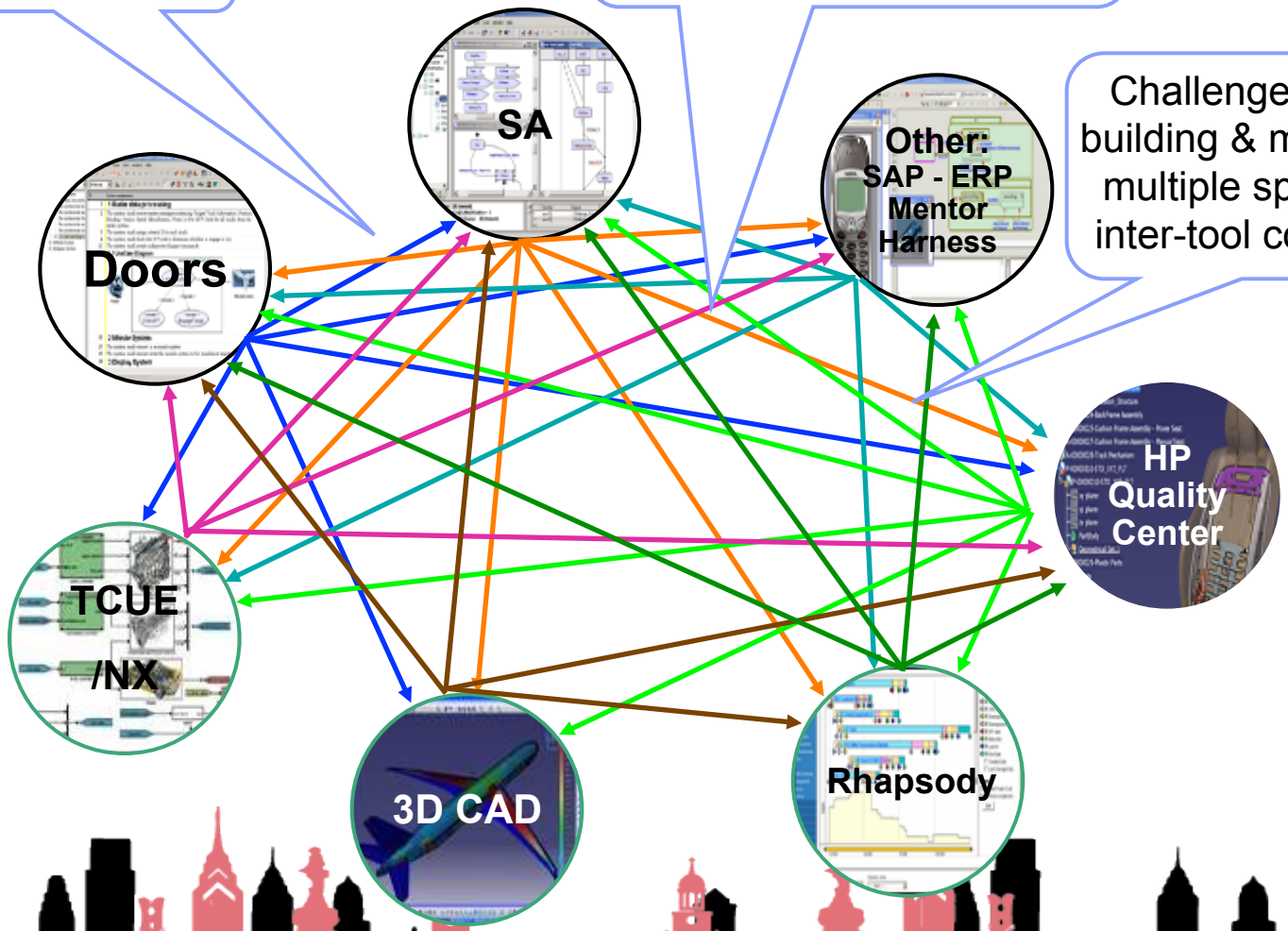
Provides common, cross-product capabilities (search, query, report, process, etc.)

Data Continuity Challenges

Challenge 3: Extend to additional tools

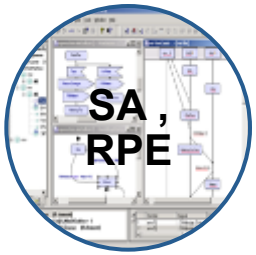
Challenge 2: Avoid inter-tool data duplication , while maintaining traceability

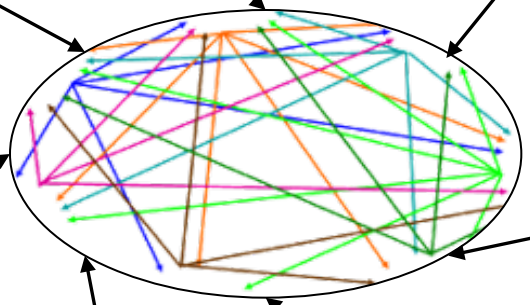
Challenge 1: Avoid building & maintaining multiple specialized inter-tool connectors

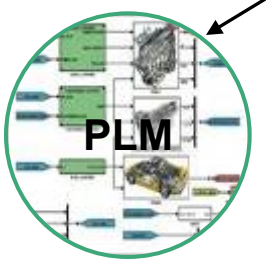


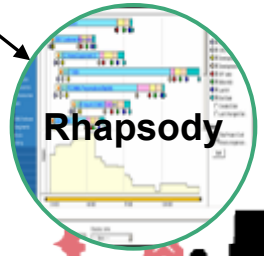
The Solution Approach

- ✓Product data exists in different systems
- ✓Traceability
- ✓Impact analysis
- ✓No peer to peer integration
- ✓Data Continuity
- ✓Data Duplication









Smarter development using an Internet inspired architecture

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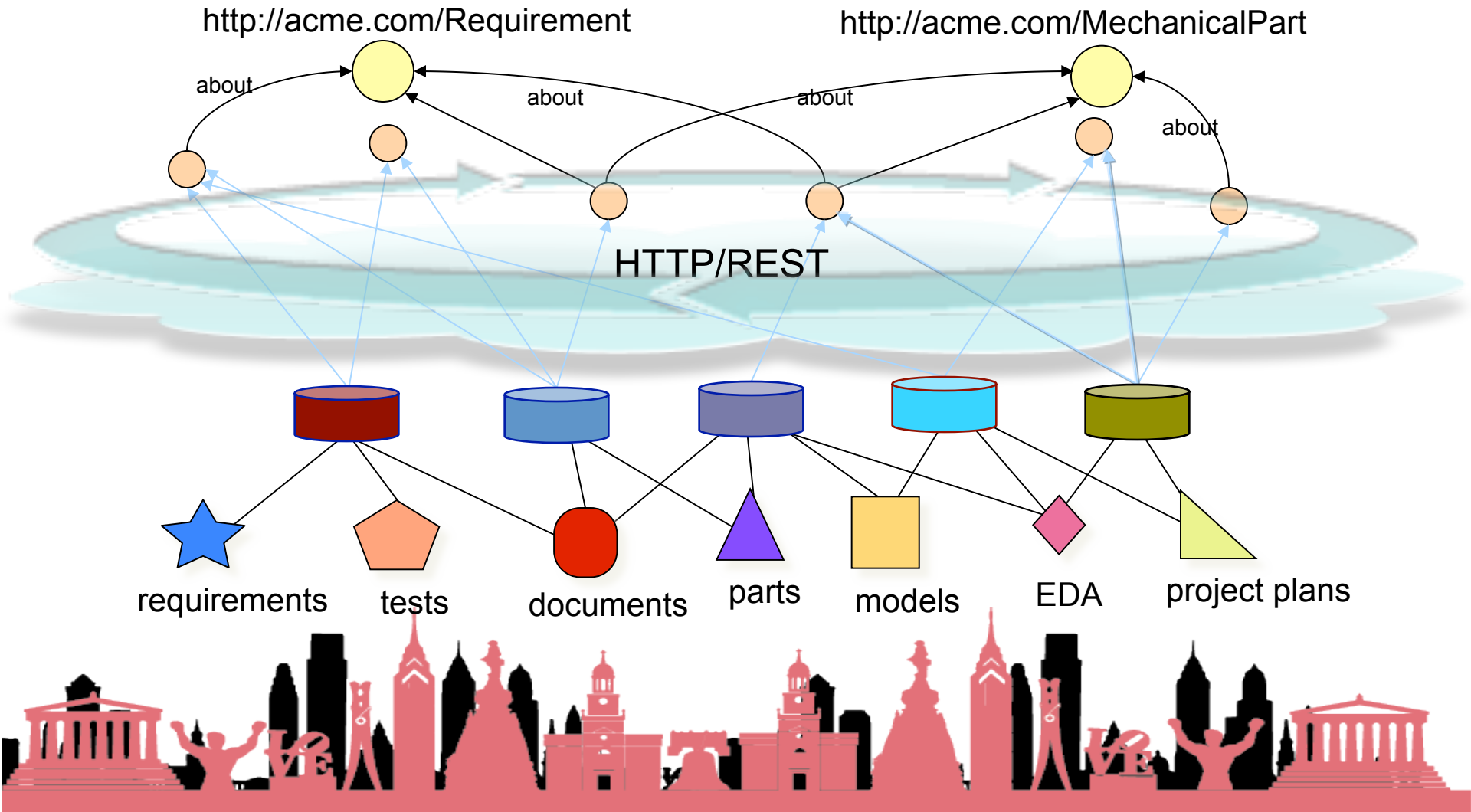
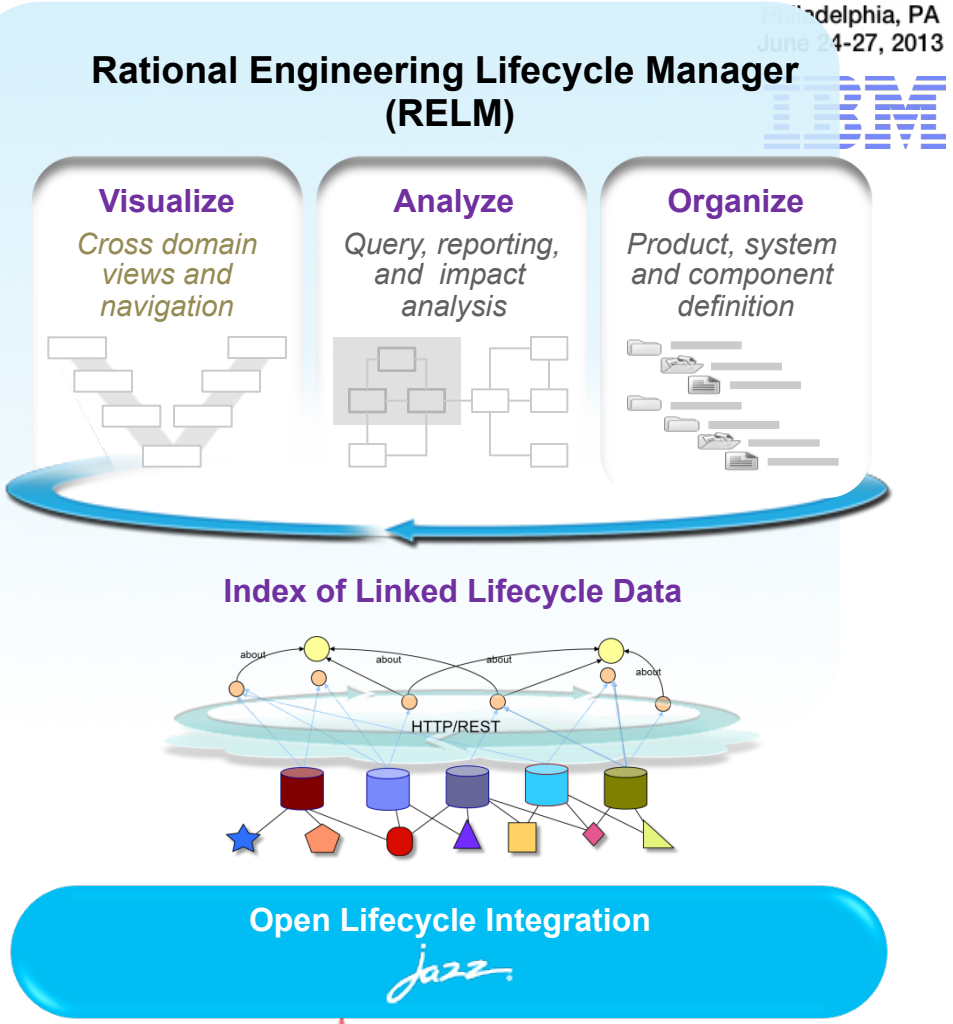
The Web has proven to be the most scalable, open, and flexible integration technology



Rational Engineering Lifecycle Manager

- Uses a Linked Data approach that enables
  - *Visibility* – across many sources of data
  - *Organization* – information in context
  - Analysis - answer questions using that contextualized information

- Allows stakeholders to:
  - manage growing complexity
  - derive knowledge from the available data
  - make timely and correct engineering and business decisions



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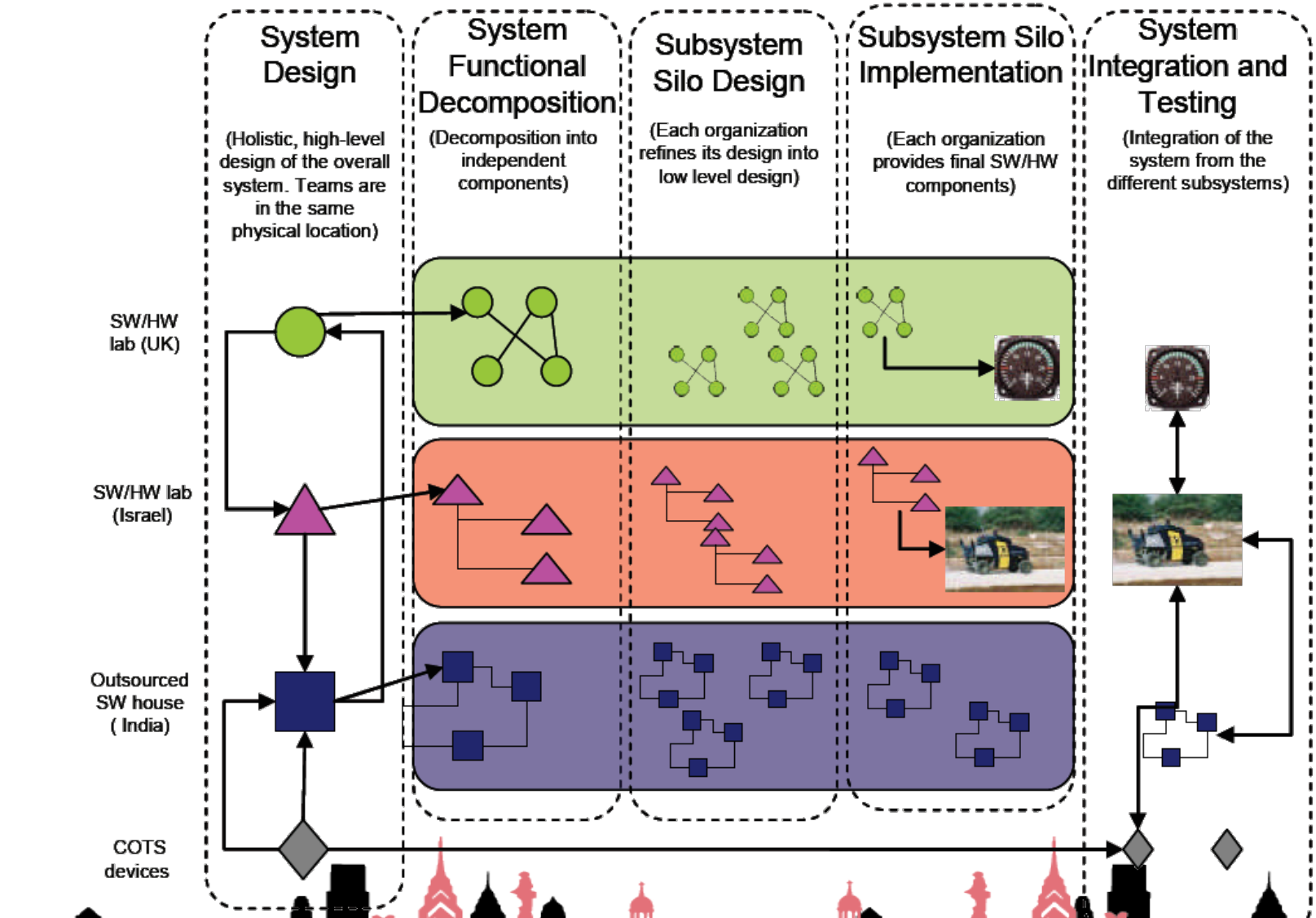
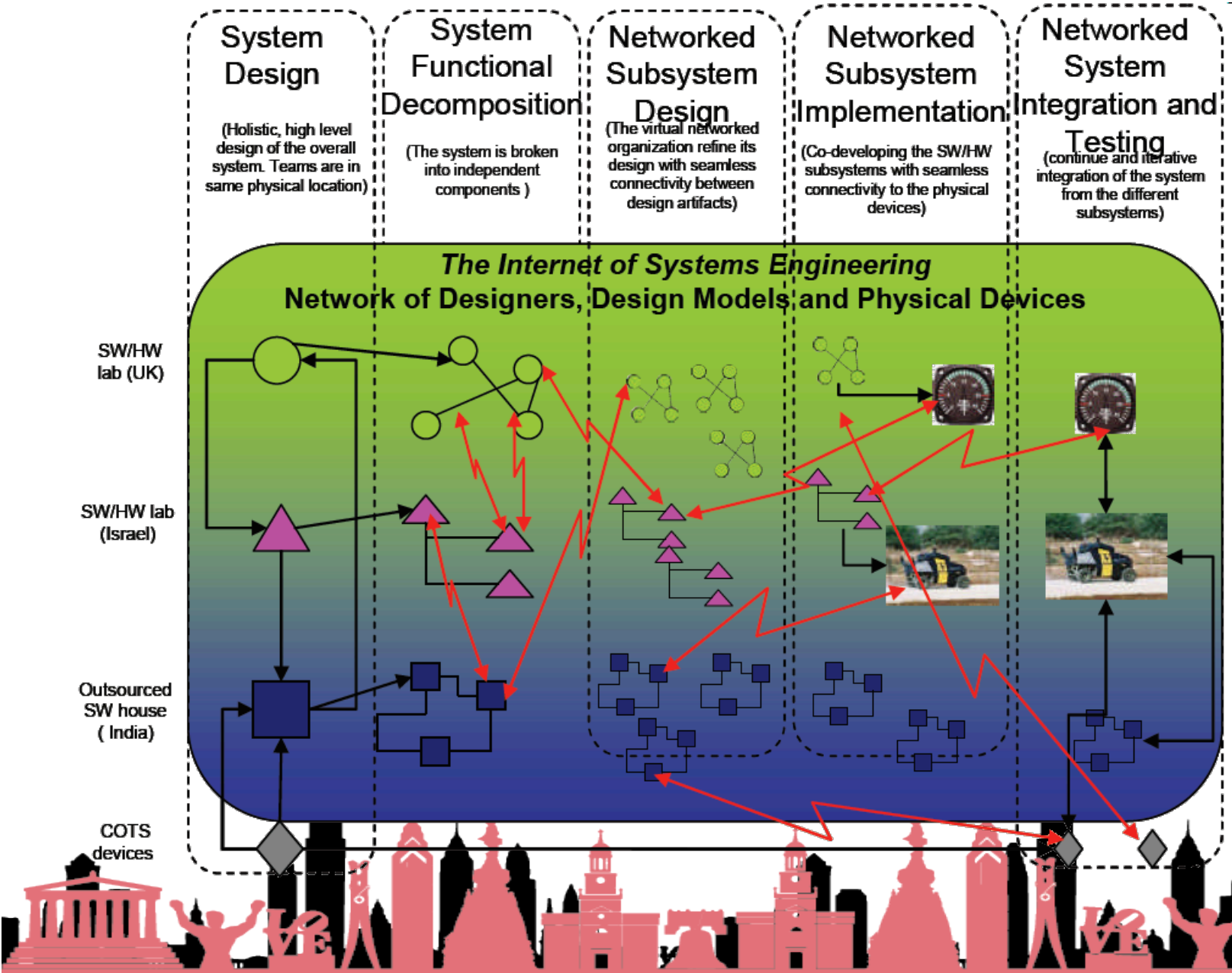
Beyond Linked Data

Co-development

Starting Point – Today Approach



Desired Goal – Next Generation



Multiple Tools and Applications Architecture

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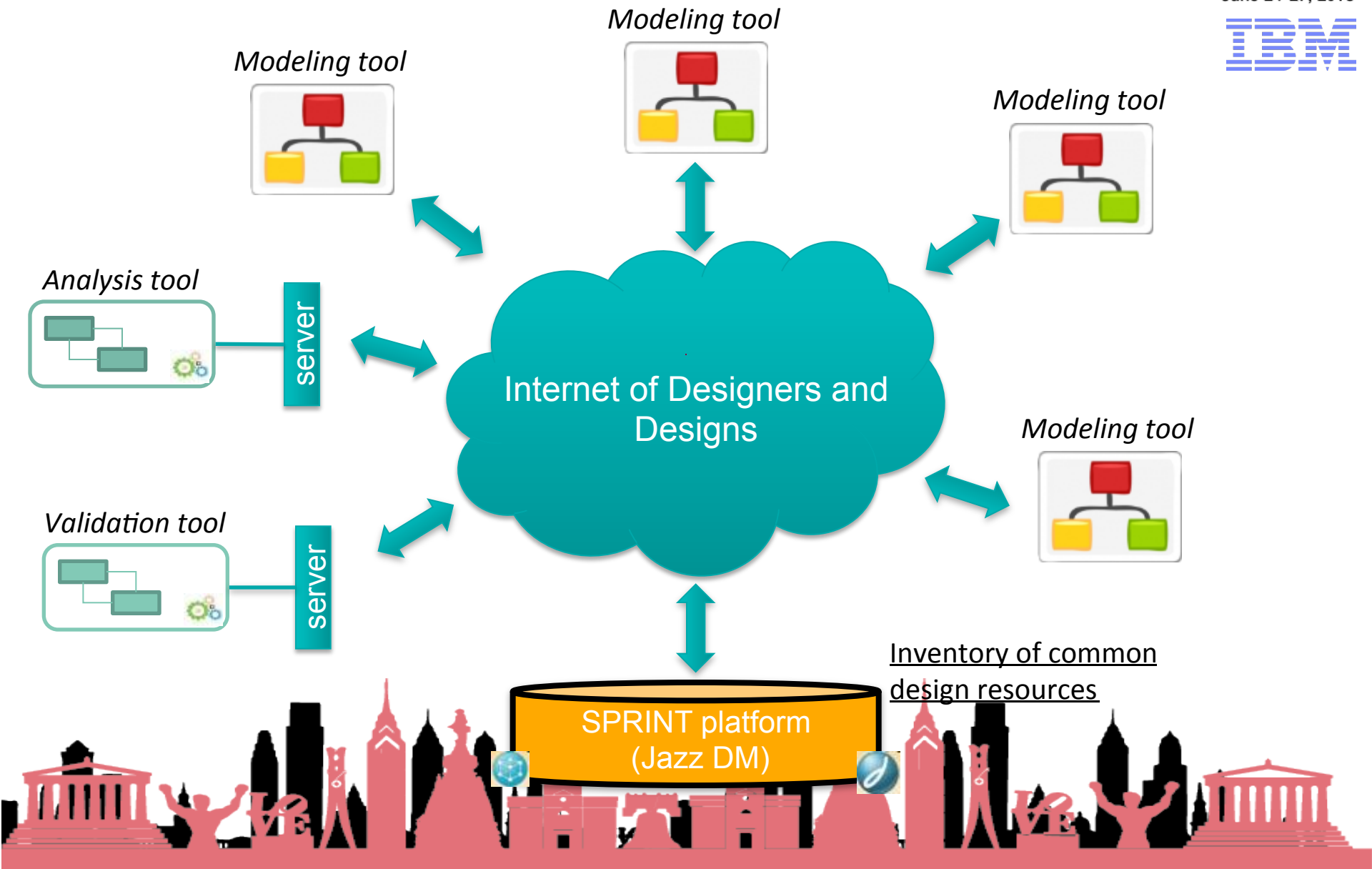
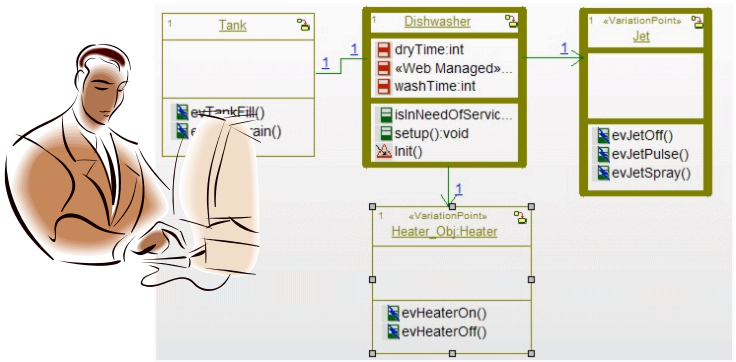
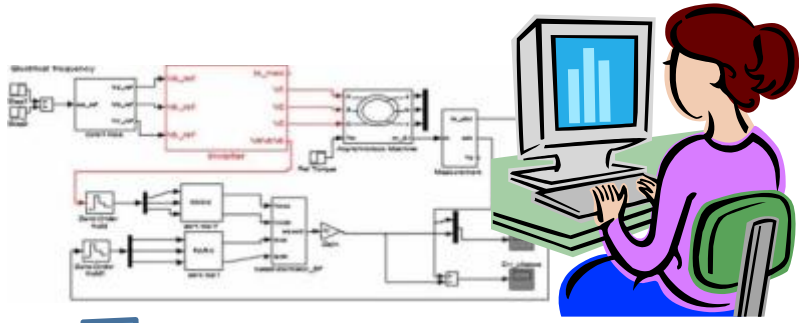


Working Environment - Now



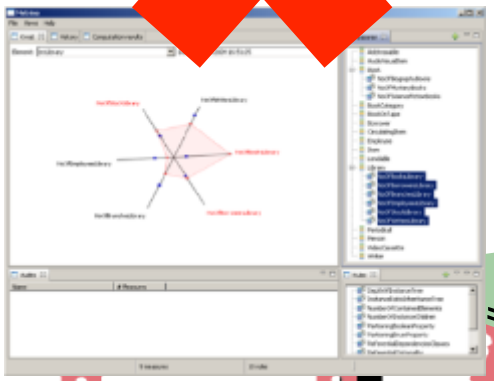


Rhapsody

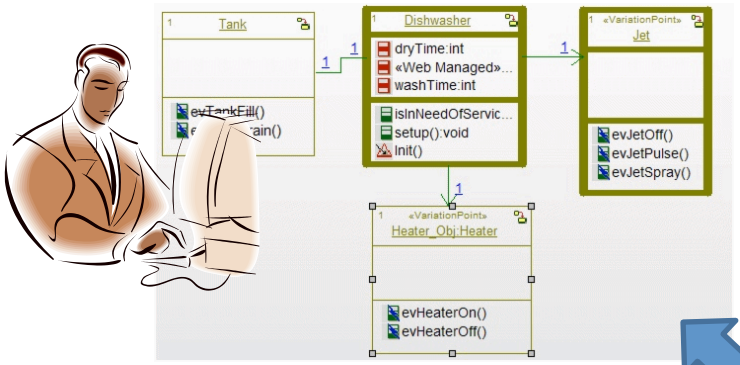
Simulink®

Rhapsody Importer

Simulink Importer



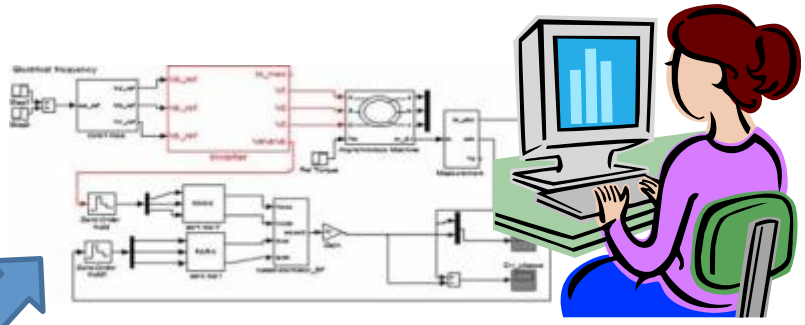
Working Environment - Soon



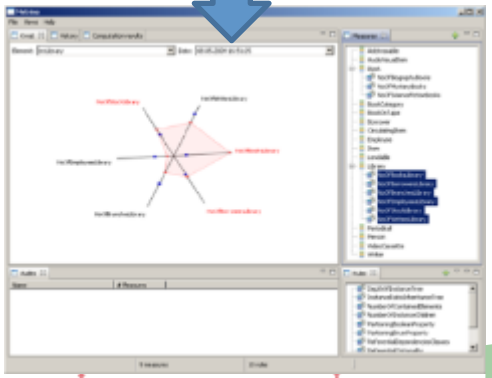
Rhapsody

IoSE

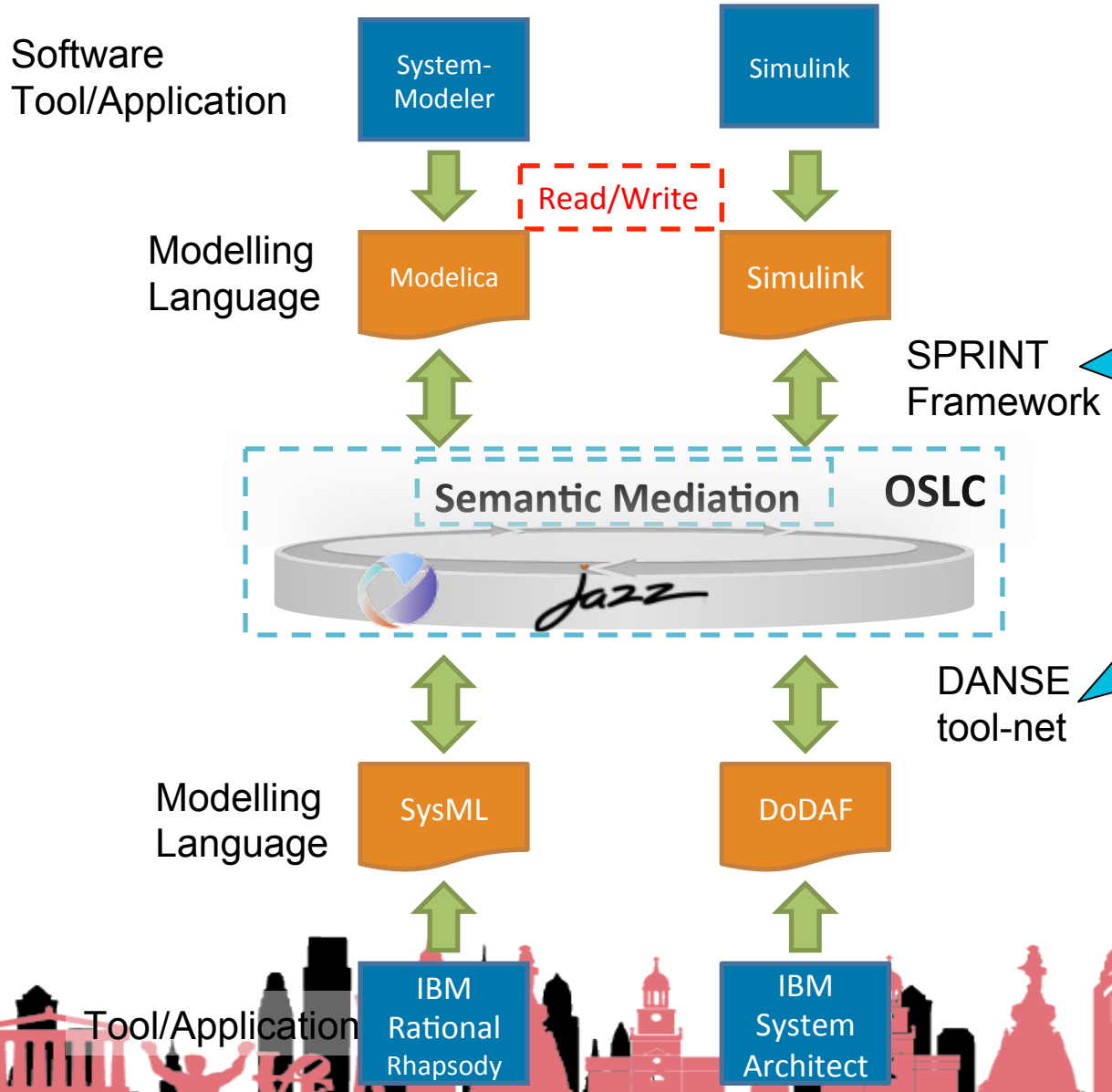
Internet of Systems Engineering



Simulink



IoSE Story in a Nutshell



SPRINT EU FP7 project

Objective: build an interoperability platform for Model Based Systems Engineering

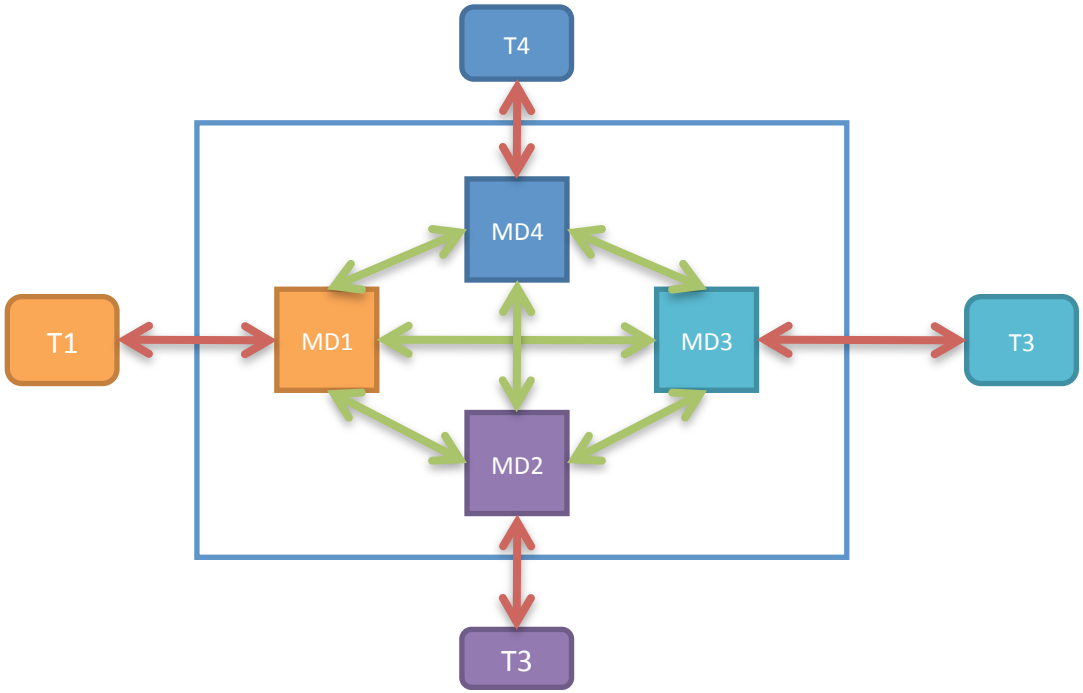
Partners: EADS, IAI, IBM, UTC, Wolfram, Elvior, Fraunhofer

DANSE EU FP7 project

Objective: build an integrated tool-chain and methodology for Systems of Systems design

Partners: EADS, IAI, Thales, VW, IBM, UTC, OFFIS, INRIA, Sodius, Loughborough U, HonourCode

Point-to-point semantic mediations

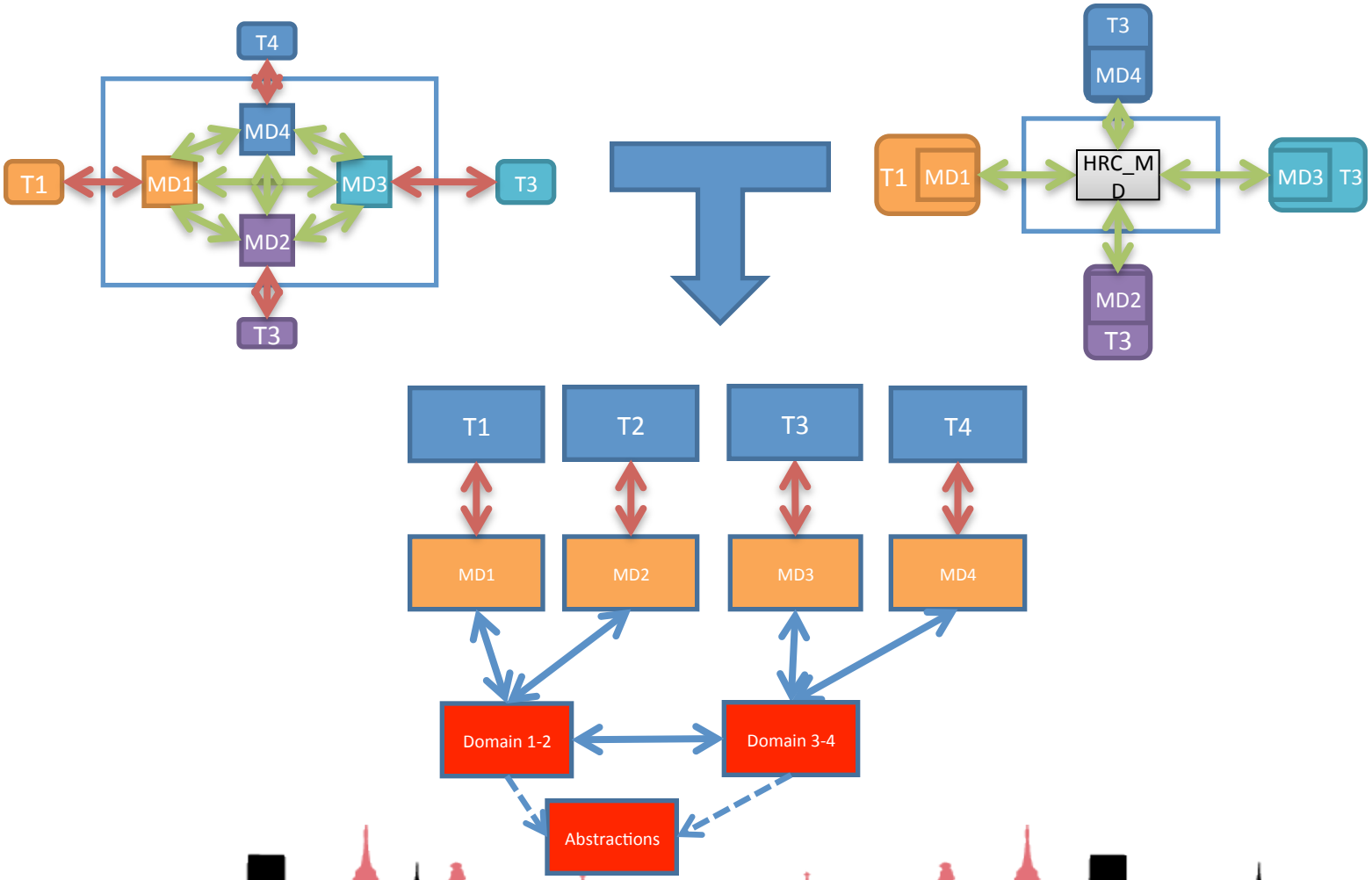


- Each tool imports/exports models on its own meta-data
- Semantic mediation relations established between each pair of meta-data
  - ➔ To cover all transformations, we need (N*(N-1)) / 2 relations

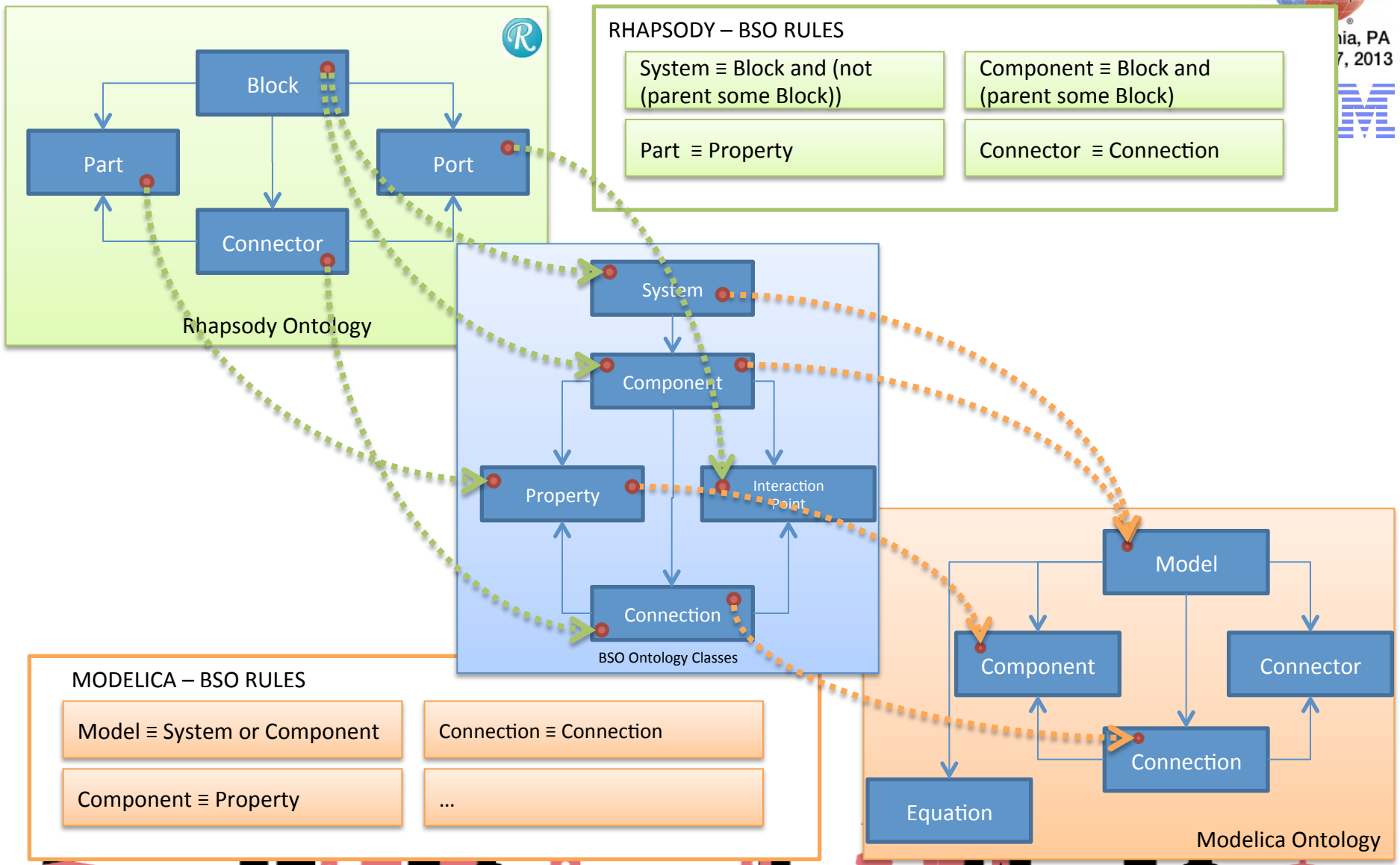
Common Meta Model

- Each tool imports/exports models on the universal, commonly agreed meta-data
- Semantic mediation is guaranteed by the usage of the unique meta-data for the exchange of models

Evolution of the Semantic Mediation Idea

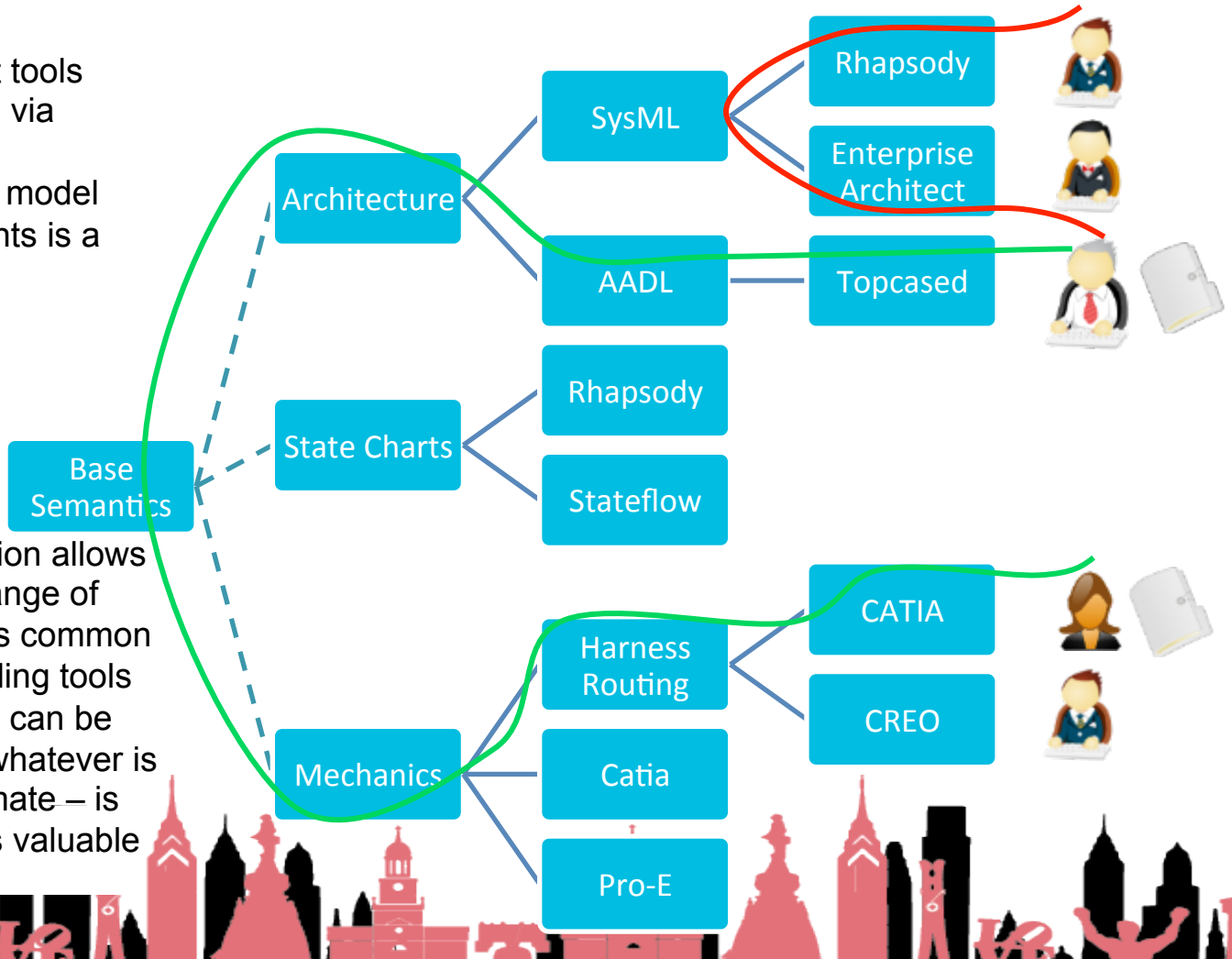


Semantic mediation in action



Semantic Mediation Framework Architecture

- Users of different tools today collaborate via documents.
- The exchange of model data via documents is a manual process



- Semantic Mediation allows automated exchange of model data that is common to different modeling tools
- Not all properties can be exchange – but whatever is possible to automate – is automated and is valuable

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Analytics Integration Platform

Who needs the data?

modeFRONTIER
the multi-objective optimization and design environment

Optimization

Dashboards

Metrics

SIMULIA

Business Analytics

Verification

ModelCenter

Simulation

Safety Analysis
(FMECA, FTA,…)

Where is the data?

Modeling tools

TEAMCENTER

IBM

CATIA

SAP

PLM/PDM

ERP

Quality Center

Windchill

Microsoft Office Project

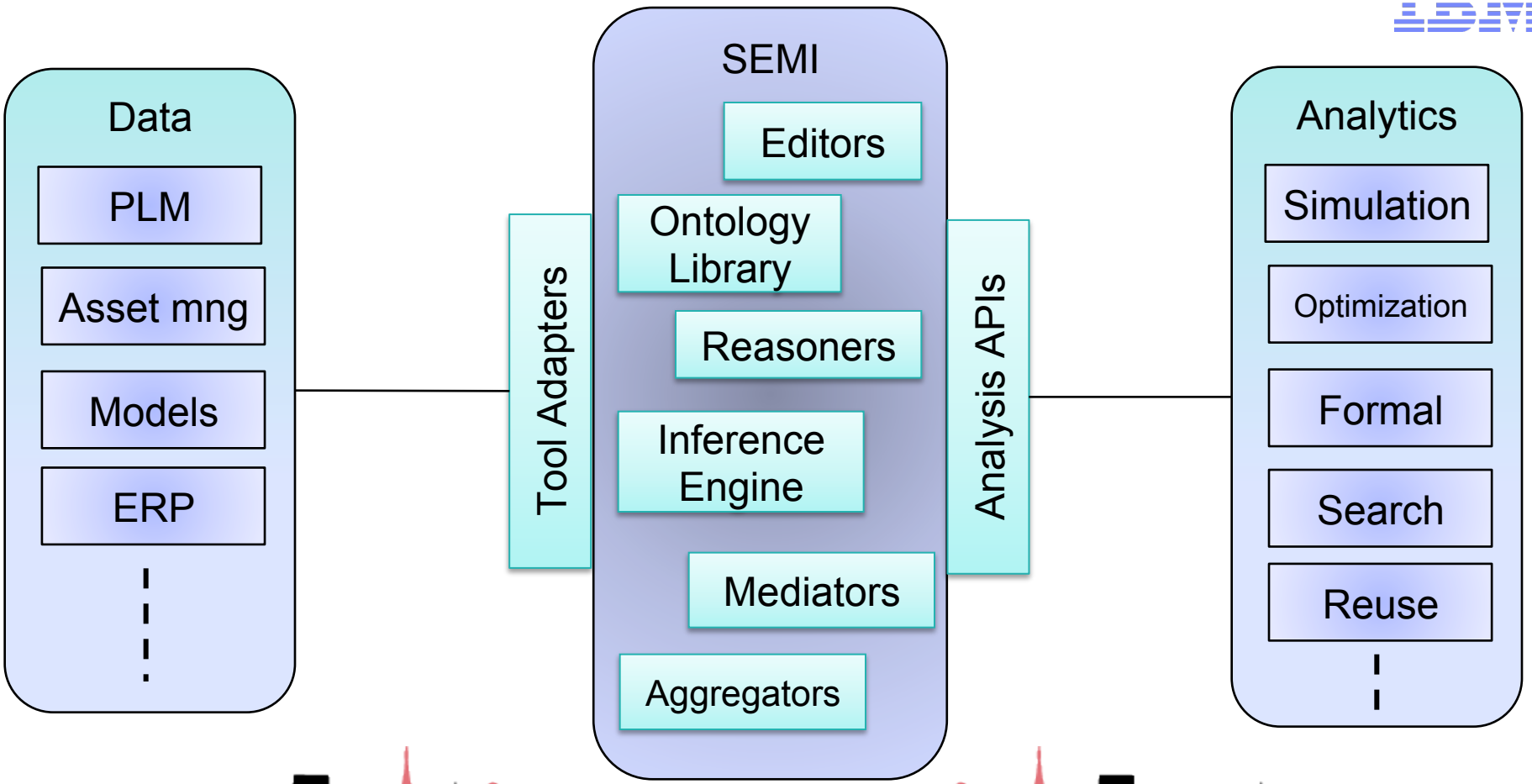
Project Management

Asset Management

Analysis results

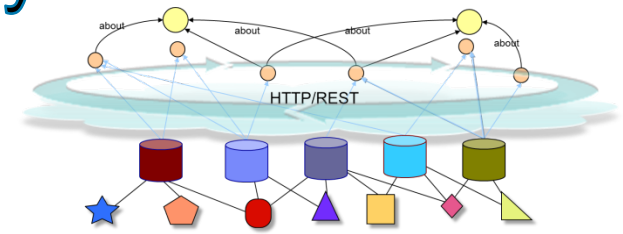
IBM maximo

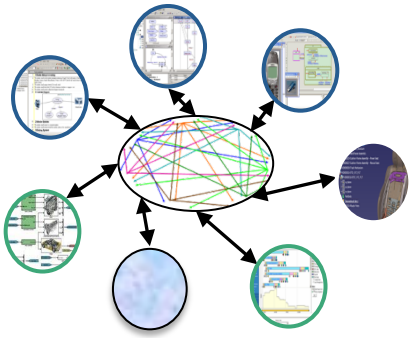
Semantic Middleware (SEMI)



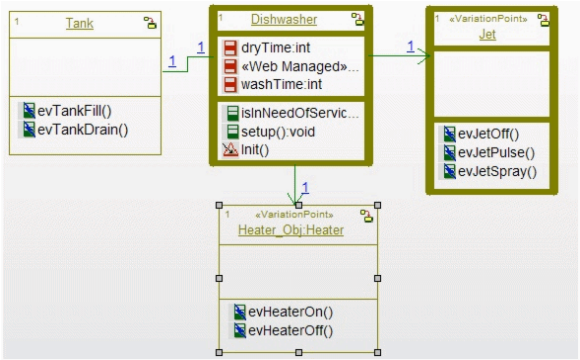
Summary

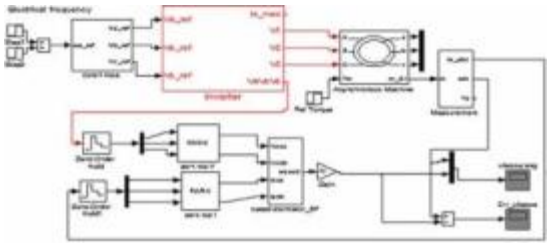
Link





Understand





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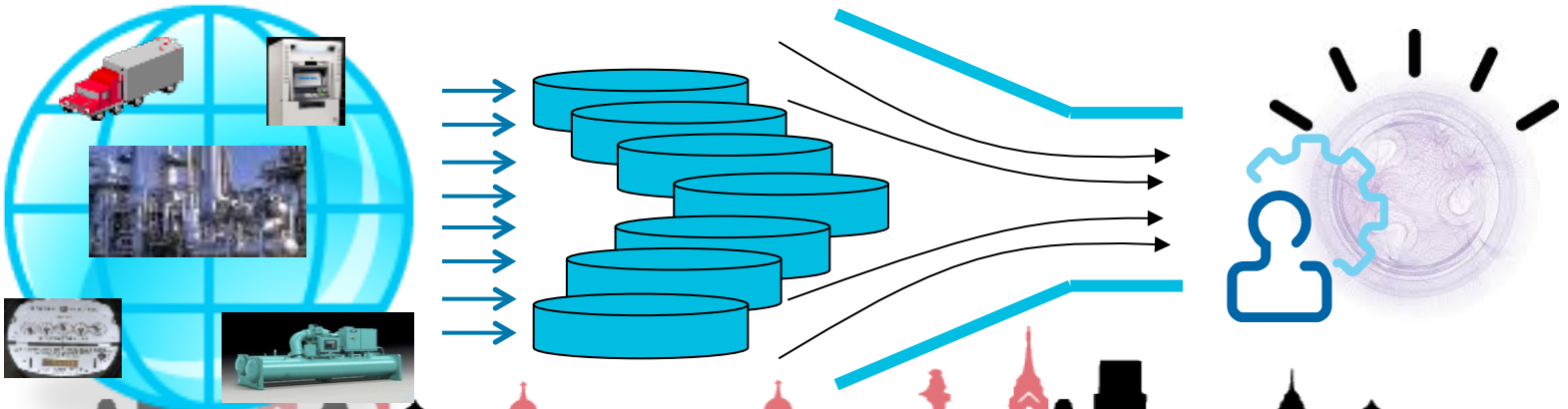

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Questions ?

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