



Manprit Singh
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Fuel your Automotive Innovation with IBM Rational platform for automotive industry.

Learn about adoption experiences and results achieved by top OEMs and T1s

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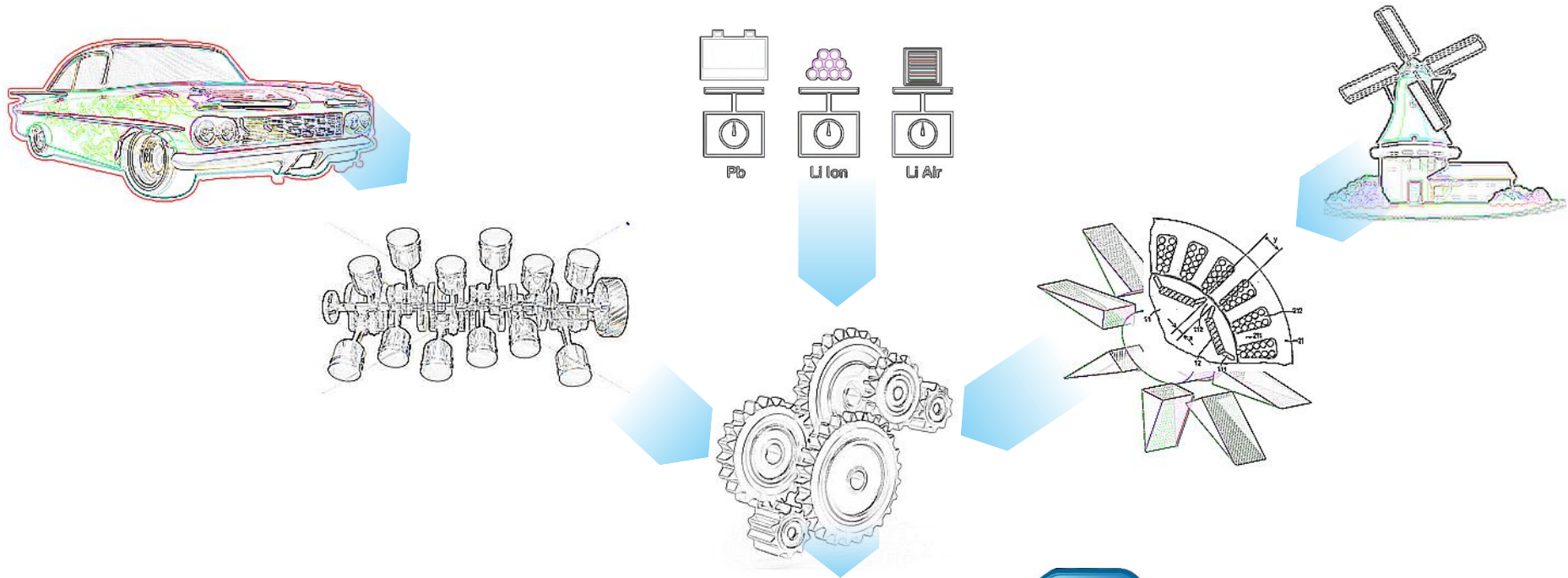
Agenda

- Many tools for many tasks
multidisciplinary engineering with Rational
- Adoption Experiences from leading OEMs
and suppliers



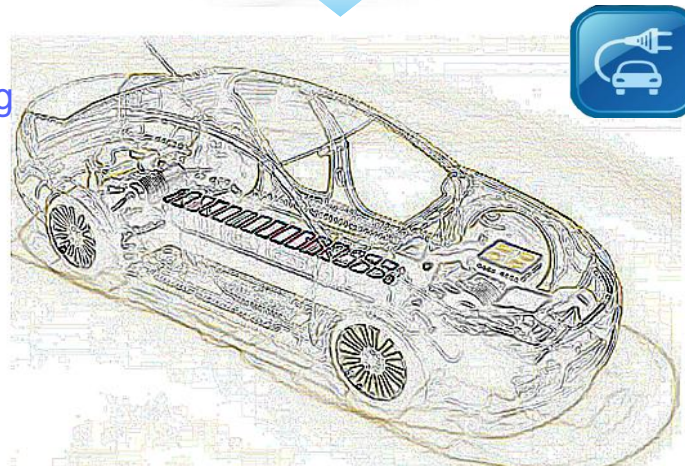
Technological fusion for next-gen automotive technology :

According to **AberdeenGroup**, **68 percent** of manufacturers cite synchronization of mechanical and electrical design representations as a key product development challenge.

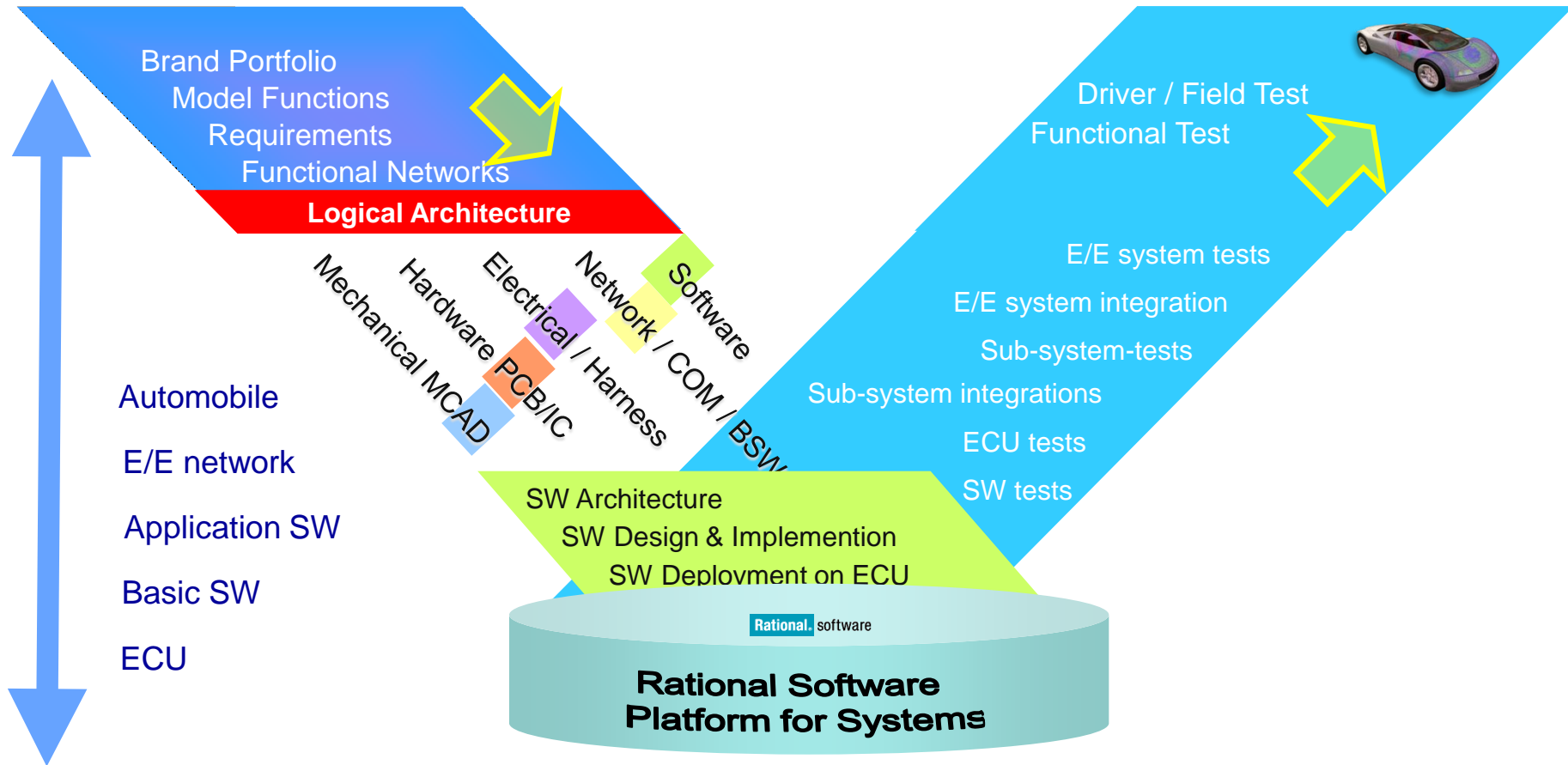


Engineering merger :

- New fundamentals derive from existing know-how
- New technology can rapidly evolve if existing assets are well managed



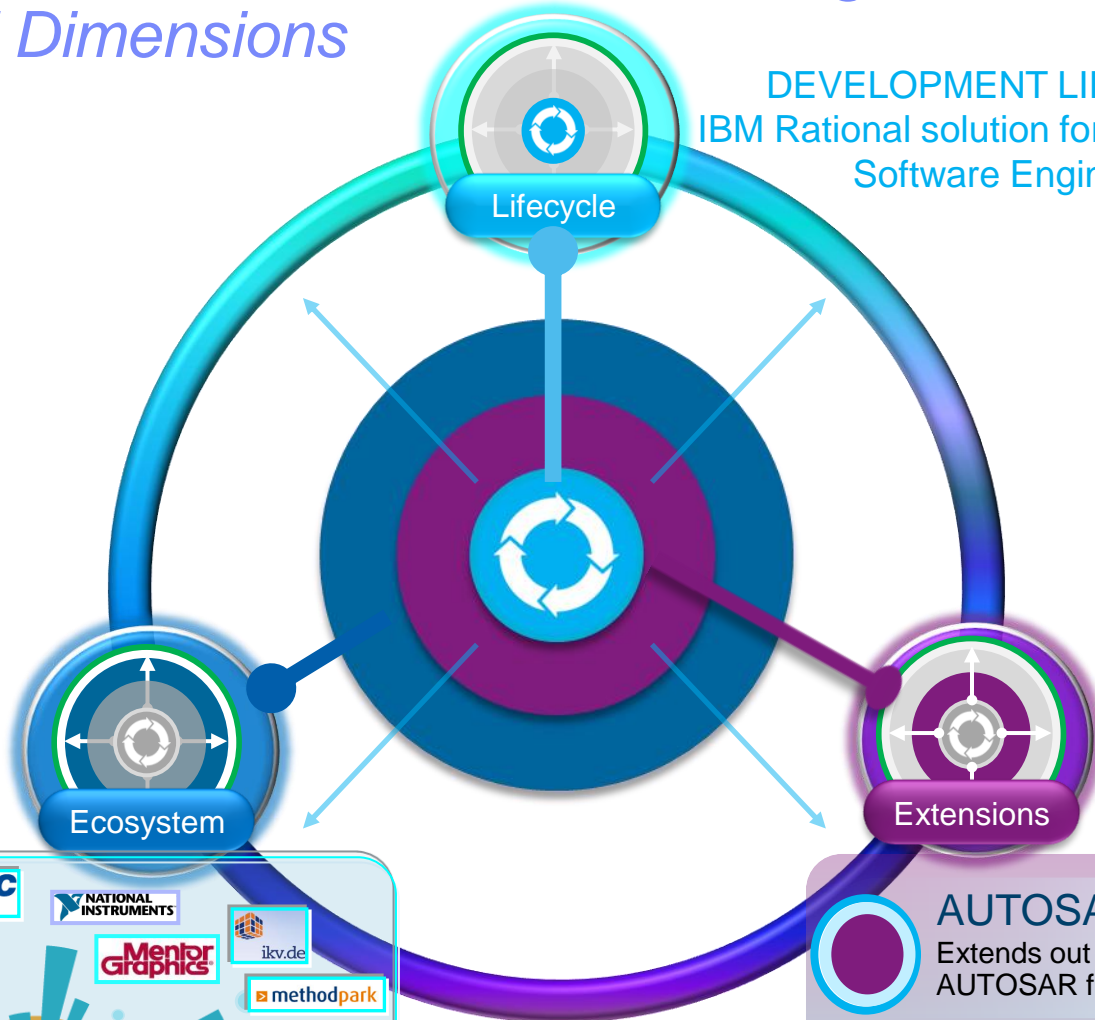
Multiple Parallel Vs running multidisciplinary engineering



Rational Solution for Automotive Engineering

3 Integrated Dimensions

DEVELOPMENT LIFECYCLE
IBM Rational solution for Systems and Software Engineering



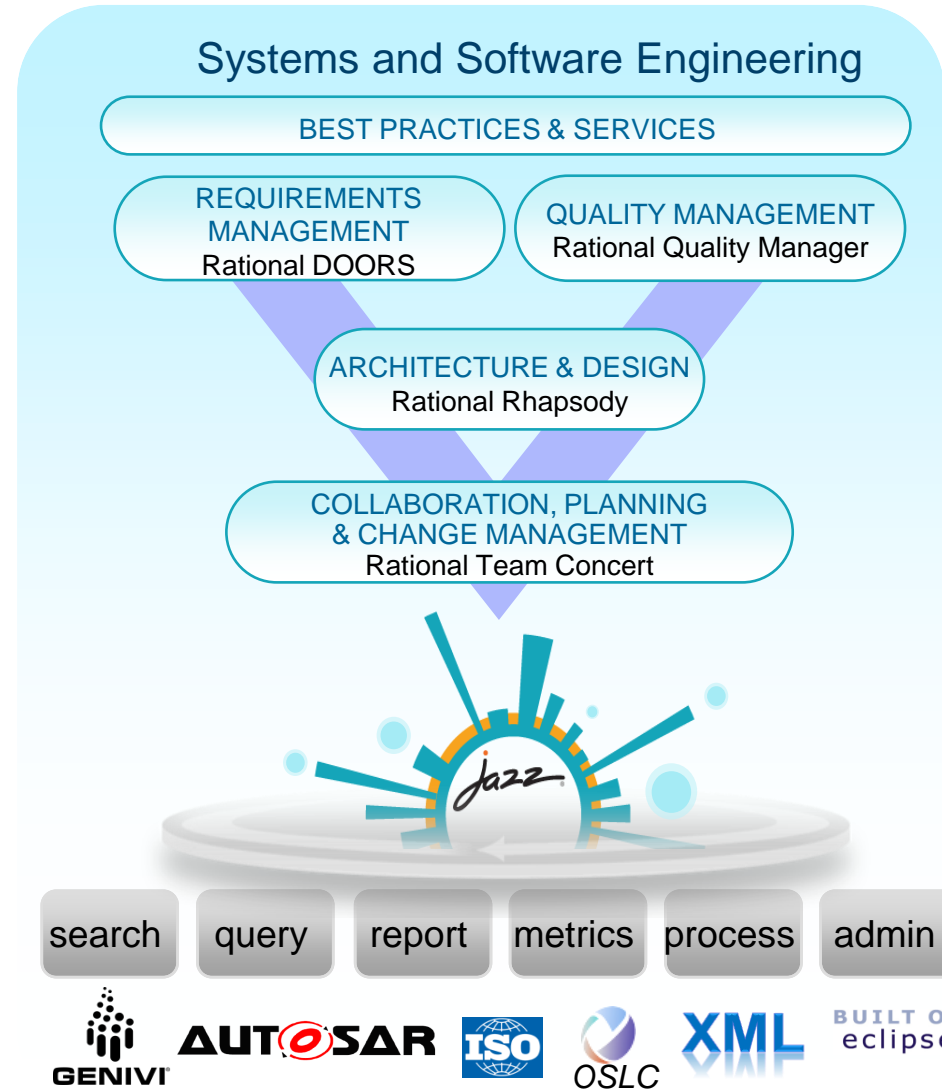
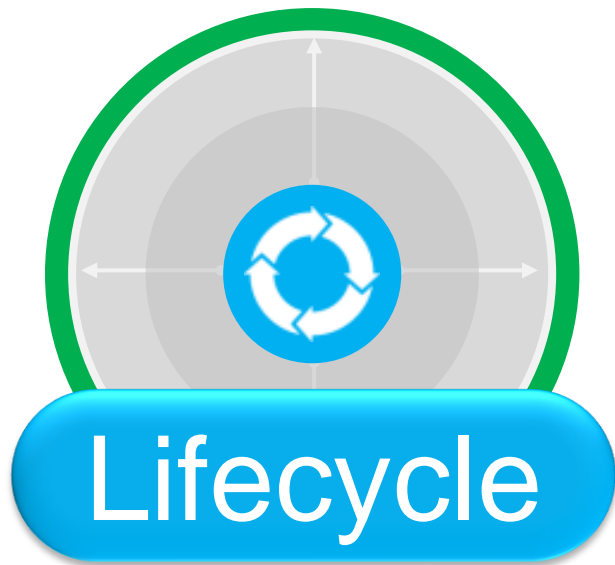
ECOSYSTEM

Extensions

- AUTOSAR**
Extends out base S&S Accelerator with AUTOSAR for ECU software implementation
- ISO26262**
Extends base S&S Accelerator with support for Automotive Functional Safety standard, ISO 26262. Provides process, practice guidance and tooling that support ISO 26262

Rational Solution for Automotive Engineering

Dimension 1 - Lifecycle



Open Services for Lifecycle Collaboration

Simplifying collaboration across the software delivery lifecycle



**Open Services
for Lifecycle
Collaboration**

Open interfaces. Open possibilities.

An industry initiative for making it easier to use software delivery tools in combination.

Current Membership Includes

BigLever	General Motors
Boeing	IBM
EADS	Northrop Grumman
Ericsson	Siemens

Barriers to sharing resources across the software lifecycle

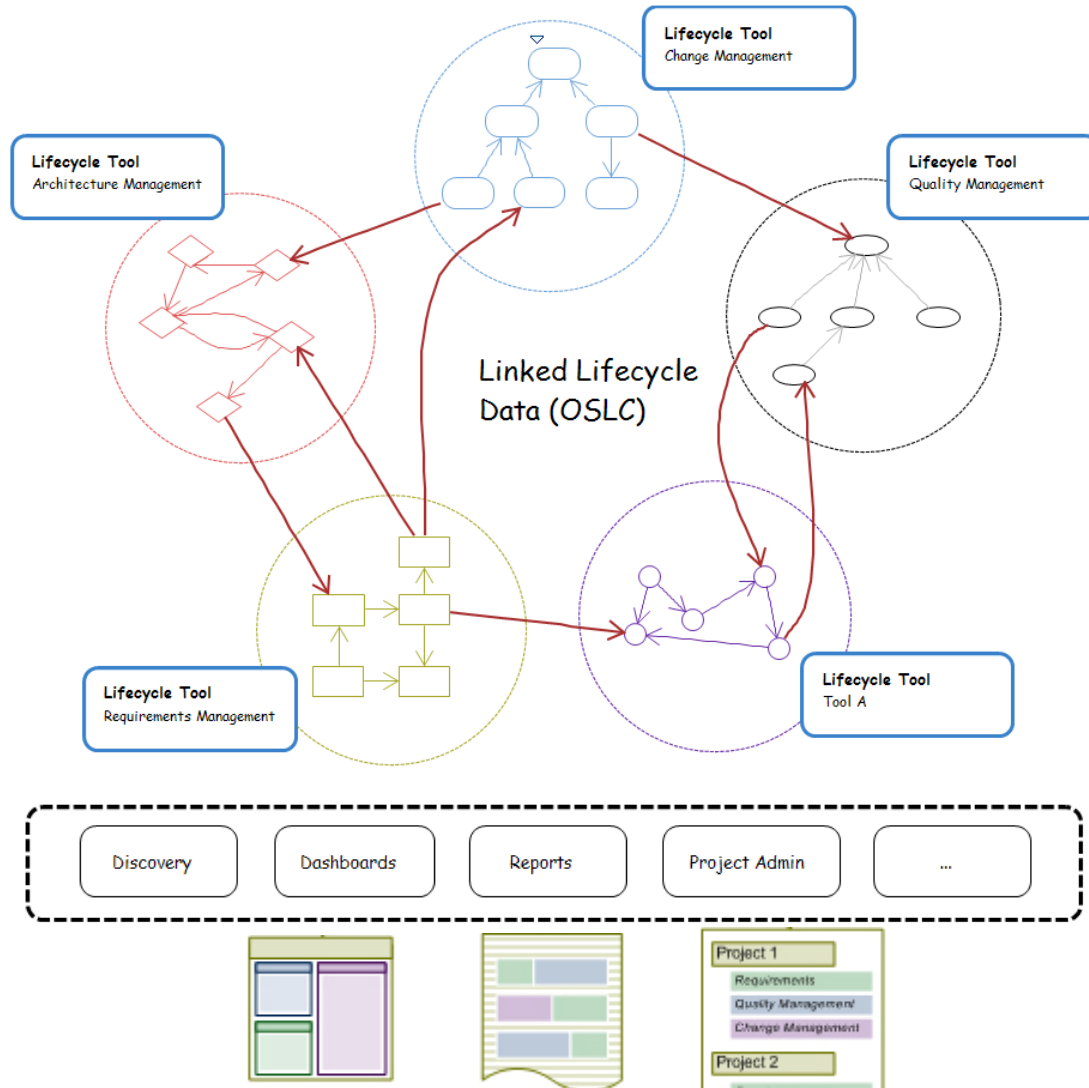
- ▶ Multiple vendors, open source projects, and in-house tools
- ▶ Private vocabularies, formats and stores
- ▶ Entanglement of tools and data

The Open Services initiative is

- **Building** a community of software vendors, open source projects, integrators, and corporate IT teams, operating at open-services.net
- **Creating** public specifications of resources and services for sharing the things that software teams rely on, like change requests, test cases, defects, requirements and user stories
- **Delivering** loosely coupled resource formats and services with “just enough” standardization

OSLC and Jazz: An open architecture for lifecycle tool integration

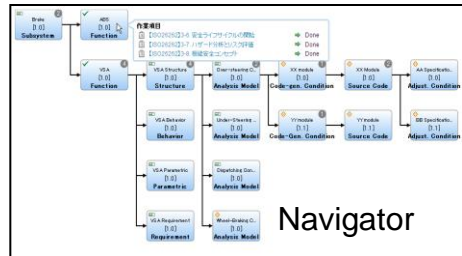
- **Built for the 21st century:** designed using Web architectural principles, implemented with Web technologies
- **Realistic:** recognizes that customers will not replace their current investments wholesale
- **Pragmatic:** allows tools and services to be upgraded independently, without sacrificing rich integration
- **Open:** supports the requirement to have a variety of tools from different sources



Jazz
Integration
Services

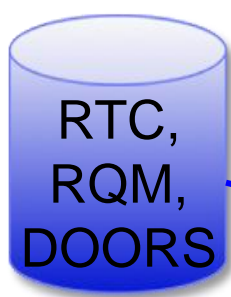
Example Deployment for a Jazz-based Engineering Platform

IBM tool
3rd party



Organize, Visualize, and Analyze across artifacts & configurations

Architecture & Software Design



Components, Streams, Work items, Test artifacts, Requirements



Model elements

System, network and software models



Plant and algorithm models

Plant Simulation

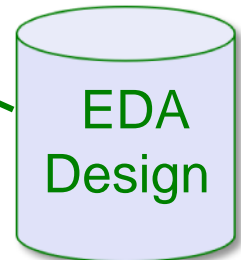


Mechanical assemblies



Financial data

PCB, wiring, bus models



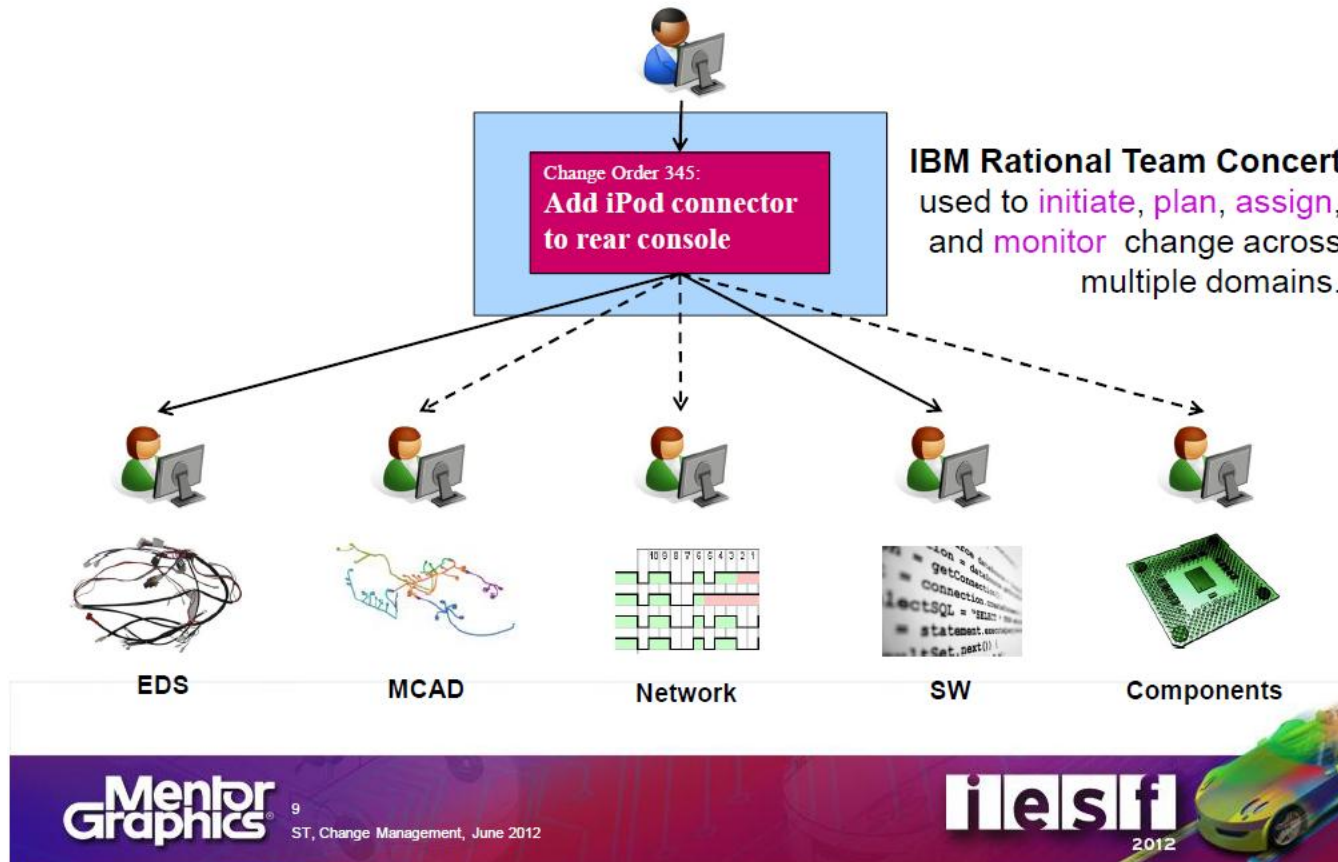
Rational Solution for Automotive Engineering

Dimension2 - Ecosystem



Multi domain integration : *Harness Design using MG Capitol and RTC Integrated with OSLC*

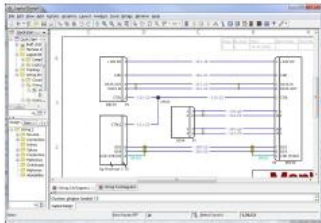
Participating in the Change Ecosystem



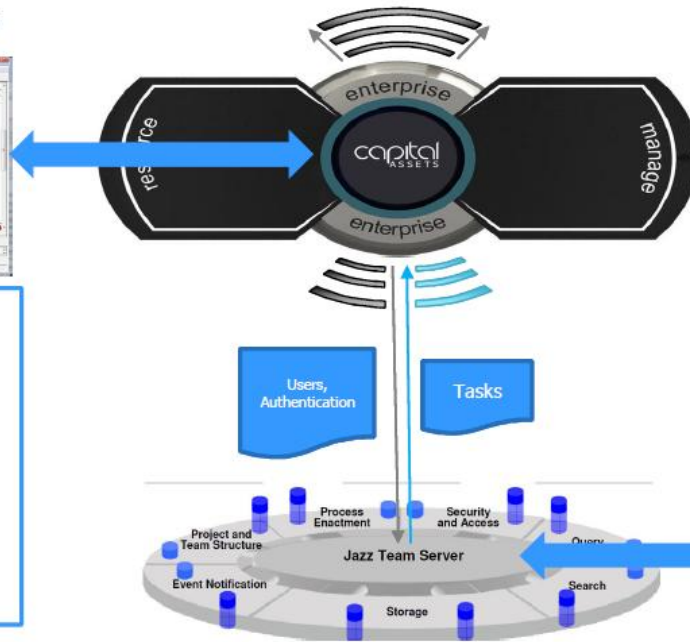
<http://s3.mentor.com/events/iesf/detroit/presentations/2012/cracking-the-change-management-problem.pdf>

Multi multidisciplinary integration : *Harness Design using MG Capital and RTC Integrated with OSLC*

Capital's
 Design Applications



- Work items automatically become Change Orders in Capital
- Individuals can view their open activities
- Participating designs will become associated with work items
- Status of participating designs changed – eg completed



- Work items created in Team Concert
- Individuals can be associated with these work items / change orders
- Status of designs participating in work items visible



Rational Team Concert

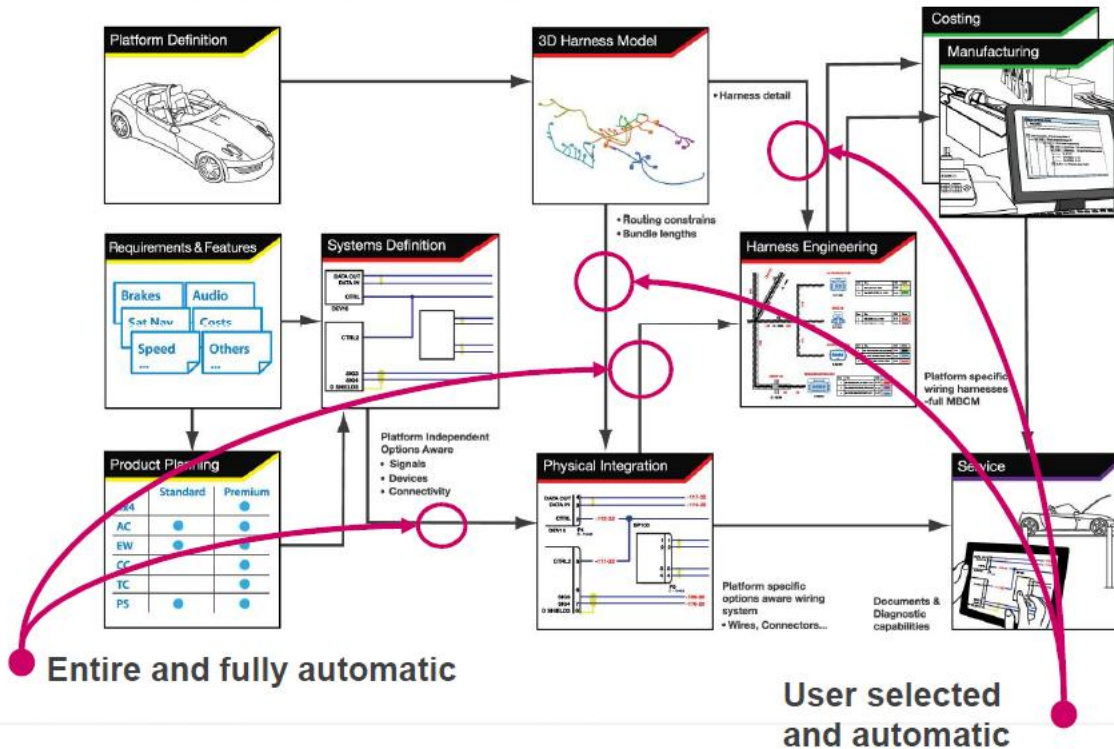
Member of *Ready for Rational Program*



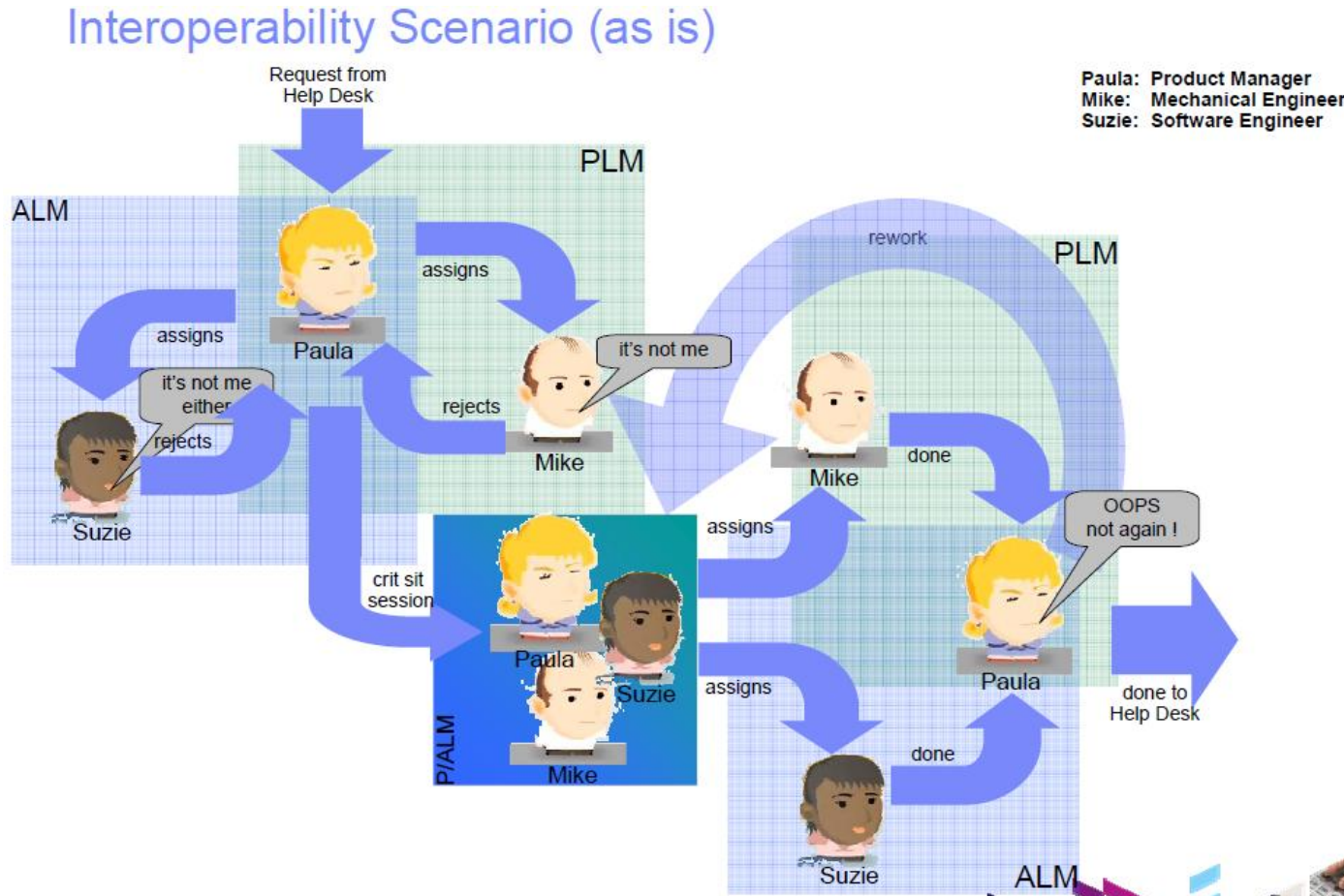
<http://s3.mentor.com/events/iesf/detroit/presentations/2012/cracking-the-change-management-problem.pdf>

Multi domain integration : *Harness Design using MG Capitol and RTC Integrated with OSLC*

Change Propagation in the Flow



Multi domain integration : PLM using Siemens and RTC Integrated with OSLC



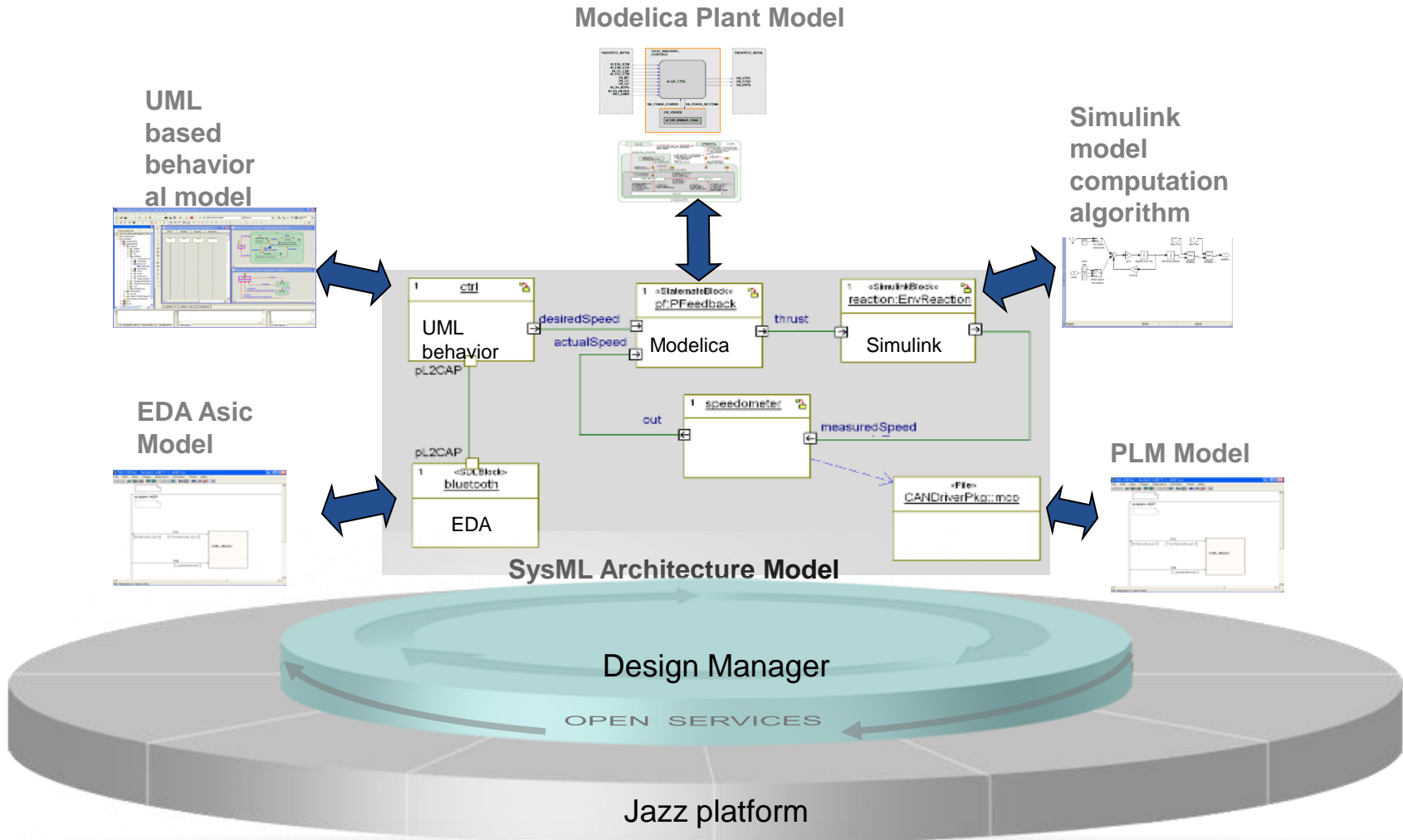
[An Open Services \(OSLC\) Approach to ALM and PLM Integration for Systems Development](#)

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Multi domain integration :



The need for integration: Cyber Physical Systems (CPS)

- The term cyber physical system refers to the integration of computation with physical processes.
 - “In CPS, embedded computers and networks monitor and control the physical processes, usually with feedback loops where physical processes affect computations and vice versa. The design of such systems, therefore, requires understanding the joint dynamics of computers, software, networks, and physical processes.” (Edward A. Lee and Sanjit A. Seshia, *Introduction to Embedded Systems, A Cyber-Physical Systems Approach*, <http://LeeSeshia.org>, ISBN 978-0-557-70857-4, 2011)



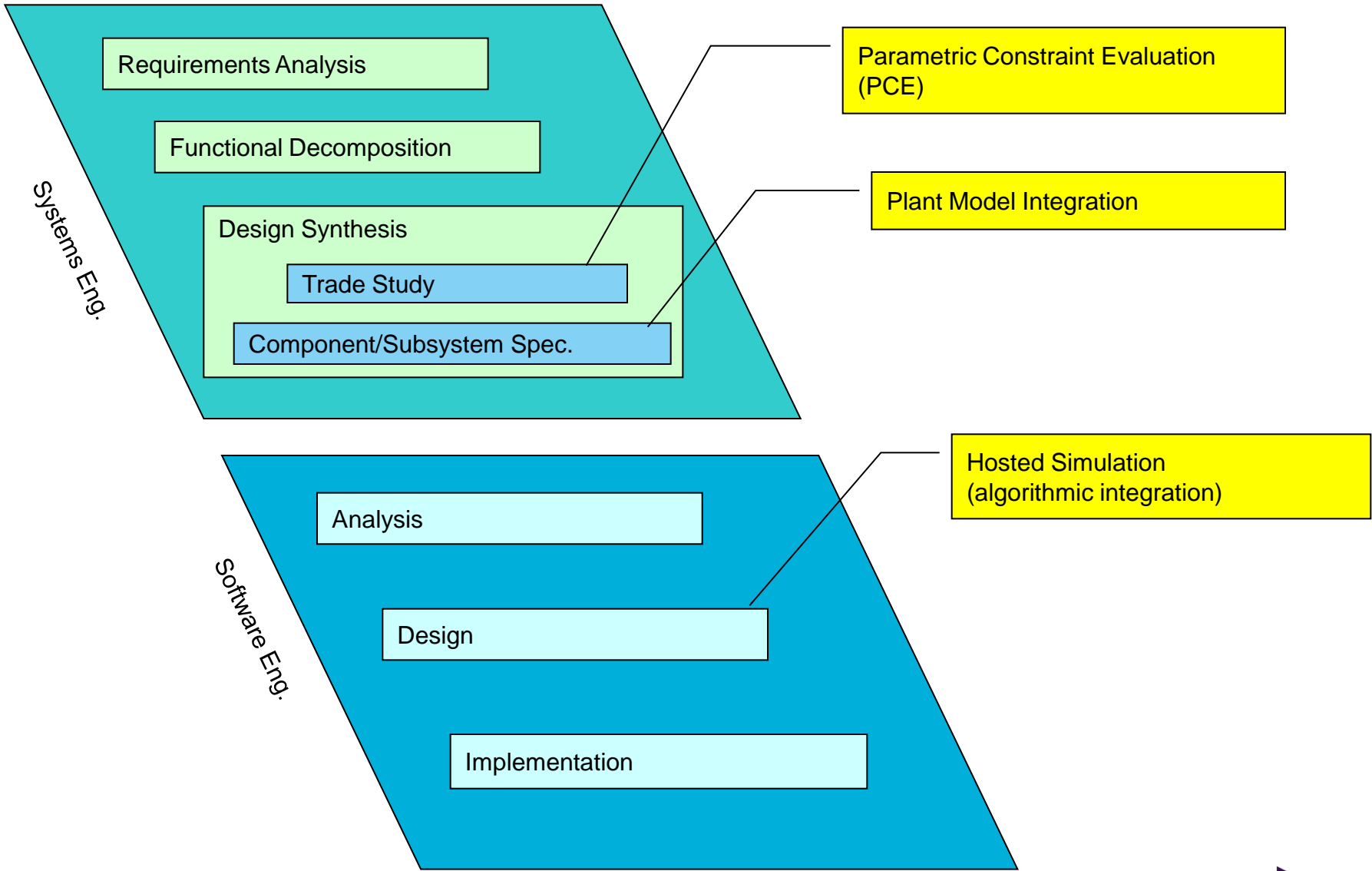
The need for integration

- UML and SysML are well suited for
 - Specifying and analyzing requirements (requirements, use cases, actors, etc.)
 - Specifying system and software structures (blocks/classes, parts, connectors, ports, associations, etc.)
 - Specifying processes spanning across multiple classifiers using activity diagrams
 - Specifying complex reactive behaviors using state machines
 - Specifying procedural behavior using activity diagrams
- Simulink is well suited to describe continuous transformational behavior
 - Continuous algorithms for control systems
 - Continuous plant behavior describing physical processes
- MATLAB is an efficient tool to perform complex computations using vector algebra
- MATLAB Symbolic Math Toolbox is a Computer Algebraic System (CAS) able to solve equations symbolically

Rational Rhapsody integration points with the Mathworks products

Integration point	Short description	The Mathworks Products
Hosted Simulation	<ol style="list-style-type: none"> 1. Generate executable code from a Rhapsody model with parts implemented in Simulink <ol style="list-style-type: none"> 1. The Simulink code may represent either: <ul style="list-style-type: none"> ▪ Algorithms implemented in the system ▪ The behavior of the environment (plant) 2. Models can be animated if code is instrumented 3. Rhapsody references code generated from Simulink by Embedded Coder 	MATLAB, Simulink, Real-time workshop with Embedded Coder
S-Function Generation	Generate an S-Function block to be used in Simulink models from a UML class / SysML block	MATLAB, Simulink
Plant Model Integration	Generate and simulate a Simulink model from a structured SysML block/UML class that consists of SysML/UML parts connected to parts implemented in Simulink	MATLAB, Simulink
Parametric Constraint Evaluation	<ol style="list-style-type: none"> 1. Solve SysML parametric diagrams using MATLAB Symbolic Math Toolbox 2. Include MATLAB expressions for computations 	MATLAB, MATLAB Symbolic Math Toolbox

Integration points usage on the "V-Model"

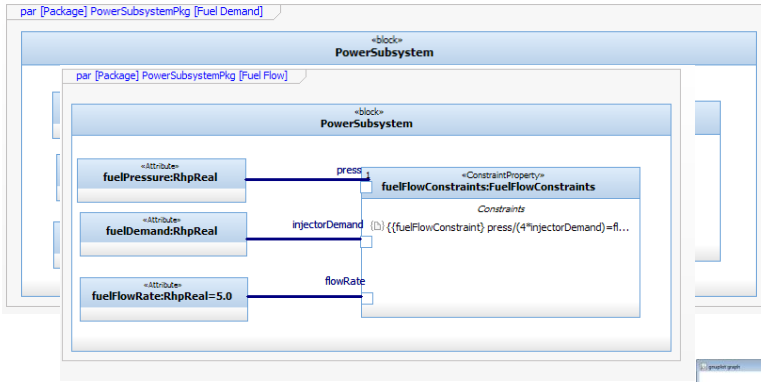




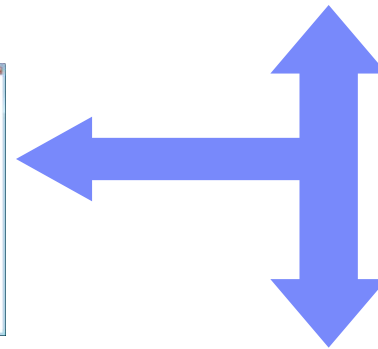
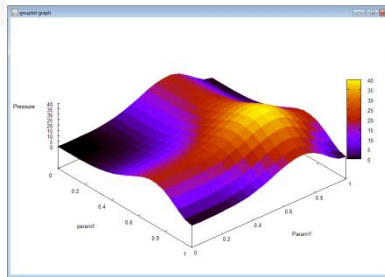
Parametric Evaluation using MATLAB expressions and Modelica equations

SysML Parametric Diagrams – constraints are expressed using a subset of the Modelica language or MATLAB expressions

Constraint View – a spread sheet like editor to control the evaluation



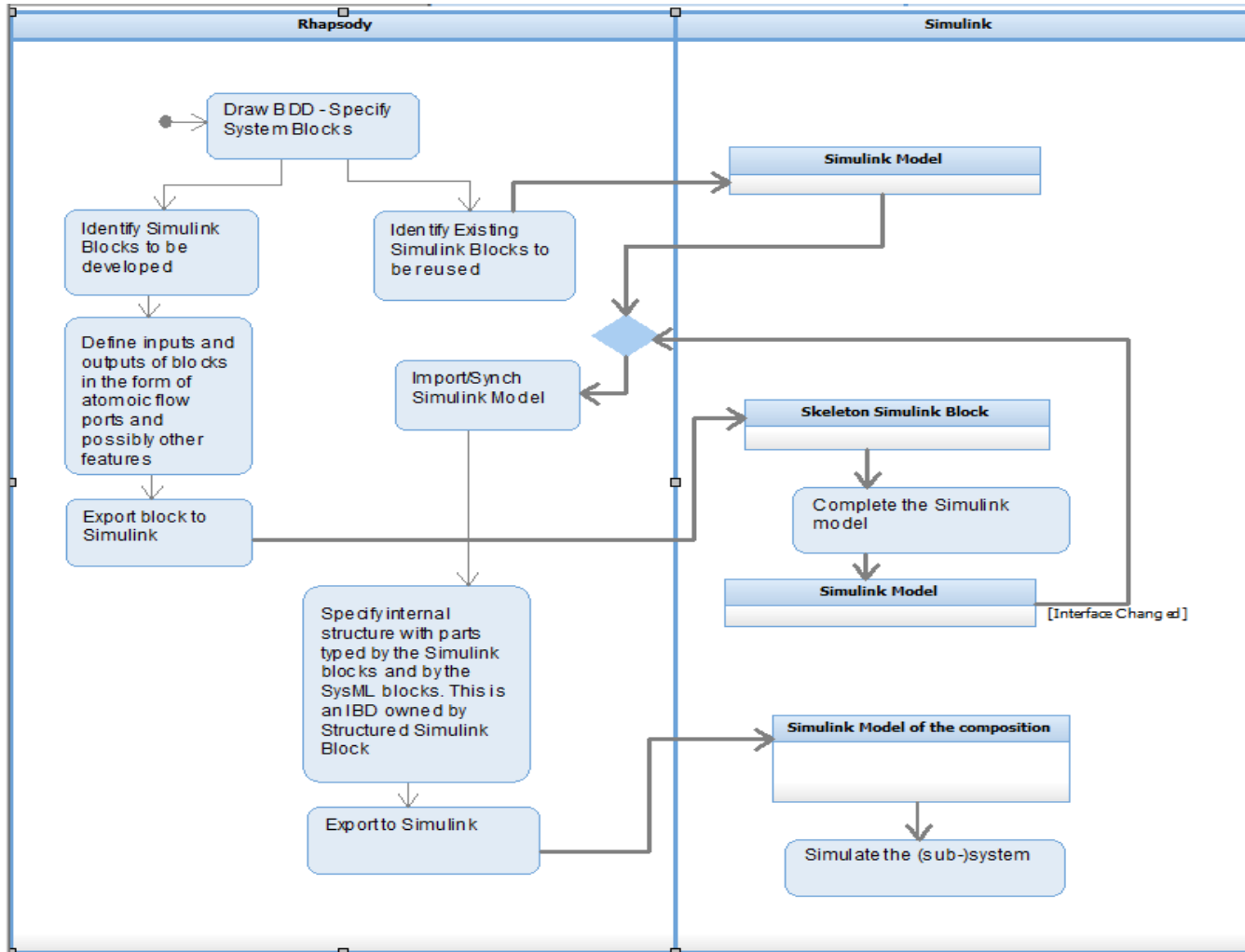
Name	Type	Original Value	Value	Min.	Max.	Command
Fuel Demand	Parametric Diagram					
PowerSubsystem	PowerSubsystem	0.3	0.3			Fix
paramY	RhpReal	0.4	0.4			Fix
fuelDemand	RhpReal		0.3099226397...			
fuelDemand/Constrain	FuelDemandConstr...					
Fuel Flow	Parametric Diagram					
PowerSubsystem	PowerSubsystem	6.1984527951...	6.1984527951...			
fuelPressure	RhpReal		0.3099226397...			
fuelDemand	RhpReal		5.0			Fix
fuelFlowRate	RhpReal	5.0	5.0			
fuelFlow/Constraints	FuelFlowConstraints		6.1984527951...			
press	press_implicitType		5.0			
flowRate	flowRate_implicitT...		0.3099226397...			
injectorDemand	injectorDemand_s...		press/(4*injec...			
fuelFlow/Constrain	Constraint		press/(4*injec...			



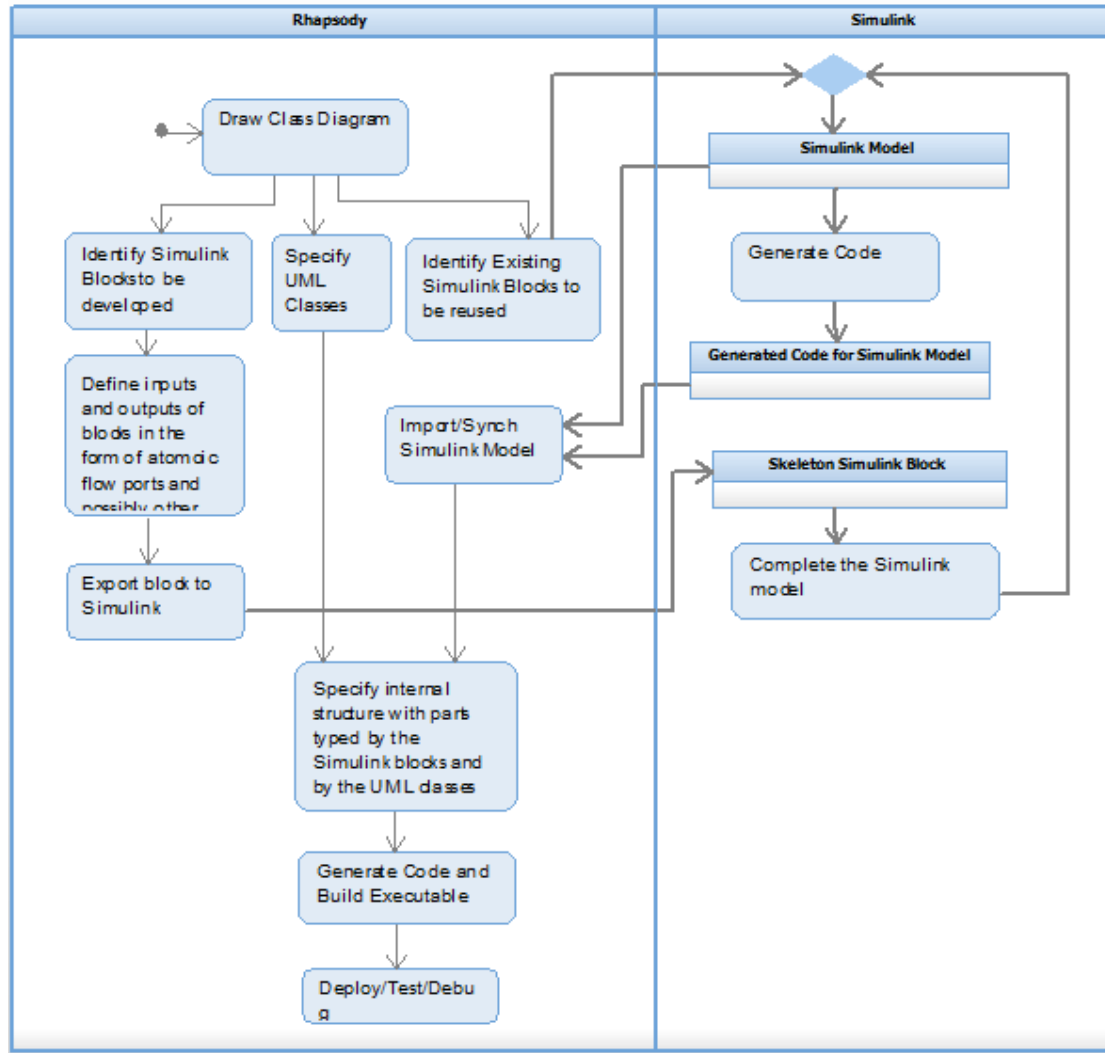
Computer Algebra System (CAS) – MATLAB Symbolic Math Toolbox or MAXIMA

More information is available in the PCE tutorial: <https://www-304.ibm.com/support/docview.wss?uid=swg27018723>

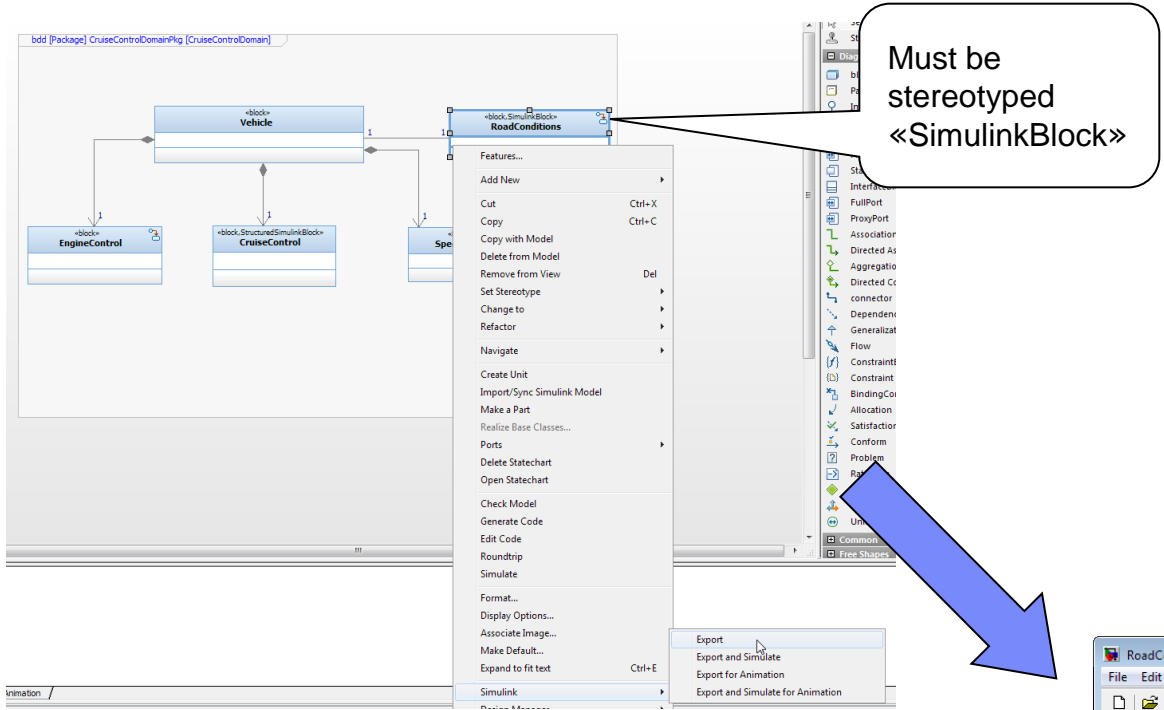
Plant Model Integration Canonical Workflow



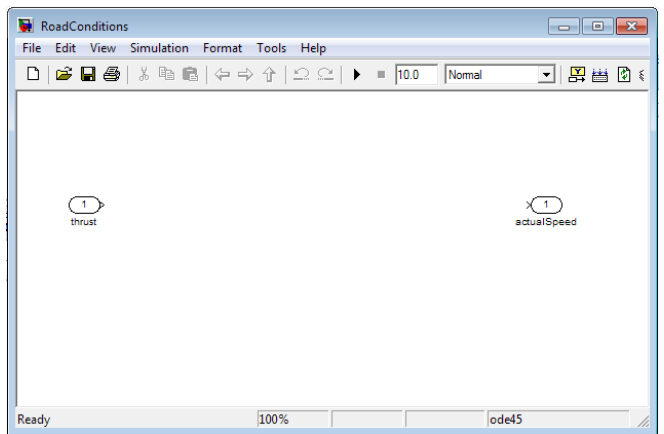
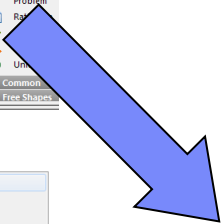
Hosted Simulation canonical workflow



Creating a skeleton Simulink model from a stub SysML block (In Development for Rhapsody next)



New:
 -Data Structures are transformed into Simulink buses and vice versa
 - Support for enumerated data types

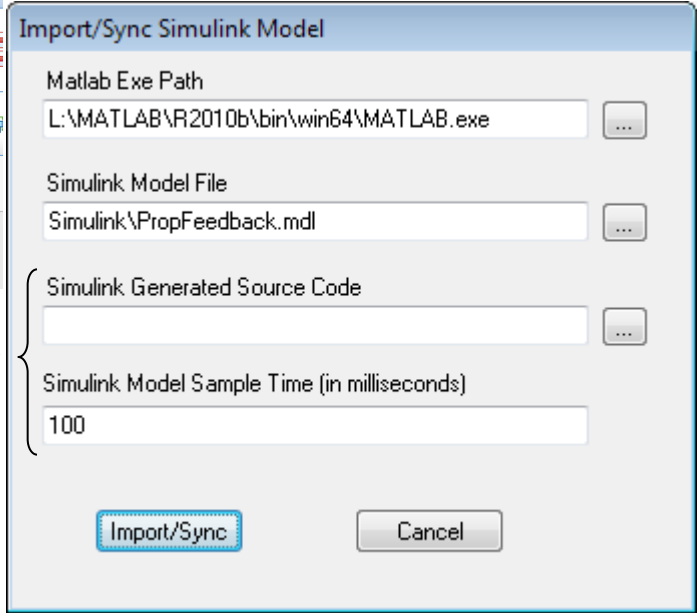
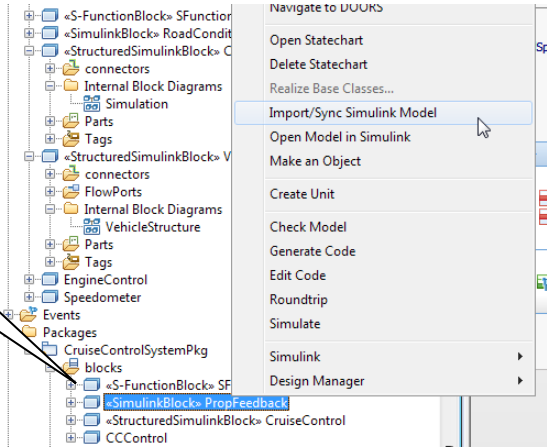


Note: In the current Rhapsody version, one needs to specify the Simulink model first and then synchronize it into the model (see next slide)

Importing a Simulink model into Rhapsody (with or without implementation code)

Must be stereotyped «SimulinkBlock»

Relevant only for hosted simulation



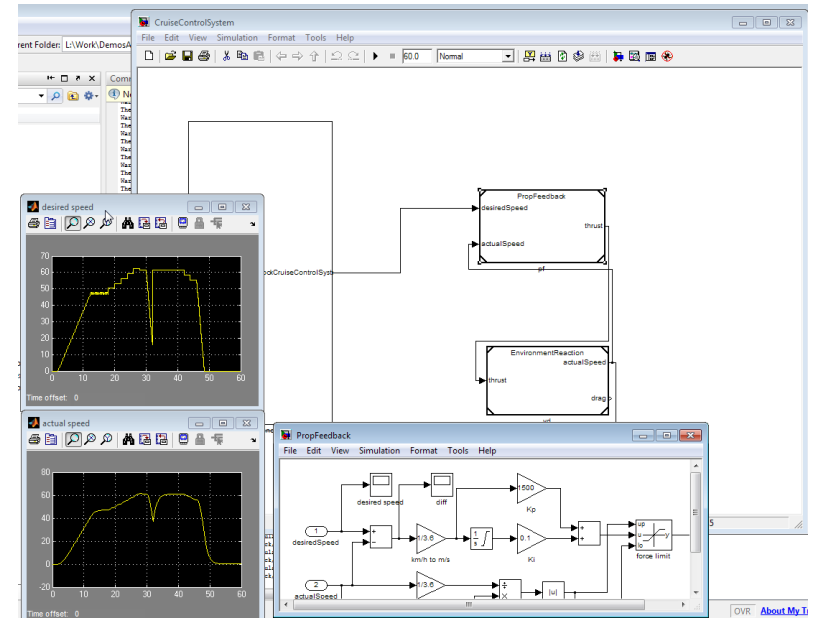
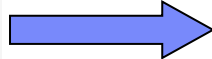
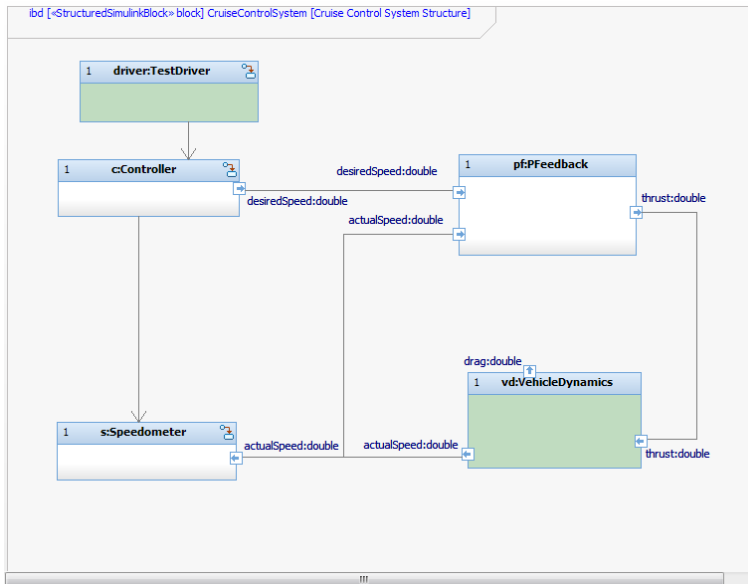
- For hosted simulation one needs to generate code from the Simulink model and then import/synch
 - Requires Simulink embedded coder
- For plant model integration one needs to import/synch only if the ports were modified in the Simulink model, **there is no need to generate code from Simulink**

S-Function Generation

- MATLAB/Simulink S-Function is a user defined block implemented in C/C++ or other programming language.
 - The S-Function code must conform to the S-Function standard in order for Simulink to understand its interfaces and to interact with it.
 - Simulink models can have S-Function blocks which are using these user defined action.
- Rhapsody can generate C/C++ code corresponding to blocks stereotyped «S-FunctionBlock» along with a mex option file to generate an S-Function simulink block
 - The generated code conforms to the S-Function standard and transforms the ports accordingly
- The S-Function generation capability is used by the Plant Model integration



Simulation in Simulink (aka “plant model integration”)



- «StructuredSimulinkBlock» are blocks that contain parts typed by «SimulinkBlock» in their hierarchy
- A «StructuredSimulinkBlock» is transformed to a Simulink model that consists of an S-Function block for the SysML/UML parts and usages of the Simulink models represented by the «SimulinkBlock» parts or other «StructuredSimulinkBlock» parts (involves code generation of S-Function)

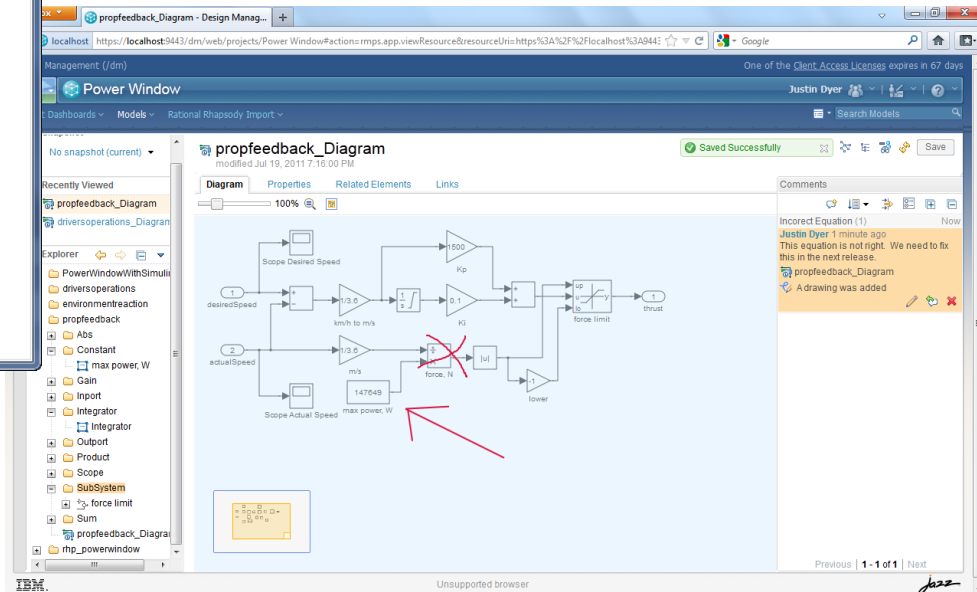
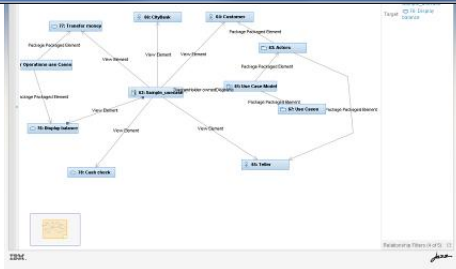
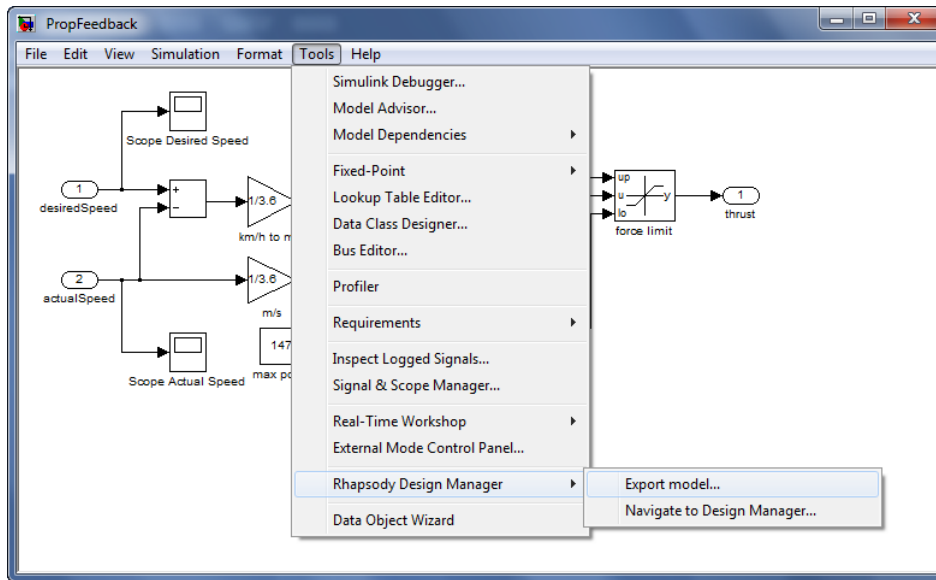


Model execution in Rhapsody (aka “hosted simulation”)

- Once the import/synch is done for the blocks (Simulink model and generated code) , simply generate / make / run to execute
- If the configuration is set to Animation, the non-Simulink parts of the model will be animated
 - The Simulink blocks are treated as “black box”

Integrating Simulink in Rhapsody Design Manager

- It is possible to publish Simulink models into Rhapsody Design Manager (RDM) and create links to the model
 - In RDM Next we plan to automate a creation of an OSLC link between the SysML Simulink Block and the Simulink model based on the information in the Rhapsody model that references the Simulink model file. In the current version this link can be created manually.*



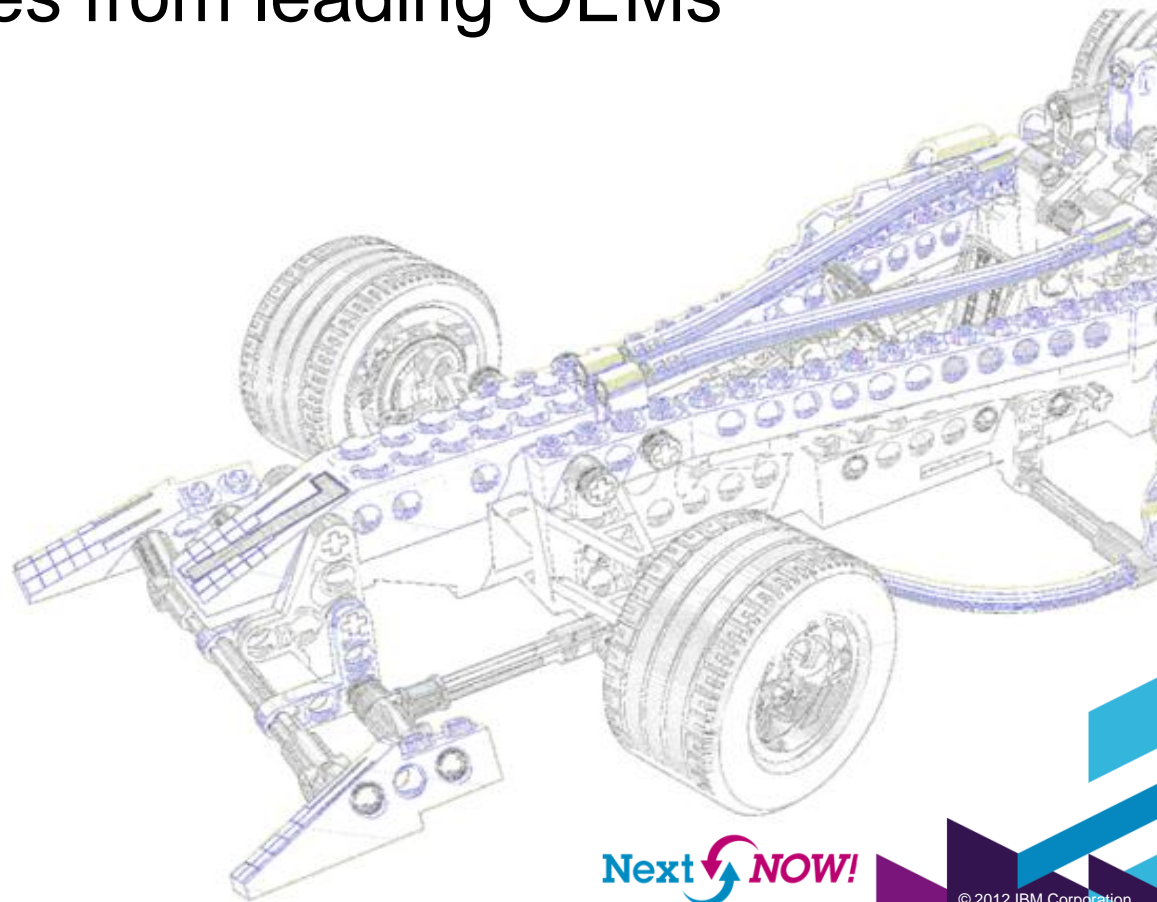
Summary

- Several integration points are available between Rhapsody and MATLAB/Simulink
- The integration allows design and simulation of cyber physical systems
 - UML/SysML provides the high level design capabilities and discrete behaviors
 - MATLAB/Simulink provides the means to describe continuous behavior
 - PCE allows solving equations and performing MATLAB computations in the context of the design model
- Bringing Simulink into RDM enables a distributed model accessible over a web interface as well as leveraging the advantages of the Jazz platform for Simulink

Integration point	Short description	The Mathworks Products
Hosted Simulation	Generate executable code from a Rhapsody model with parts implemented in Simulink	MATLAB, Simulink, Embedded Coder
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Agenda

- Many tools for many tasks
multidisciplinary engineering with Rational
- Adoption Experiences from leading OEMs
and suppliers



General Motors leverages Rational tools to develop innovative products *IBM helps GM develop smarter products like the Chevrolet Volt*



What's smart?

- Innovative electric drive system uses software and electronics to control interaction of electric motors and gasoline engine
 - “System of systems” seamlessly integrates electric drive system with powertrain and body controllers
 - >10 million lines of code in car; nearly 100 microprocessors

Smarter business outcomes

- Smarter products delivered in less time
 - Volt was delivered in <5 years, compared to typical 10+ year development cycle for new vehicle technology

How IBM helps GM develop smarter products

- Rational DOORS for requirements management
- Rational Rhapsody for model-driven development
- Rational Team Concert for team collaboration
- Rational Asset Manager for engineering asset management
- Rational Professional Services for technical services
- IBM Global Services for business transformation services



“The IBM Rational platform enables our globally distributed teams to collaborate in real-time to develop innovative software and electronics for our vehicles. GM’s use of the Rational platform will deliver business results in efficiency, time-to-market, quality, and overall customer satisfaction.”

General Motors



Customer Success: Create and sustain market demand

Hydraulic hybrid delivery vehicles - Eaton & UPS

What's smart?

- Innovative technology for urban delivery trucks in stop-and-go traffic
- Smart software to optimize energy usage and reduce greenhouse gases

Smarter business outcomes

- 60-70% increase in fuel economy, according to EPA
- 40% reduction in CO₂ emissions

How Rational enables smarter products

- Software modeling to optimize system performance
- Automatic generation of in-vehicle software code

Think Rational

One of many ways Rational enables a smarter planet.

“The suite of Rational tools, including Rhapsody, DOORS, ClearCase and ClearQuest, provides Eaton an integrated software framework that allows us to deliver innovative products more quickly and efficiently.”



Customer Success: Smarter products require efficient processes

Complex systems for automotive - Delphi Corporation

What's smart?

- First prepackaged airbag assembly within a steering wheel
- Teams in 35 countries collaborating on parallel releases using shared requirements

Smarter business outcomes


- Successful introduction of prepackaged airbag/steering wheel in the Smart Fortwo vehicle made by Daimler

How Rational enables smarter products

- Requirements sharing across globally distributed teams and projects
- Component reuse enabled by automated requirements management

Think Rational

One of many ways Rational enables a smarter planet.



“DOORS has helped Delphi improve development team communication, resulting in meeting customer requirements faster and more accurately.”

Customer Success: Integrated automotive control systems

Continental Automotive Body & Security Group

What's smart?

- Passive start and entry systems, remote keyless entry, and more - in one integrated system
- Enhanced driver experience with intelligent safety and convenience features

Smarter business outcomes

- Cost-optimized flexible system solution
- Reduced development costs based on use of standardized hardware and software components

How Rational enables smarter products

- Requirements management across development teams and with vehicle manufacturers
- Streamlined development environment with model-driven systems and software development supporting **AUTOSAR**

Think Rational
One of many ways Rational enables a smarter planet.

Continental

"IBM Rational DOORS and Rhapsody are essentially helping us prevent fragmentation of our development environment and enabling us to better manage the complex architectures of our products."



QUESTIONS

www.ibm.com/software/rational

Get Involved on Jazz.net

jazz.net/projects/design-management

- Technology initiative to...
 - ✓ *Bring design management capabilities to Jazz*
 - ✓ *Provide a collection of design management services that can be used by any design tool*
 - ✓ *Involve the community in defining the services needed for design management*

- You can participate
 - ✓ [Learn more](#)
 - ✓ [Register on jazz.net](#)
 - ✓ [Download and try it out](#)
 - ✓ [Ask questions and give feedback](#)
 - ✓ [View plans and dashboards](#)
 - ✓ [Report defects and request enhancements](#)

The screenshot shows the Jazz.net community site. At the top, there is a navigation menu with links for Home, About Jazz, Roles, Projects, Downloads, Forums, Library, Development, and Community. A user login section is on the right with fields for User ID and Password, and a Log In button. Below the navigation, a large banner features the text "Collaborative software and systems design" and a sub-headline "Start to break down the architecture, engineering, and development silos. Connect your software and systems designs with the entire team and collaborate using new design management services for Jazz." To the left of the banner are three key features: "Agile planning and tracking", "Scoring with scorecards", and "Design Management". Below the banner is a "Jazz Team Blog" section with three entries: "New project at Jazz.net: Design Management", "CLM Beta 3 now available", and "Rational Asset Manager 7.5.0.2 now available". On the right side of the page, there are several call-to-action buttons: "Learn about Jazz", "Take a tour of Jazz.net", "Explore development projects", and "Download products". There is also an "Events" section listing "IBM Rational Jazz Roadshow 2011 - Spain" and "Jazz/RTC Open Mic Series: Licensing update/direction". At the bottom, there are sections for "New from Our Library", "In the News", and "Testimonials".

A Dr. Dobb's Webcast: Evolution of Automotive System Requirements - The Increased Need for Collaborative Design Management



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A Dr. Dobb's Webcast:
Evolution of Automotive System Requirements - The Increased Need for Collaborative Design Management

Duration: One Hour

In recent years, automotive systems have grown increasingly complex as electronic control units define a greater percentage of vehicle functionality and end-product differentiation. To maintain schedule adherence and satisfy complex development requirements, engineering organizations are increasingly turning toward software and system lifecycle management solutions as a means of promoting efficiencies and synergies in their development process.

The complexity and rising popularity of standards, such as AUTOSAR and GENIVI are driving more automotive system manufacturers to improve their current development processes. One way organizations are attempting this is through the use of commercial modeling tools that promote the modularity, traceability, and reusability of the assets under development. Engineering organizations will need to evaluate additional products and methodologies that enable collaboration between engineering groups, manage levels of abstraction, and support any development efficiencies. This webinar discusses how these tools deliver enhanced collaboration to automotive engineering teams.

Featured Speaker:

[Christopher Rommel](#): Vice President, Embedded Software & Hardware, VDC Research

[Neil Patterson](#): Marketing Manager, IBM

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