



Quelques exemples d'utilisation des outils d'IS de Rational

Lors de cette session, nous vous présentons des cas d'utilisation des outils d'ingénierie Systèmes de Rational, en particulier pour la gestion des exigences et la modélisation : quels outils, pour quoi faire ? Nous vous rendons aussi compte des témoignages que des clients ont fait lors de notre conférence annuelle en juin en Floride, USA.

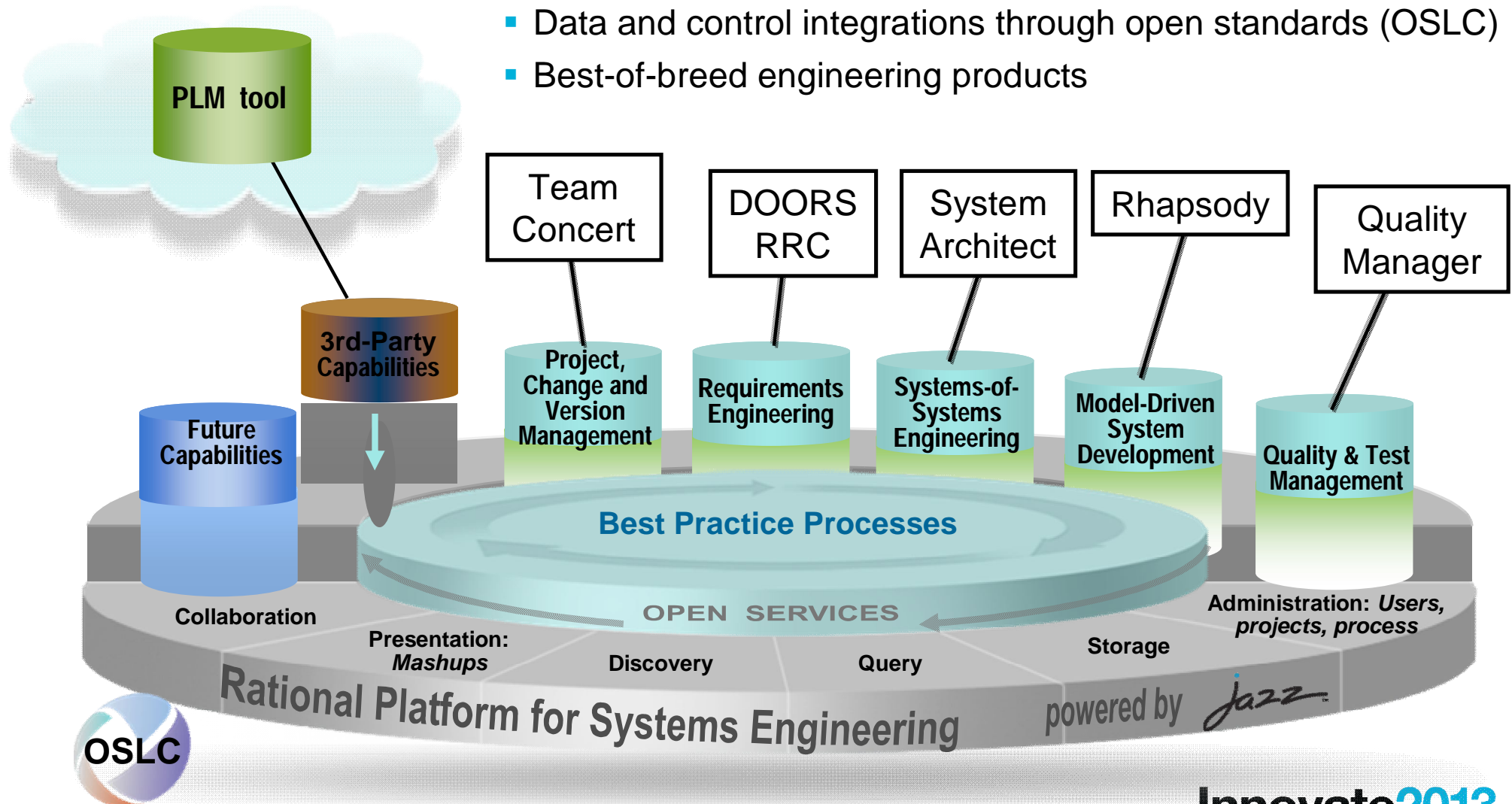
[Redacted], philippe.leblanc@fr.ibm.com

Innovate 2010
The IBM Technical Summit



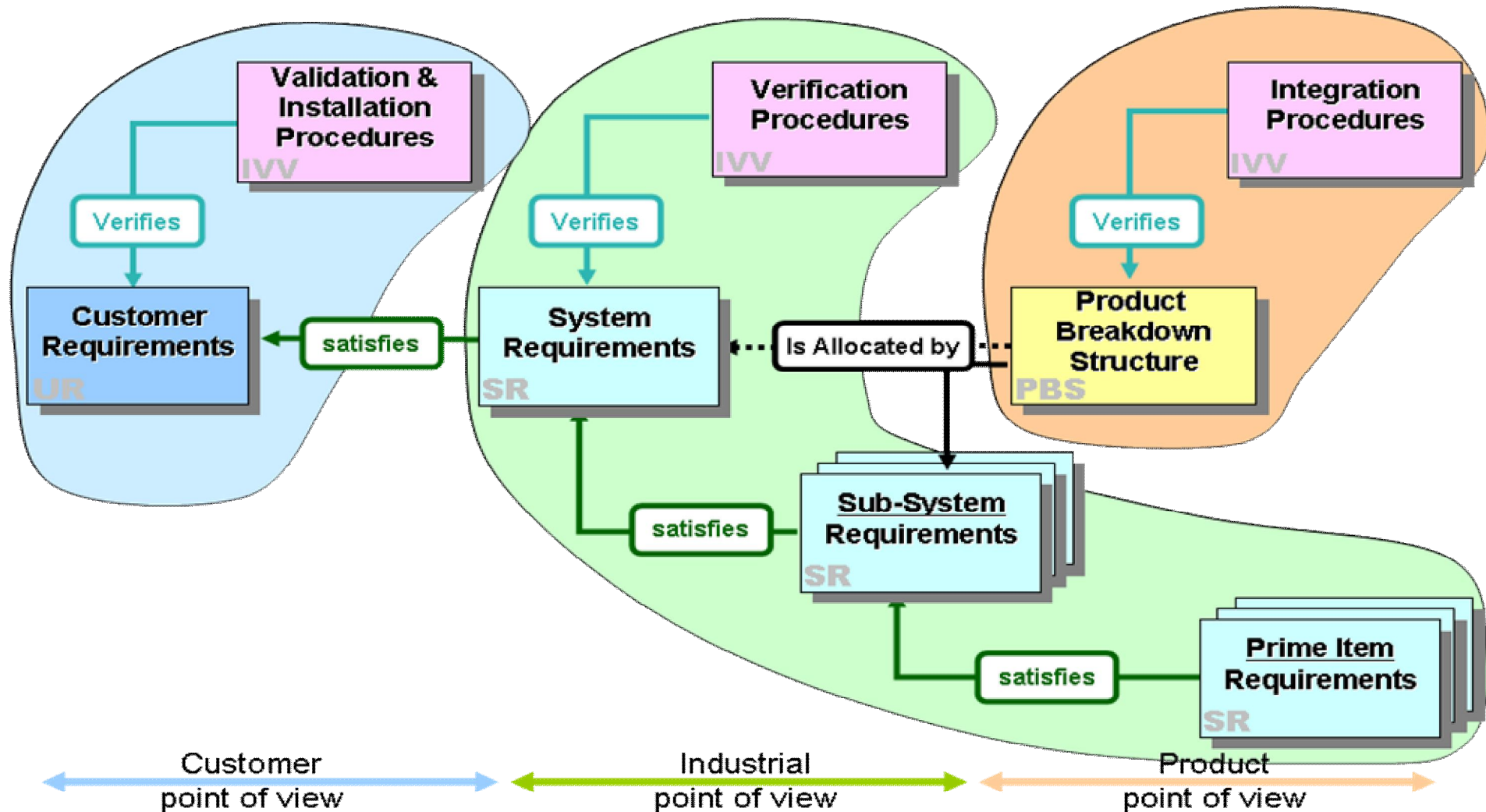
L'atelier Systems and Software Engineering (SSE)

- Set of advanced services for team collaboration, data management, security and process support
- Data and control integrations through open standards (OSLC)
- Best-of-breed engineering products



Gestion des exigences : Utilisation de DOORS pour les systèmes complexes

- Modèle de données multi-niveaux avec traçabilité de bout-en-bout
- *Permet de maîtriser la complexité des systèmes de systèmes*



Gestion des exigences : Utilisation de DOORS dans un contexte réglementaire

- Les règlements sont intégrés dans le référentiel DOORS en tant que modules
- La compatibilité avec les règles est spécifiée par un lien de conformité
- *Facilite l'audit et la certification ainsi que l'analyse d'impact*

Governing Regulations

Interpretation of Regulations by Industry (NEI 08-09)

Related Critical Systems

Assets related to Critical Systems

10 CFR Part 72 – US regulations related to Nuclear Cyber Security

NEI is the industry trade group that interpreted and proposed a response to the CFR

Determined by technical SMEs in each utility. Varies from site to site

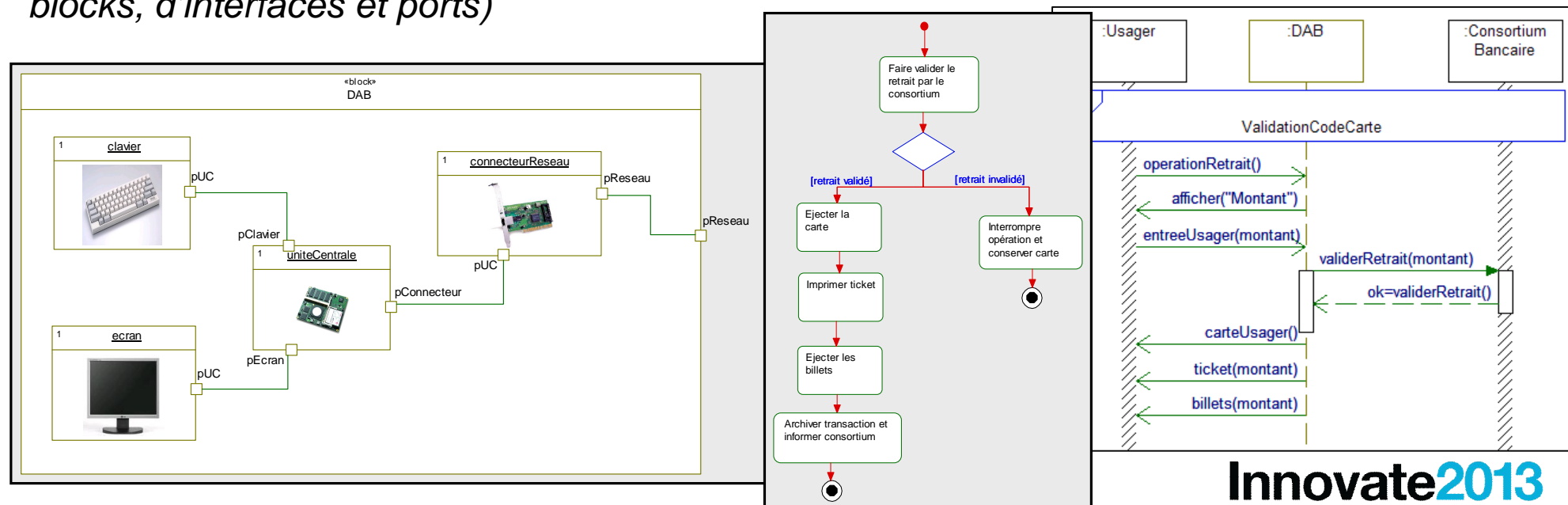
Determined by technical SMEs in each utility. Varies from site to site

Governing Regulations (Out-links)	NEI 08-09 (PrevS) Appendix A	Critical Systems (In-links)	Assets (In-links)
External Links: 10 CFR Part 73, Section 73.54, Protection of Digital Computer and Communication Systems and Networks 10 CFR Part 73, Section 73.55 Requirements for physical protection of licensed activities in nuclear power reactors against radiological sabotage.	2.2.3 Analyze digital computer and communications systems and networks and identify those assets that must be protected against cyber attack to preserve the intended function of plant systems, structures, and components within the scope of the Rule and account for these conditions in the design of the Program. (10 CFR 73.54(b)(1) and 10 CFR 73.55(b)(4)).	CS-1 Auxiliary Feedwater (AFW)	/_NRC/Auxiliary Feedwater System Inspection Guide IG-10 Diablo Canyon AFW System /_NRC/Inventory Critical Digital Assets CDA-3 Yokogawa flow transmitter / controllers /_NRC/Inventory Critical Digital Assets CDA-4 Feedback and control for electric-driven AFW pump discharge /_NRC/Inventory Critical Digital Assets CDA-5 Analog input, digital conversion / processing, analog output /_NRC/Inventory Critical Digital Assets CDA-6 Located in Central Control Room /_NRC/Inventory Critical Digital Assets CDA-11

Model-Based System Engineering (MBSE) : Utilisation de Rhapsody pour la modélisation Système



- Utilisation de SysML comme langage de modélisation des architectures de systèmes
 - Le comportement peut être décrit :
 - Par l'exemple au moyen de diagrammes de séquence
 - Exhaustivement au moyen de diagrammes d'états et diagrammes d'activité
 - Les modèles comportementaux (états, activités) peuvent être exécutés et peuvent ainsi être vérifiés par rapport à un comportement attendu (séquences)
 - Rhapsody va bientôt supporter le nouveau standard ALF de l'OMG – langage d'action neutre indépendant des langages de programmation
- *Facilite l'élaboration d'architectures modulaires évolutives (grâce aux concepts SysML de blocks, d'interfaces et ports)*



Model-Based System Engineering (MBSE) : Validation de systèmes réactifs avec Rhapsody



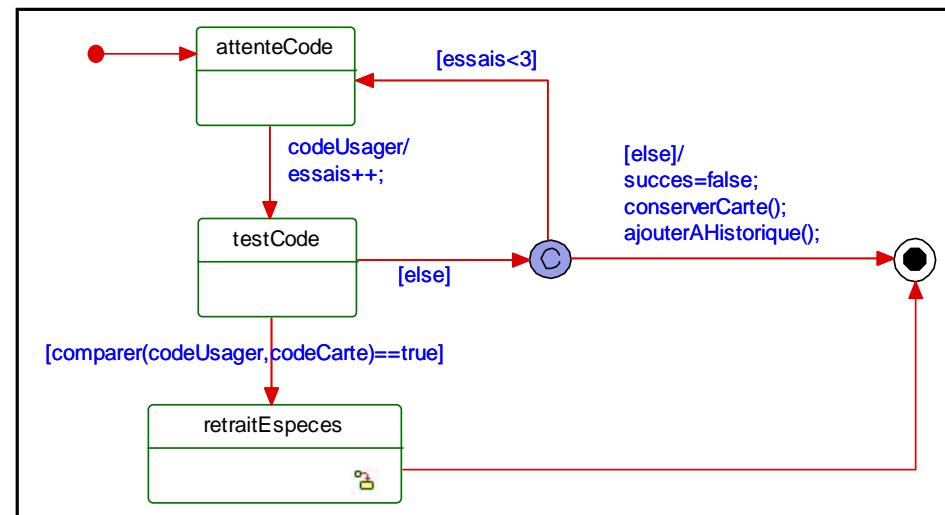
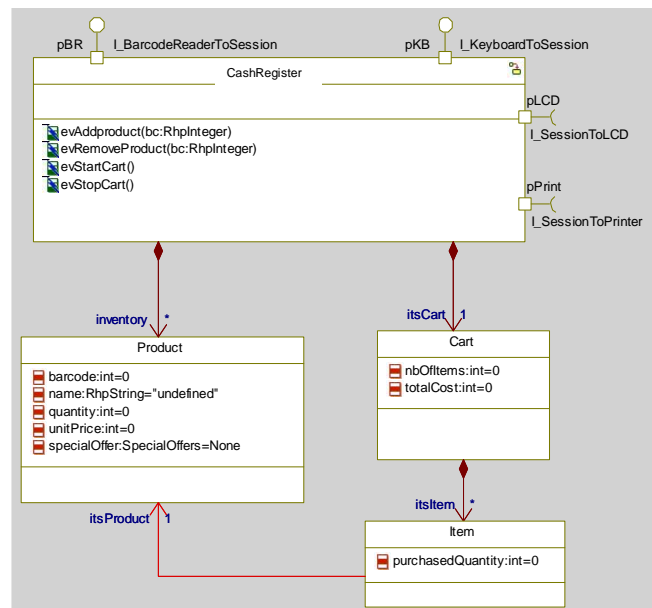
The screenshot displays the Rhapsody software environment for modeling a mobile phone system. On the left, a graphical user interface (GUI) of a Nokia 6210 mobile phone is shown. The main workspace contains several statechart diagrams:

- Statechart of : MobilePhone - Builder[0]->itsMobilePh...**: This diagram shows states for 'Disconnected' and 'Connected'. Transitions include 'ev/Disconnect' and 'ev/Connect'. A timer 'tm(1000)' is associated with the 'Connected' state. A 'page' container includes 'welcomePage' and 'volumePage' states.
- Statechart of : Headset - Builder[0]->itsHeadset**: This diagram shows states for 'disconnected', 'connected', and 'connecting'. It includes transitions for 'ev/LongPress', 'ev/ShortPress', and 'ev/Connect'.
- Statechart of : Button - Builder[0]->itsHead...**: This diagram shows an 'idle' state, a 'debounce' state, and a 'pressed' state. Transitions include 'ev/Press', 'ev/Release', and a timer 'tm(100)'. A long press transition is labeled 'tm(3000)/itsHeadset->GEN(ev/LongPress)'.

At the bottom, there are panels for 'Call Stack' and 'Event Queue'. The status bar at the bottom right indicates 'GE MODE' and the date/time 'Fri, 4, Aug 2006 4:03 PM'.

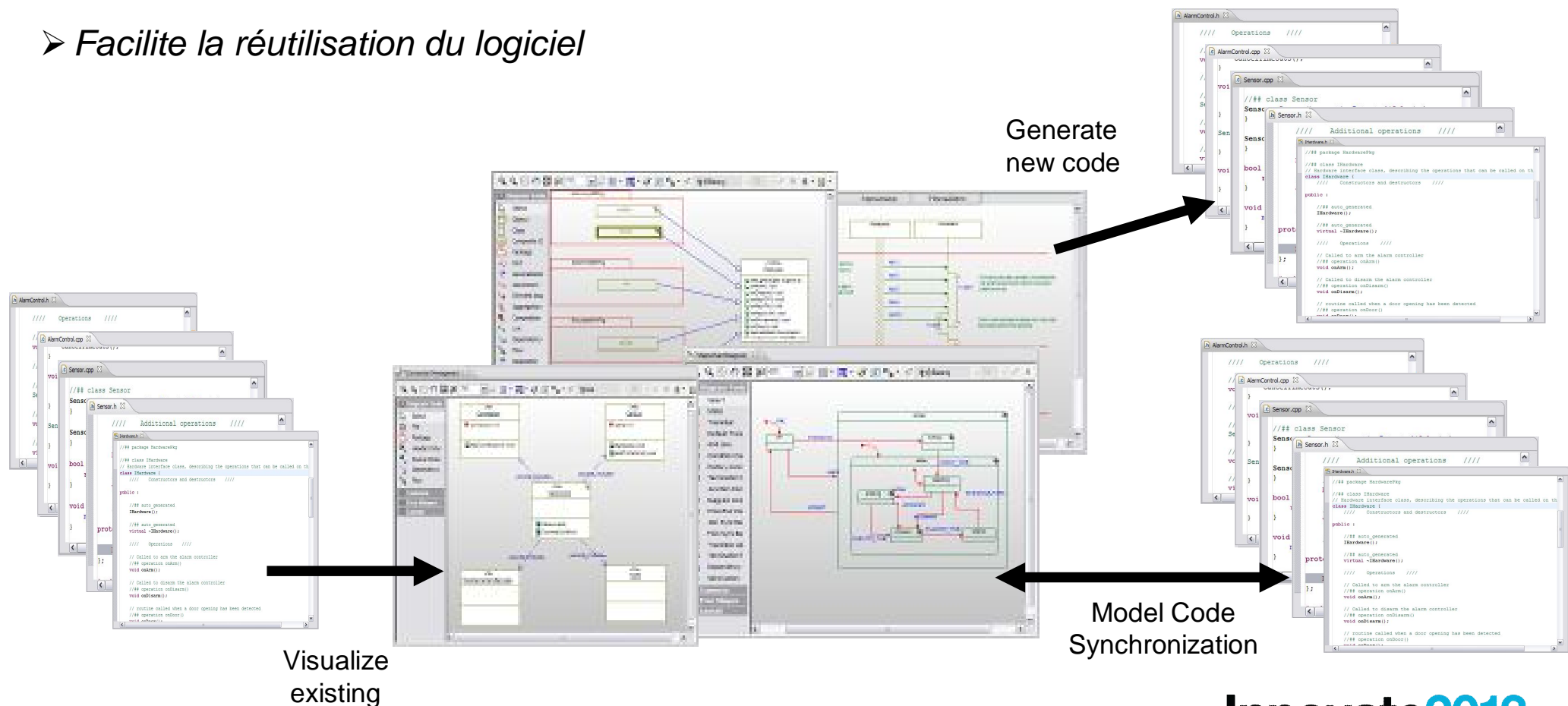
Model-Driven Development (MDD) : Utilisation de Rhapsody pour la génération de code

- Utilisation de UML comme langage de modélisation des logiciels embarqués
- Comme en SysML, le comportement peut être décrit au moyen de diagrammes de séquence, diagrammes d'états et diagrammes d'activité (algorithmique graphique)
- Les diagrammes de classe, d'états et d'activités) sont transformés en code lisible et exécutable
- Facilite la conception par composants (la conception est visuelle) et la réutilisation (concepts UML d'interfaces et de ports)
- Permet de tester le logiciel sur la machine hôte tôt dans le cycle de vie
- Facilite une approche agile par cycles courts itératifs



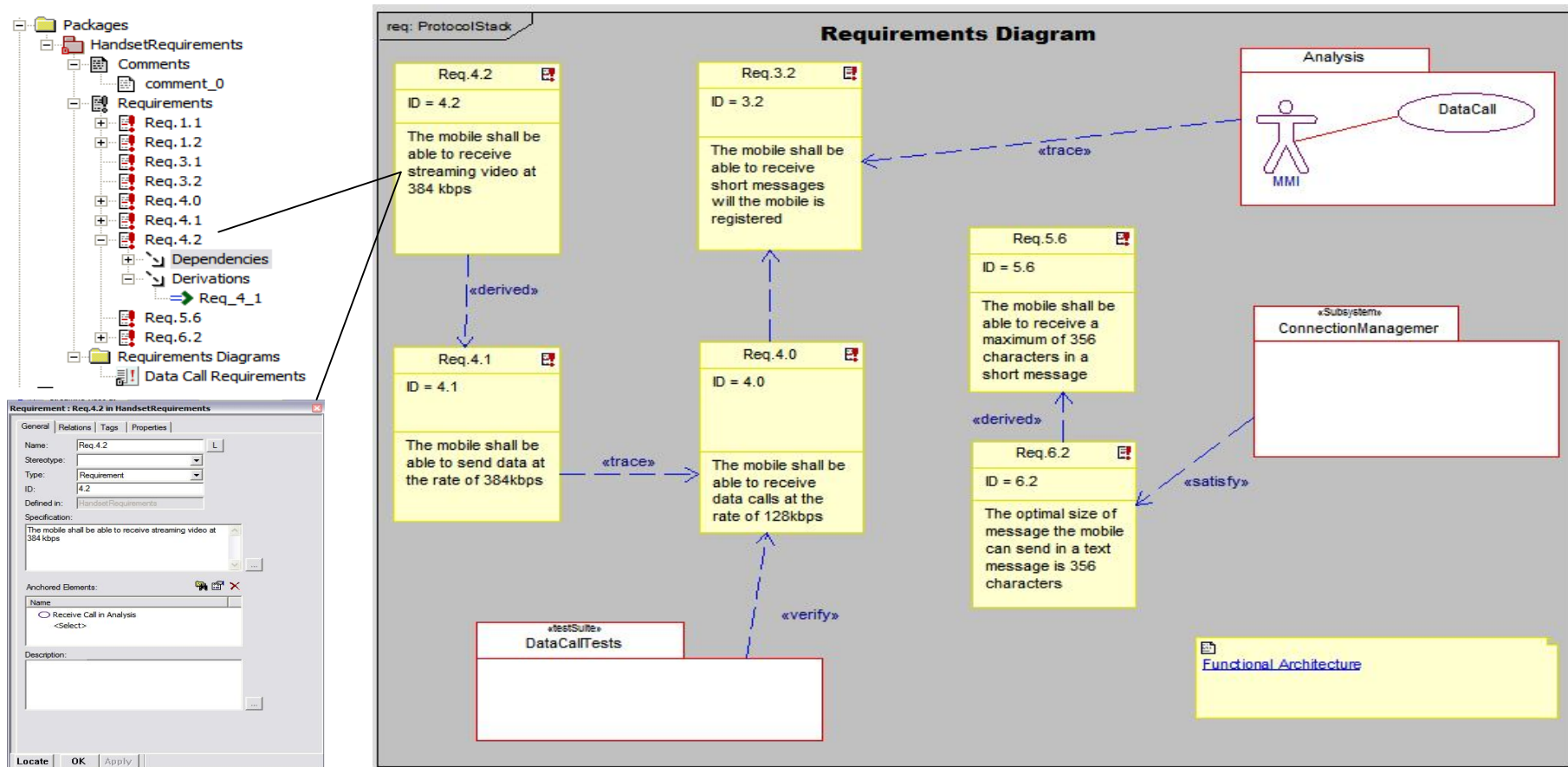
Model-Driven Development (MDD) : Utilisation de Rhapsody pour la génération de code

- Rhapsody inclut des générateurs de code pour les langages C, C++, Ada et Java
 - Le simulateur de Rhapsody est utilisé ici pour faire la mise au point du modèle
 - Les tests de non-régression peuvent être automatisés avec le module Test Conductor
- *Augmente la productivité et la qualité du logiciel*
- *Facilite la réutilisation du logiciel*



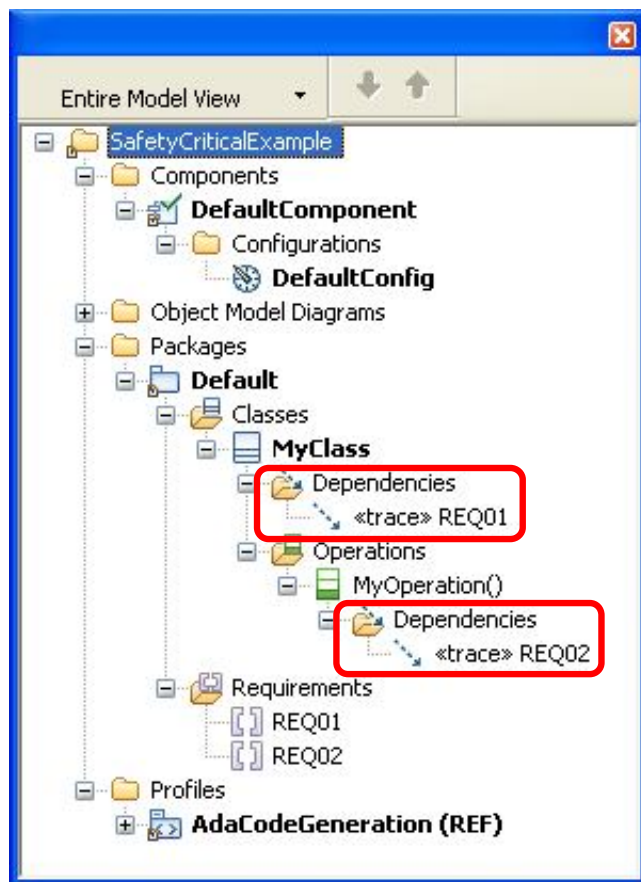
Approches MBSE et MDD : Traçabilité avec l'analyse et la conception du système

- Les exigences peuvent être tracées sur les modèles d'analyse (use cases) et de conception (blocks, classes, interfaces...)
- Permet de justifier l'architecture conçue
- Permet de vérifier que les exigences sont prises en compte



Approche MDD : Traçabilité avec le code

- Dans une approche DOORS-Rhapsody pour le MDD, le code généré à partir du modèle UML peut être enrichi avec un retour aux exigences Systèmes
 - Code généré pour les classes, opérations et automates
- *Facilite la certification du logiciel*



```
--++ class MyClass
-- Realizes requirement REQ01 :
-- This is requirement 01
package MyClass is

  type MyClass_t;
  type MyClass_acc_t is access all MyClass_t;

  type MyClass_t is tagged null record;

  --Public Functions/Procedures section -----
  -- Realizes requirement REQ02
  --++ operation MyOperation()
  procedure MyOperation (this : in out MyClass_t);

private

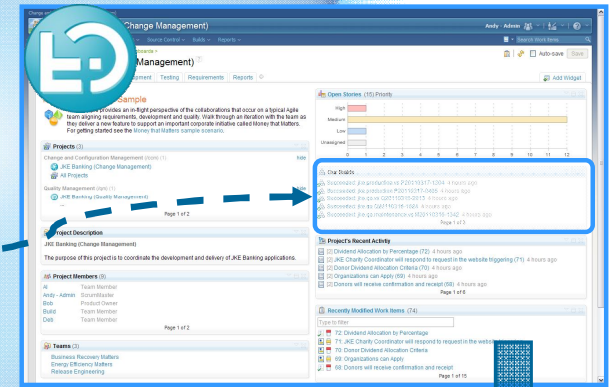
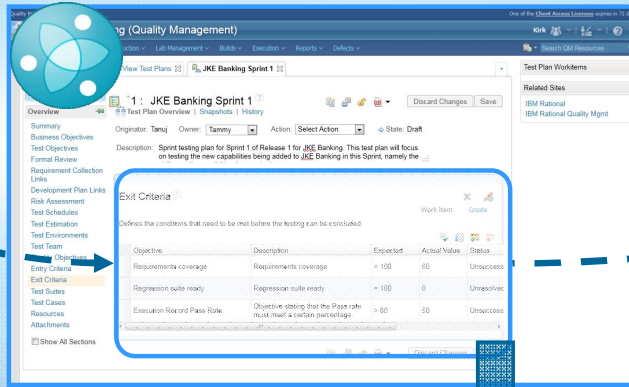
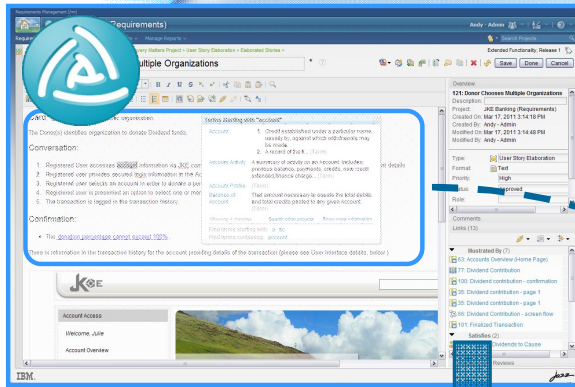
end MyClass;
```

Traçabilité OSLC de bout-en-bout

RM - DOORS Next

CCM - Team Concert

Test - Quality Manager



ID	Name	Artifact Type	Implemented By	Validated By
8	Dividend allocation by percentage	Feature	75: Dividend Allocation by Percentage	18: Dividend Allocation by Percentage
	Requirements	Feature	67: Customers can Nominate an Organization	21: Customers can nominate an organization for the program
12	Donor Dividend Allocation Criteria	Feature	73: Donor Dividend Allocation Criteria	10: Customers Organization
23	Frequency of dividend transfer	Feature	58: Frequency of dividend transfer	16: Donor Dividend Allocation Criteria
	Satisfied by			1: Frequency of dividend transfer

Exemples d'utilisation des outils d'IS témoignés à Innovate US 2013



■ Aeronautique-Espace-Défense

- Raytheon :
 - RTC-RMC-DOORS-Rhapsody, SE-1567
 - DOORS-Rhapsody, SE-2327
- Indian Navy : Harmony, SE-2285
- Cassidian : Rhapsody et VAPS, AS-1298
- Lockheed-Martin :
 - DOORS-Rhapsody, SE-1539
 - UML Action Language, AS-1625
- Airbus Innovation Works : RELM, SE-1487
- SAAB : MBSE, AS-1815

■ Gouvernement

- Atelier IS, SE-1751

■ Automobile

- GM : MBSE avec DOORS-Rhapsody, AS-1871
- Jaguar Land Rover : DOORS-RTC-RQM (et Rhapsody) avec DS Enovia, SE-2576

■ Transport

- Alstom Transport: DOORS, SE-1383

■ R&D Projects

- DANSE : Europe, Rhapsody, SoS, UPDM, simulation multiphysique, SE-1535

■ Initiative OSLC

- SE-1976

A Process Makeover to Enhance Usability and Compliance

A Process Makeover to Enhance Usability and Compliance

Lee Kappel
Engineering Fellow, Raytheon Company
Lee_J_Kappel@Raytheon.com
Stream: Team Directions
Track: Systems Engineering

Basic Concepts – Method Content, Process *Basis for Reuse*

Stay ahead.

- Method Content (Who, What, Why, How)
 - Highly re-usable information
 - Definition of Roles, Tasks, Work Products and associated relationships
 - Includes Guidance and Categories
 - No timing information
- Process (When)
 - End-End sequence of Phases, Iterations, Activities and Milestones that define the development lifecycle.
 - Defines When tasks are performed via Activity Diagrams and/or Work Breakdown Structures



OMG Software & Systems Process Engineering Meta-Model Specification (SPEM) V2.0
<http://www.omg.org/spec/SPEM/2.0/PDF>

A Process Makeover to Enhance Usability and Compliance

Example of a Practice

A Process Makeover
to Enhance Usability and Compliance

Lee Kappel
Engineering Fellow, Raytheon Company

The screenshot displays a web application interface. On the left is a navigation pane titled 'CPA Digital Delivered Product Process' with a tree view of categories including 'Practices', 'Management Practices', 'IV&V Practices', 'Requirements Practice', 'Operations and Support Practice', 'Capture Engineering Practices', 'Hardware Engineering Practices', 'Agile Practices', 'Tasks', 'Work Products', 'Roles', and 'Guidance'. The 'Practices' category is expanded to show 'Architecture Development and System Design Practice' selected. The main content area shows the title 'Practice: Architecture Development and System Design Practice' and a description: 'The Architecture Practice includes development, maintenance and governance of enterprise, system and subsystem architectures throughout program acquisition and lifecycle phases. This practice ranges from analysis of operating concepts down to and including end product level of details. This practice is one of several that encompass the broader category of requirements and architecture development. The processes contained in requirements and architecture development are separate activities realized in parallel, with requirements and architecture as touch-points. Other activities include Concept of Operations (CONOPS) development and Modeling & Simulation (M&S). Modeling & Simulation is an enabler for CONOPS, Requirements, Architecture and Design - making, enhancing, or validating decisions in each domain.' Below the description is a 'Relationships' section with a 'Content References' list: 'Architecture Review Board Concept', 'Concept of Operations (CONOPS) Development Concept', 'Tasks' (including 'Develop Architecture Approach', 'Develop Architecture Review Approach', 'Develop Mission Architecture', 'Develop and Assess Functional Architectures', 'Prepare for Architecture Review', 'Conduct Architecture Review', 'Document Architecture', 'Develop and Assess Physical Architectures'), 'Guidance' (including 'Examples' like 'Supplier Design Risk Assessment Matrix', 'Architecture Stakeholder Analysis Workbook', 'Architecture Review Board Architecture Review Risk Assessment Workbook'), and 'Templates' (including 'CONOPS Development Template', 'Architecture Compliance Assessment Checklist Template', 'REAP Tailoring Checklist and Architecture Validation Template', 'Architecture Review Board Presentation Architecture Template', 'Architecture Review Board Report Template').

A Process Makeover to Enhance Usability and Compliance

Example of a Task

A Process Makeover to Enhance Usability and Compliance

The screenshot displays a software interface for task management. On the left is a navigation tree under 'CPA Digital Delivered Product Process'. The main area shows the details for the task 'Develop Mission Architecture'.

Task: Develop Mission Architecture

Develop the mission architecture to visualize and understand the customer's intent.

Disciplines: Architecture
Extends: Develop Mission Architecture

Purpose
To describe the steps in creating the mission architecture that describes from the users' perspective and in the users' language, the desired characteristics of the system to be developed.

Relationships

Parent Practices	<ul style="list-style-type: none"> Architecture Development and System Design Practice 	
Roles	Primary Performer: <ul style="list-style-type: none"> System Architect 	Additional Performers: <ul style="list-style-type: none"> Hardware Engineer Software Engineer Systems Engineer Test Engineer
Inputs	Mandatory: <ul style="list-style-type: none"> Architecture Data Dictionary (AV-2) Architecture Overview and Summary (AV-1) Customer OV-1 High-Level Operational Concept Graphic Reap Tailoring Checklist and Architecture Validation Guideline Technical Standards and Policies (StdV-1) 	Optional: <ul style="list-style-type: none"> Concept of Operations (CONOPS) Customer Capabilities Description Document (CDD) IPDS Stage 1 Architecture Products
Outputs	<ul style="list-style-type: none"> Architecture Data Dictionary (AV-2) Architecture Overview and Summary (AV-1) Customer OV-1 High-Level Operational Concept Graphic Mission Architecture Products Reap Tailoring Checklist and Architecture Validation Guideline Technical Standards and Policies (StdV-1) 	

Main Description
If available, IPDS Stage 1 architecture products act as an input to this activity, and are reviewed for potential reuse and updated based on additional resources.

A Process Makeover to Enhance Usability and Compliance

Example of a Role

A Process Makeover to Enhance Usability and Compliance

The screenshot shows a software interface for role management. On the left is a navigation pane with a tree view under 'CPA Digital Delivered Product Process'. The main area is titled 'Role: System Architect' and shows a diagram of relationships. The 'System Architect' role is shown performing several tasks and being responsible for various documents and products. Below the diagram are two lists: 'Additionally Performs' and 'Modifies'.

Role: System Architect

Role Sets: Systems Engineering

Relationships

performs

- Develop and Assess Functional Architectures
- Develop and Assess Functional Architectures
- Develop Architecture Approach
- Develop Mission Architecture
- Develop Mission Architecture
- Develop Mission Architecture
- Develop the Architecture Approach

responsible for

- Architecture Briefing
- Architecture Compliance Assessment
- Architecture Compliance Assessment Results
- Architecture Data Dictionary (AV-2)
- Architecture Overview and Summary (AV-1)
- Architecture Review Metrics
- Customer OV-1 High-Level Operational
- Functional Architecture Products
- Mission Architecture Products
- Physical Architecture
- Reap Tailoring Checklist and Architecture
- Technical Standards and Policies (StdV-1)

Additionally Performs

- Develop and Assess Physical Architectures

Modifies

- Architecture Compliance Assessment Checklist
- Architecture Data Dictionary (AV-2)
- Architecture Overview and Summary (AV-1)
- Concept of Operations (CONOPS)
- Customer OV-1 High-Level Operational Concept Graphic
- Functional Architecture Products
- Mission Architecture Products
- Reap Tailoring Checklist and Architecture Validation Guideline
- System Architecture Description Document (SADD)
- Technical Standards and Policies (StdV-1)

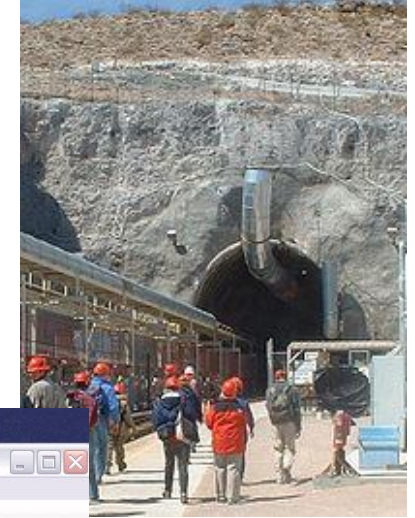
Navigation pane (left):

- CPA Digital Delivered Product Process
 - Tasks
 - Work Products
 - Roles
 - Role sets
 - Architecture
 - Architecture
 - Basic Roles
 - Capture
 - Configuration Management
 - Development
 - Environment
 - Hardware Engineering
 - Mission Assurance
 - Organization
 - Program Engineering
 - Program Support
 - Project Management
 - Project Management
 - Requirements
 - Software Engineering
 - Specialty Engineering
 - Systems Engineering
 - Lead Modeling & Simulation Engineer
 - Lead Systems Engineer
 - Modeling & Simulation Engineer
 - Systems Engineer
 - IV&V Engineer
 - Chief Engineer/Technical Director
 - System Architect**
- Delivered Product Lifecycle
- Agile Lifecycle
- Delivery Processes
- Practices
- NCS Tool Mentors
- Glossary

US Department of Energy (DOE) - Yucca Mountain Repository

Develop a national site for spent nuclear fuel & high-level [radioactive waste](#) storage. Project lead by a consortium of government contractors, URS Corporation, Shaw Corporation and Areva Federal Services LLC.

The program used **Rational's DOORS** product to develop an extensive requirements database to track and manage an extremely broad range of program and regulatory requirements ranging from US CFRs to Contract Requirements.



Requirements in ~20 areas managed with DOORS

Emergency Mgt.

Object Type	Applicability	Implement	Comments
Requirement	Applicable Now	Yes	Responsibility for coordination falls under Business Operations. Currently LL staff have roles/responsibilities in the event of an emergency.
Requirement	Applicable Now	Yes	LL developed ESH-PLN-001 and ESH-PRG-001 and supporting desktops. These are located on SharePoint under Emergency Response.
Requirement	Applicable Now	Yes	Responsibility for coordination falls under Business Operations.
Requirement	Applicable Now	Yes	Limited Applicability. 2.0 Note - Lead Lab reports incident to OCRWM Science Division
Requirement	Applicable Now	Yes	SNL on pg 3 - maintains docs to implement this Plan. Implementing or "in lieu of" Mechanism- ESH-DSK-001 ESH-DSK-002 ESH-DSK-003 ESH-DSK-004 ESH-DSK-005 ESH-PLN-001 ESH-PRG-001.

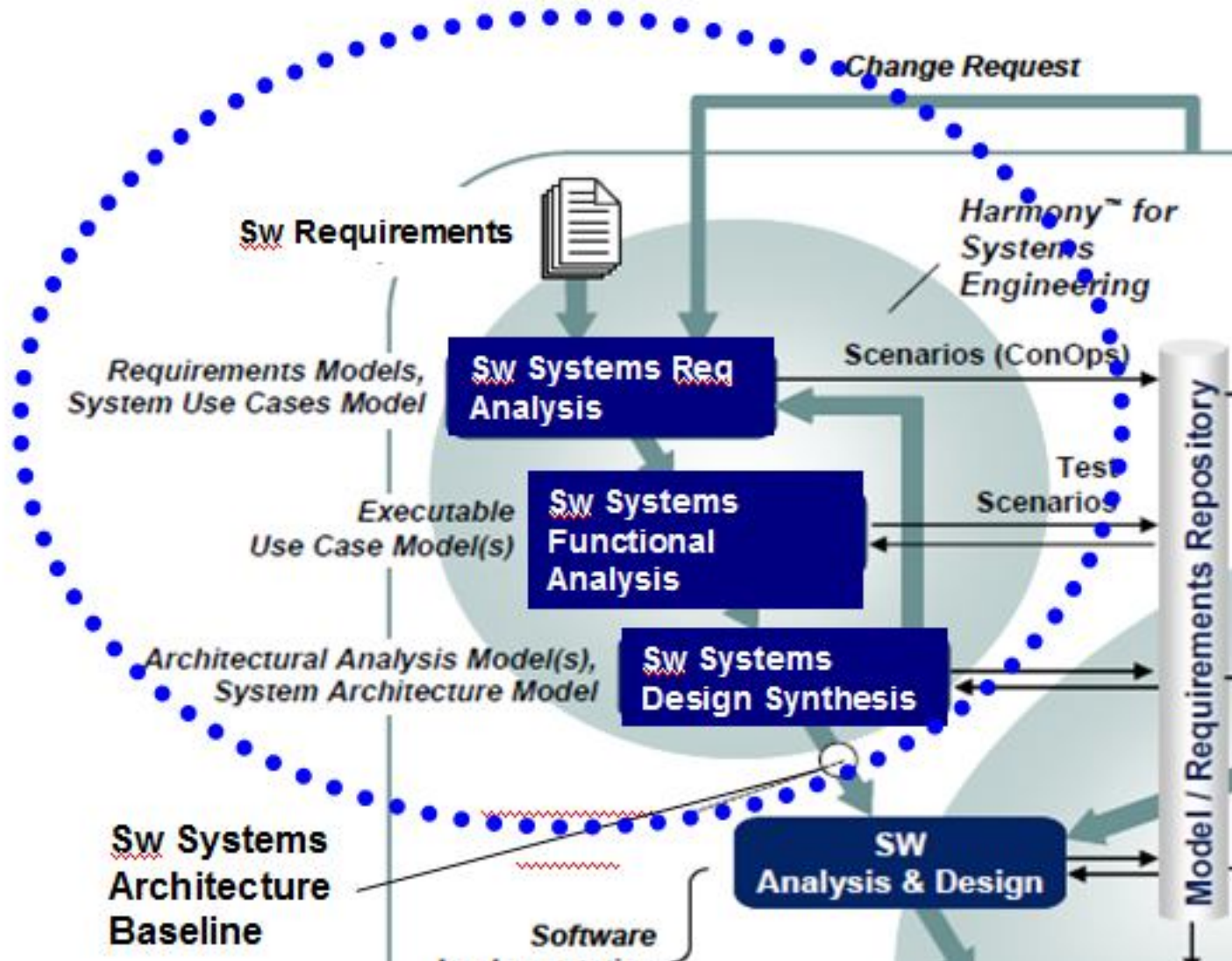
Safety and Health

Object Type	Applicability	Implement	Comments
Requirement	Applicable Now	Yes	Implemented via SNL's NNSA-approved WSHPP (851) program (Doc PG4/0246).
Requirement	Applicable Now	Yes	Compilation of all former individual ES&H Safety Manual Sections, supplements, and Safety Basis Level 3 documents.
Requirement	Applicable Now	Yes	RMRT-0049

Safeguards & Security

Object Type	Applicability	Implement	Comments
Requirement	Applicable Now	Yes	RMRT-0054 Formerly CPR400.3.5, Foreign Interactions

Integrated SW Systems Engineering Based on Rational Harmony for Systems Engineering



SW Systems Engineering Correlated to Systems Engineering

Faster Indigenous Navy Systems fueled by MBSE

Systems Engineering (SE) Phase	Sw Systems Engineering (SSE) Phase	Description (Key Aspect)
Requirement Analysis	Sw Req Analysis	The inputs to this phase in SSE are requirements allocated to Software compared to Stakeholder Requirements of SE. The output of this phase in SSE are Sw System Requirements and Sw System Use Case Model.
System Functional Analysis	Sw System Functional Analysis	The inputs to this phase in SSE are Sw System Use Cases compared to System Use Cases of SE. The output of this phase in SSE are Sw System Operations, Executable Sw Use Case Models and Sw Use Case black-box scenarios.
Architectural Analysis	Sw System Architectural Analysis	The output of this phase in SSE are Sw System Architecture compared to System Architecture of SE. The Block Definition Diagram of SSE consists of S/w Subsystems, compared to hardware, electrical, software, .. Block in SE.
Architectural Design	Sw System Architectural Design	The focus of this phase in SSE is on allocation of Sw System Operations to identified Sw Subsystems compared to allocation of System Operations to Subsystems based on engineering disciplines in SE.
Architectural Detailed Design	Sw Architectural Detailed Design	The focus of this phase in SSE is on is on the definition of the ports and interfaces and on creation and validation of state-based behavior of the system blocks at the lowest level of the architectural decomposition.
Handoff	Sw Subsystems Handoff	The suitable handoff to s/w subsystems development in SSE consists of key artifacts namely baselined executable models of s/w subsystems, subsystem level ports & logical interfaces, test scenarios and allocated functional, non-functional and performance requirements.

Benefits Realized

■ Quantitative

- 60% reduction in overall Development Schedule and Cost
 - attributed to upfront validation of system behavior
- 80% Reduction in Integration issues/defects
 - attributed to precise definition of logical interfaces of sw subsystems.
- 80% reduction in ramp-up time of new officers and scientists
 - attributed to scientifically written system requirements, visual representation of system architecture and dynamic/runnable system behavior models

■ Qualitative

- Set a benchmark and precedence in Indian Defense systems development entities
- Easy and unambiguous to view and audit Sw Systems Architecture and Behavior
- Teleological questioning led to Systemic Thinking
- The Navy Officers involved confident to repeat the workflow in other projects.



Faster Indigenous Navy Systems fueled by MBSE

G S Jawanda
Project Director, Indian Navy
gjawanda@hotmail.com
Session Code 2285

Sudhir M Rao
Solutions Architect, IBM
SudhirRao@in.ibm.com
Session Code 2285

Innovate2013
The IBM Technical Summit

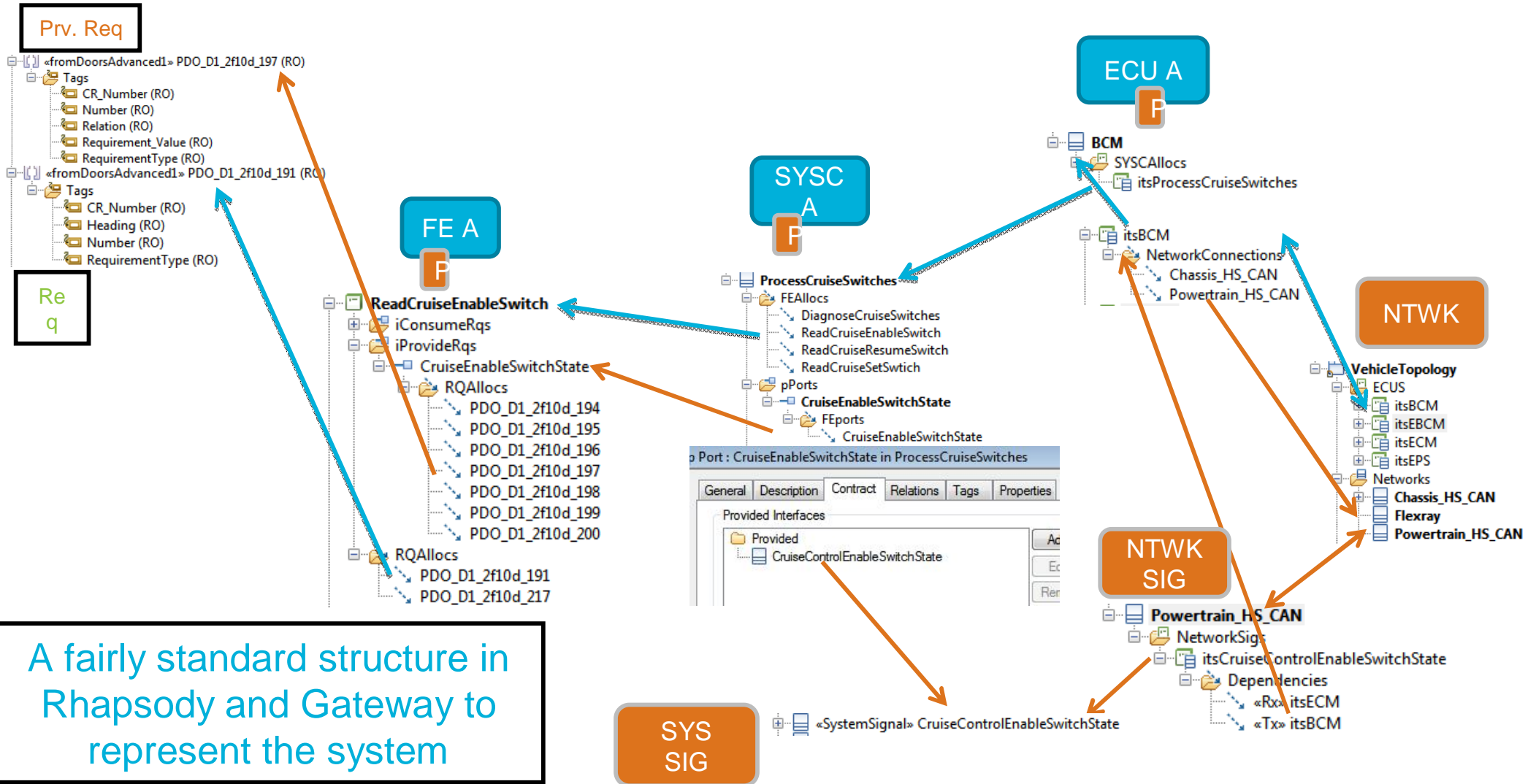
Stay ahead.

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Requirements-Functions-Components

General Motors: Large Scale Model Driven System Design, Architecture Management and Requirements Allocation with Rhapsody at an Automotive OEM

Len Wozniak



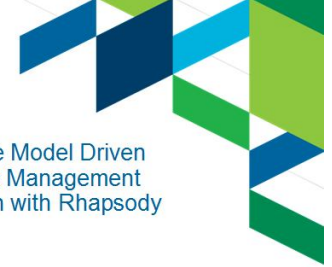
A fairly standard structure in Rhapsody and Gateway to represent the system

GM Model Development Kit (MDK)



General Motors: Large Scale Model Driven System Design, Architecture Management and Requirements Allocation with Rhapsody at an Automotive OEM

Len Wozniak



ahead.

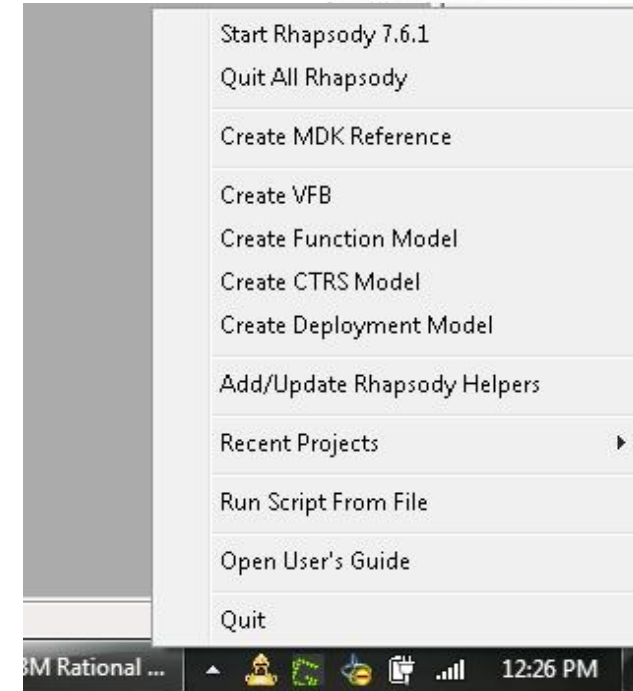
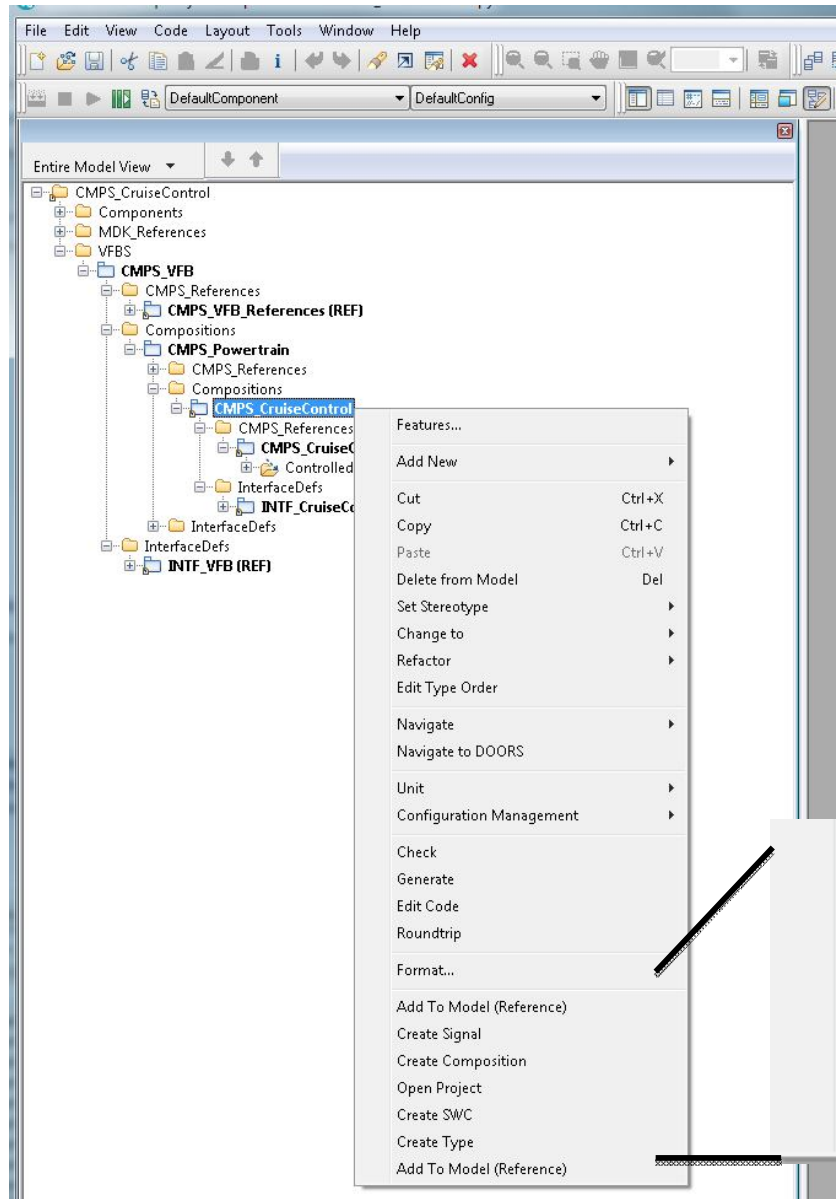
- The GM MDK is a toolkit composed of modeling 'Profiles' and a set of 'Scripts' that abstracts the engineers from the complexity of model element creation and maintenance based on GM's defined architecture.
- Profiles
 - Contain terms used in our architecture that are applied to the model elements for quick identification, grouping or filtering.
 - GM makes extensive use of the Rhapsody "Term" capability to allow engineers to work in our terminology instead of native UML
- Scripts
 - These are model element context-based applications written in Java that use the Rhapsody API to manipulate model elements. The scripts have a User Interface for information entry and a corresponding logic that runs the script.
 - An example of a script is 'Create Signal'. A signal is composed of several model elements that have interconnected relationships. The script ensures that these elements and relationships are created properly and the proper term (Profile) applied.
- The GM MDK is installed using a Windows installer and runs as a stand alone application.
- Total of ~2.5 man years development effort (requirements → test → deployment)

GM Rhapsody MDK

General Motors: Large Scale Model Driven System Design, Architecture Management and Requirements Allocation with Rhapsody at an Automotive OEM

Len Wozniak
Electrical, Controls and Software Process and Tool Systems Architect

Stay ahead.



Notification Area Menu

Context Menu Extensions



Modelling a certifiable UAV Ground Control Station with Rational Rhapsody SysML and Presagis VAPS

Dietmar Pfeiffer – dietmar.pfeiffer@cassidian.com
Systems Engineer - System Design, Airborne Capabilities & Integration

Methods and Toolset

GCS : Ground Control Station

GCS Concept - document based
General Principles, Trade Offs,
Hardware Issues, Operational Concepts

GCS Definition - model based

HMI Model

Presagis VAPS XT

(options: Qt, Rhapsody, Altia, ...)

- Reuse of available libraries
- Experienced users
- Verification through execution
- Certifiable code possible
- Reuse of model during later implementation

Interface
(optional)

Functional Systems Model

IBM Rational Rhapsody

- SysML with Harmony SE toolkit
- Reuse of model elements from earlier UAV use cases
- Experienced users
- Verification through execution
- In-house guidelines available
- System requirements in Word

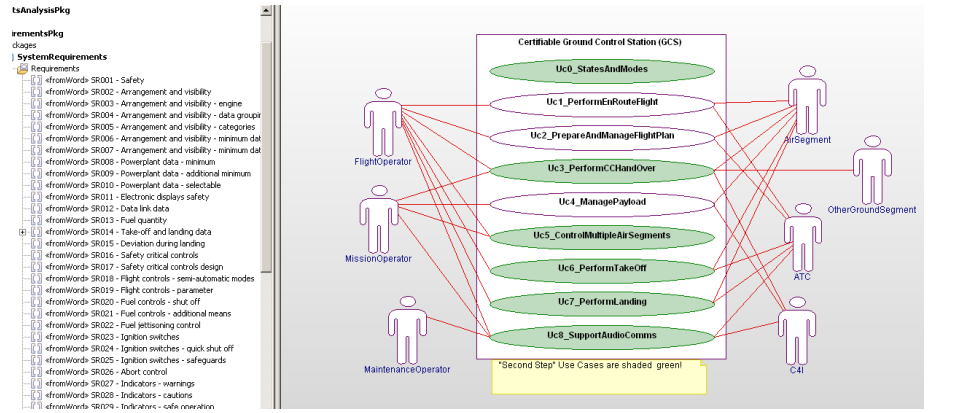


Modelling a certifiable UAV Ground Control Station with Rational Rhapsody SysML and Presagis VAPS

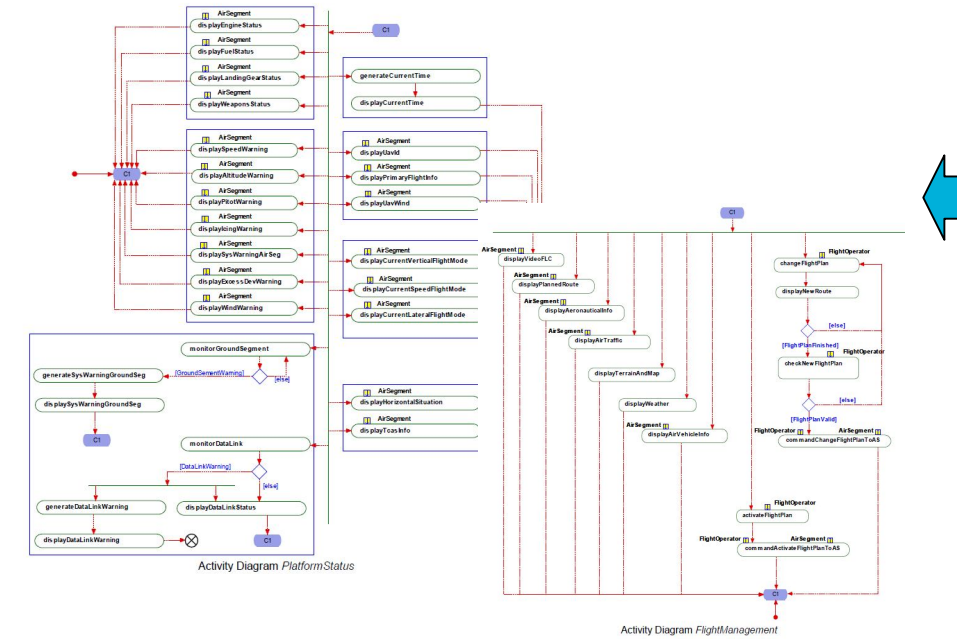
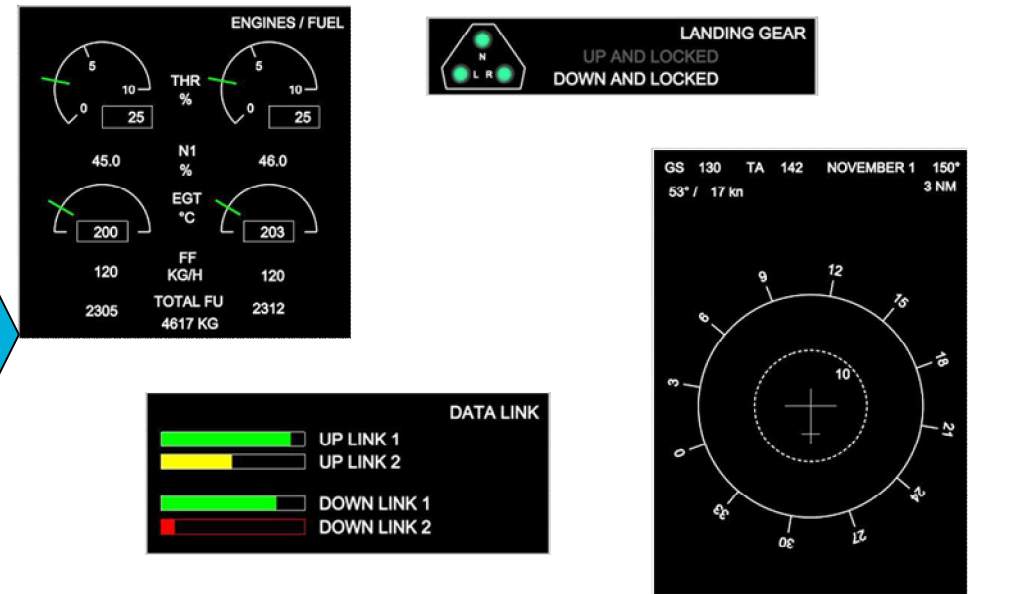
Dietmar Pfeiffer – dietmar.pfeiffer@cassidian.com
Systems Engineer - System Design, Airborne Capabilities & Integration

AN EADS COMPANY

SysML Model in Rhapsody



HMI Model in VAPS





Conclusion, tendances

- Les valeurs sûres
 - Gestion formelle des exigences (en général avec DOORS)
 - UML pour la modélisation, mais complété avec d'autres techniques comme Simulink, Modelica et le maquetage 3D (CATIA)
 - UPDM et DoDAF pour les systèmes de systèmes et la Défense
- Pratiques en cours de généralisation
 - Formalisation des processus
 - MBSE avec allocation Exigences-Architecture
 - Multi-disciplinarité, communication entre outils, ouverture, OSLC
 - Simulation avec IHM graphiques
- Besoins émergents
 - Connexion avec le PLM
 - Simulation multi-physique
- N'apparaissent pas comme des besoins immédiats
 - Génération de code assistée ou automatisée

Questions

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