

Innovate2011

The Rational Software Conference

11th and 12th of October

Let's **build** a smarter planet.

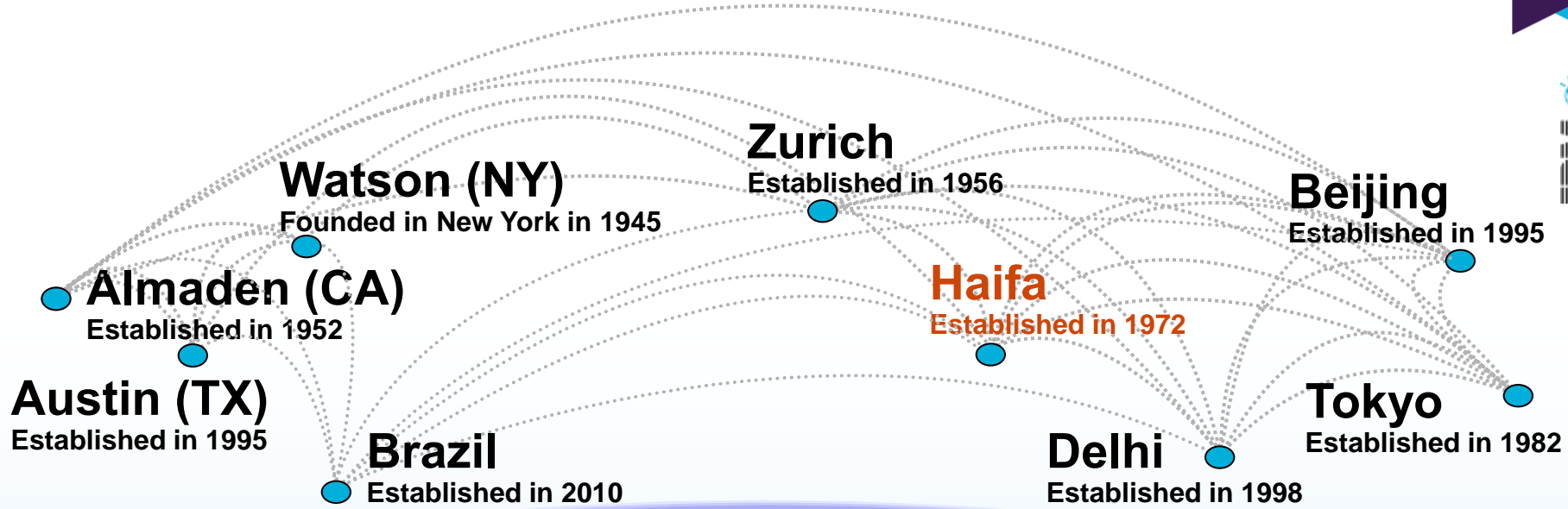


IBM Research – In search of smarter systems

Cindy Eisner



The sun never sets on IBM Research



Awards and Honors



5 Nobel Prizes



6 Turing Awards



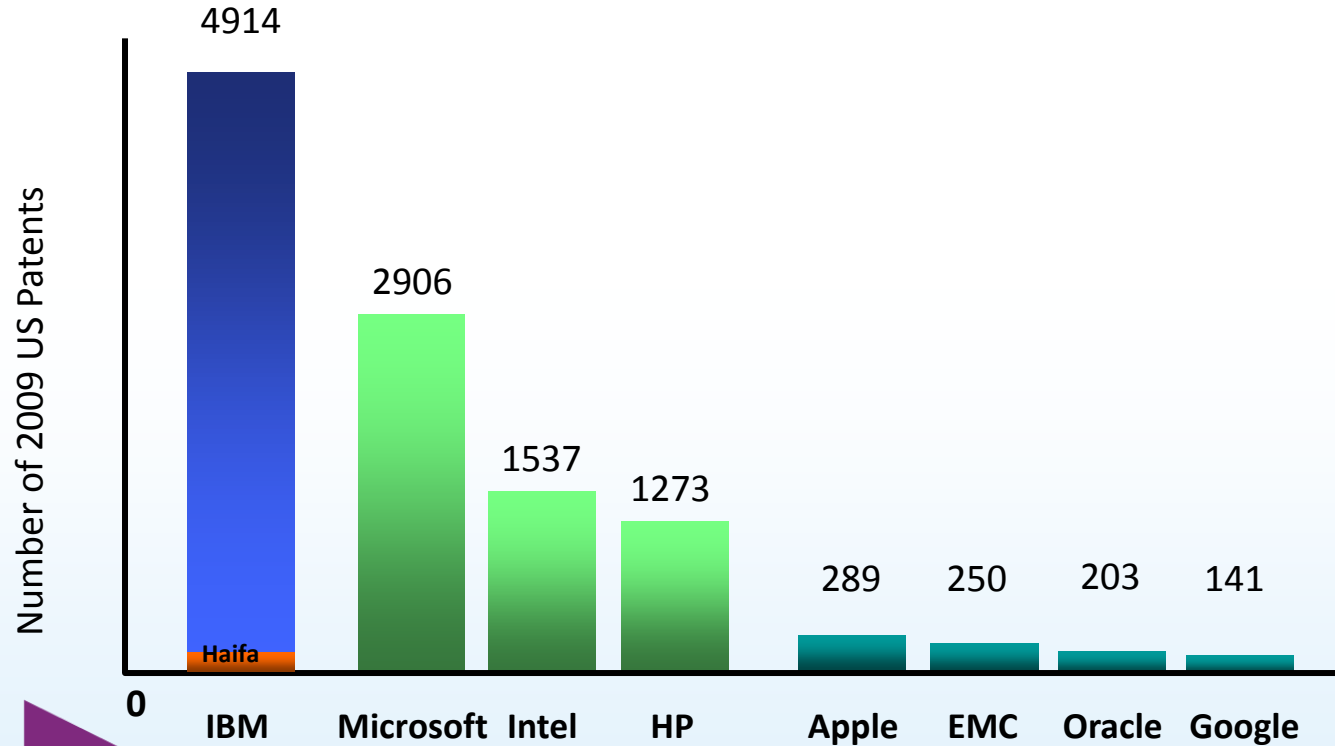
11 Inventors Hall of Fame



14 National Medals



17 years of IBM Patent Leadership



IBM Research

Long term

- New concepts and technologies
- Tackle open problems
- Innovative and risky research



Medium term

- Extend and develop mature technologies
- Develop methodologies and custom solutions for customers
- Collaborative projects



Short term

- Apply our technology to new domains
- Add capabilities to existing tools



What we do

Develop new technologies

- **Innovative ideas** turn into **Research assets** turn into **Innovative IBM products**

Solve problems

- Identify and answer IBM's needs in different domains
- Solve problems for IBM's customers



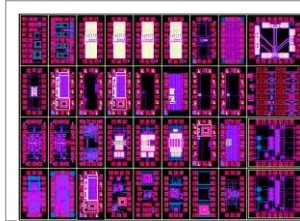
IBM Research – Haifa core competencies

Largest IBM Research facility outside the US

Spanning all IBM Research strategy areas



Cloud Computing



Verification



Software Development



Storage



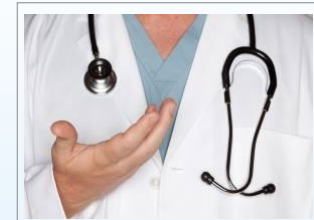
**Optimization
Technologies**



**Collaboration &
Social Networking**



**Analytics &
Machine Learning**



Healthcare



Formal Verification for UML/SysML



Developing a *Research Asset*

- A Rhapsody plug-in that performs formal verification
 - On behavioral models, with an appropriate subset of UML
 - Environment interaction is safely abstracted
 - Counterexamples displayed as sequence diagrams

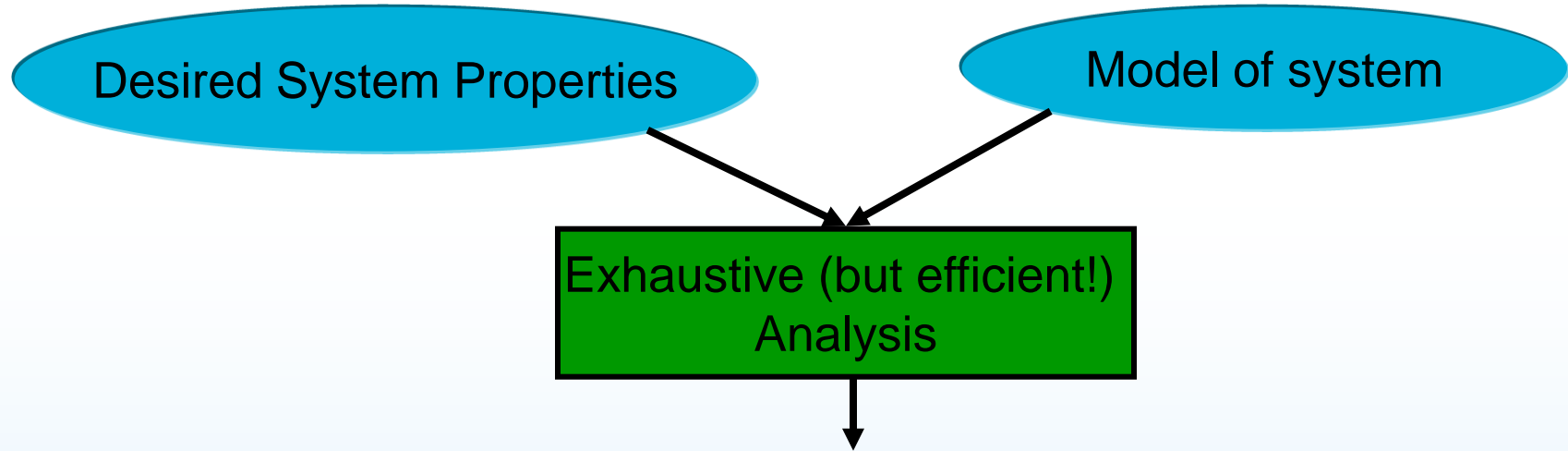
Interacting with potential users

- Understanding needs and use cases



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Formal Verification



Does the system obey its requirements ?
Demonstrate the cases where the system fails

What can we check?

Example template properties:

- Dead states / dead transitions
- Non-determinism
- Attribute bounds
- Deadlock freedom
- Mutual exclusion
- Invariants

Temporal logic

- Highly expressive
- Enables describing complicated sequences of events



**This is customizable –
What do **you** need?**



System Optimization Workbench



“First Of A Kind” project (FOAK) with EADS

- **Mission:** Find optimal design solution for aerospace systems
- **Problem:** No automated and integrated solution currently available
- **Approach:**
 - Model-based multi-criteria optimization
 - Component model library, Variability Modeling
 - Back-annotation into engineering environment
- **Use Case for Validation:**
 - Simplified Aircraft Doors and Slides Control System
 - Minimize cost, weight, power consumption, etc.
 - Fulfil safety and real-time constraints

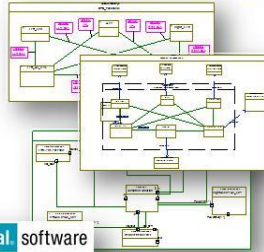


Henry Broodney
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The technology



1. Describe system through different SysML views, including design alternatives, constraints and goals

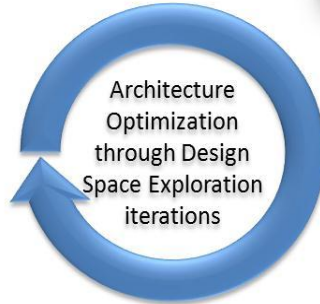


Rational software
Rhapsody

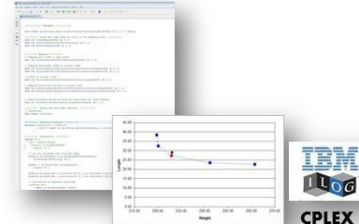
2. Derived Data Schema for Input and output structures

idname	guid	variants
1:Junction	GUID e1eb1581-c487-4be2-9fd6-8ca56a53b2ea	Cat.Junction
3:Relay	GUID 8feb223d-5bc6-4066-6179-46b5ff3d7e58	Cat.Relay

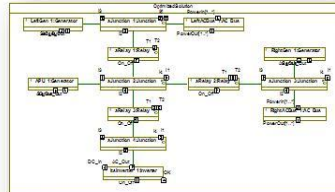
id	name	guid	typeId	type name	variants	base from to
1	2:PParameter	GUID 29e322-9e8b-4810-d81e-4510a3202a2	2:PParameter	2:PParameter	2:PParameter	
2	3:PParameter	GUID 88e871a-108e-4a65-d745-50a7387f13a1	3:PParameter	3:PParameter	3:PParameter	
3	1:SPParameter	GUID 84d097-708e-4a65-d745-50a7387f13a1	1:SPParameter	1:SPParameter	1:SPParameter	2:1
4	3:PParameter	GUID 10a0d7-08e0-4901-8a8b-c9e131e1e7	3:PParameter	3:PParameter	3:PParameter	2:1
5	2:CF	GUID 141326a-7e4c-47c5-81c2-0a4923303183	2:CF	2:CF	2:CF	
6	2:Parameter	GUID 380a08-107e-4a65-818a-702f7a840c2	2:Parameter	2:Parameter	2:Parameter	
7	2:SPParameter	GUID 2130d21-6a8b-47f5-917e-aa483a4724	2:SPParameter	2:SPParameter	2:SPParameter	2:1
8	3:SPParameter	GUID 30a070-108e-4a65-d745-50a7387f13a1	3:SPParameter	3:SPParameter	3:SPParameter	2:1
9	1:Junction	GUID 8813a19-19d8-4a65-d778-10a234821313	1:Junction	1:Junction	1:Junction	2:1
10	3:Relay	GUID 810e8-108e-4a65-d778-10a234821313	3:Relay	3:Relay	3:Relay	
11	1:SPParameter	GUID 470b3d-708e-4a65-9098-c81c1c1a8ba	1:SPParameter	1:SPParameter	1:SPParameter	2:1



3. Automatic translation (via an interchange format) into Optimization solver

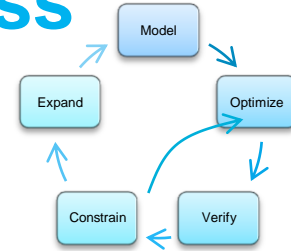


4. Optimized architecture back annotated to SysML model



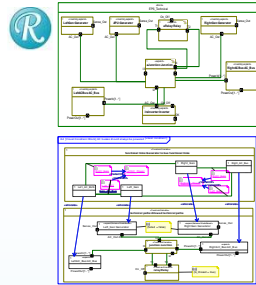
IBM
LOG
CPLEX
Studio

IBM Design Space Exploration Process



Model

- Concise modeling
- Constraints and Algebras
- Contracts
- Contains the entire model information
- Serves as a base for the rest of the processes
- Utilizes LinguaFranca language

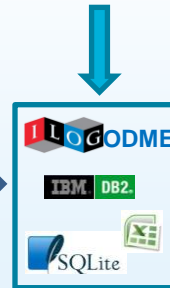


Constrain
Monitors

Verify

- Checks static or dynamic behaviors that the optimizer cannot solve
- Enables block-box in the loop
- Constraints modified based on the tool feedback

External library of components



Database

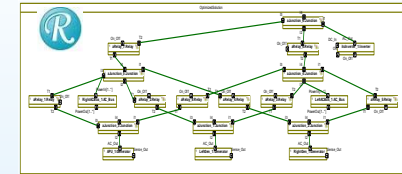


Optimize

- Generate architectures that satisfy constraints
- Optimize for multiple objectives

Expand

Expanded model – full architecture



Product line engineering

Companies are developing product lines – families of products

- ...but not using a systematic engineering approach

PLE core idea: A single set of artifacts for a family of products

- Capturing the commonalities and variabilities
- Automatically deriving artifacts of individual products

Claimed benefit*: an order of magnitude improvement in:

- Cost
- Time to market
- Productivity
- Quality

Payoff Point:

- Product-line architecture design is naturally more costly and time-consuming than for a single product
- Literature suggests ROI after deriving 3-5 products

Nokia 2008 models



Ford 2009 Models

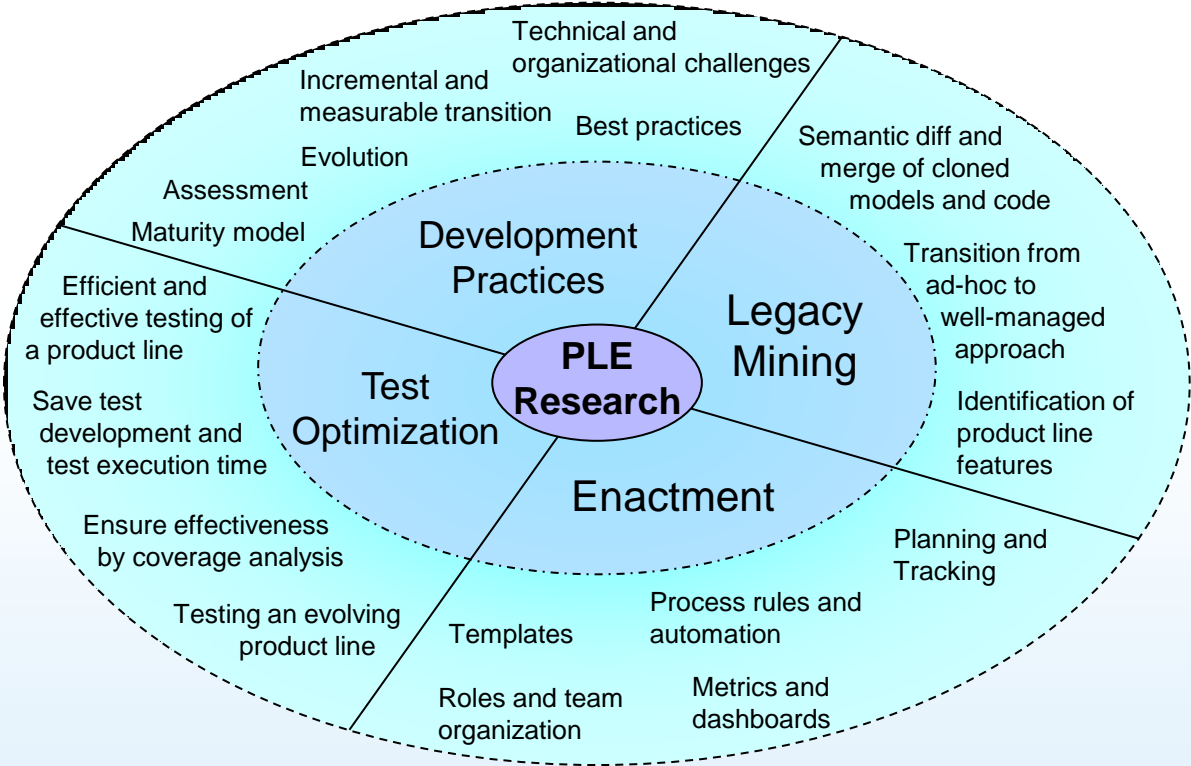


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Research activity



Method



Direct customer engagement

- Help customers move from one-off project approach to Product Line engineering approach
- First phase – assessment
 - Identify products that would benefit from the transition
 - Identify gaps in methodology and tools
- Second phase - guide and support the transition



Summary

- **IBM Research does short and long-term deep research**
- **Into areas directly relevant to customers**
- **Complex and embedded systems**
- **We work for IBM but also directly with**
 - Customers
 - Universities
 - Business partners
- **Let us know how we can help you!**





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