



Interaction Flow Modeling Language

Model-Driven Development of Software Front Ends

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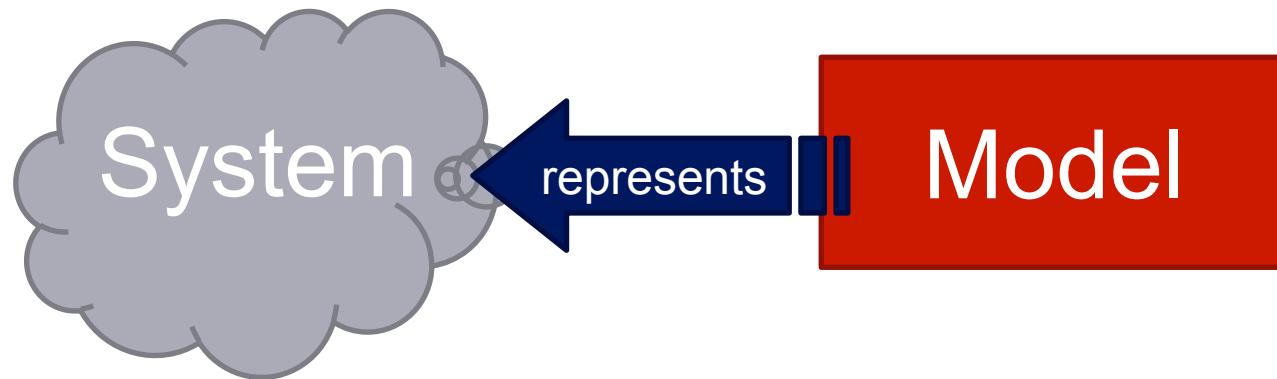
The modeling approach





Models

What is a model?



Mapping Feature

A model is based on an original (=system)

Reduction Feature

A model only reflects a (relevant) selection of the original's properties

Pragmatic Feature

A model needs to be usable in place of an original with respect to some purpose

Purposes:

- descriptive purposes
- prescriptive purposes



MDSE aim at large

MDSE considers models as first-class citizens in software engineering

The way in which models are defined and managed is based on the actual needs that they will address.

MDSE defines sound engineering approaches to the definition of

- models
- transformations
- development process.



Concepts

Abstraction from specific technologies

- model once, build everywhere

Automated code generation from abstract models

- Increased **productivity** and **efficiency** (models stay up-to-date)

Separate development of application and infrastructure

- Separation of application-code and infrastructure-code (e.g. Application Framework) increases **reuse**



Modeling Languages

Domain-Specific Languages (DSLs):

languages that are designed specifically for a certain domain or context

DSLs have been largely used in computer science. Examples: HTML, Logo, VHDL, Mathematica, SQL

General Purpose Modeling Languages (GPMLs, GMLs, or GPLs):

languages that can be applied to any sector or domain for (software) modeling purposes

The typical examples are: UML, Petri-nets, or state machines



Model Transformations

Purpose: Transforming items

- defining a mapping between elements of a model to elements to another one (**model mapping or model weaving**)
- Code is just another model

Transformations themselves can be seen as models



Types of models

Static models:

Focus on the static aspects of the system in terms of managed data and of structural shape and architecture of the system.

Dynamic models:

Emphasize the dynamic behavior of the system by showing the execution



Modeling Levels

CIM, PIM, PSM

Computation independent (CIM): describe requirements and needs at a very abstract level, without any reference to implementation aspects

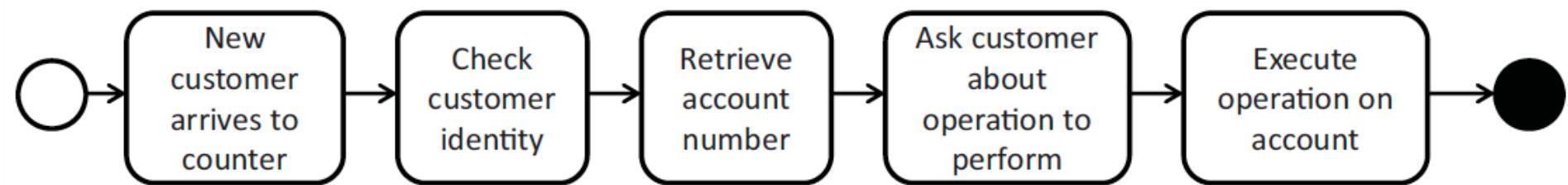
Platform independent (PIM): define the behavior of the systems in terms of stored data and performed algorithms, without any technical or technological details

Platform-specific (PSM): define all the technological aspects in detail



Modeling levels - CIM

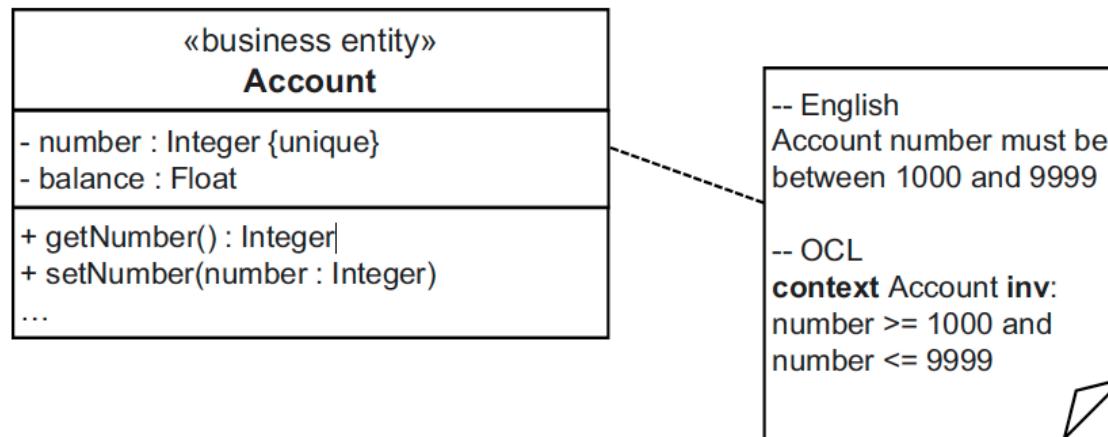
Eg., business process





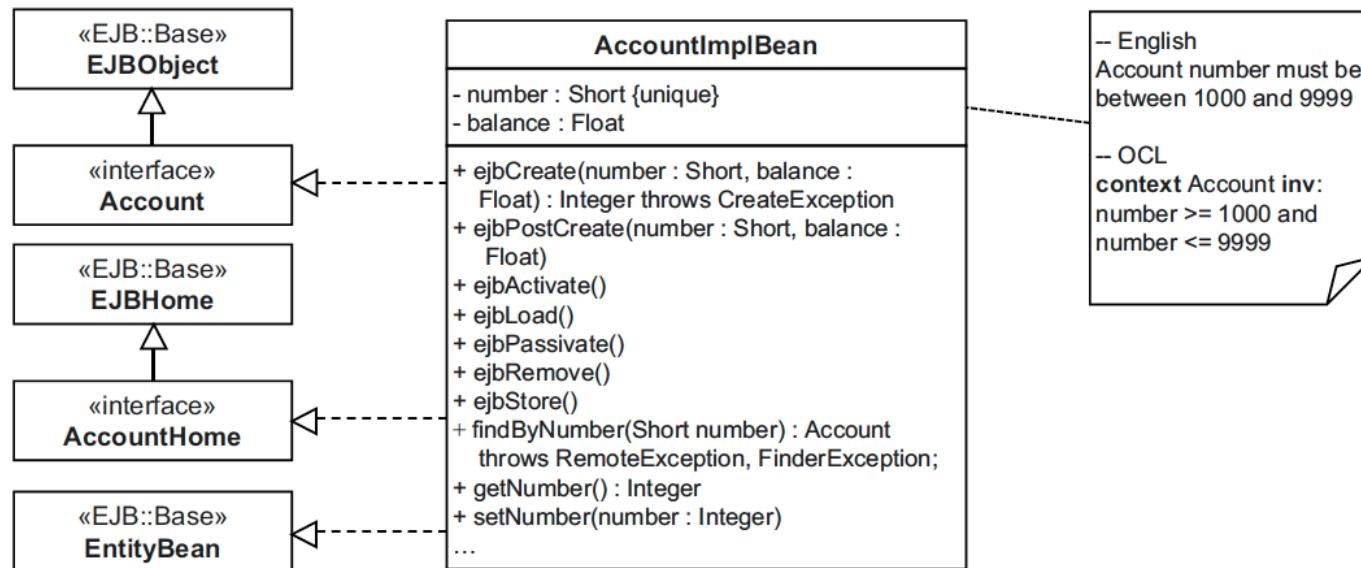
Modeling levels - PIM

Eg., business object description and constraints





Modeling levels - PSM



How the functionality in the PIM is realized on a certain platform

Using a UML-Profile for the selected platform, e.g., EJB



The UI Modeling Problem





UI Modeling Problem

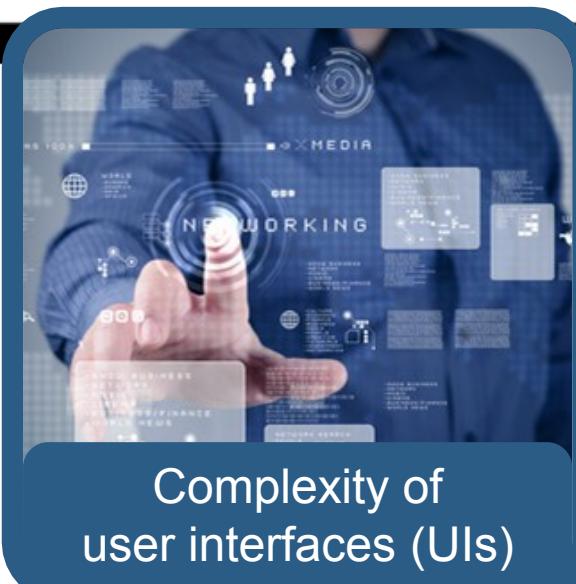
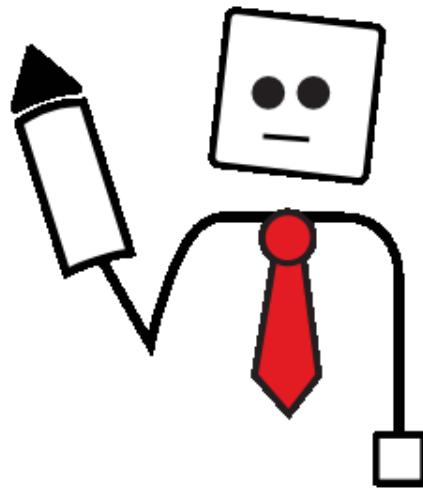
**User interface and interaction development
is a painful phase of software process**

... for everybody!



The UI Design Problem

Costly and
Inefficient process



Complexity of
user interfaces (UIs)



Ineffective
tools



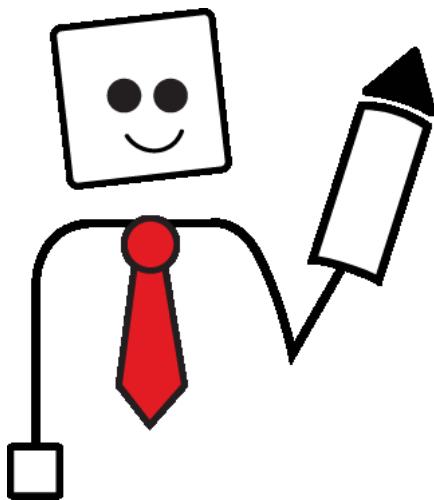
Manual
development



No MDE
technology



The UI Design solution: IFML



Platform independent description of UIs

Focused on user interactions

No definition of graphics and styles

Reference external models



Standardization gap

- User interaction has been overlooked in software engineering standards
- Hence **the Interaction Flow Modeling Language (IFML)**



- In less than 2 years (a record in OMG!), we obtained approval of the IFML standard



The Interaction Flow Modeling Language





IFML Objectives



Event

Content

Navigation Path

Binding to
Business Logic

Binding to Persistence Layer



IFML Objectives: Content

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September Spotlight:

The Lowland by Jhumpa Lahiri

"Her most accessible – and most profound – book yet."
– Sara Nelson, Amazon Editorial Director

[Learn more](#)

The book cover for "The Lowland" by Jhumpa Lahiri. The title is written in a large, stylized, lowercase font. Below it, "a novel" is written in a smaller font. At the bottom, the author's name, "Jhumpa Lahiri", is printed, along with the subtitle "Winter of the Hollow Tree".

Amazon Editors' Top Picks for the Best Books of September

We're happy to share with you the unique mix of books that our editors have hand picked as this month's best.

The book cover for "The Maid's Version" by Daniel Woodrell. The title is at the top, followed by "A NOVEL". Below that, the author's name, "DANIEL WOODRELL", is printed. The background of the cover features a fiery, orange-toned scene.

The book cover for "A House in the Sky" by Amanda Lomanjou & Sara Corbett. The title is at the top, followed by "A NOVEL". Below that, the authors' names are listed. The background is dark with a pattern of small, white, bird-like shapes.

The book cover for "Help for the Haunted" by John Searles. The title is at the top, followed by "A NOVEL". Below that, the author's name is listed. The background is dark with a large, white, stylized letter "H".

The book cover for "The Mushroom Hunters" by Langdon Cook. The title is at the top, followed by "ON THE TRAIL OF THE UNDERGROUND AMERICA". Below that, the author's name is listed. The background shows a close-up of several mushrooms growing in the ground.

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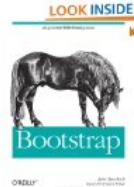
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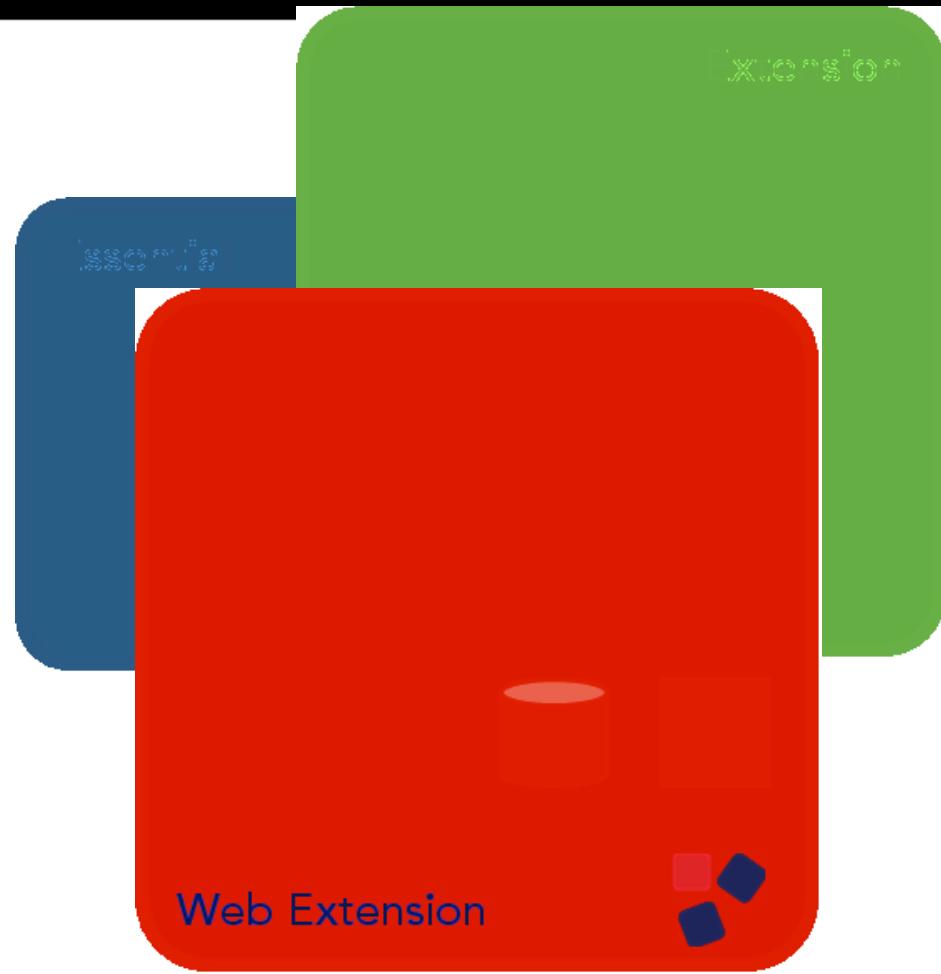
A large blue arrow points from the "Content" box towards the right side of the slide, indicating the flow of data.

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Cover: file
List Price: currency
Price: currency
Save: currency
Rating: integer
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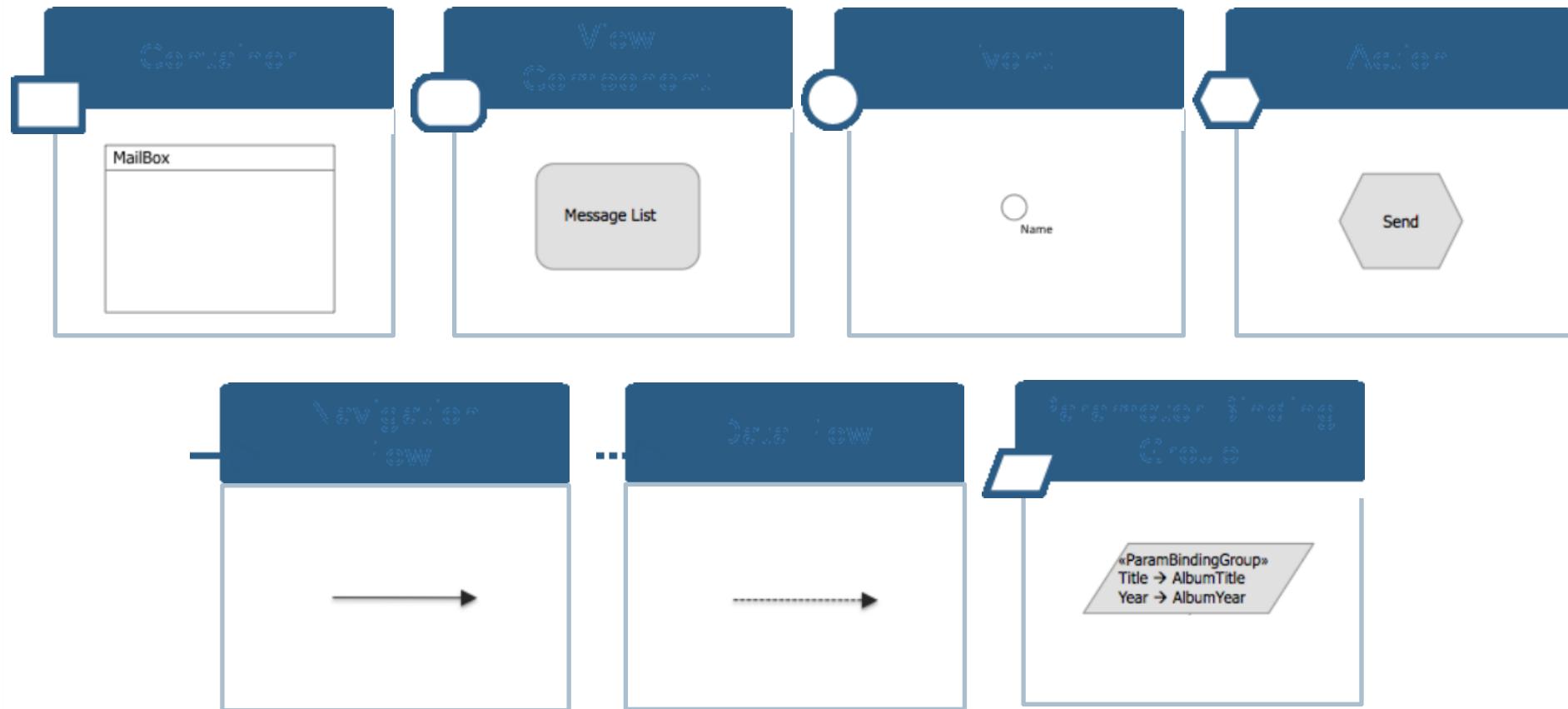


IFML Overview





IFML Essentials



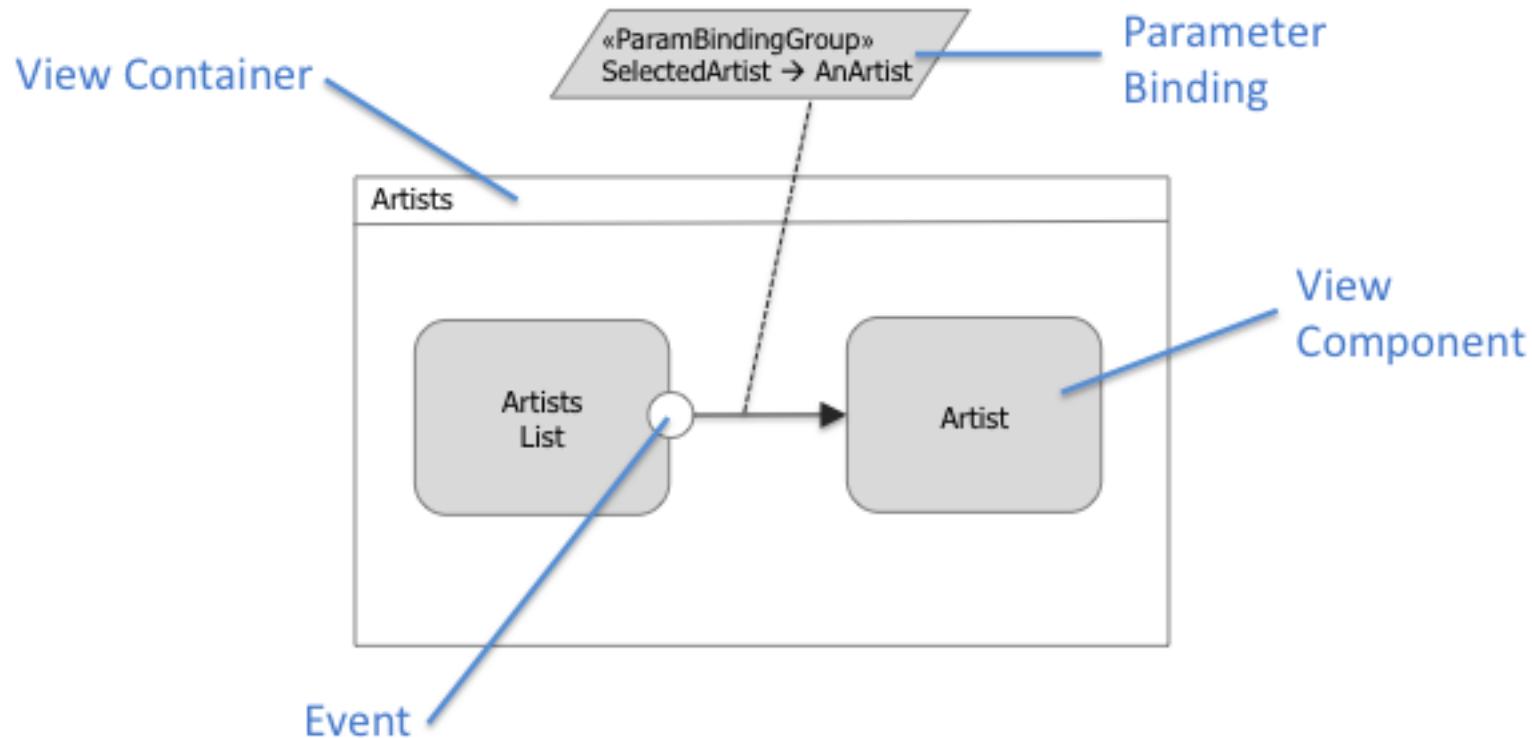


Covered aspects

- **Multiple views** for the same application
- **Mobile and multi-device** applications
- Visualization and input of data, and production of **events**
- **Components** independent of concrete widgets and presentation
- **Interaction flow**, initiated by the user or by external events
- **User context**: the user status in the current instant of the interaction (position, history, machine, platform,...)
- **Modularization** of the model (design-time containers for reuse purpose)
- User input **validation**, according to OCL or other existing constraint languages



IFML by example



Basic navigation flow between ViewComponents



IFML ViewComponents

ProductList

ProductDetails

ProductEntry
Form

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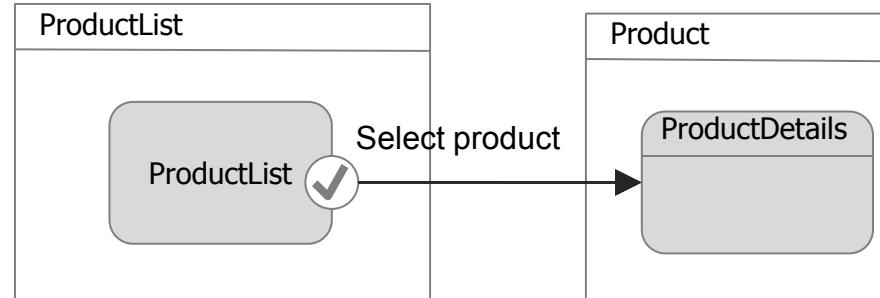
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IFML Multiple containers and navigation



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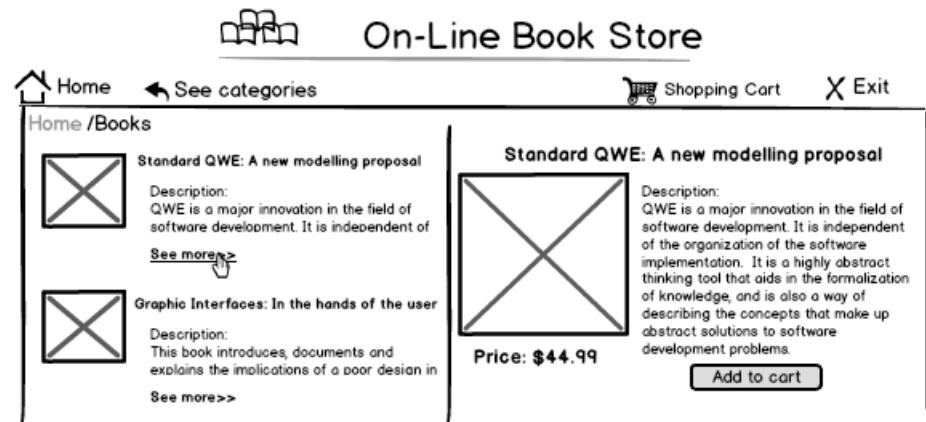
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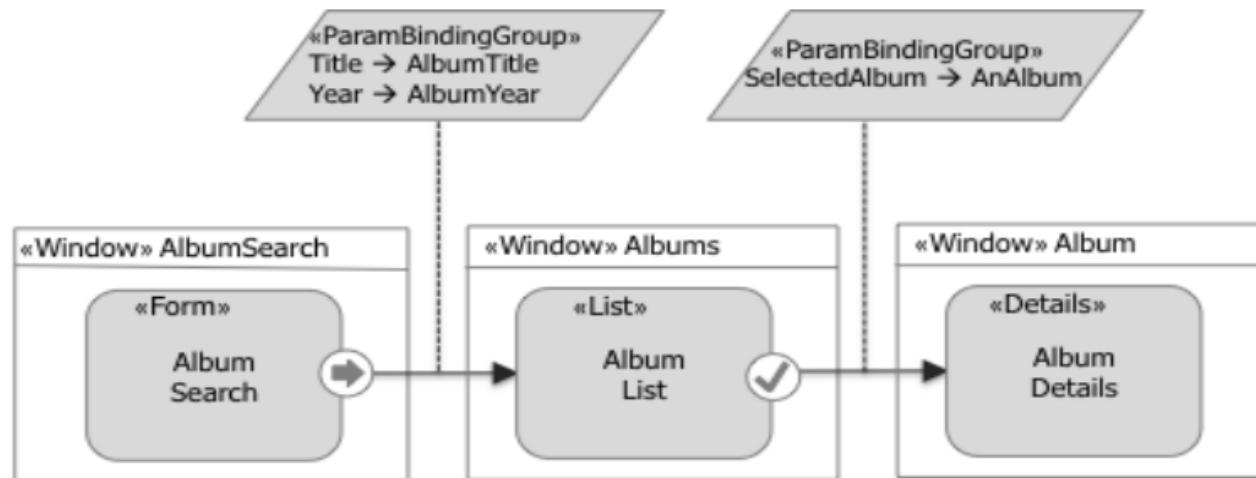
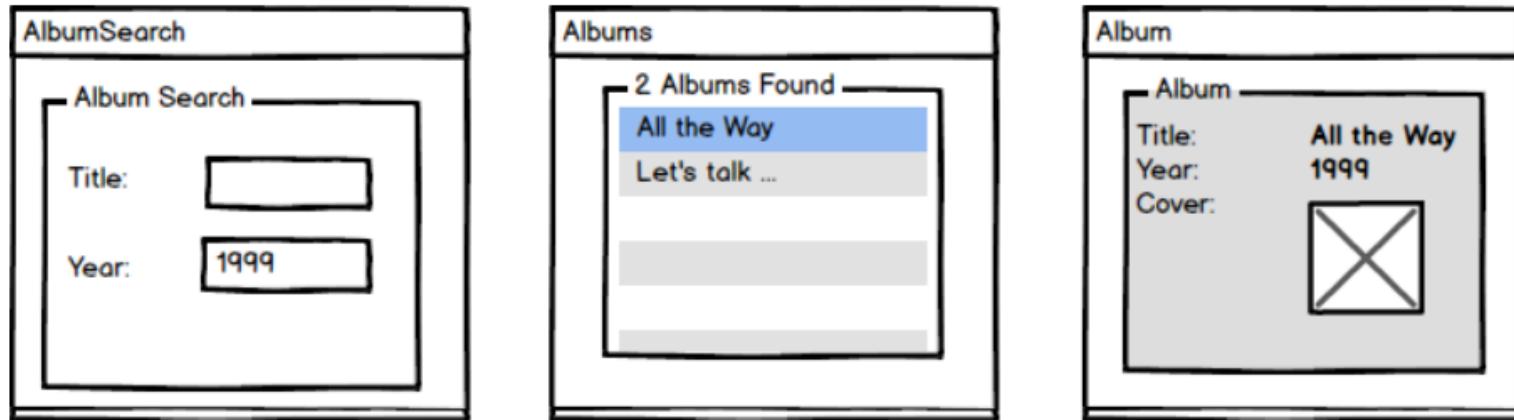


IFML Single container and navigation



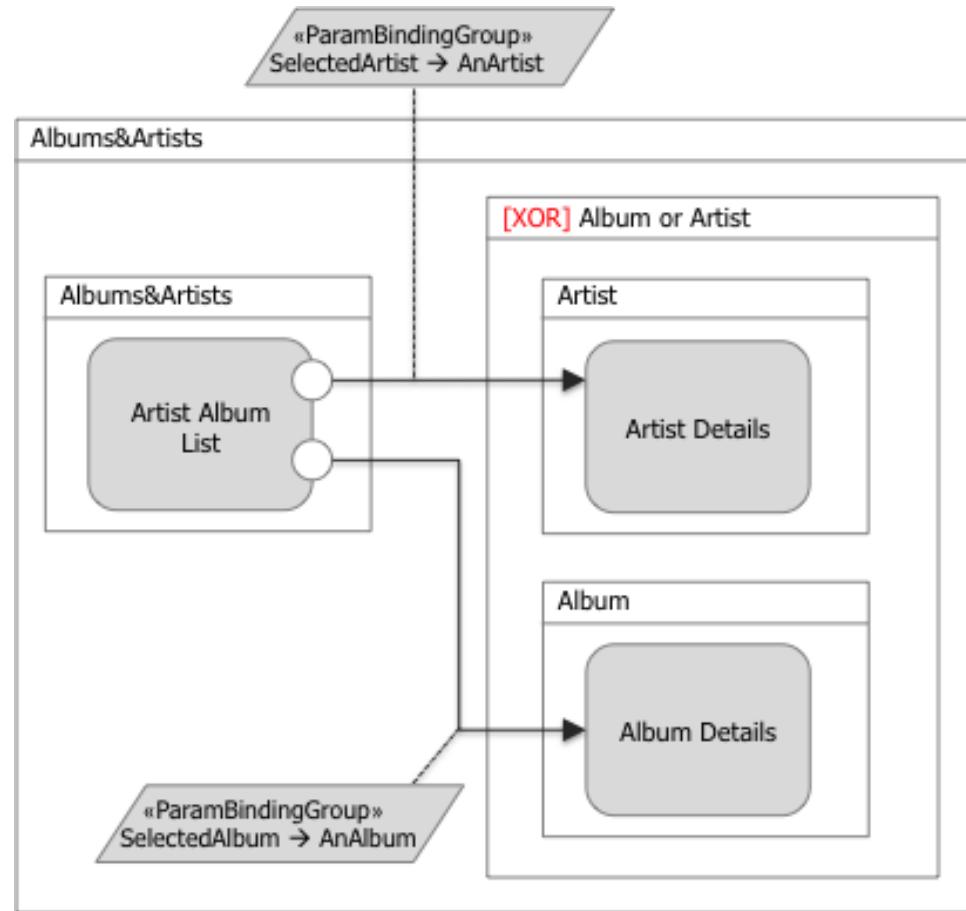


IFML by example





IFML by example



Nesting of ViewContainers

Tagged ViewContainers (XOR, L, D, Modal, Modeless)



IFML ViewContainers

[XOR] MAIL Top

[D] [L] Messages

[XOR] MessageSearch

[D] Search

FullSearch

[XOR] MessageManagement

[D] MailBox

[XOR] MessageViewer

[D] Message List

MessageDetails

[L] Settings

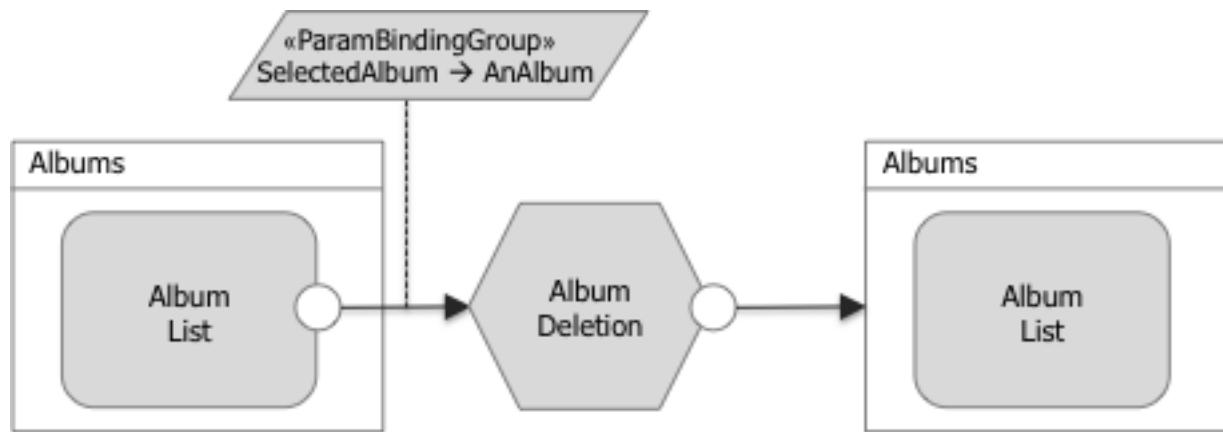
[L] MessageWriter

Message toolbar

[L] Contacts



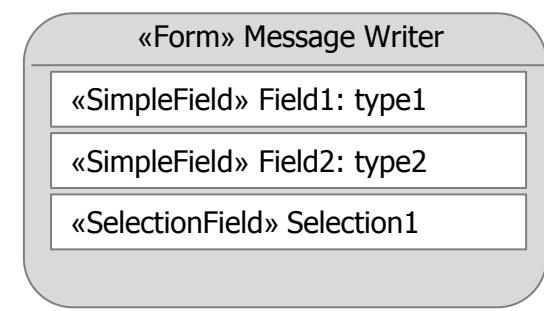
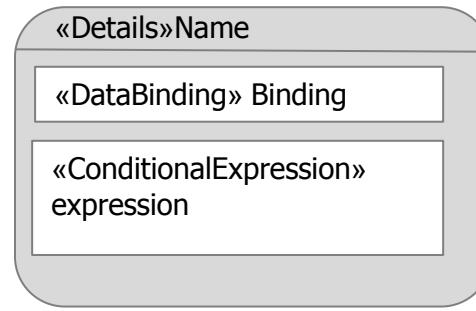
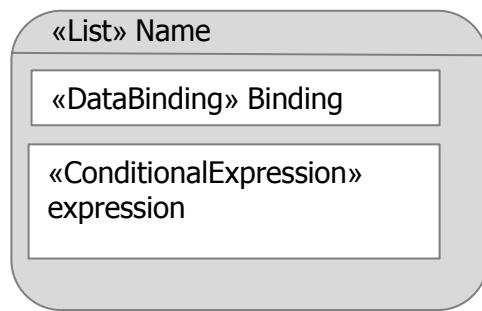
IFML by example



Actions



IFML – adding details to ViewComponents



ViewComponentParts:

- Data binding
- Parameters

Types of ViewComponents (<<List>>)



Data binding

- Joint use of IFML and other modeling languages:
 - DataBinding to classes and attributes of UML Class Diagrams
 - Upcoming: also with other content models, such as: Entity-Relationship, Ontologies, ...

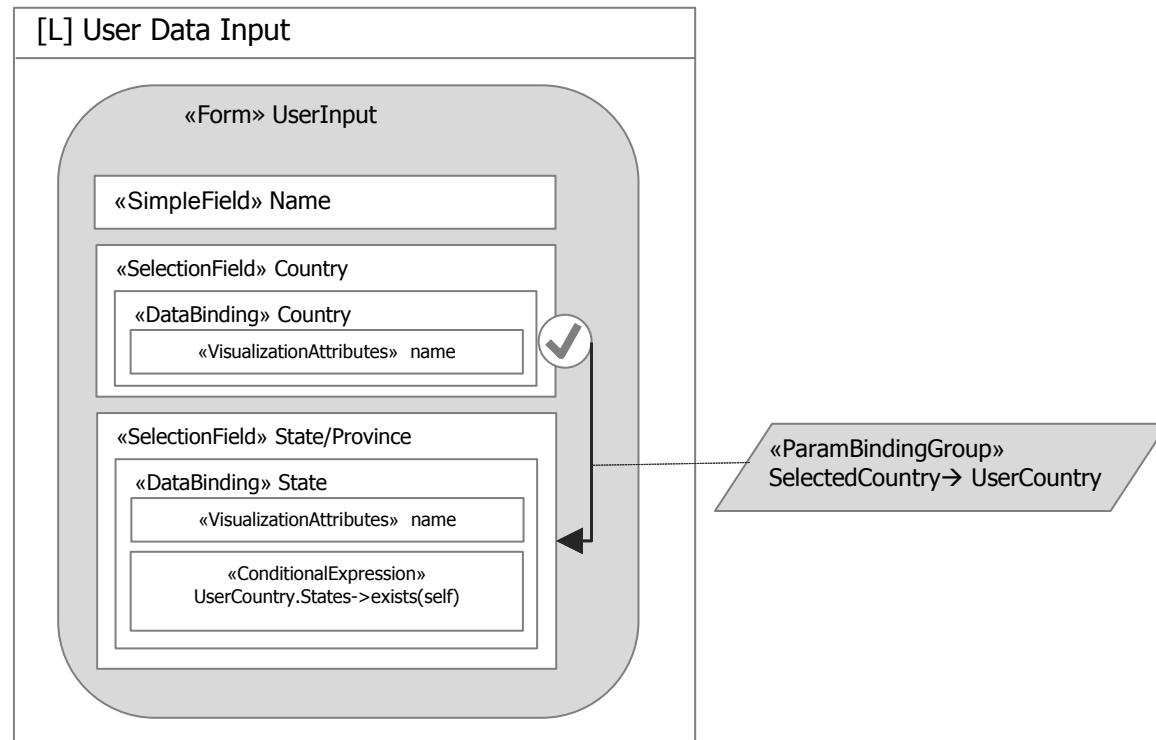


Dynamic Behaviour

- Joint use of IFML and other modeling languages
- Connection of Actions to back-end business logic as
 - UML methods of classes
 - whole UML dynamic diagrams
 - activity diagram, sequence diagram, state chart diagram, ...

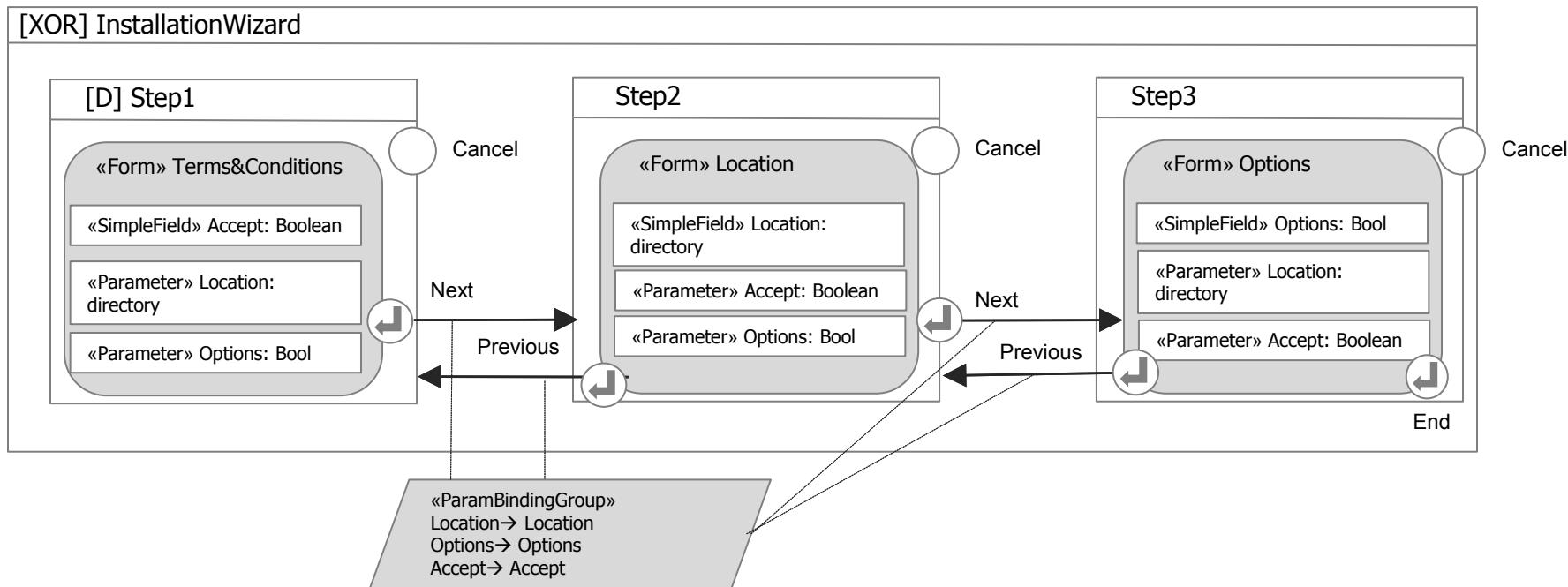


Dynamic Form Behavior



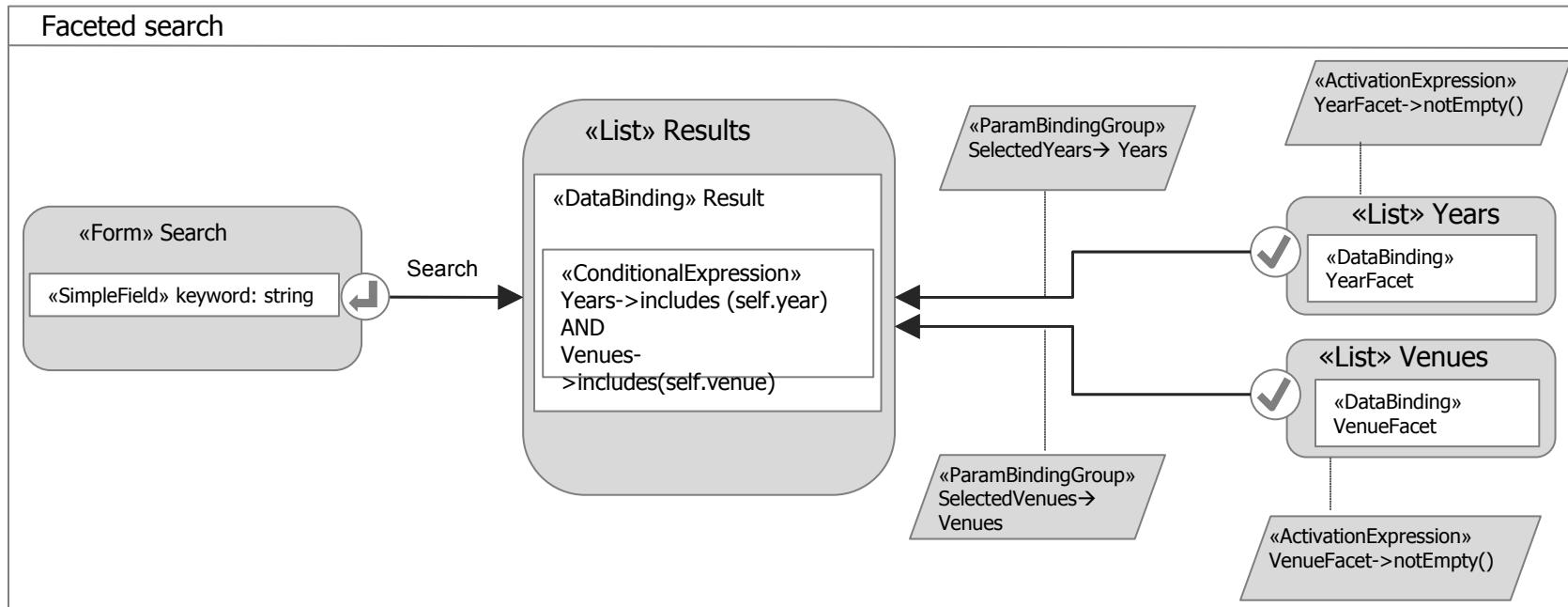


Example: Wizard



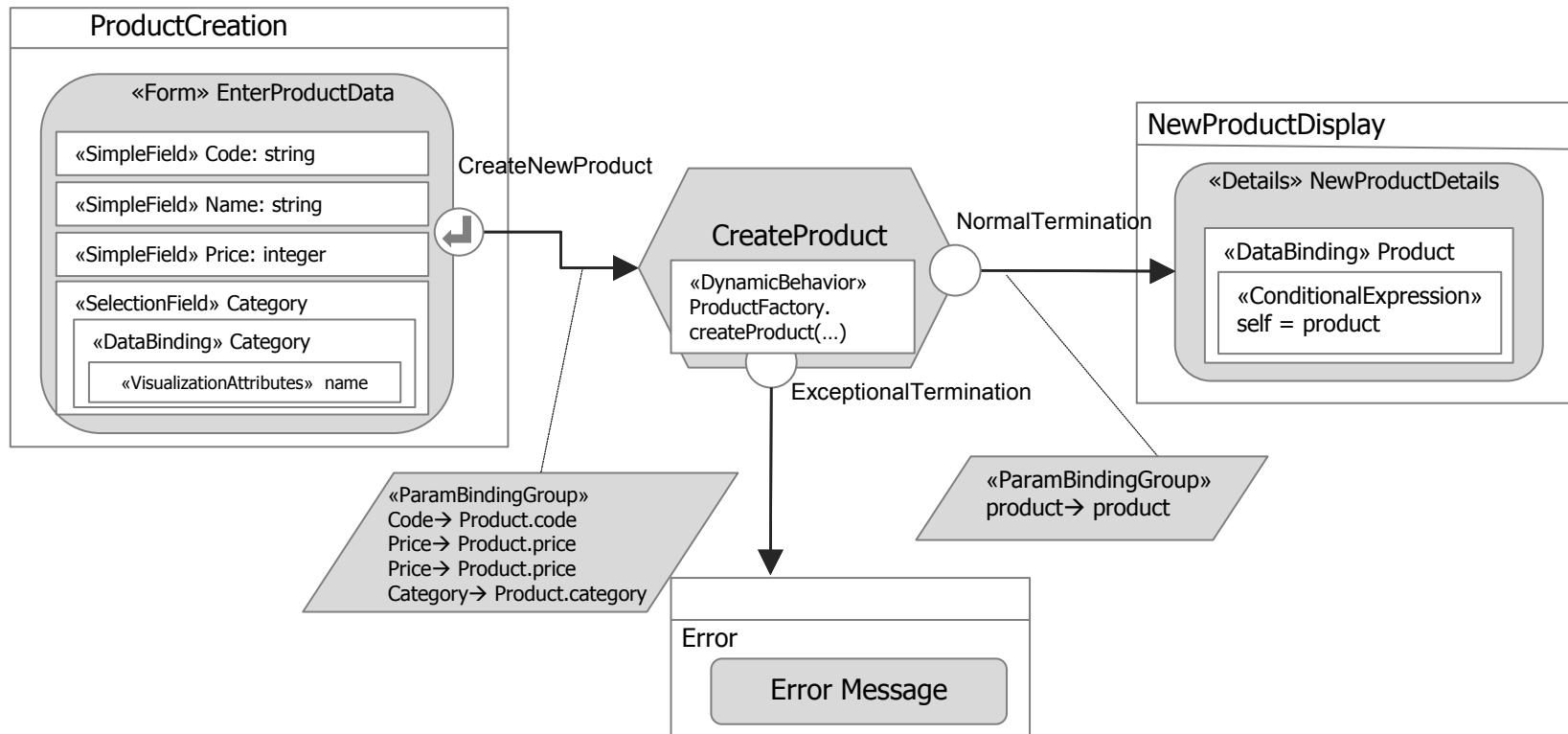


Example: Faceted Search



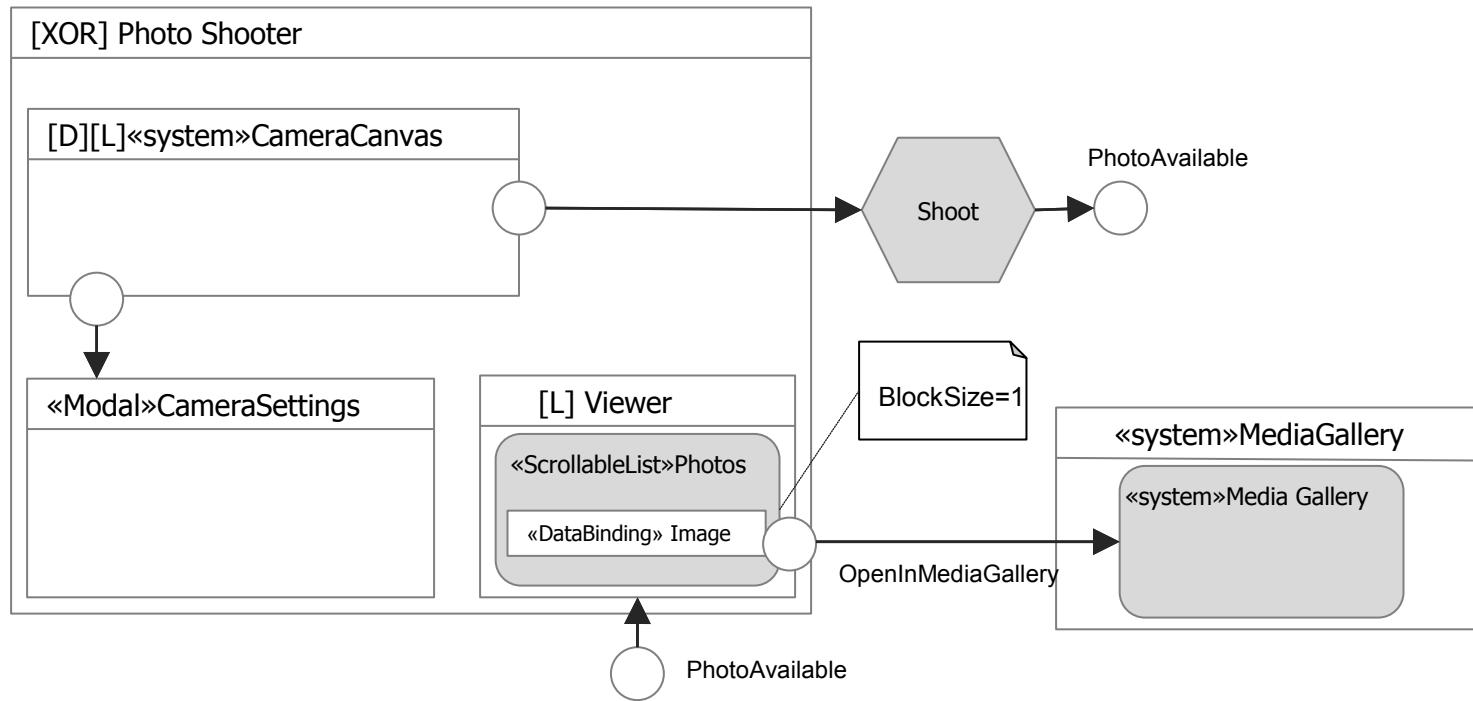


Example: Details on Actions



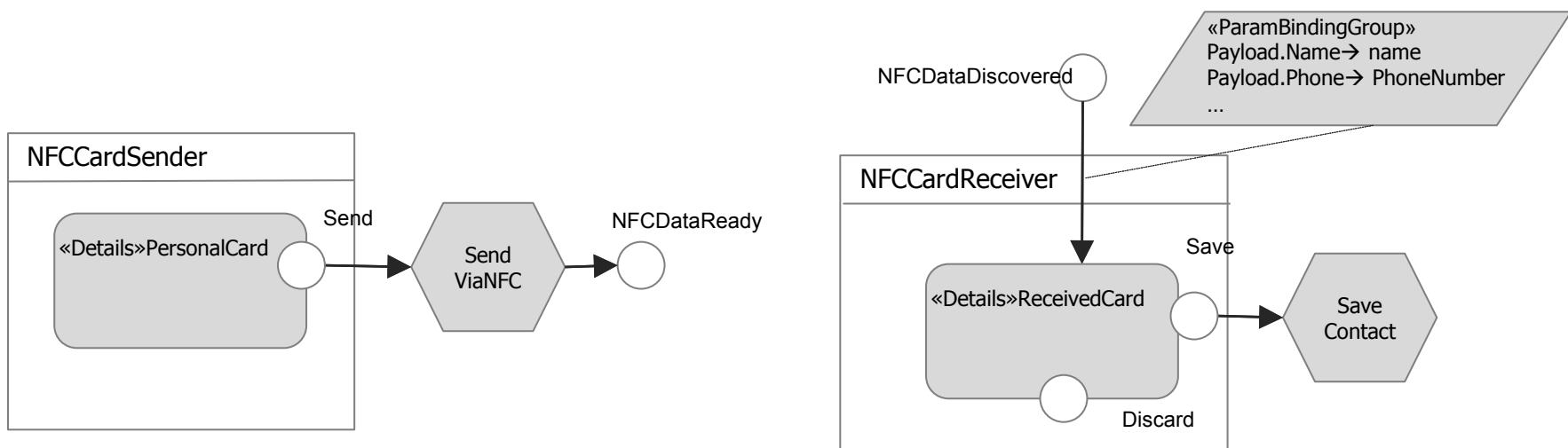


Example: Mobile Device, Camera Controls





Example: NFC Controls



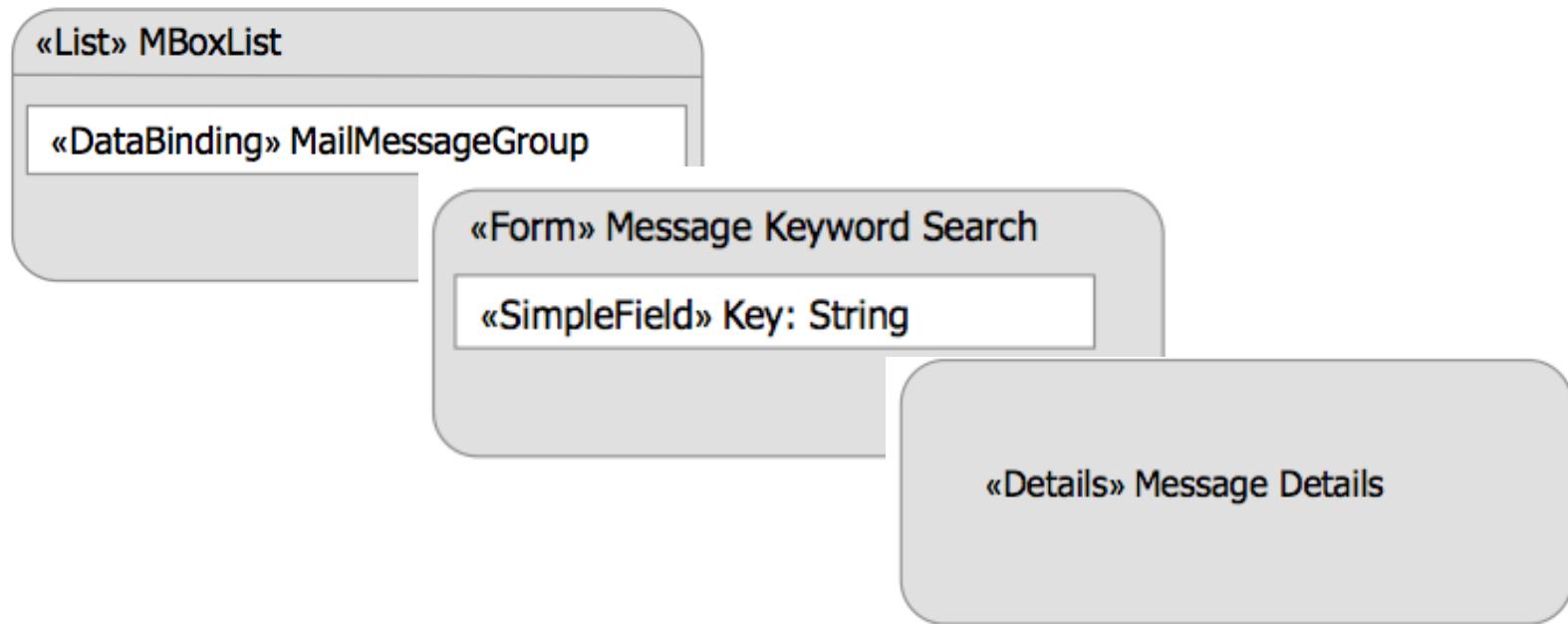


IFML – subtyping components and events

Selection event



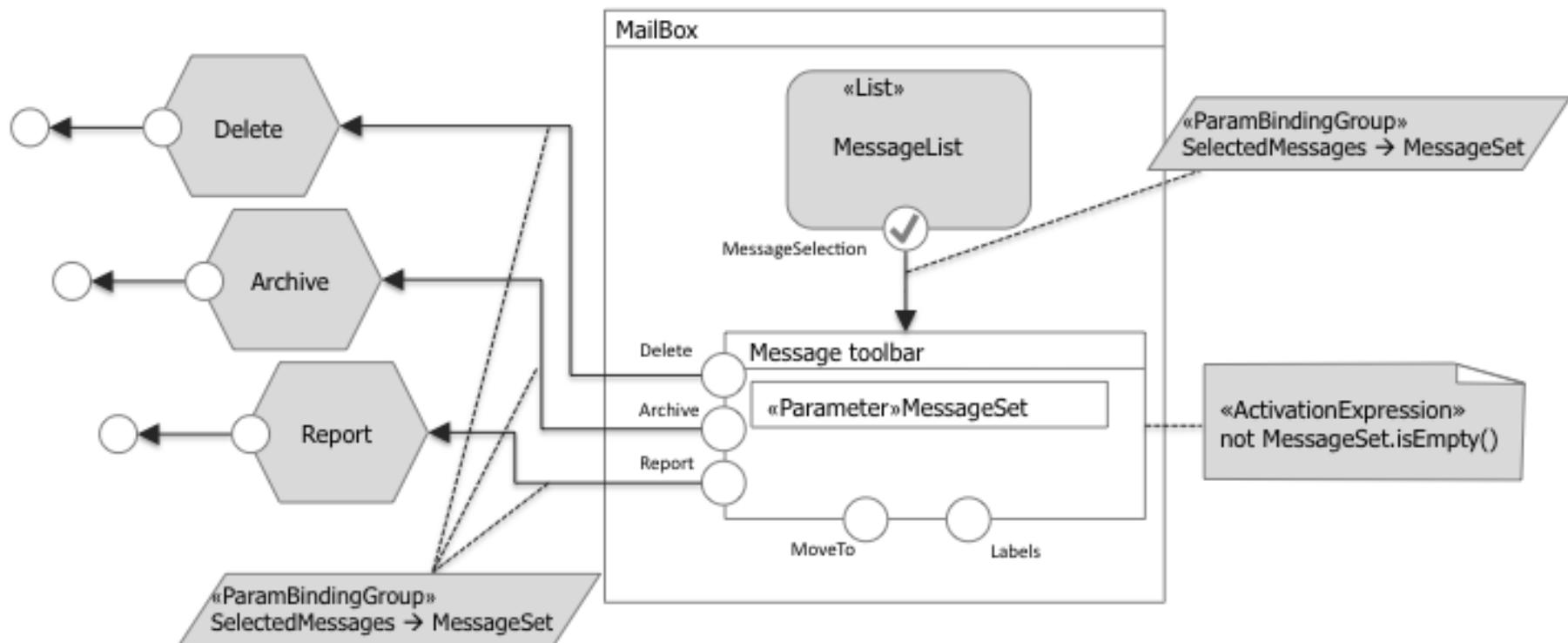
Submit event



.. And as many others as you want!



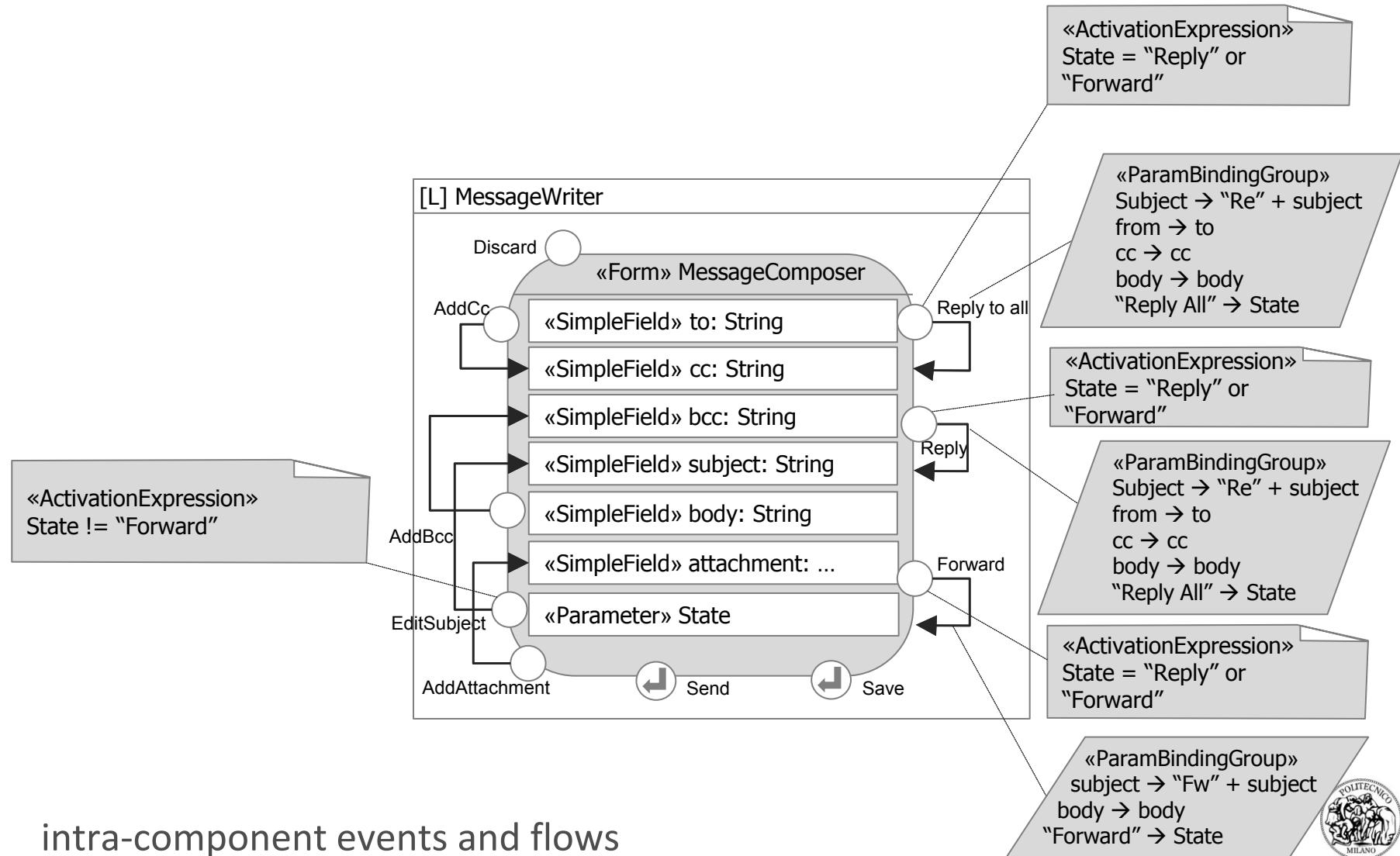
IFML by example



ActivationExpression, SubmitEvent, Event generation

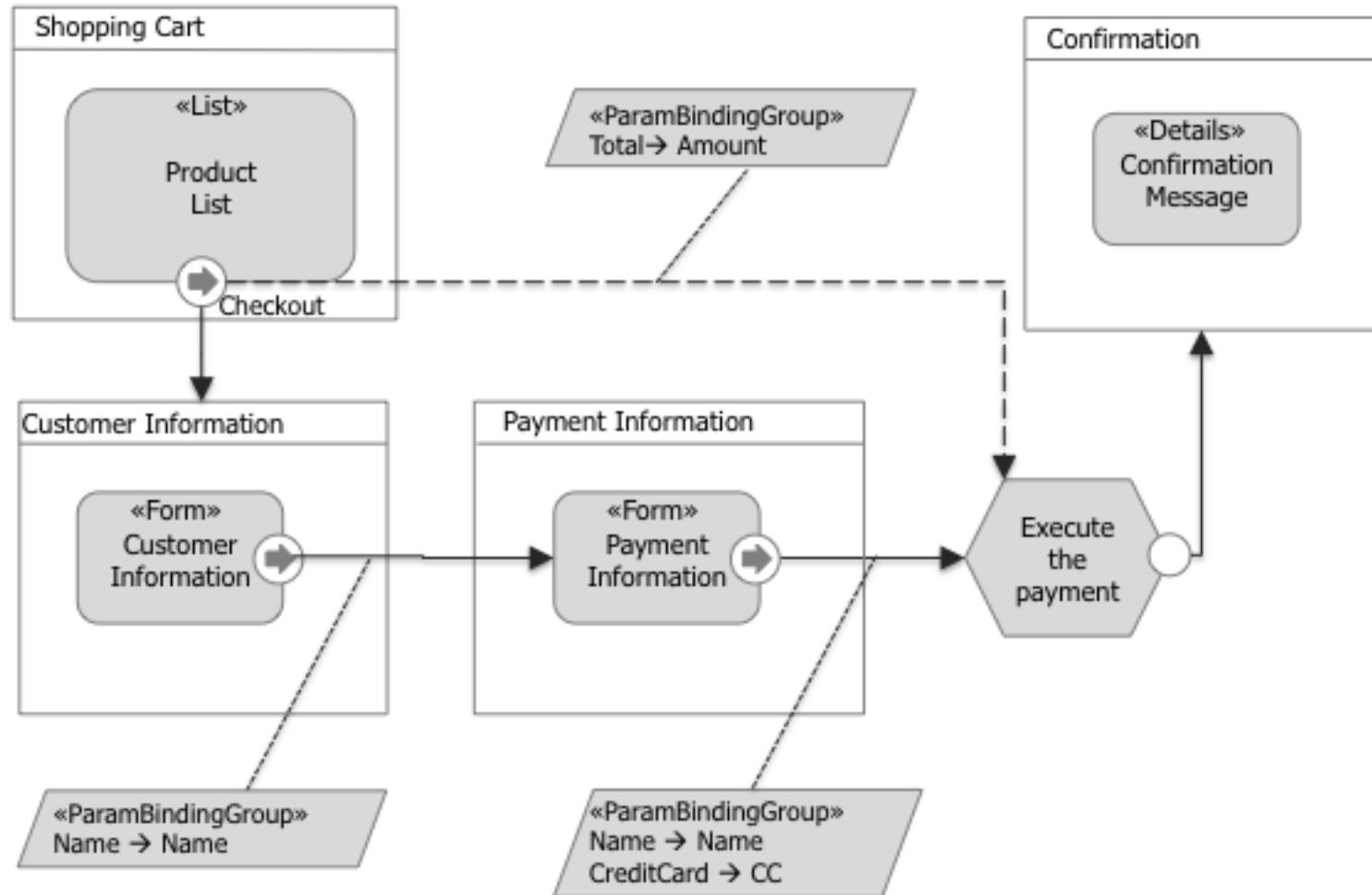


IFML concrete syntax by example





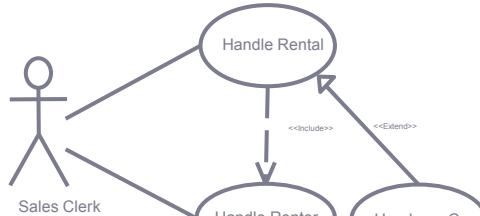
IFML example – online payment



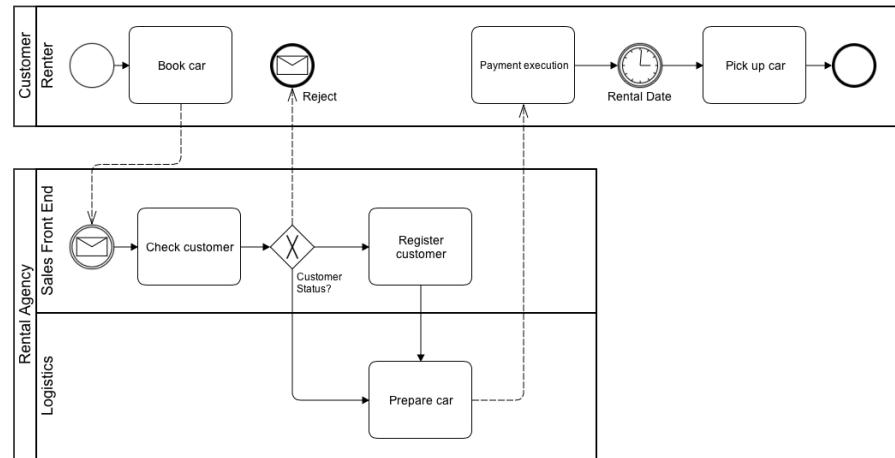


Multiple aspects modeling – 1 (business and requirements)

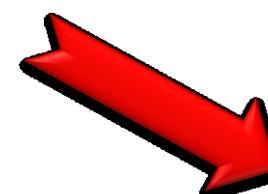
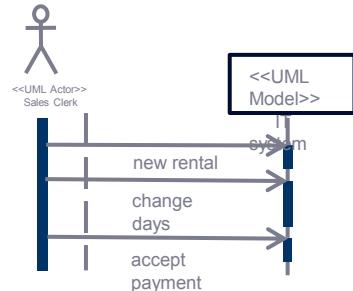
UML Use Case



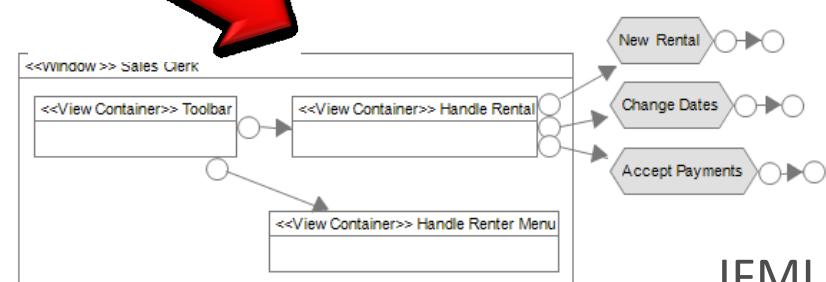
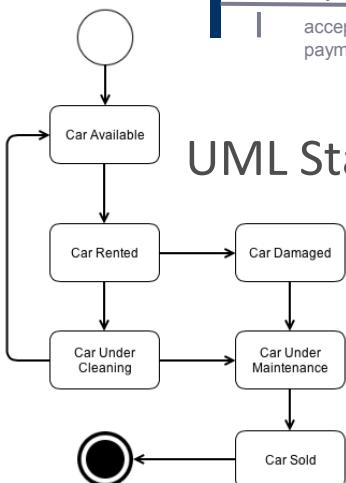
BPMN process



UML Sequence



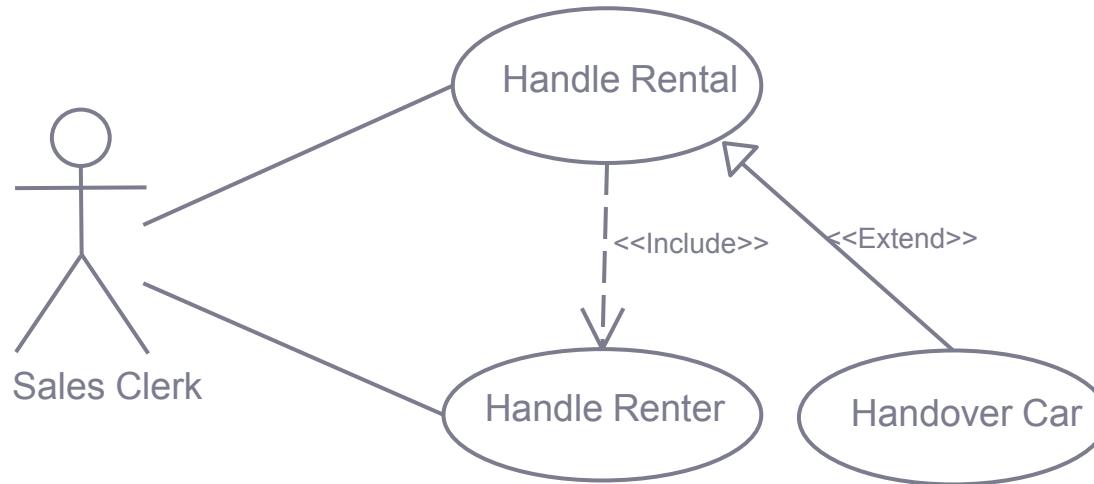
UML Statechart



IFML



Integration with UML Use Cases

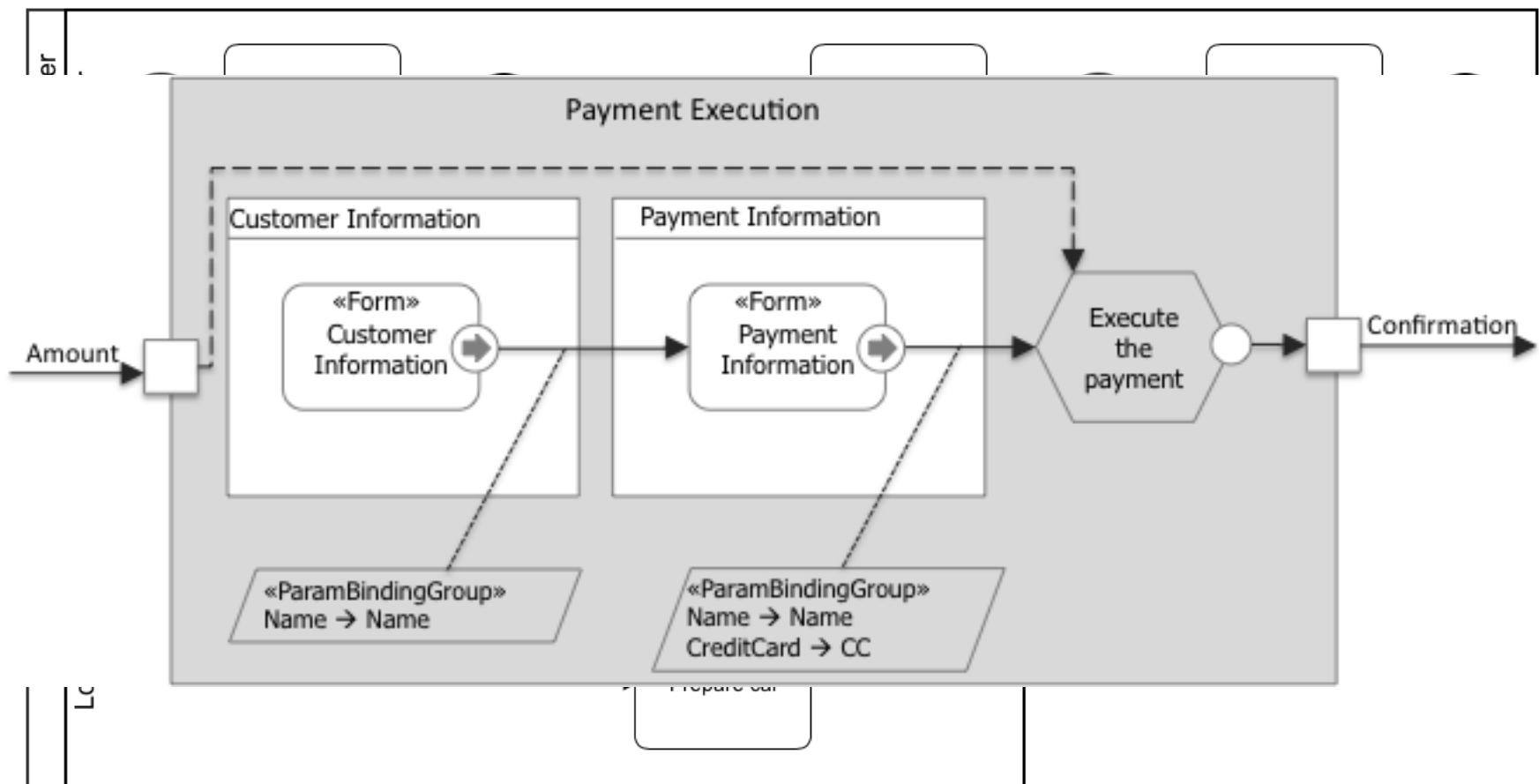


Each use case can be described by

- A business process
- A plain UI description in IFML
- Some UML dynamic diagrams (e.g., activity, sequence, ...)

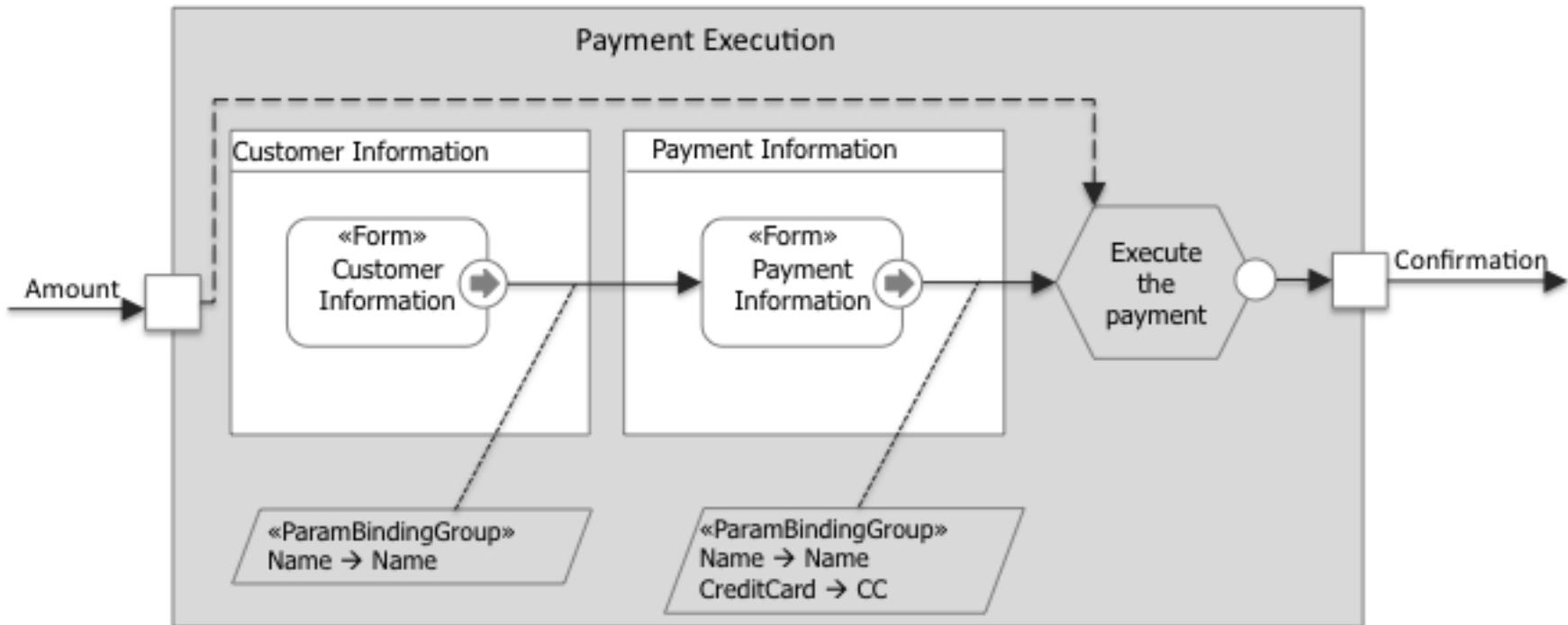


Integration with BPMN





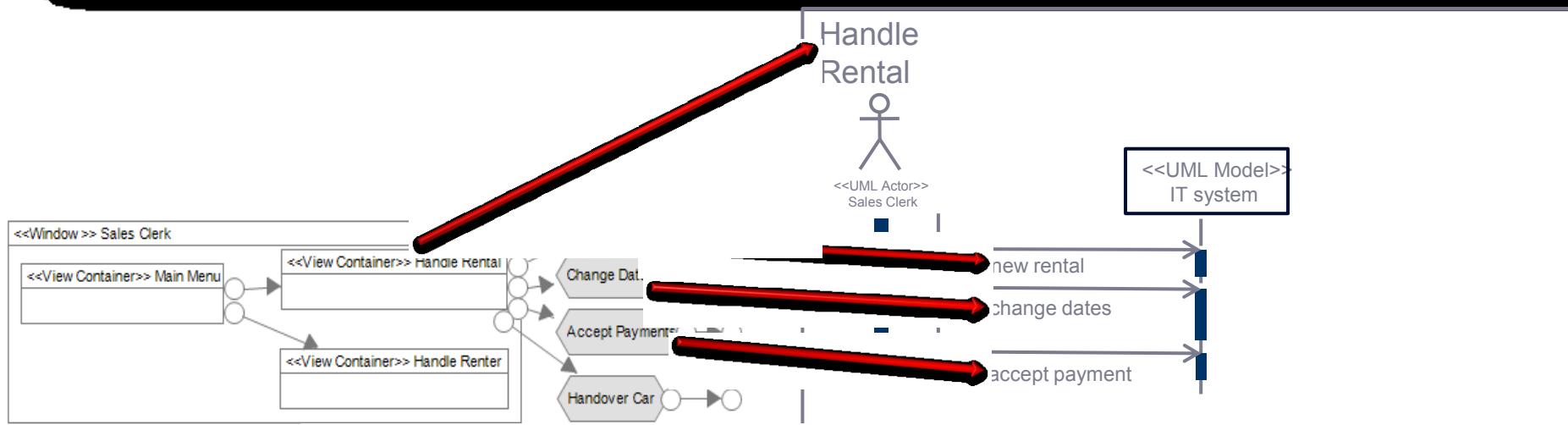
IFML concrete syntax by example



IFML Modules - definition



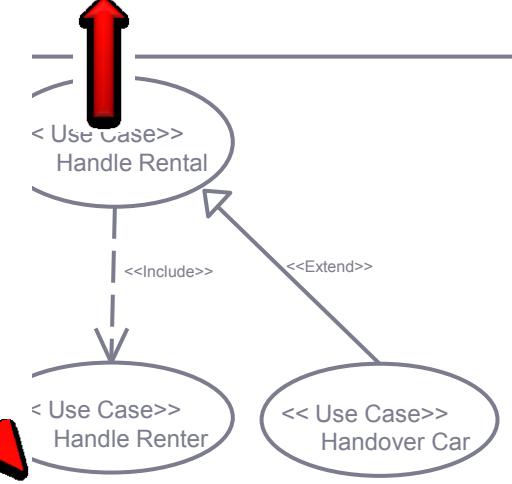
Example of UML - IFML mapping



IFML Model

IFML models can be reworked or refined after being generated

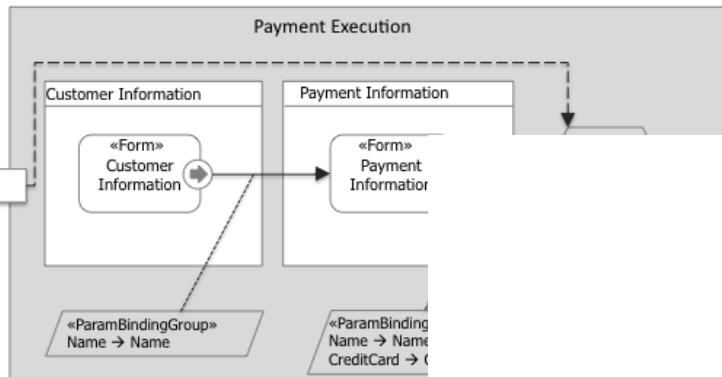
UML Use Case Diagrams



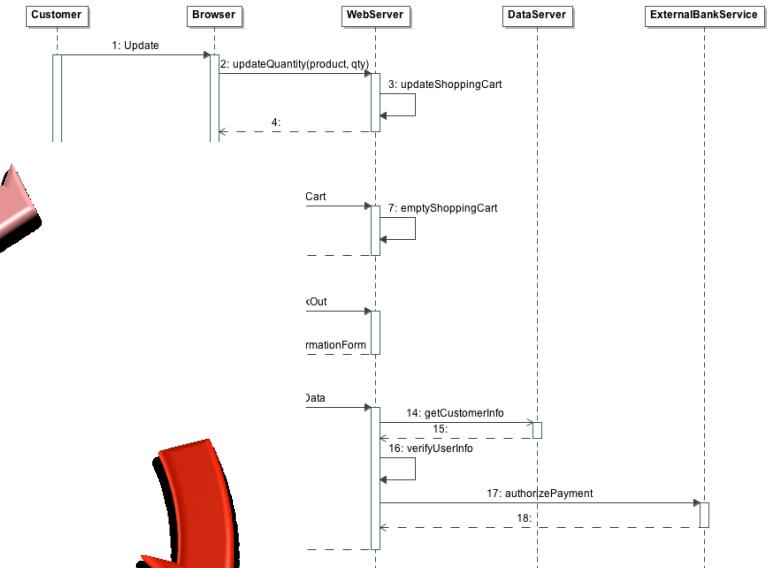


Multiple aspects modeling – 2 (implementation and architecture)

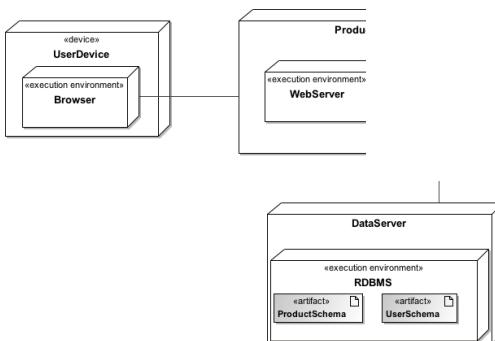
IFML



UML Sequence



UML Deployment



UI Mockup models

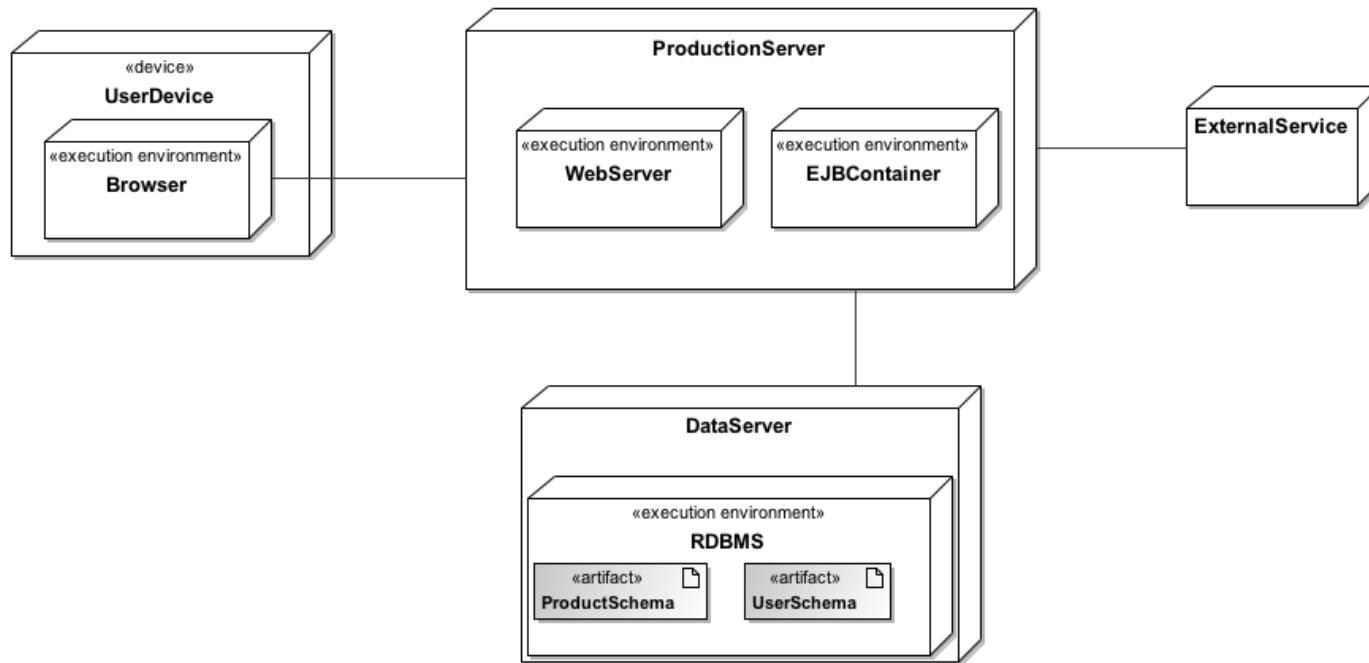




Integration with UML

Description of deployment architecture

- UI is just one facet of system design
- Often need to position it in a broader architectural vision

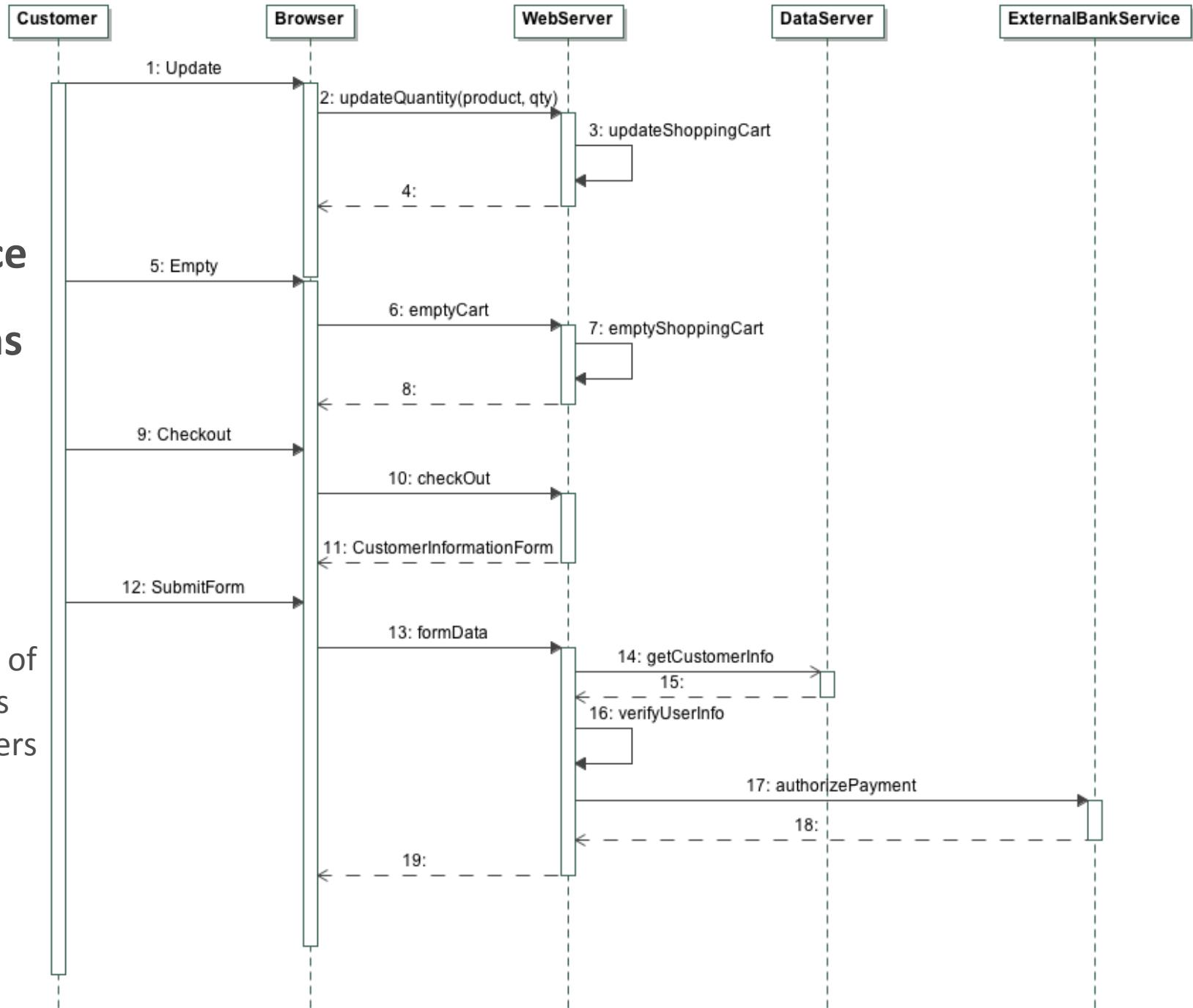


- UML deployment diagram

UML Sequence Diagrams

Tiers and calls

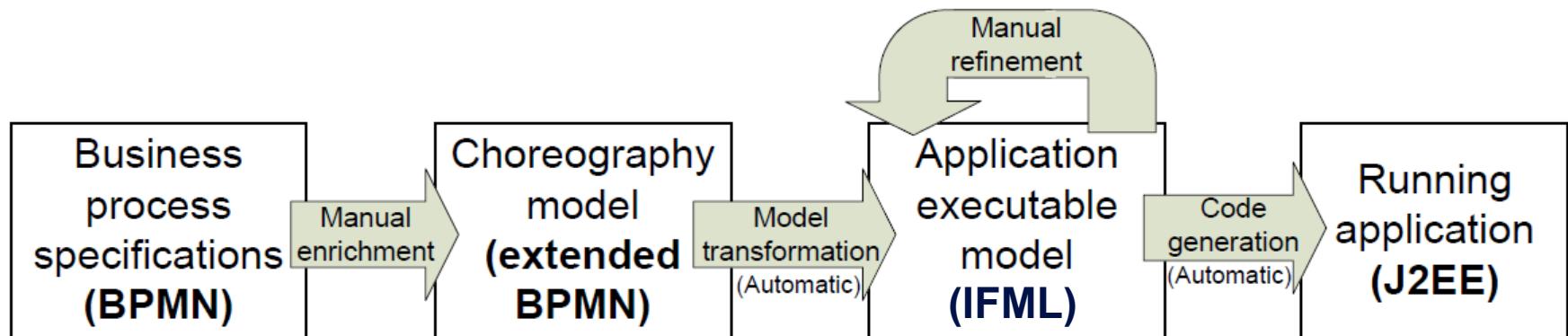
Explicit
description of
interactions
between tiers





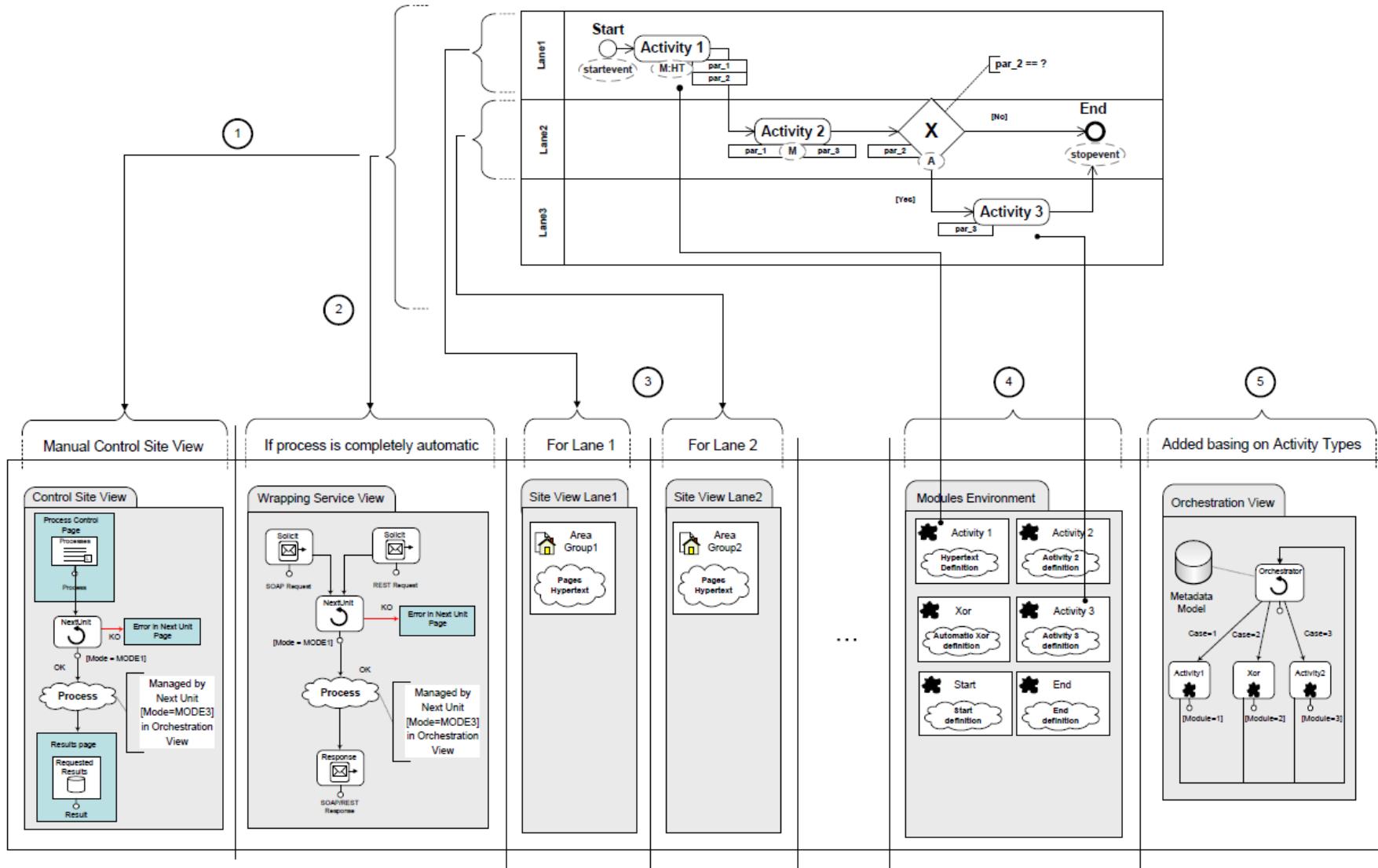
Model-driven Development Process

- Manual specification of BPMN process model
- Automatic transformation of BPMN to IFML
- Possible manual refinement of IFML models
- Automatic running code generation on J2EE platform
- Virtuous development cycle





The generated model artifacts

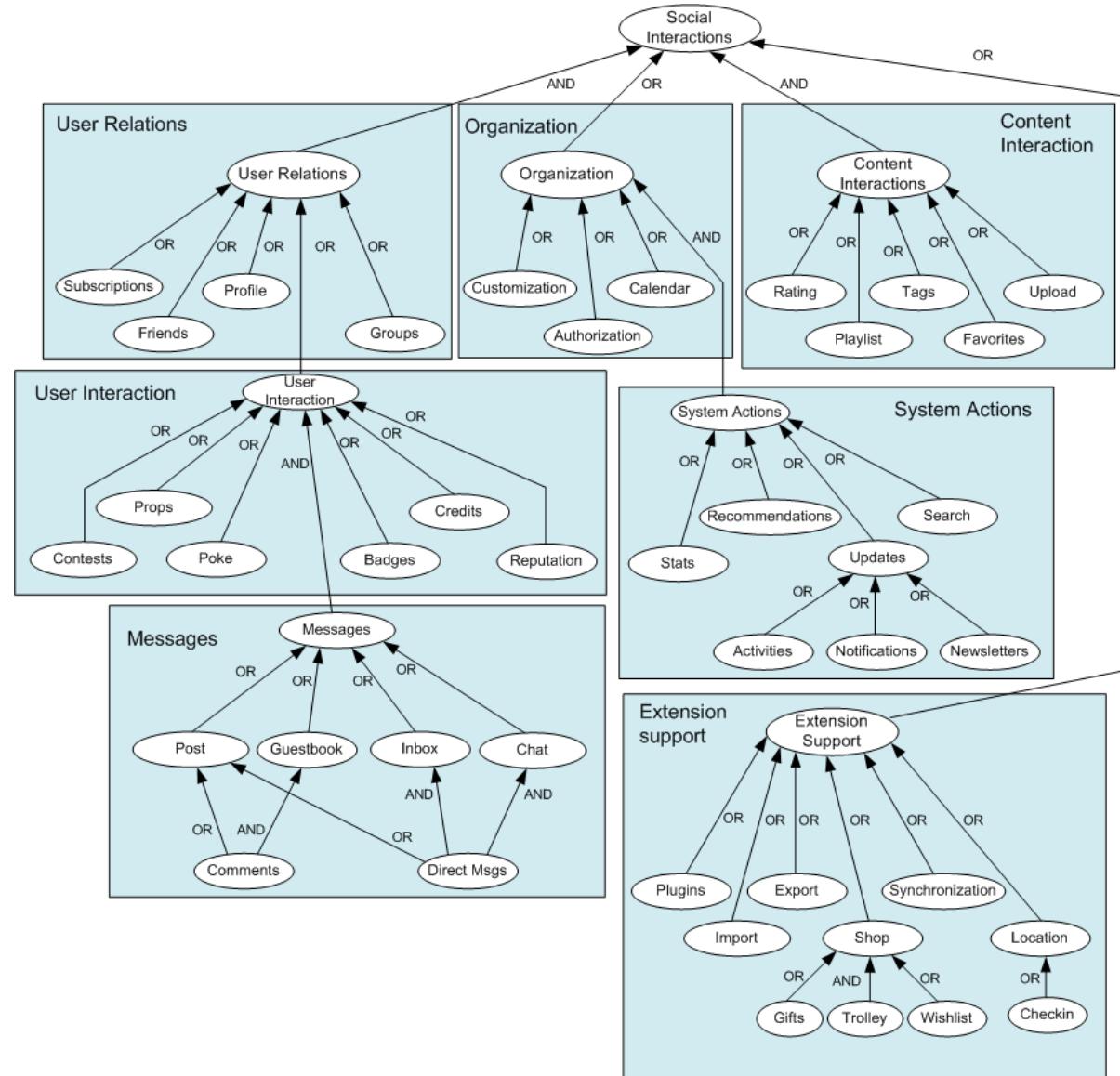




Example: from social networking goals..

Goal taxonomy

Interleaving with enterprise values





.. to design patterns

As in the tradition of BPM design patterns, they capture reusable solutions to recurrent socialization requirements:

- Dynamic enrollment
- Poll
- People / Skill search
- Social content publication
- Social sourcing (vs. crowdsourcing)
- Progress notification
- Ranking and commenting



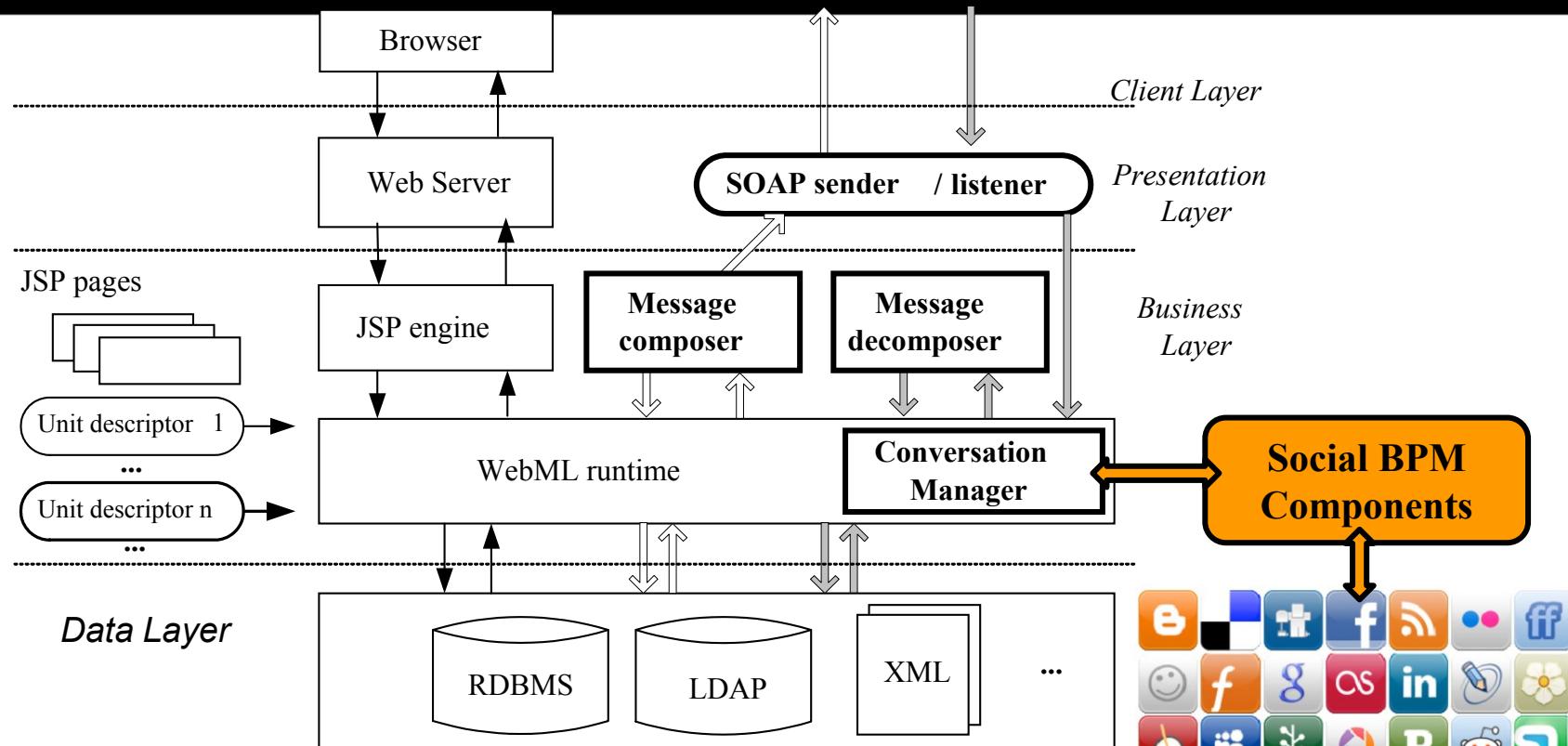
... and business objectives

Socialization goals can be used as drivers for the selection of the social BPM design patterns that are more relevant to a process socialization effort

	Weak Ties / Tacit Knowledge	Transparency	Participation	Activity distribution	Decision distribution	Social f.back	Knowledge sharing
Dynamic enrollment			X				
Poll					X	X	
People / Skill search	X			X	X		
Social content publication		X					X
Social sourcing				X			
Progress notification		X					
Ranking and commenting	X				X	X	X



WebRatio runtime architecture and extension for Social Business Logic



Legenda

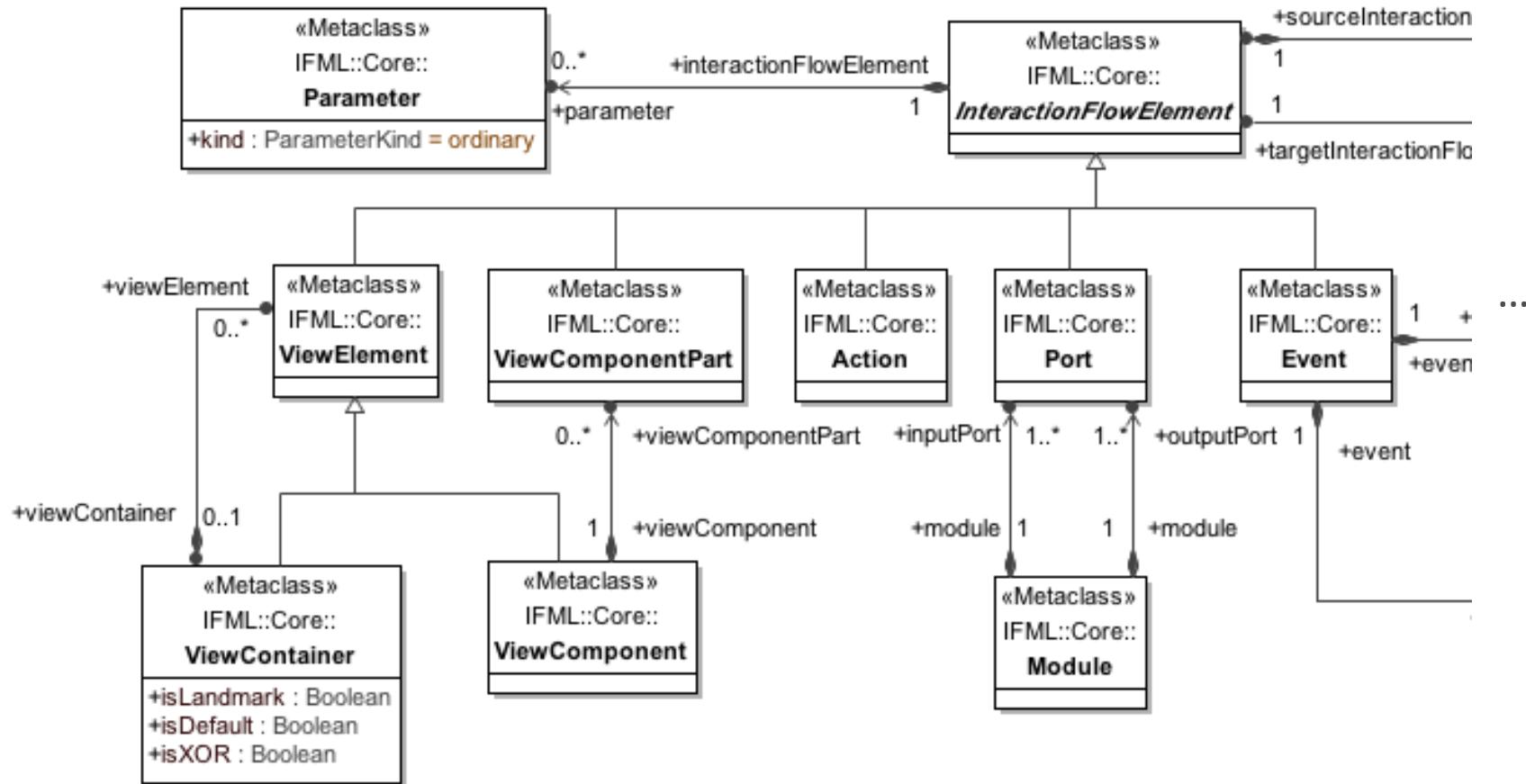
- Processing of messages received by the site
- Construction of messages sent by the site
- Standard components interactions

*Social networks and social APIs
(public or enterprise)*



How does it work? IFML metamodel (1)

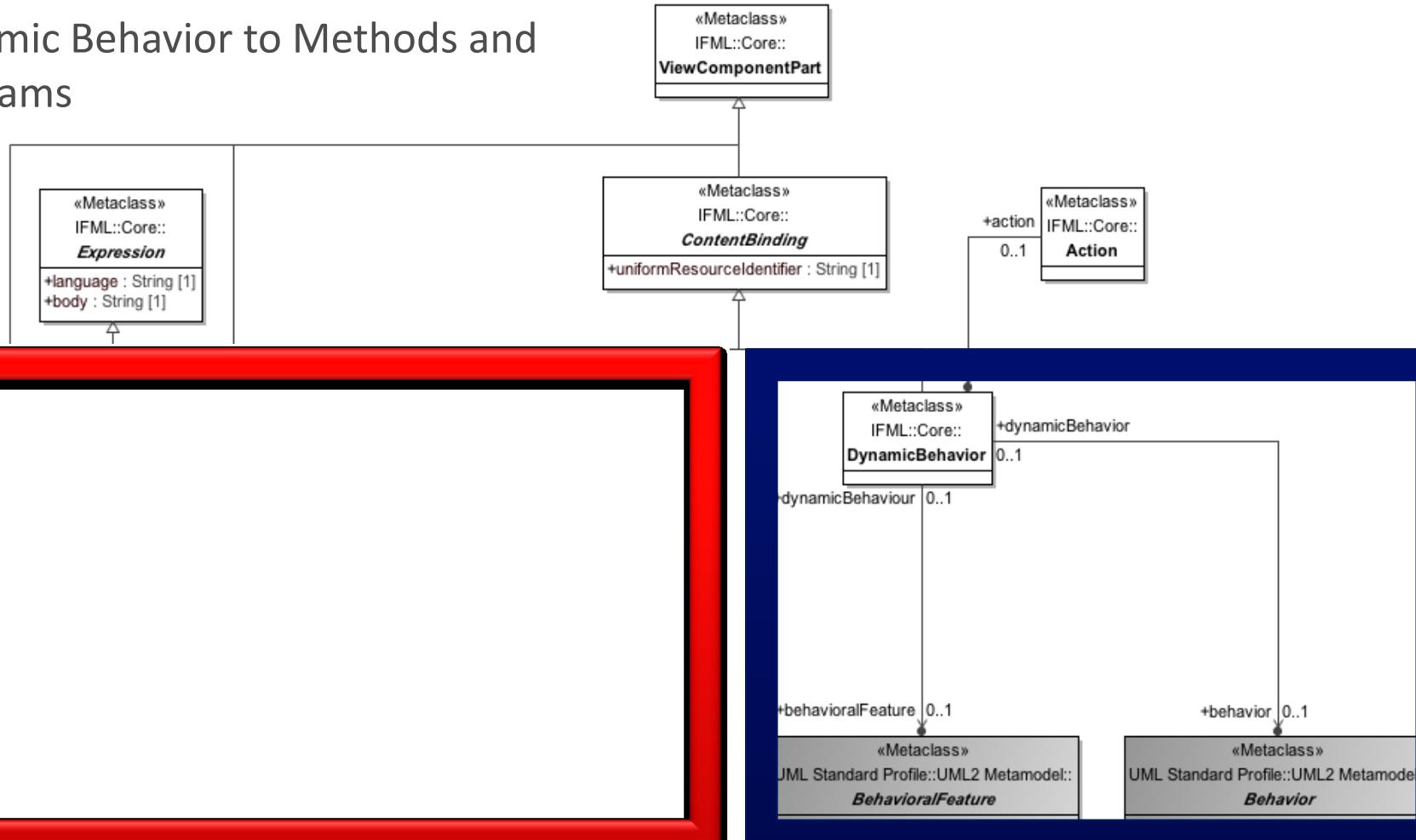
IFML is defined through a metamodel





IFML metamodel (2): Content Binding

- Data binding to Classes and Attributes
- Dynamic Behavior to Methods and Diagrams





Practical results of having a standard

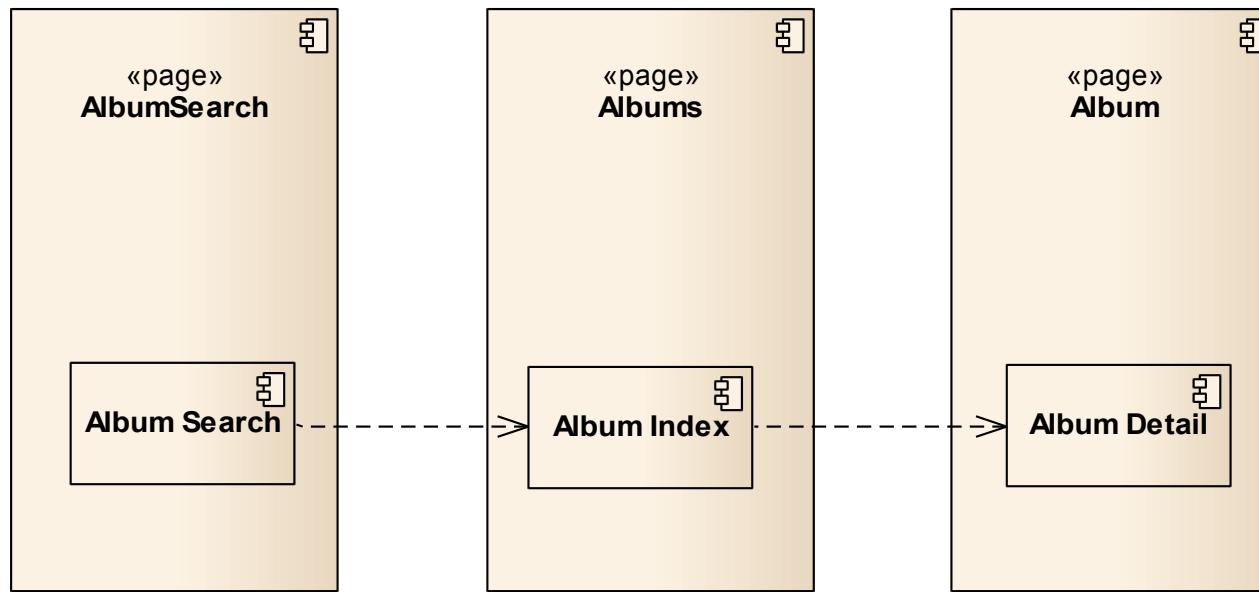
- An official **metamodel of the language** which describes the semantics of and relations between the modeling constructs
- A **graphical concrete syntax for the interaction flow notation** which provides an intuitive representation of the user interface composition, interaction and control logic for the front-end designer
- A **UML Profile** consistent to the metamodel
- An **interchange format** between tools using XMI

- All this, specified through standard notations themselves



Also: interchange with profile-based diagrams. The UML Profile for IFML

Static aspects



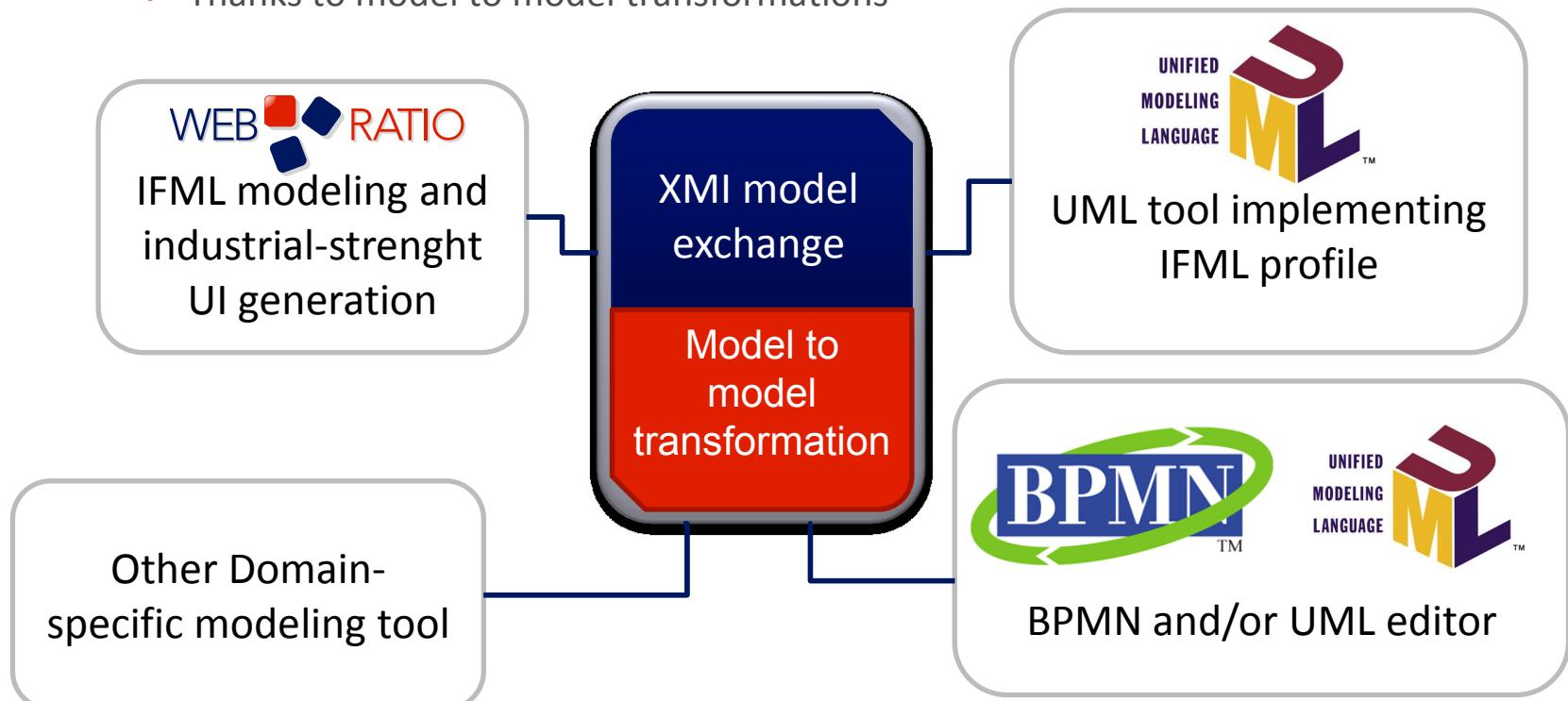
Dynamic aspects





Model integration and interchange

- Tight and seamless integration between different modeling tools
 - Thanks to XMI interchange format, UML profiles, vendor-specific notation implementations
 - Thanks to model to model transformations





Broader, enterprise-wide system modeling

- Joint usage of IFML with other MDA languages can be devised:
 - SysML
 - SoaML
 - ...
- ... and also with other frameworks (e.g., Model Driven Enterprise Engineering)

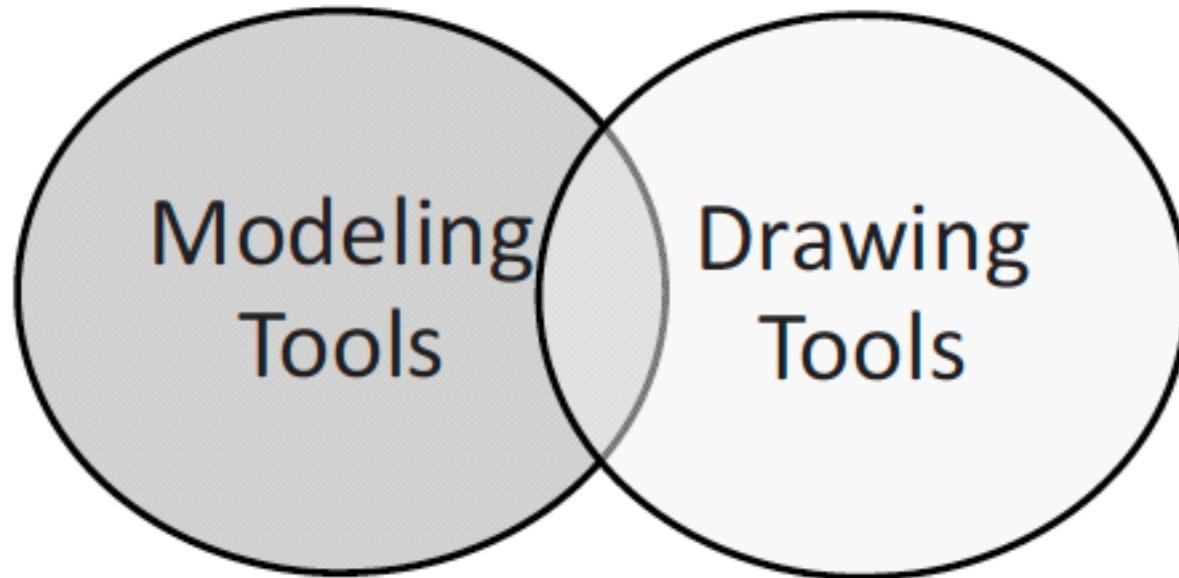
The tool





Tool support for MDE/MDD

Drawing vs. modeling

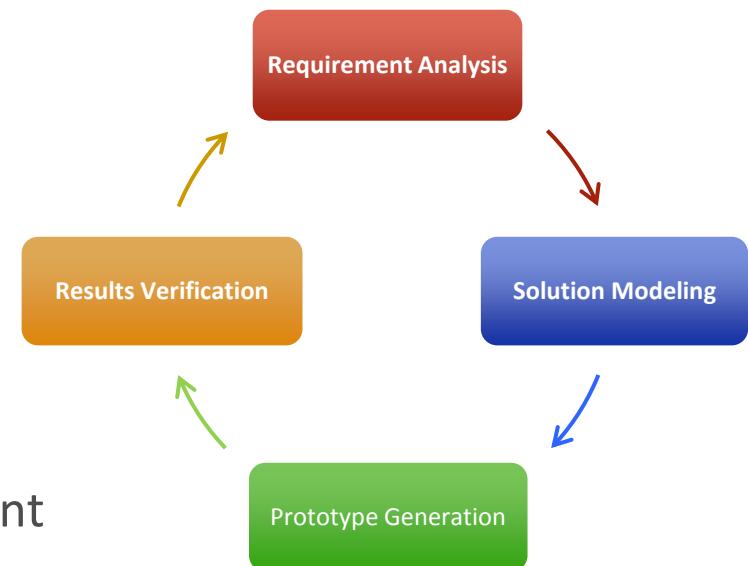




What is WebRatio

An Eclipse-based development environment allowing:

- Modeling: ER + IFML + BPMN
- **100% code generation** of standard JEE applications
 - Clear separation between design time and run time
 - No proprietary runtime
- Quick and agile development cycles
- Extending the generation rules
 - Defining new presentation styles
 - Defining new components
- Versioning, teamwork, full lifecycle mgt
- Truly multi-role model-driven development





Some numbers

WebRatio is

- now at 7th release
- on the market since 2001

WebRatio customers

- 130+ companies and 500+ commercial users
- mainly Italy, USA, Europe and Latin America

WebRatio adoption

- 15,000+ users of the free edition
- Used in hundreds of universities all over the world

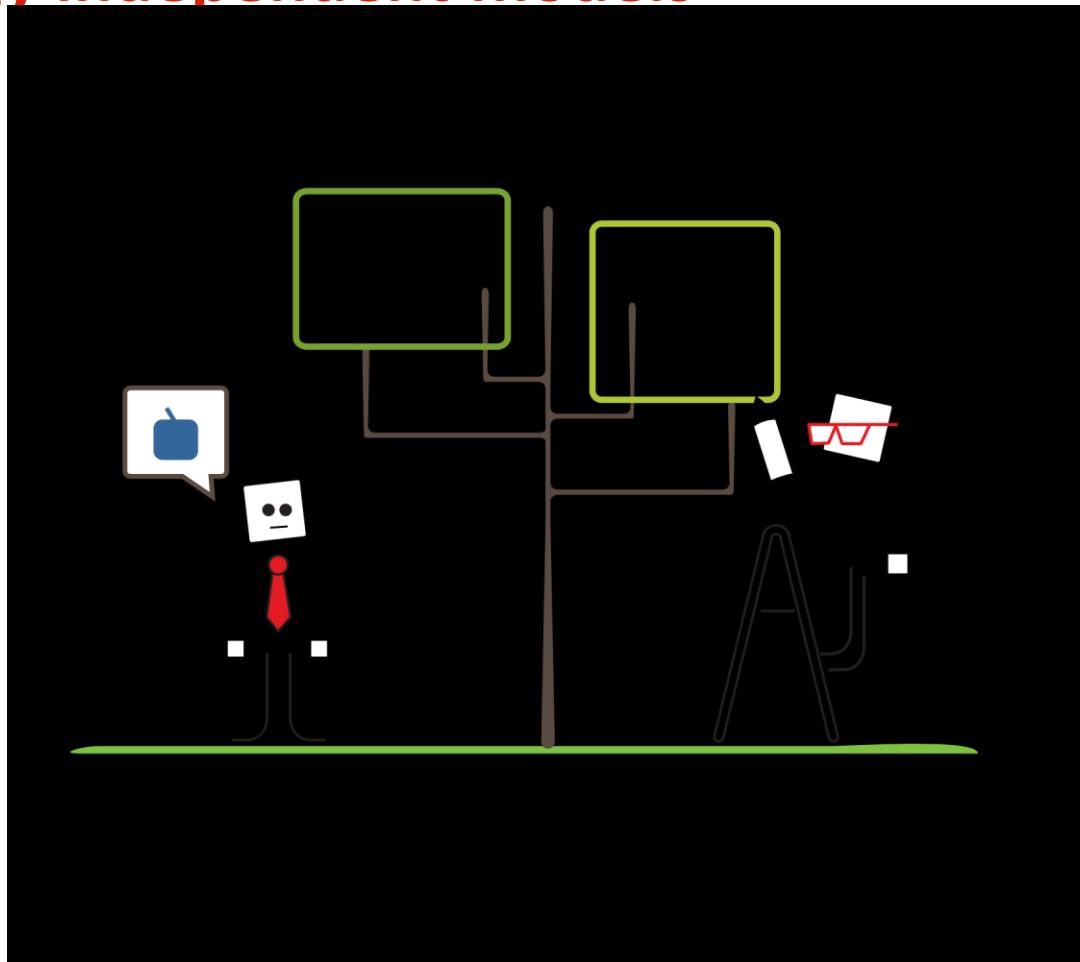
WebRatio partners

- 40+ software houses and system integrators
- 300+ universities worldwide, 13.000+ students



WebRatio – Step 1

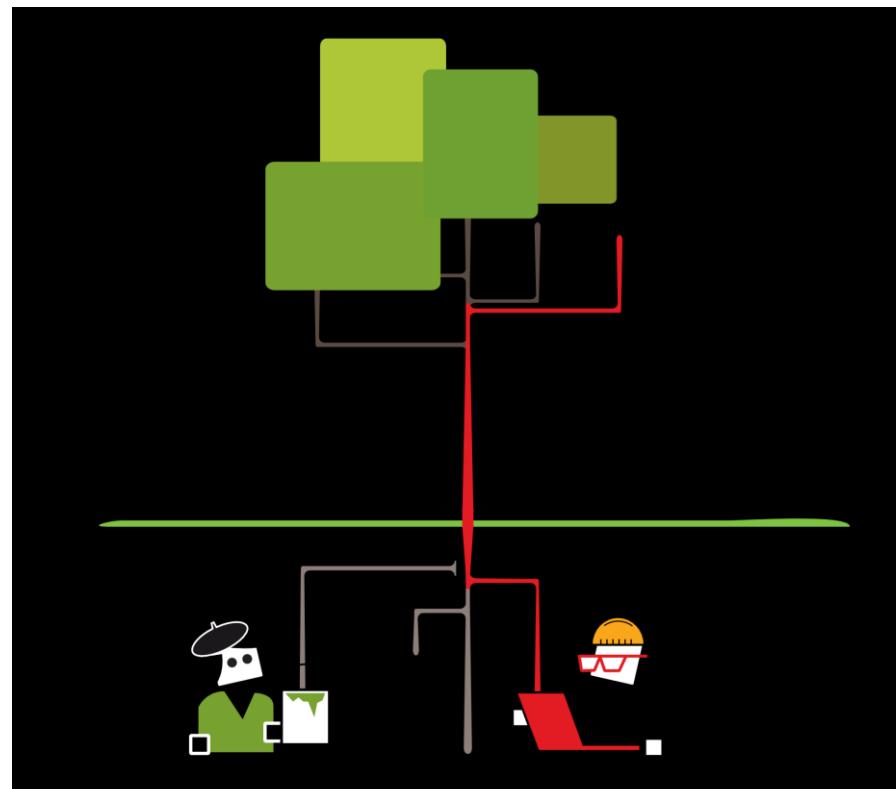
You capture business requirements in abstract,
technology independent models





WebRatio – Step 2

You customize the environment by defining your own generation rules

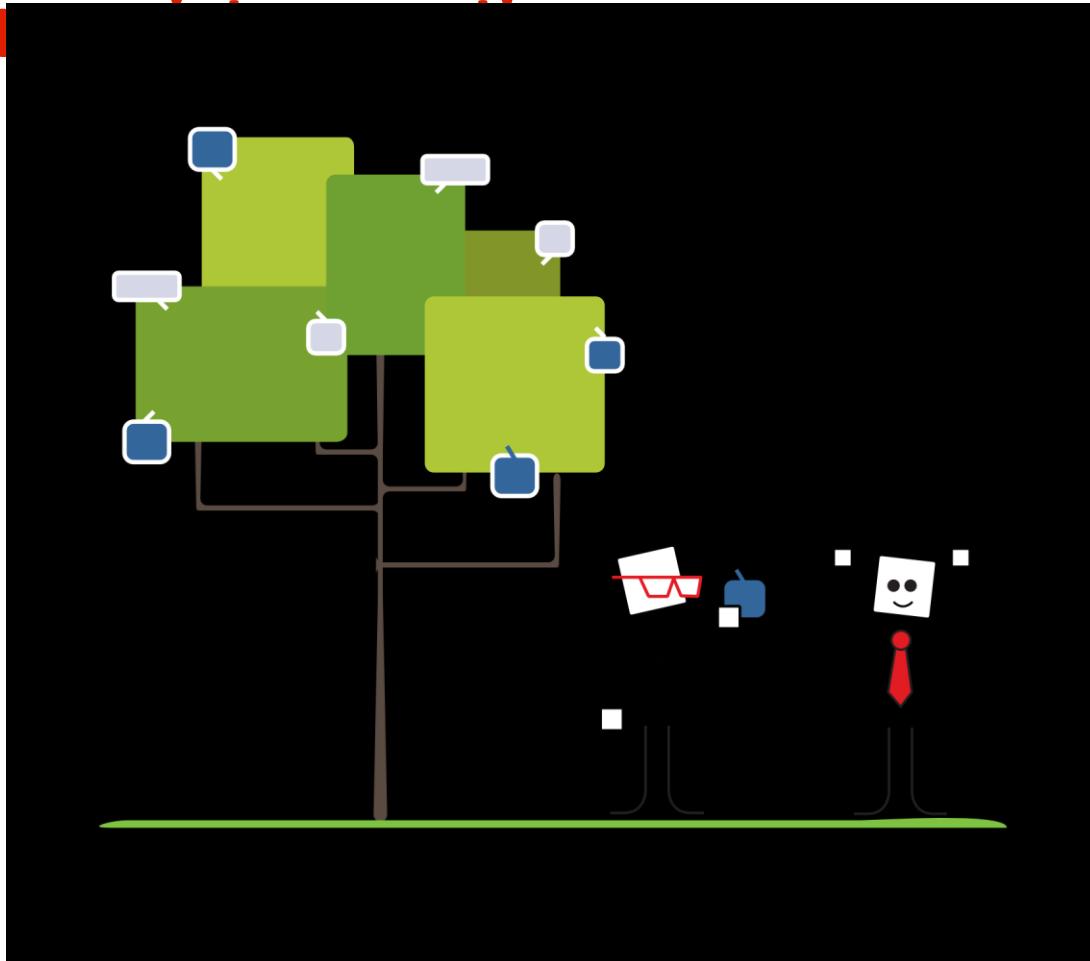


HTML 5 + CSS + Java



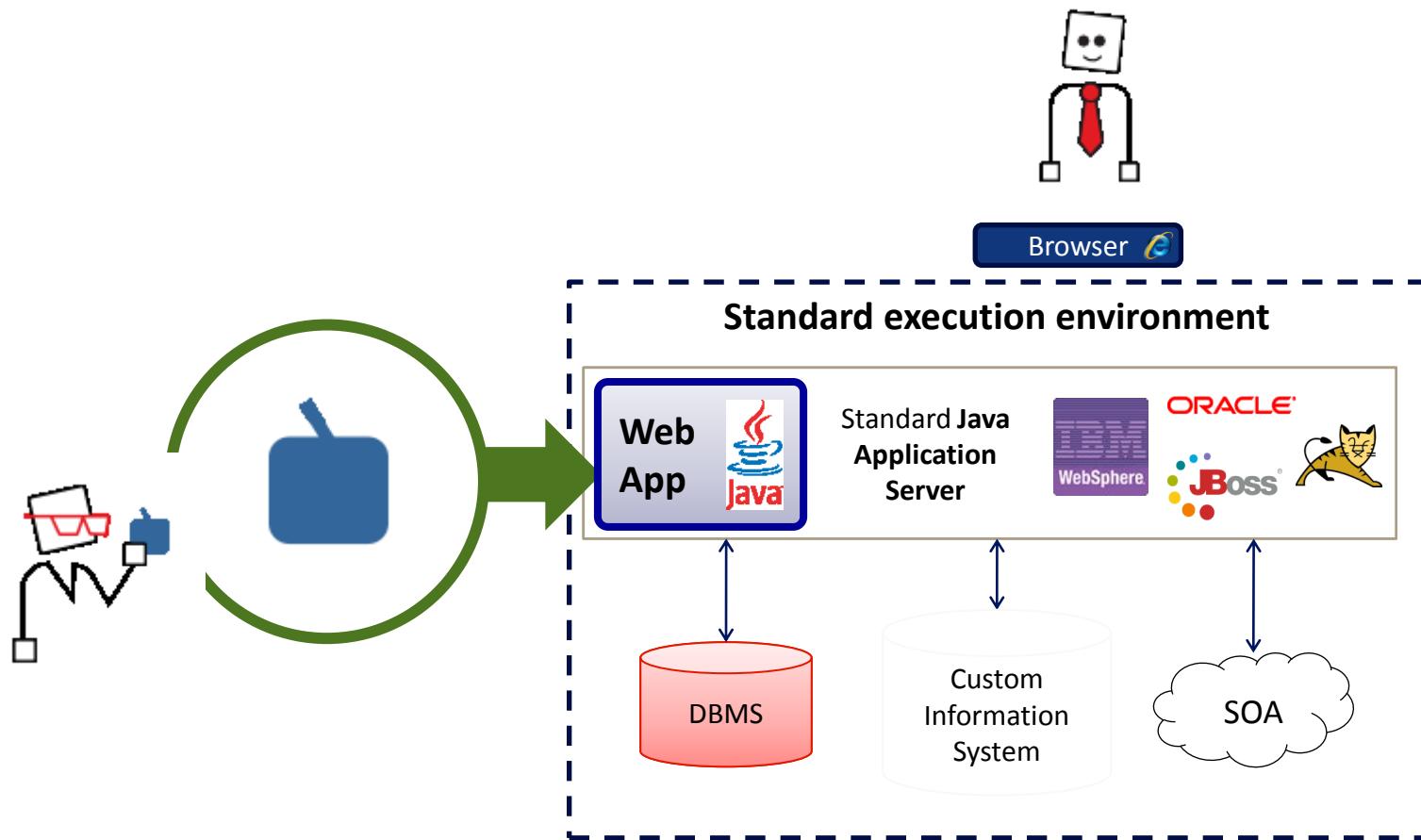
WebRatio – Step 3

You get a tailored, yet standard, Java Web application
with no programming required





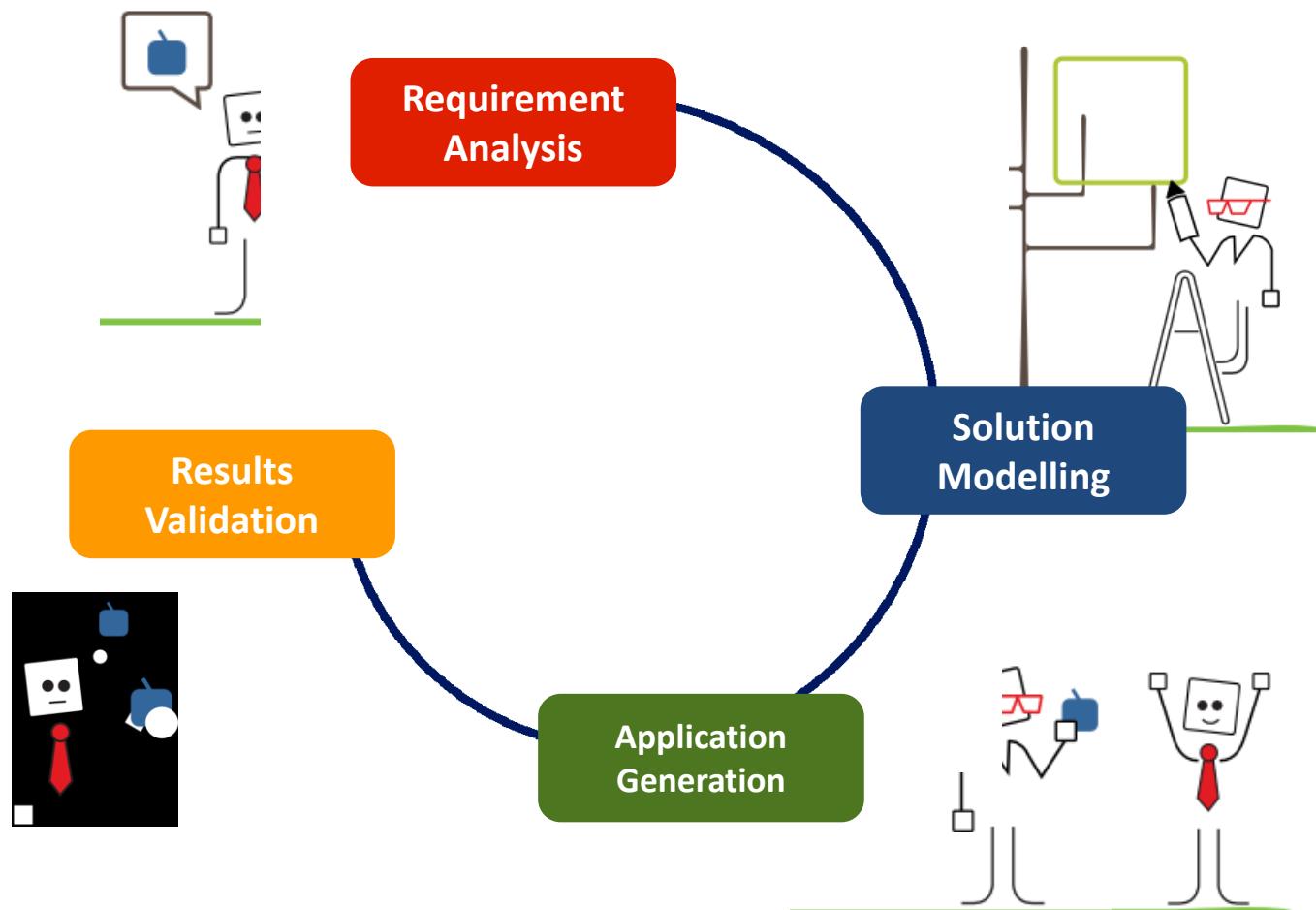
Get the application





Agile, quick prototyping

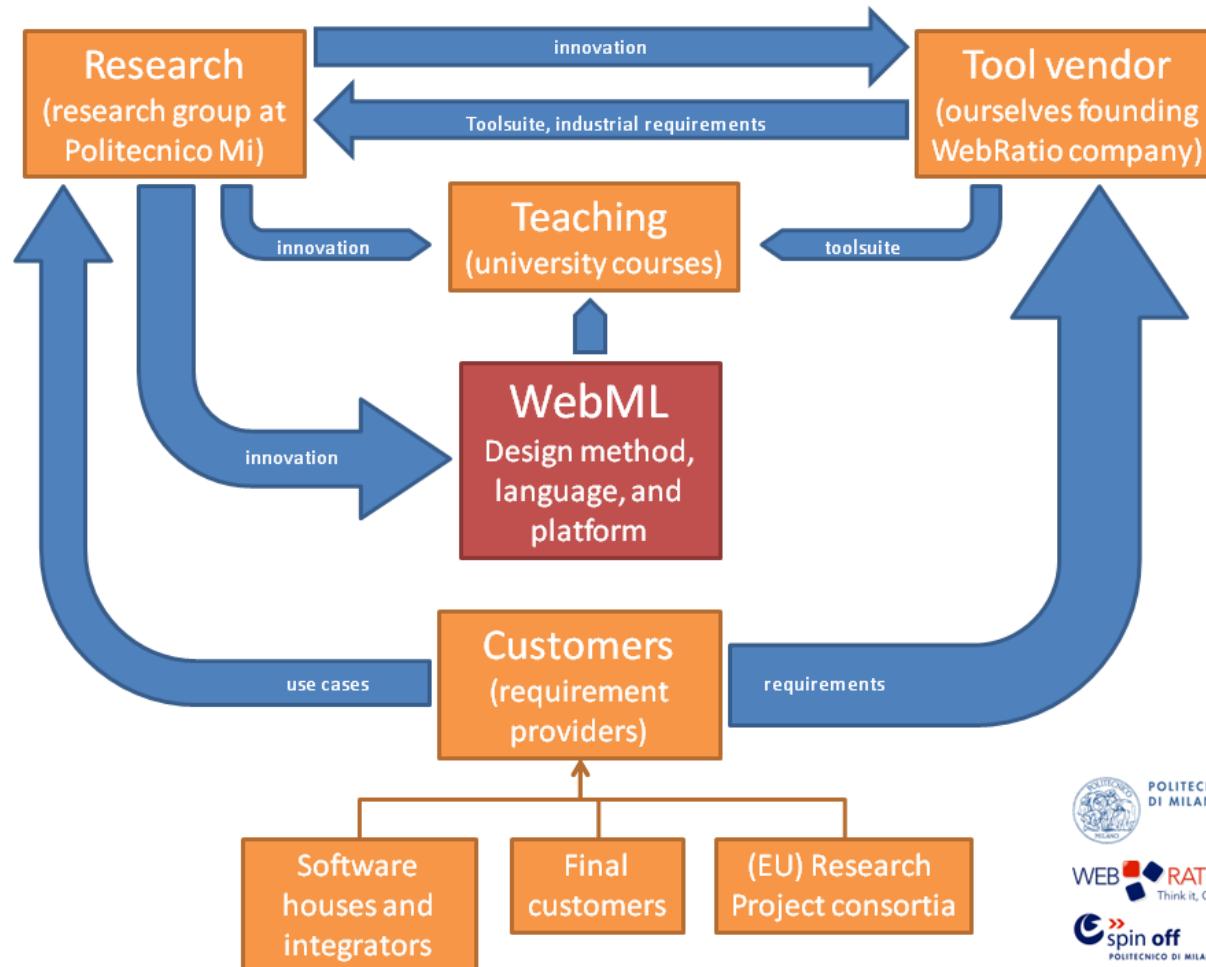
Involve business users in the development process and converge quickly to the target



RATIO

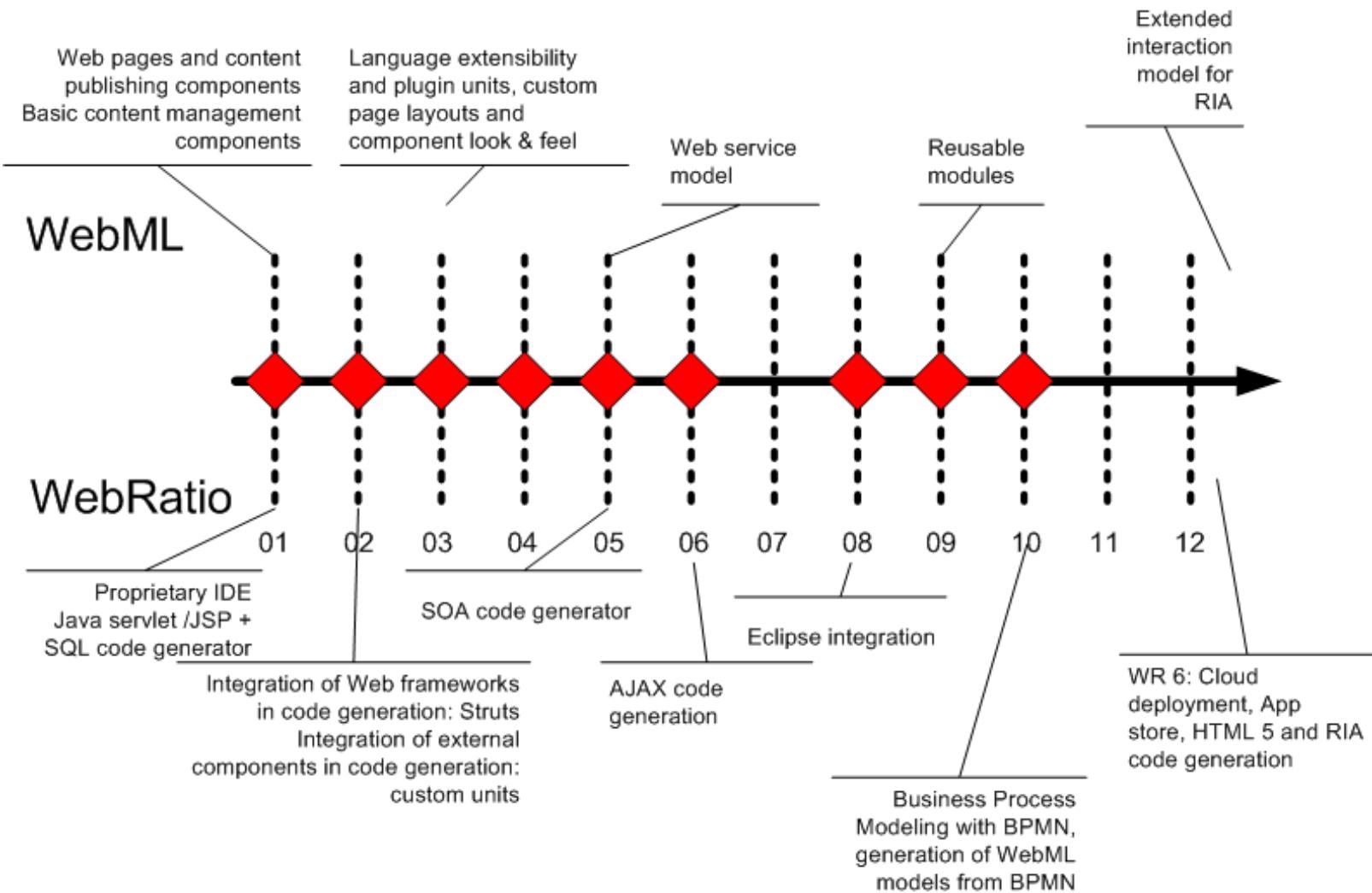


Our innovation environment



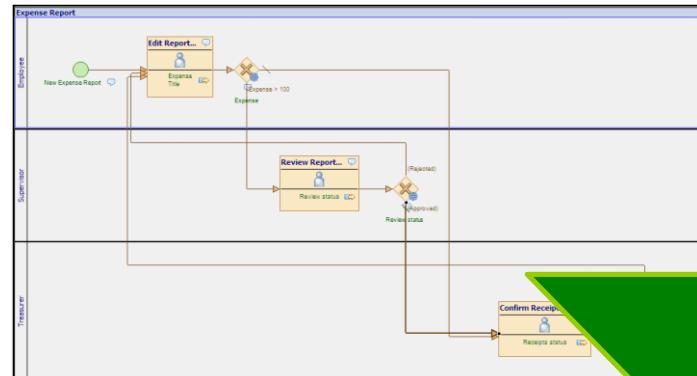


Evolution of tool (and language)



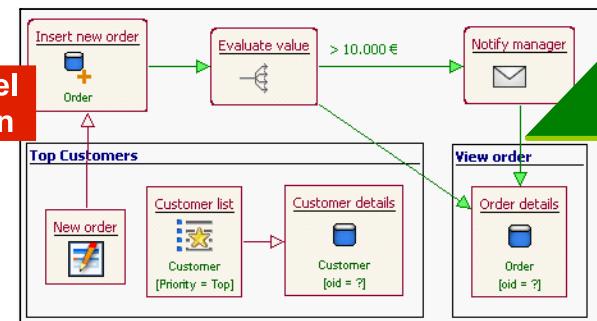


The final picture



Iterative
refinement of the
process enactment
applications

Business Process
Model



Application model

Model to code
transformation

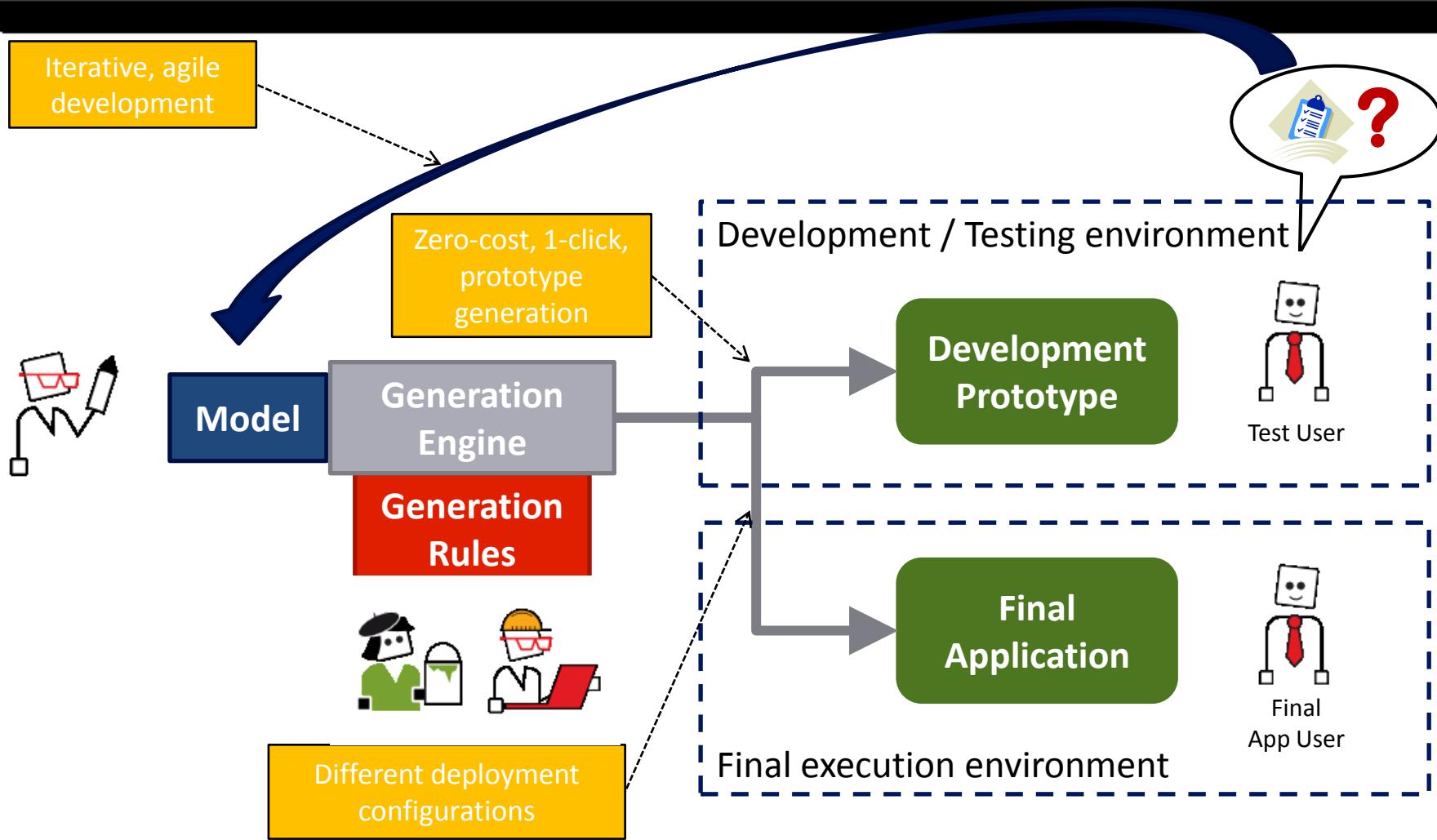
Iterative refinement
of the activity
execution
applications

Standard
Java
application

Model to model
transformation



Agility + MDD

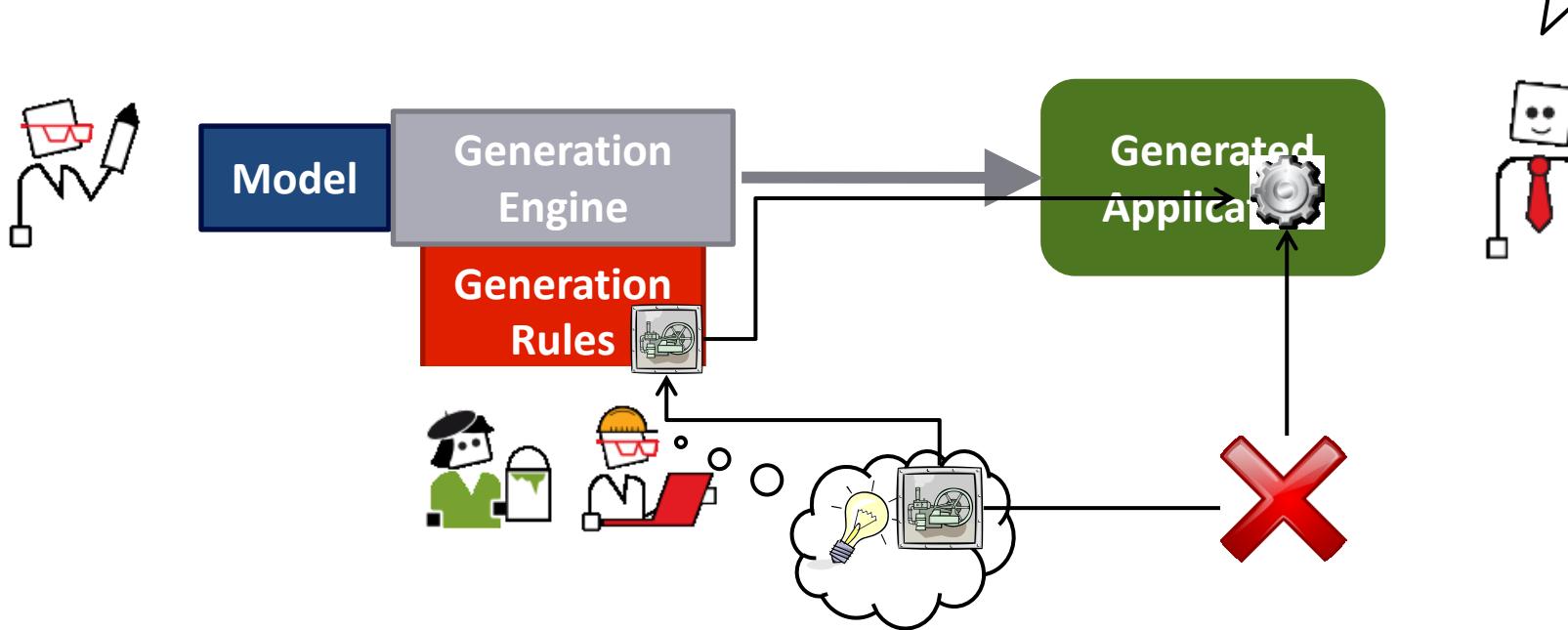




The MDE Virtuous Cycle

Do not change the generated application code

Touch the generation rules instead



Case Studies





Kinds of application





Acer

B2C + CMS Web applications initially for 14 EU countries

Corporate news, Product technical & commercial data, Service & Partner area, Where to Buy...

Multilingual, multi-actor, distributed workflows for local and central PMs, local and central MarCom managers

... and a: very limited Time to Market (7 weeks!!)



Size & effort

Class	Dimension	Value
Size	Number of localized B2C web sites	14
	Number of main CMS applications	4 (Admin, News, Product, Other content)
	Number of supported languages	12 for B2C Web sites, 1 for CMS
	Number of data entry masks	39
	Number of automatically generated database tables	46
	Number of automatically generated database views	82
	Number of automatically generated database queries	279 for data extraction, 89 for data update
	Number of automatically generated JSP page templates	48
	Number of automatically generated or reused Java classes	250
Time & effort	Number of automatically generated Java lines of code	12500 Non commented lines of code
	Number of elapsed workdays	49
	Number of development staff-months (analysts and developers)	6 staff-months (6 weeks x 4 persons)
	Total number of prototypes	9
	Average elapsed man days between consecutive prototypes	5,4
	Average number of development man days per prototype	15,5



Size & effort

DEGREE OF AUTOMATION	
Number of manually written SQL statements	17(SQL constraints)
Percentage of automatically generated SQL code	96%
Number of manually written/adapted Java classes /JSP templates	10% JSP templates manually adapted
Percentage of automatically generated Java and JSP code	90% JSP templates, 100% Java classes
COST AND ROI	
Total cost of software development of first version	75.000 €
HW, SW licenses, and connectivity cost of first version	70.000 € (db server license)
Return on investment of first version	12-15 months
Average effort of extension to one additional country	0,5 staff-months
Average cost of extension to one additional country	7.500 €
Average ROI of extension to one additional country	2 months
PRODUCTIVITY	
Number of function points	177 (B2C web site) + 612 (CMS) = 789
Average number of function points delivered per staff-month	131,5



Comments

On the positive side:

- Almost 80% of the delivery effort concentrates in the phases of data design, hypertext design and prototyping:
 - more development time is spent with the application stakeholders

MDD allows a more flexible distribution of responsibilities between the IT department and the business units

The peak productivity rates has reached five times the number of delivered function points per staff-month of a traditional programming language like Java



Comments (continued)

On the negative side..

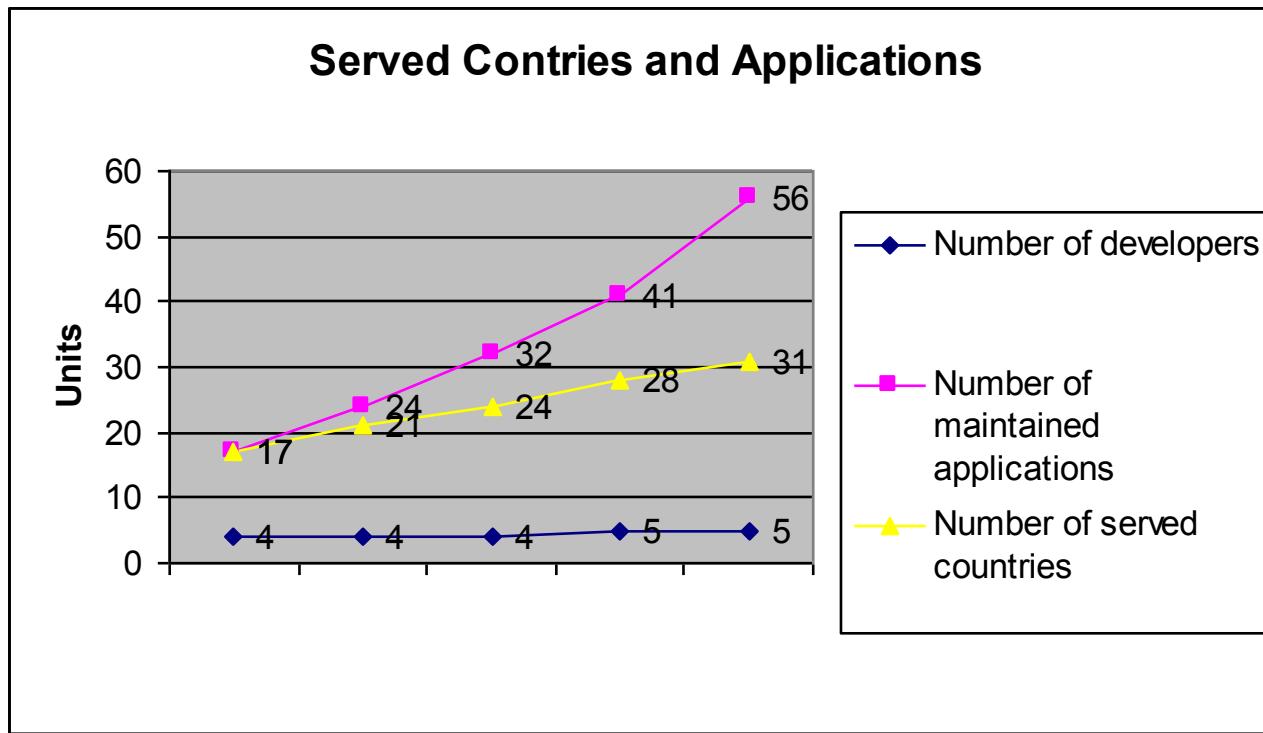
- Acer estimates that it took from 4 to 6 months to have fully productive developers with MDD, IFML, and WebRatio
- Difficult to find skilled people

..but..

- The initial investment in human capital required by MDD pays off in the mid term
 - MDD benefits testing, maintenance, and evolution (which account for over 60% of the total lifecycle cost)
 - reasoning on the system is far more effective at the conceptual level



Maintenance effort





GTT: Turin Transportation Group

- Public company owned by the City of Turin in Italy
- Local public transport serving 190 million passengers every year.
- A new e-ticketing system (available at <http://ecommerce.gtt.to.it> and serving 64,000 daily passengers)
- published on-line in only 2 months.
- The application comprises 100 page templates (IFML pages) and 1215 IFML units.
- KEY: iterative and quick prototyping approach supported by WebRatio



A2A: Utility in Milan

- Multi-utility company buying and selling wholesale electric power.
- Integrated Energy Management System that replaced individual productivity tools used by traders for the management of electric power.
- KEY: quick prototyping approach and involvement of actual users in the development process.
- Deployment of final app in 6 months after the initial meeting with WebRatio (time to market that took one-third of the time estimated in case of adoption of a traditional development)



Other experiences

- **Banking (UniCredit)**
 - BPM + SOA + Web interfaces
 - Crucial points: modularization, multiple models integration, multiple tools integration, strict runtime platform requirements
- **Banking (ABI)**
 - System integration (Pure backend!)
 - Why IFML?
- **Latin America**
 - Cooperatives, banks, public bodies, central government
- **Wholesale (IKEA)**
- **Financial / leasing (GE Capital)**

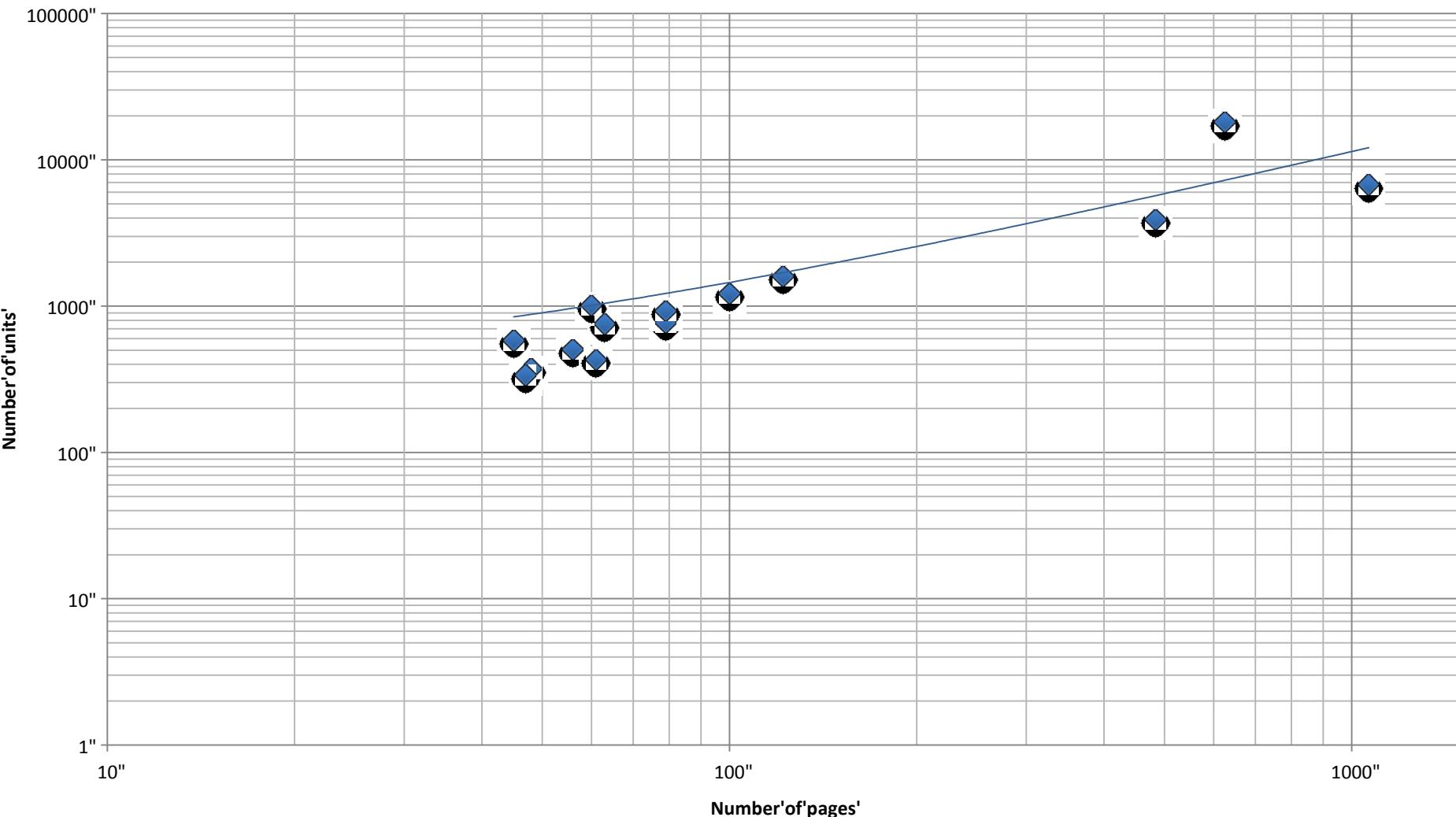


Where IFML works

- **Models integration**
- **Large applications with strong need for coherence and standardized paradigms**
 - Cooperatives, banks, public bodies, central government
- **Service orientation**
- **No pure modeling exists**
- **Code generation still win-win**

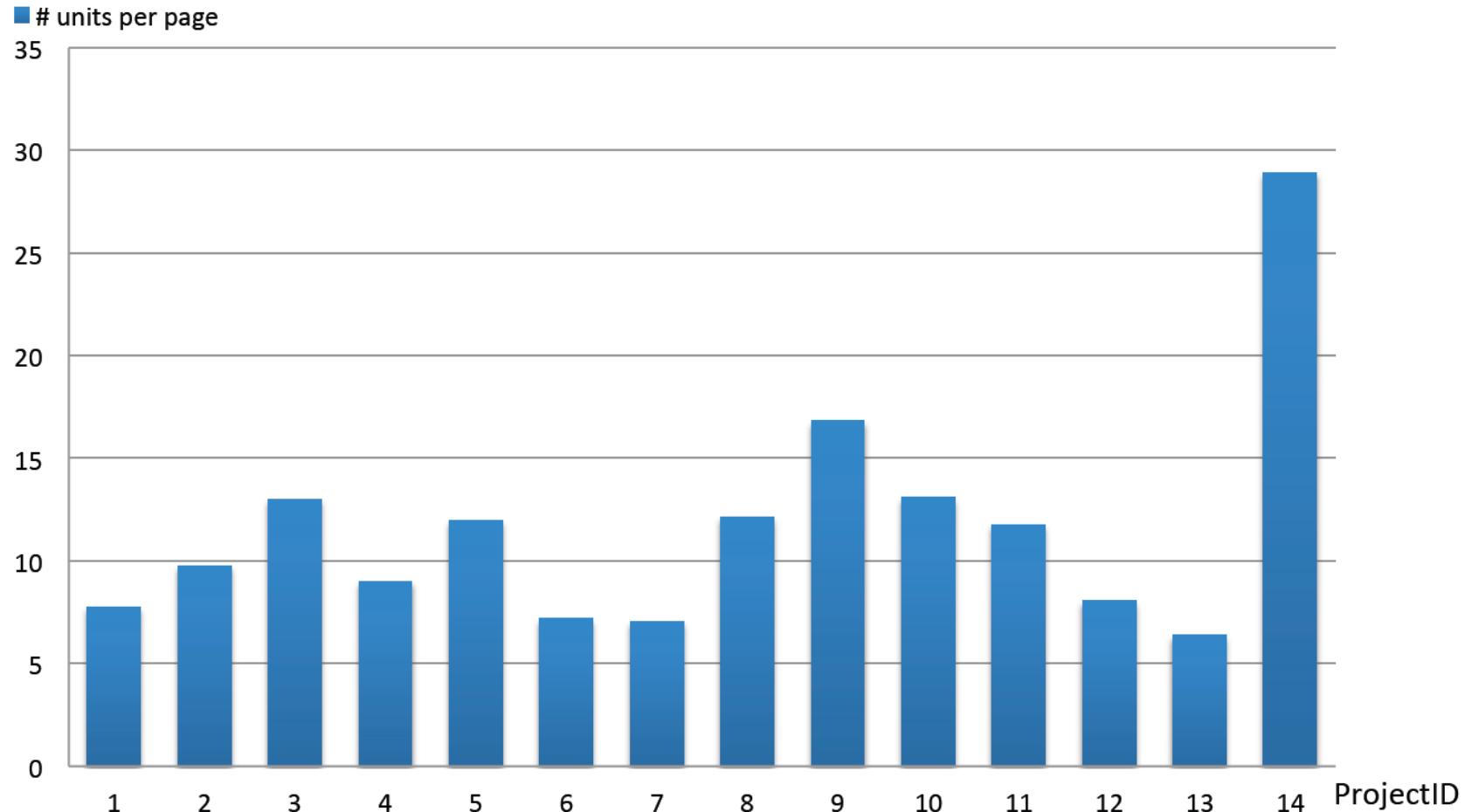


Components and pages per project



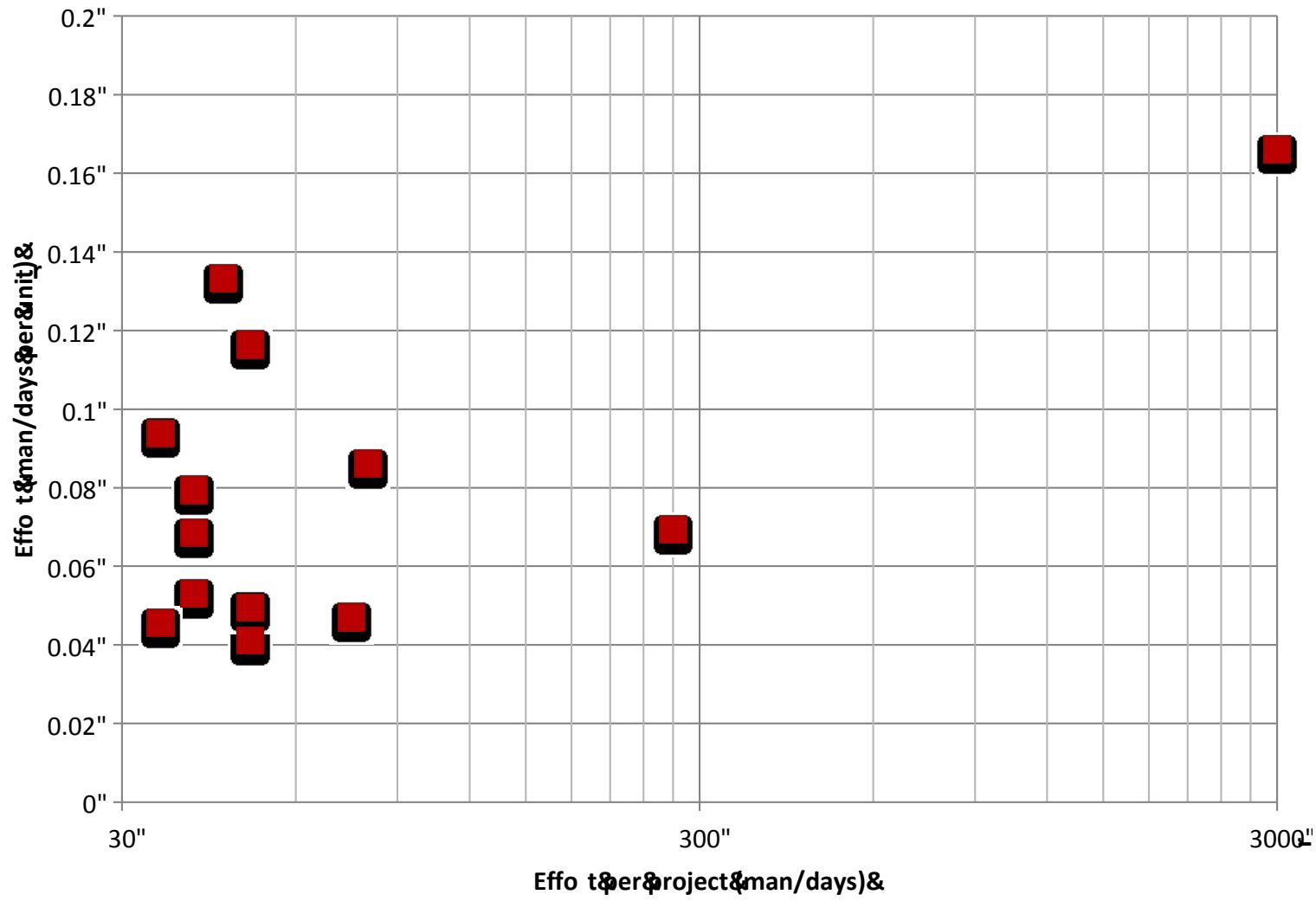


Components per page (avg)



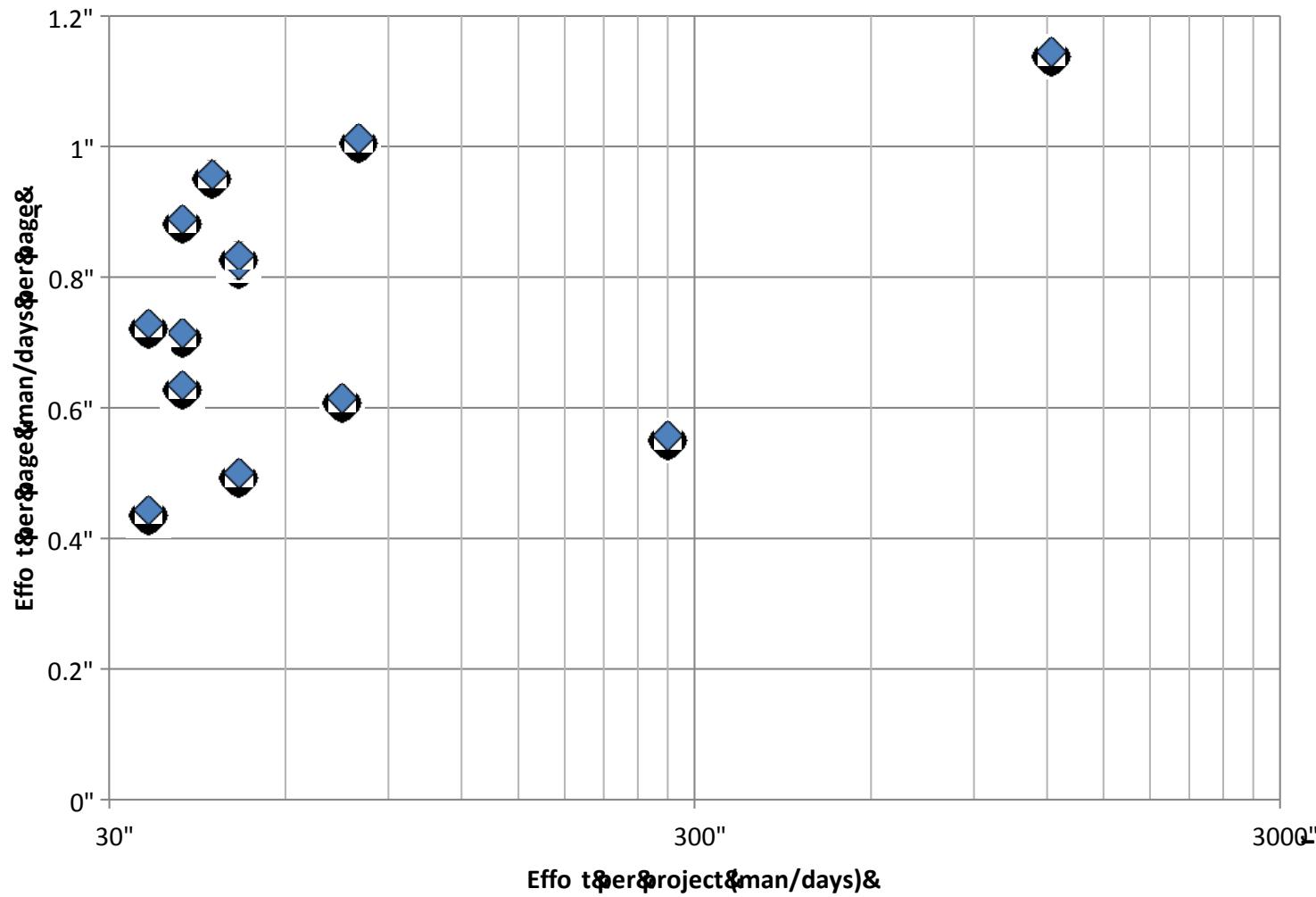


Man/days per component





Man/days per page





Tool usage stats

Description	Value
# of times the tool has been opened daily	1.79
# of daily code generations	11.76
# of 1-click generation and publishing of the application	0.26
# of checks of the modelling warnings	2.09
# of checks of graphical layout warning	0.11
# of automatic generations of the documentation	0.02



(some) references

S. Ceri, P. Fraternali, A. Bongio, M. Brambilla, S. Comai, M. Matera: Designing Data-Intensive Web Applications, Morgan-Kaufmann Publishers, San Francisco, ISBN 1-55860-843-5 (Series edited by Jim Gray, foreword by Adam Bosworth) 590 pages.

M. Brambilla, J. Cabot, M. Wimmer: Model Driven Software Engineering in Practice. Morgan & Claypool, USA, September 2012, foreword by Richard Soley (OMG), 184 pages. ISBN 978-1608458820.

Manolescu, M. Brambilla, S. Ceri, S. Comai, P. Fraternali: Model-driven design and deployment of service-enabled web applications. ACM Trans. Internet Technology (TOIT). 5(3), pp. 439-479 (2005).

M. Brambilla, S. Ceri, P. Fraternali, I. Manolescu: Process modeling in Web applications. ACM Trans. Softw. Eng. Methodol (TOSEM). 15(4), pp. 360-409 (2006).

M. Brambilla, I. Celino, S. Ceri, D. Cerizza, E. Della Valle, F. M. Facca: Model-Driven Design and Development of Semantic Web Service Applications, ACM Trans. on Internet Technology (TOIT). 8(1), pp.3:1 - 3:31 (2007).

M. Brambilla: From Requirements to Implementation of Ad-hoc Social Web Applications: an Empirical Pattern-Based Approach. IET Software, 6(2), 2012, pp.114-126.

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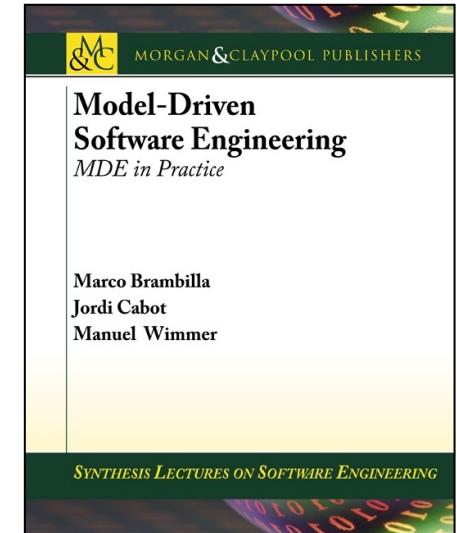
Some Ads

MD* blog

www.modeldrivenstar.com

“Model Driven Software Engineering in Practice”. Brambilla, Cabot, Wimmer.

Morgan&Claypool, USA, 2012



And the upcoming **IFML** book!

Morgan-Kauffman – Elsevier, USA, 2014





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