Executable Translatable UML for Enterprise Applications

Australian Government

Australian Research Council

Software Improvements

Dr Malte Stien
Software Engineer

Overview

- Introduction
  - – The ARC, xtUML, MDA, enterprise applications
- Practical experience, the task...
  - – Building an enterprise application with MDA/xtUML
- ... and why this is cool!
  - – Economics, advantages, etc.
- Results
  - – Some metrics, team size, lines of code, etc.
- Questions and discussion

Introduction

ARC Business

- “Advance Australia's research excellence to be globally competitive and deliver benefits to the community”
  - administer the research programs for which it has responsibility
  - make recommendations to the minister on the allocation of funds
  - provide advice to the minister in research matters
- RMS to support all processes directly associated with research funding

Research Management System (RMS): Four Phases of Roll-out

- Selection/Decision support functionality
  - Limited in time use (1 to 5 days)
  - Up to 6 active/72 passive users
- Post selection/post award functionality
  - Continuous use; up to 80 users (internal to ARC)
- Pre-award functionality
  - Continuous use; up to 80 users (internal to ARC)
- ARC external functionality
  - Continuous use, characterised by peak-load
  - Up to 50,000 assessors and applicants

What is xtUML?

- ...it's executable and translatable
- ...it's a profile of UML
- ...it has precise meaning (well, it should!)
- ...it's a model-driven technique (MDA)
- ...users can understand and review it
- ...is supported by
  - BridgePoint (Accelerated Technologies)
  - iUML/iCCG (KennedyCarter)
  - Pathfinder (Pathfinder Solutions)

What is xtUML?

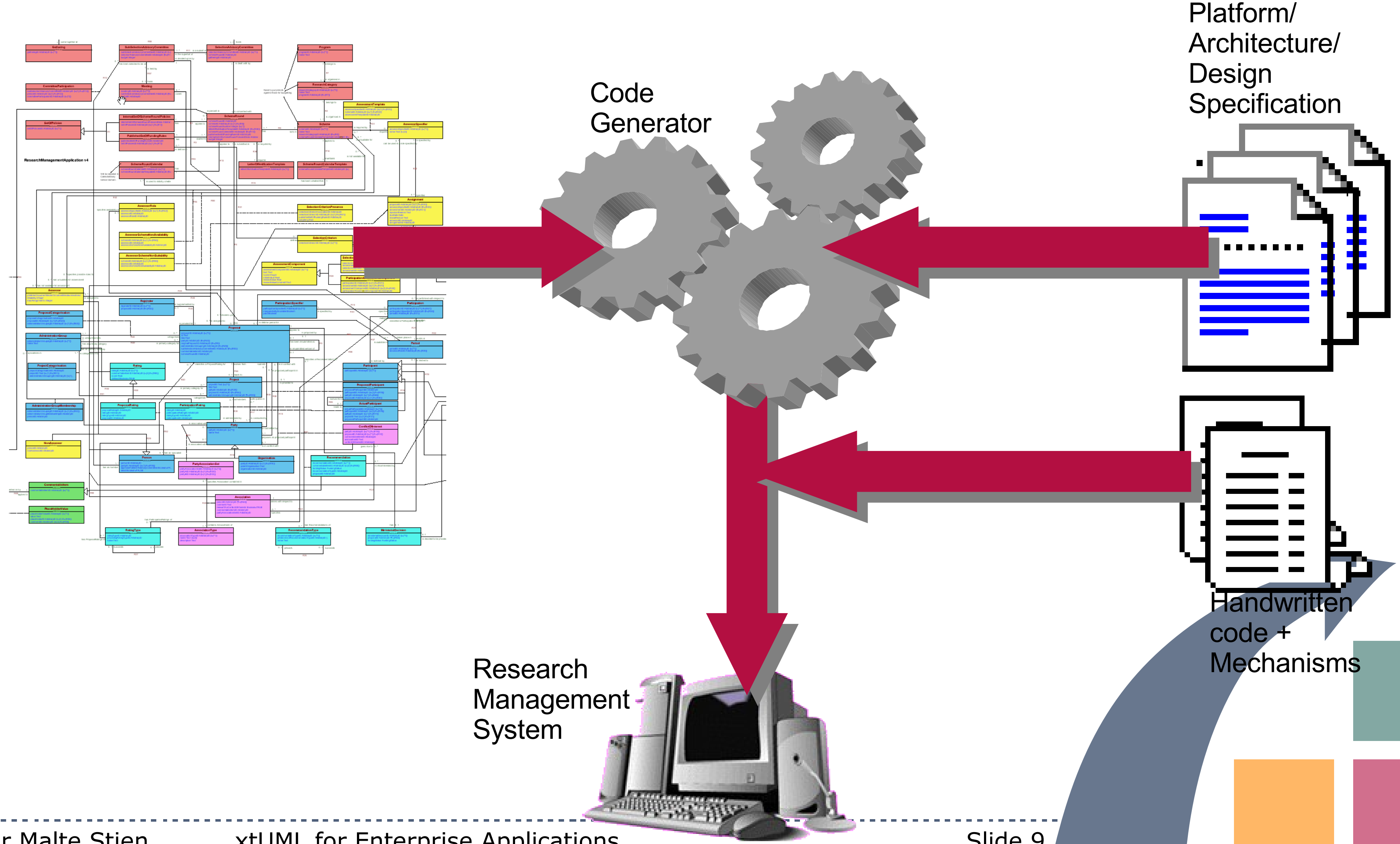
- Domain model
  - Interaction between autonomous domains
- Class model
  - Classes, Attributes, Relationships, Constraints
  - Synchronous behaviour
- State model
  - States, Transitions, Asynchronous behaviour
  - *Some* classes feature state machines
- Action procedures
  - Specified in Action Specification Language

MDA – There are two ways about it

- Model Driven Architecture
- Pure approach
  - PIM → Code
- Polluted approach
  - PIM → PSM (potentially edited) → Code

PIM: Platform independent models
PSM: Platform specific models

Building the System


ResearchManagementApplication v4
Code Generator
Platform/ Architecture/ Design Specification
Handwritten code + Mechanisms
Research Management System

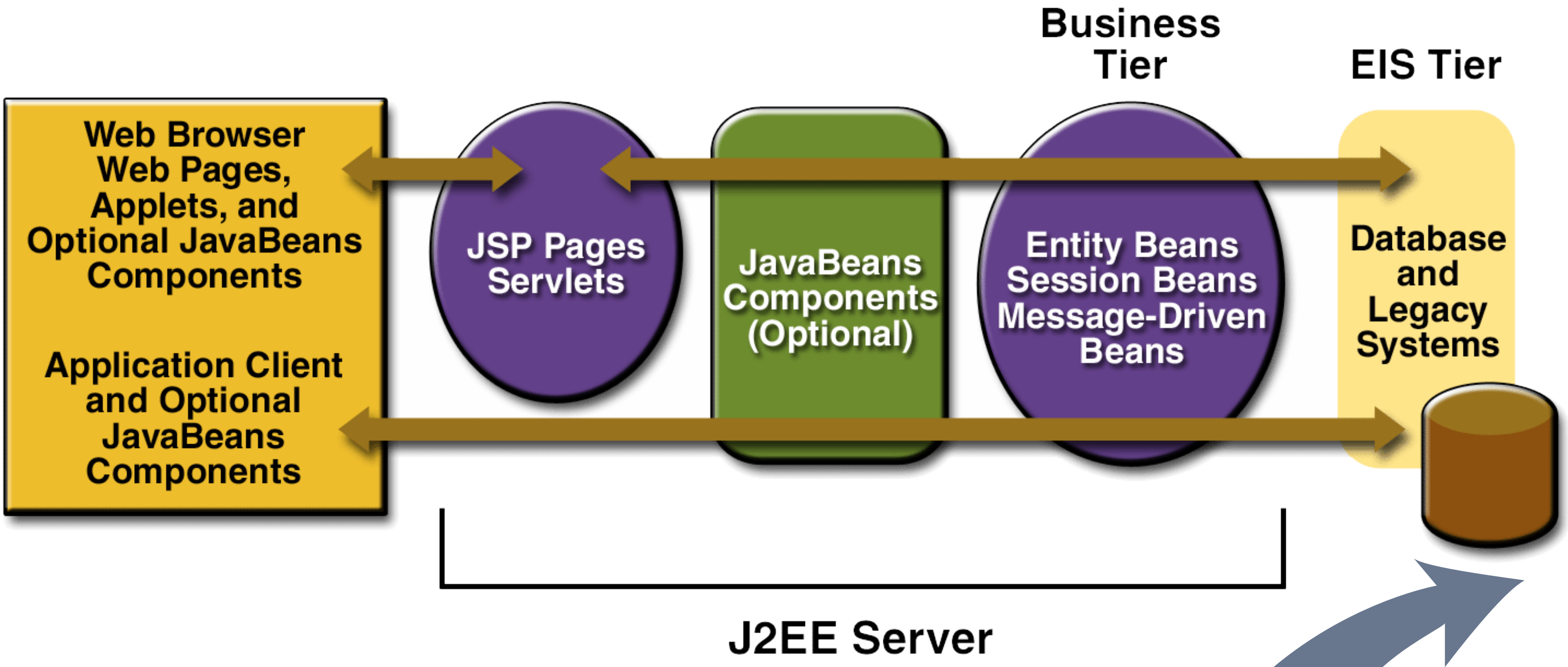
Enterprise [Application | Software]

- Enterprise [Application | Software] is...
  - ...software that solves an enterprise problem (rather than a departmental problem) and usually enterprise software is written using Enterprise Software Architecture. Due to the cost of building what is often proprietary software only large organizations attempt to build software that models the entire business enterprise and is the core system of governing the enterprise and the core of business communications within the enterprise. *--wikipedia*
  - ...is application software that performs business functions such as accounting, production scheduling, customer information tracking, bank account maintenance, and the like. It is almost always hosted on servers, and is used by multiple employees of the same organization. *--wikipedia*

Enterprise Architectures

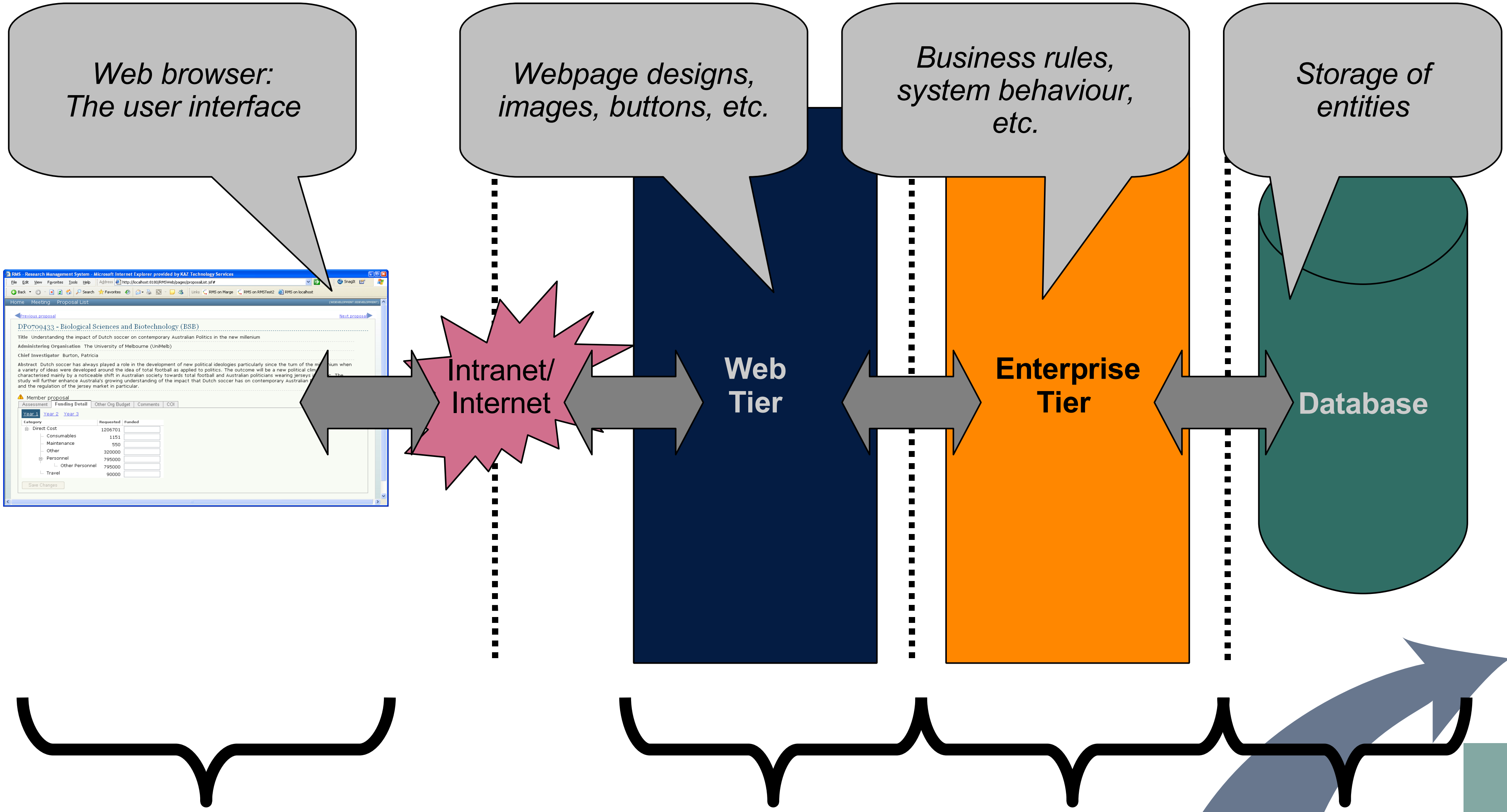
- Generic platforms...
  - SUN Java 2 Enterprise Edition (J2EE)
  - Microsoft .NET
- Specific solutions...
  - SAP
  - PeopleSoft
  - Oracle

The J2EE Architecture


Business Tier
EIS Tier
Web Browser Web Pages, Applets, and Optional JavaBeans Components
Application Client and Optional JavaBeans Components
JSP Pages Servlets
JavaBeans Components (Optional)
Entity Beans Session Beans Message-Driven Beans
Database and Legacy Systems
J2EE Server

source: Sun Microsystems

Enterprise Application Architecture



Web browser: The user interface

Webpage designs, images, buttons, etc.

Business rules, system behaviour, etc.

Storage of entities

Intranet/ Internet

Web Tier

Enterprise Tier

Database

Client Computer

Web Server

Application Server

Database Server

RMS - Research Management System - Microsoft Internet Explorer provided by KAZ Technology Services

File Edit View Favorites Tools Help
Address http://localhost:8180/RMSWeb/pages/proposalList.jsf#
SnagIt
Back
Search
Favorites
Links RMS on Marge RMS on RMSTest2 RMS on localhost
Home Meeting Proposal List
(WDEVELOPMENT:EDEVELOPMENT)
Previous proposal
Next proposal

DP0709433 - Biological Sciences and Biotechnology (BSB)

Title Understanding the impact of Dutch soccer on contemporary Australian Politics in the new millenium

Administering Organisation The University of Melbourne (UniMelb)

Chief Investigator Burton, Patricia

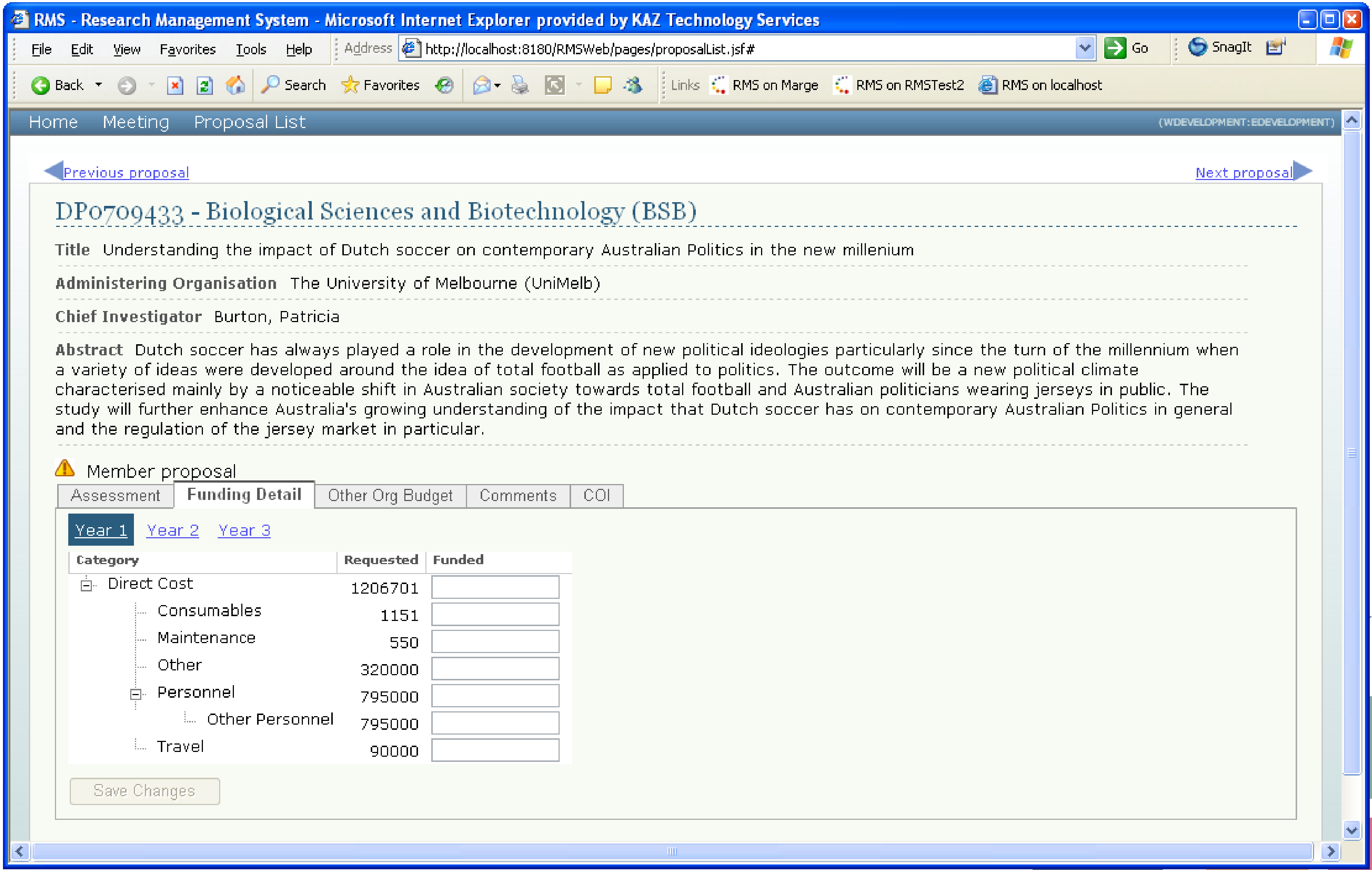
Abstract Dutch soccer has always played a role in the development of new political ideologies particularly since the turn of the mi nium when a variety of ideas were developed around the idea of total football as applied to politics. The outcome will be a new political clim characterised mainly by a noticeable shift in Australian society towards total football and Australian politicians wearing jerseys i The study will further enhance Australia's growing understanding of the impact that Dutch soccer has on contemporary Australian and the regulation of the jersey market in particular.

⚠ Member proposal

Category	Requested	Funded
Direct Cost	1206701	
Consumables	1151	
Maintenance	550	
Other	320000	
Personnel	795000	
Other Personnel	795000	
Travel	90000	

Practical Experience
The Task

Research Management System (RMS)



RMS - Research Management System - Microsoft Internet Explorer provided by KAZ Technology Services
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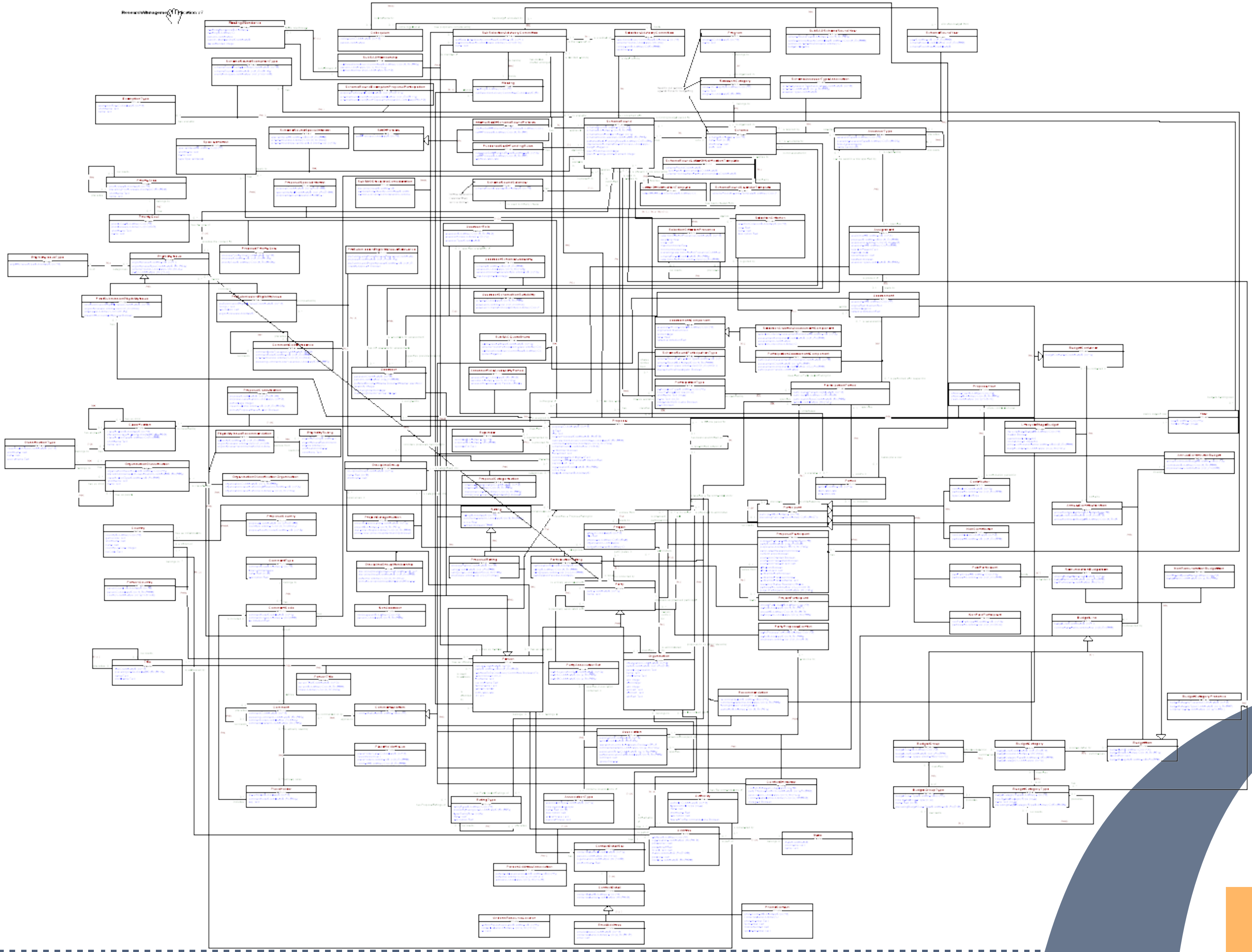
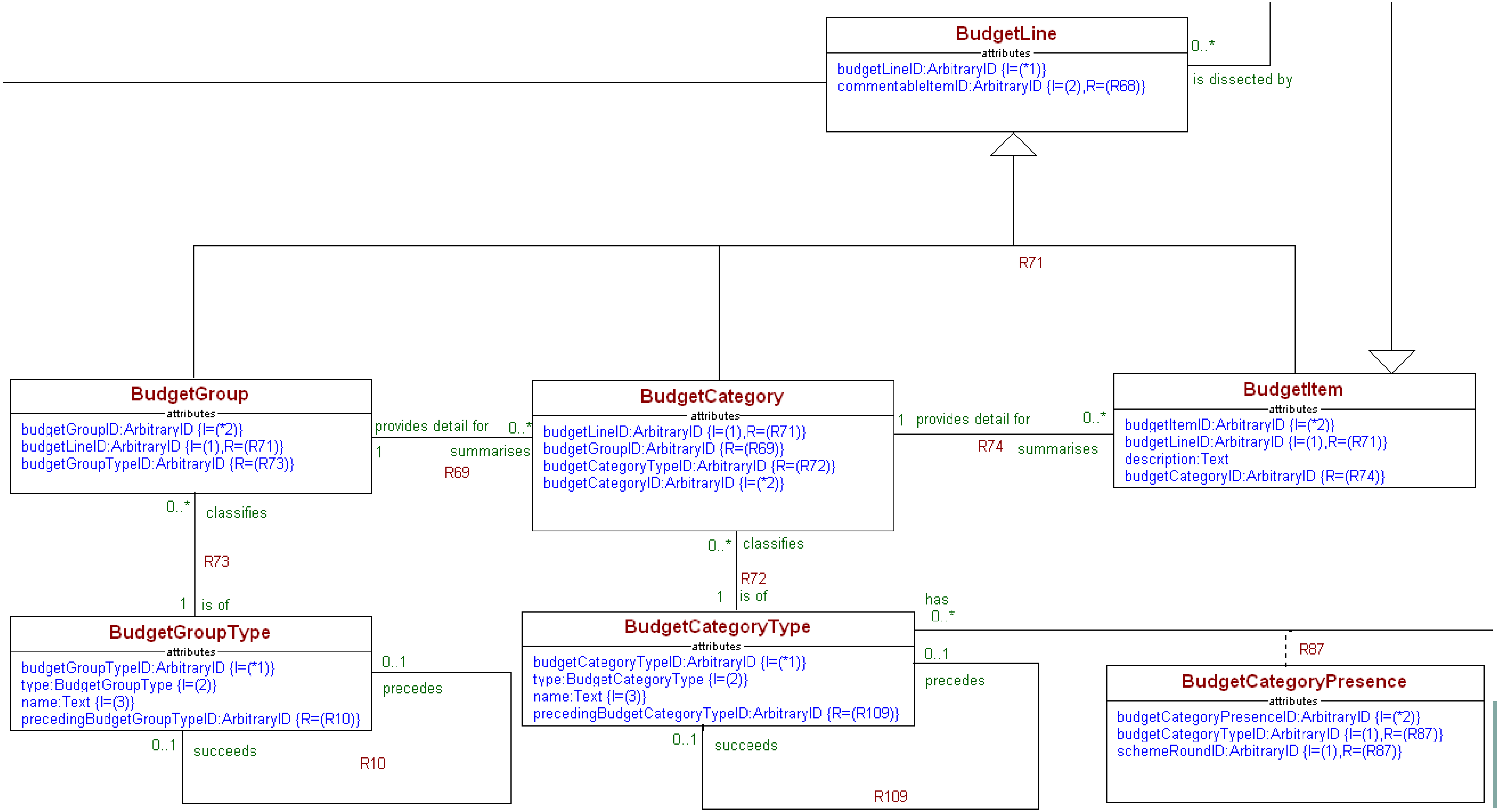
The xtUML Model



The xtUML Model – Example



BudgetLine
attributes
budgetLineID:ArbitraryID {I=(*1)}
commentableItemID:ArbitraryID {I=(2),R=(R68)}

0..*
is dissected by

R71

BudgetGroup
attributes
budgetGroupID:ArbitraryID {I=(*2)}
budgetLineID:ArbitraryID {I=(1),R=(R71)}
budgetGroupTypeID:ArbitraryID {R=(R73)}

provides detail for
0..*
1
summarises
R69

BudgetCategory
attributes
budgetLineID:ArbitraryID {I=(1),R=(R71)}
budgetGroupID:ArbitraryID {R=(R69)}
budgetCategoryTypeID:ArbitraryID {R=(R72)}
budgetCategoryID:ArbitraryID {I=(*2)}

1
provides detail for
0..*
R74
summarises

BudgetItem
attributes
budgetItemID:ArbitraryID {I=(*2)}
budgetLineID:ArbitraryID {I=(1),R=(R71)}
description:Text
budgetCategoryID:ArbitraryID {R=(R74)}

0..*
classifies
R73
1
is of

0..*
classifies
R72
1
is of

has
0..*
R87

BudgetGroupType
attributes
budgetGroupTypeID:ArbitraryID {I=(*1)}
type:BudgetGroupType {I=(2)}
name:Text {I=(3)}
precedingBudgetGroupTypeID:ArbitraryID {R=(R10)}

0..1
precedes
0..1
succeeds
R10

BudgetCategoryType
attributes
budgetCategoryTypeID:ArbitraryID {I=(*1)}
type:BudgetCategoryType {I=(2)}
name:Text {I=(3)}
precedingBudgetCategoryTypeID:ArbitraryID {R=(R109)}

0..1
precedes
0..1
succeeds
R109

BudgetCategoryPresence
attributes
budgetCategoryPresenceID:ArbitraryID {I=(*2)}
budgetCategoryTypeID:ArbitraryID {I=(1),R=(R87)}
schemeRoundID:ArbitraryID {I=(1),R=(R87)}

Action Specification Language

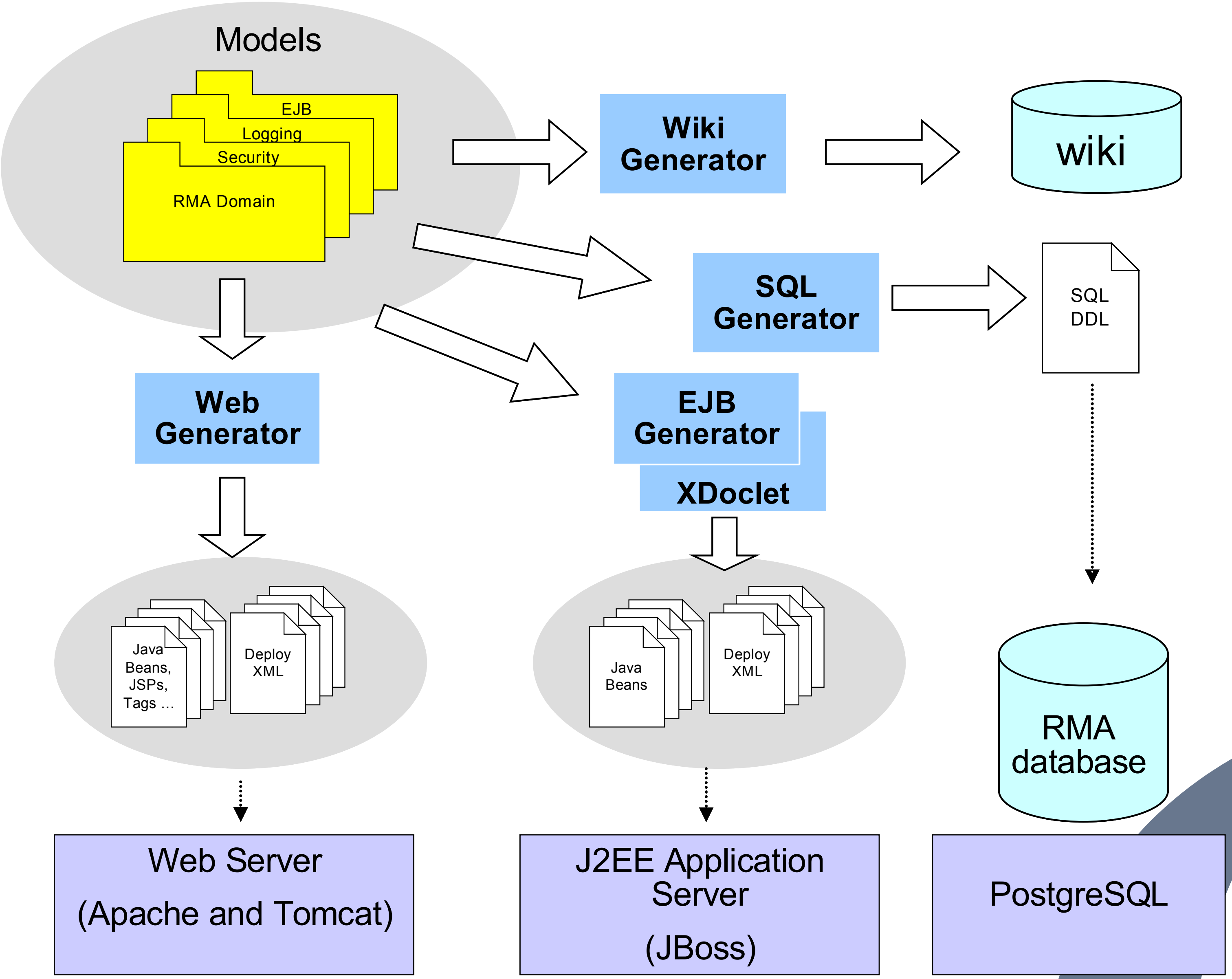
```
function BGT_GRP10:getRecursiveBudgetLineSum
  input: inContributor, inProposalYear, inBudgetContainer
  output: outCashAmount, outInKindAmount

# Initialise variables
outCashAmount=0
outInKindAmount=0

# Retrieve the BudgetCategories for this BudgetGroup
{budgetCategories}=this->R69.BudgetCategory

# Iterate over the BudgetCategories and sum them up
for budgetCategory in {budgetCategories} do
    [budgetItemCashAmount, budgetItemInKindAmount, budgetItemIsMaster] =
      BGT_CAT10:getRecursiveBudgetLineSum[inContributor, inProposalYear,
      inBudgetContainer] on budgetCategory
    outCashAmount = outCashAmount+budgetItemCashAmount
    outInKindAmount = outInKindAmount+budgetItemInKindAmount
endfor
```

Code Generators

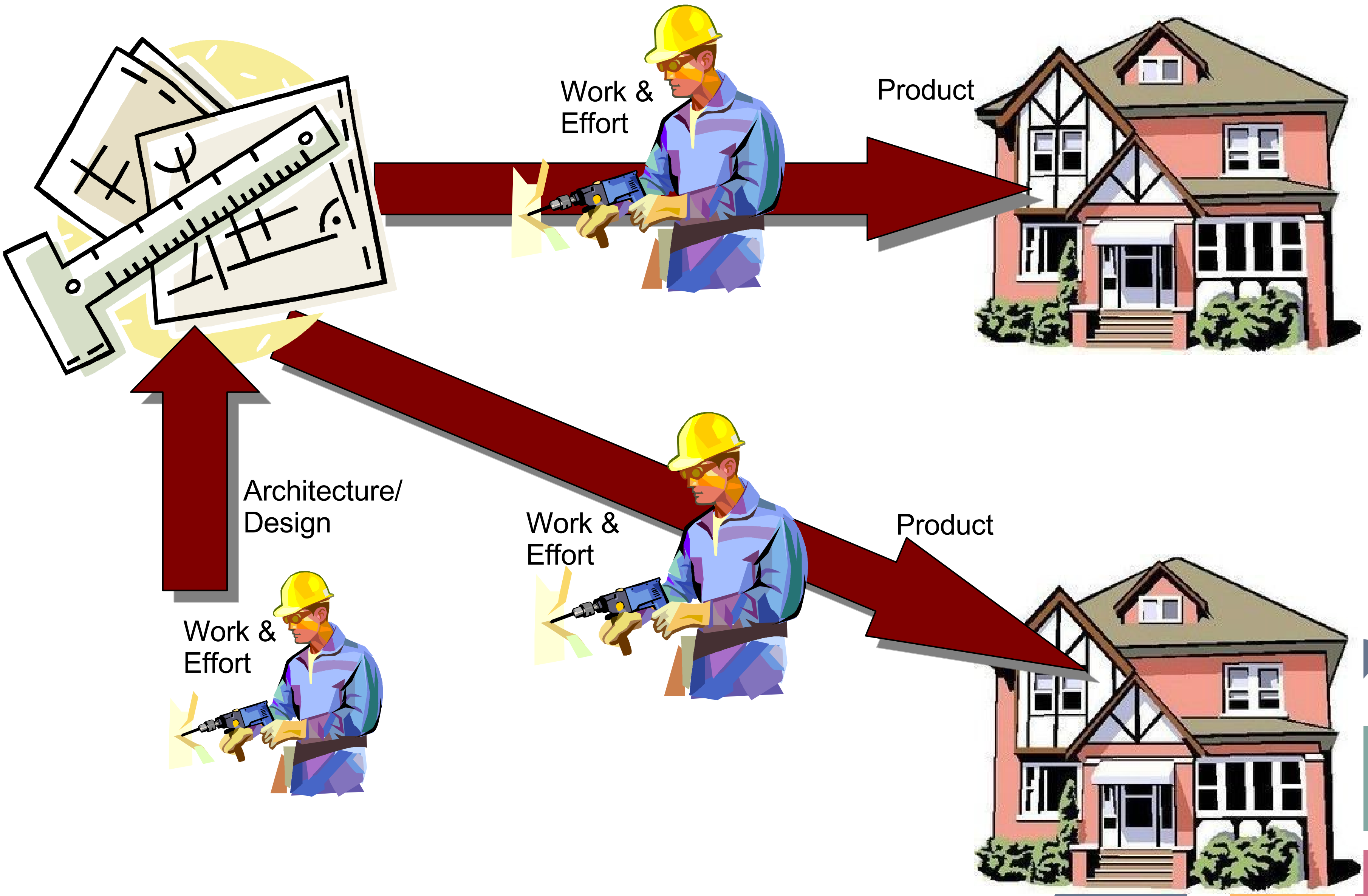


Why is this cool?

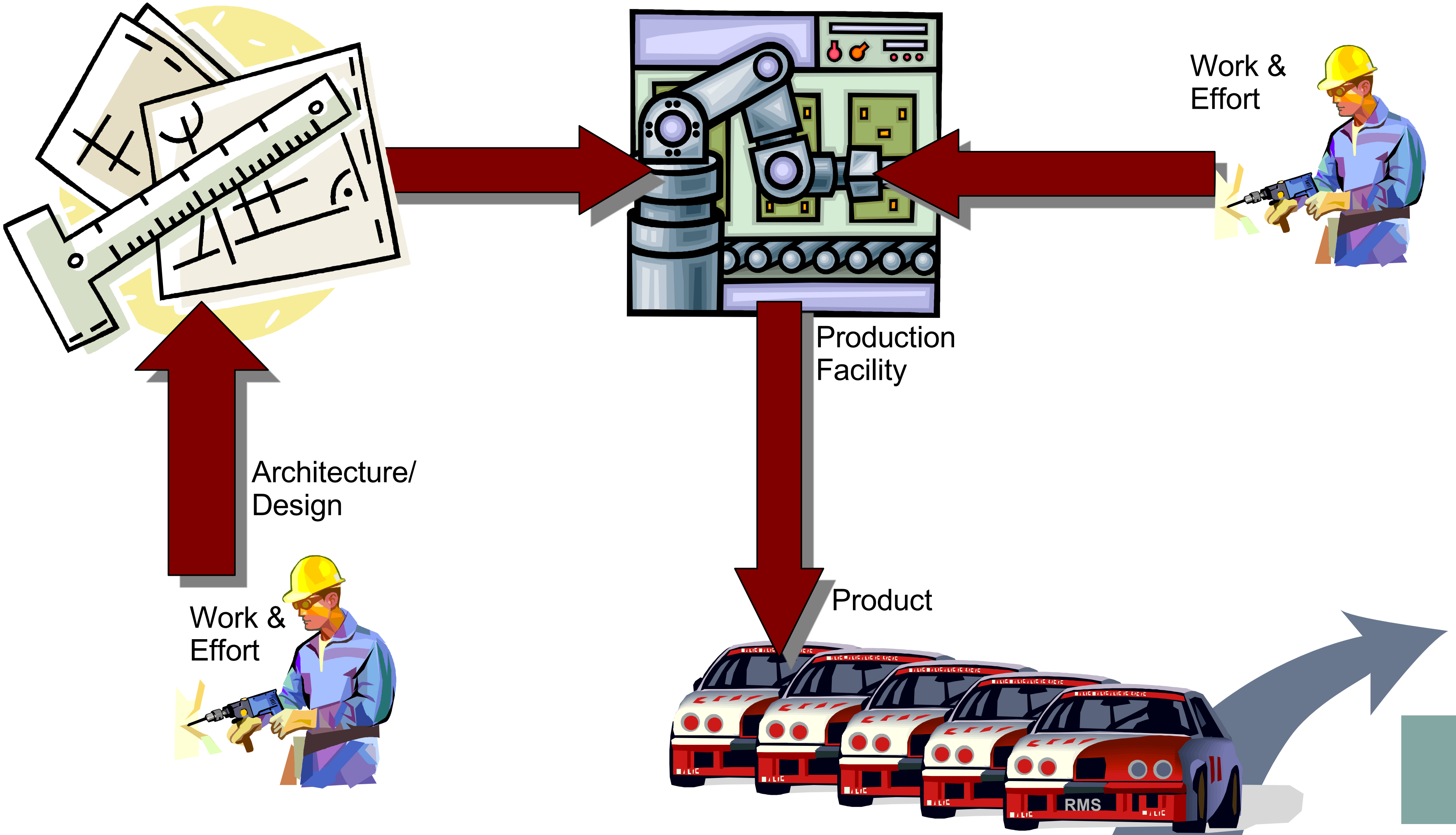
About houses and cars

- Traditional
  - …is like building houses
- Model Driven
  - …is like building cars

About Houses and Cars: Houses...



About Houses and Cars: Cars...



Work & Effort

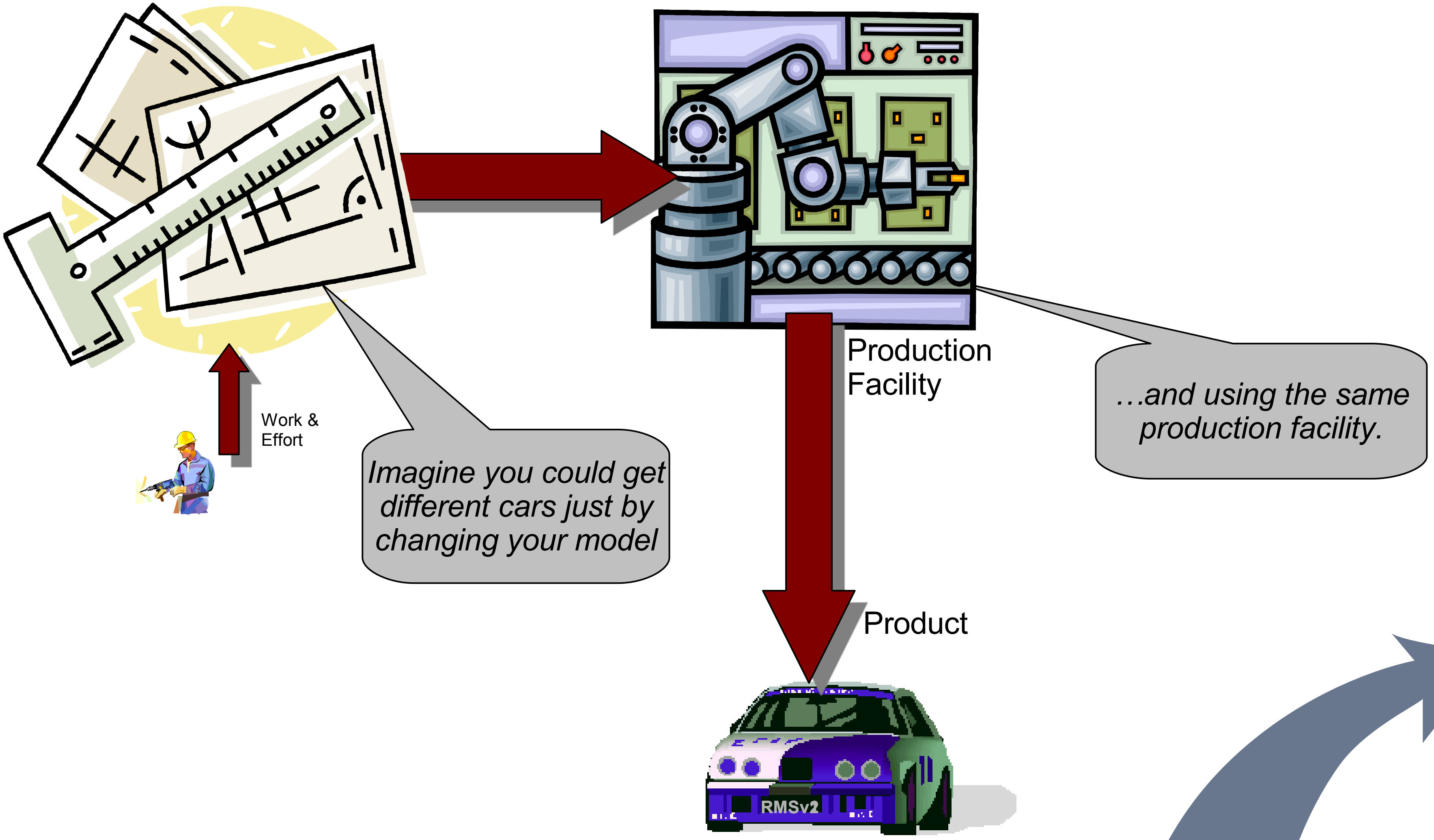
Production Facility

Work & Effort

Architecture/ Design

Product

About Houses and Cars: Cars...



Imagine you could get different cars just by changing your model

…and using the same production facility.

More on houses and cars...

- Houses
  - Architectural/design description
  - Always a one-off
  - No tooling effort
  - Defects are fixed one-by-one
  - First house: T
  - Next house: T
  - Assets: Architecture

- Cars
  - Architectural/design description
  - Serial production
  - Large tooling effort
  - Defects are fixed in the production line
  - First car: >T
  - Next car: <<T
  - Assets: Production facility and design

Valuable Assets for the ARC

- Architecture
  - Help the ARC to understand the architecture
  - The ARC can build any system using the RMS architecture
  - Maintain/publish the architecture

- Models
  - Help the ARC to understand their business
  - Facilitates process re-engineering
  - The ARC can build the RMS using any architecture
  - Maintain/publish the models

Traditional vs Model Driven Development

Software development: Traditional

Requirements

Architecture/Design

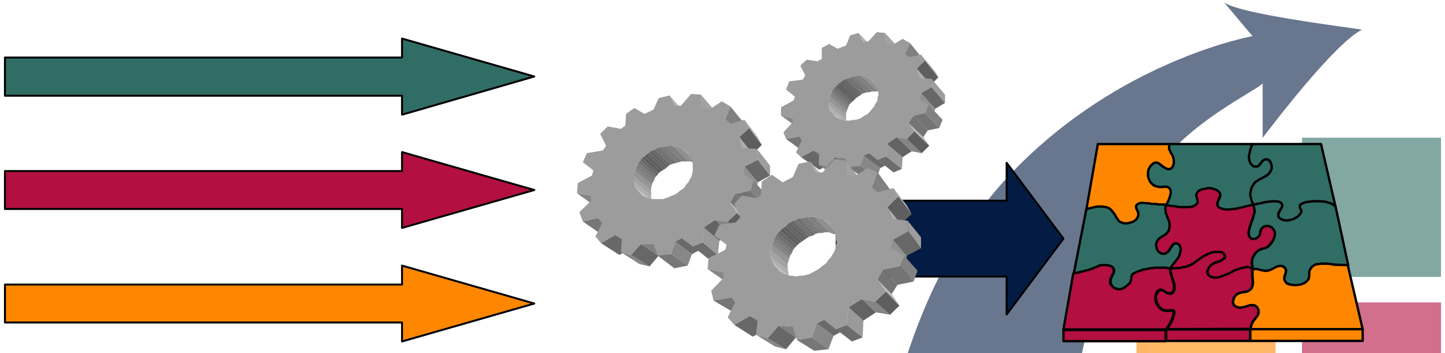
Hand-written code

Software development: Model driven

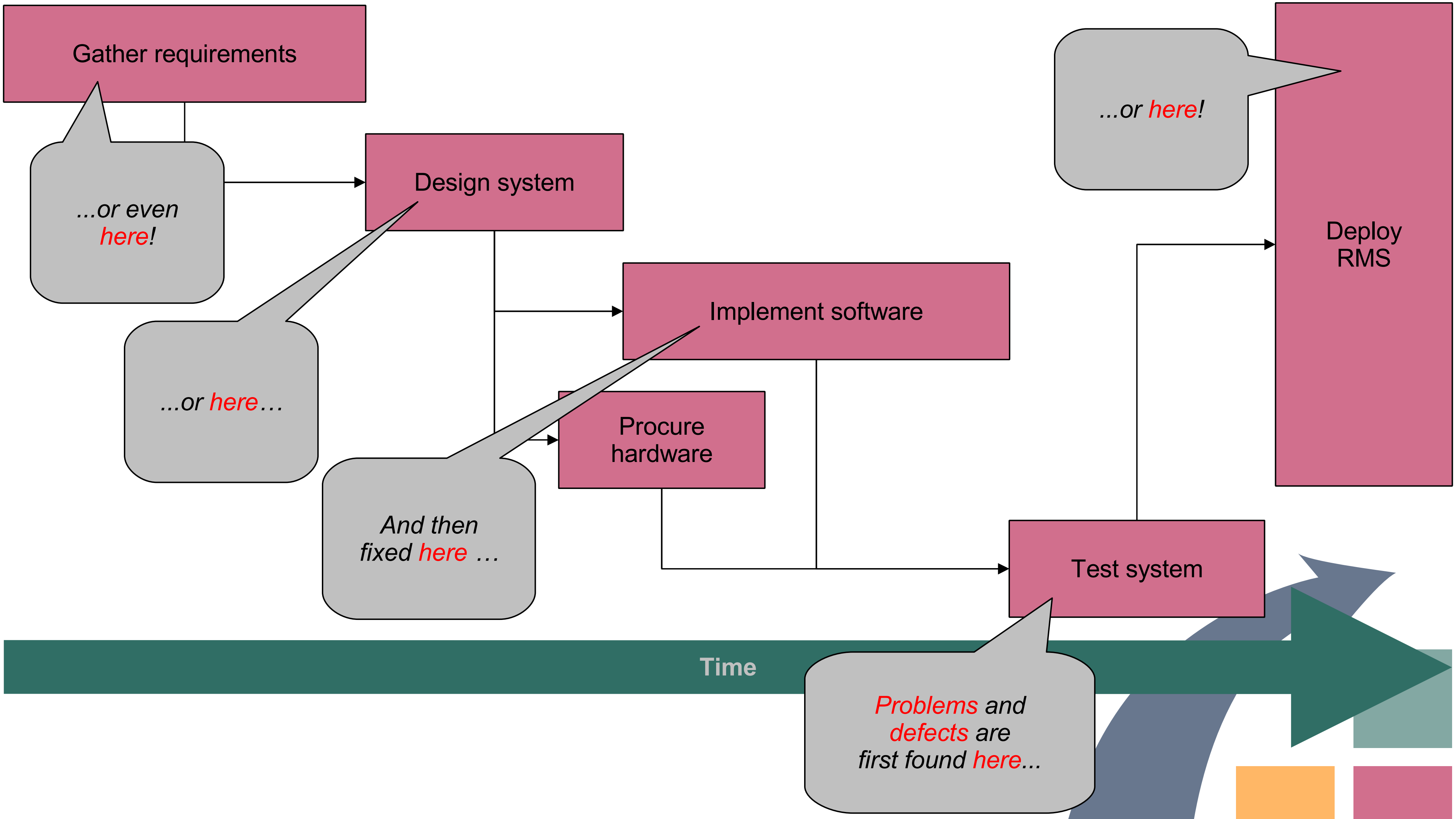
Requirements

Architecture/Design

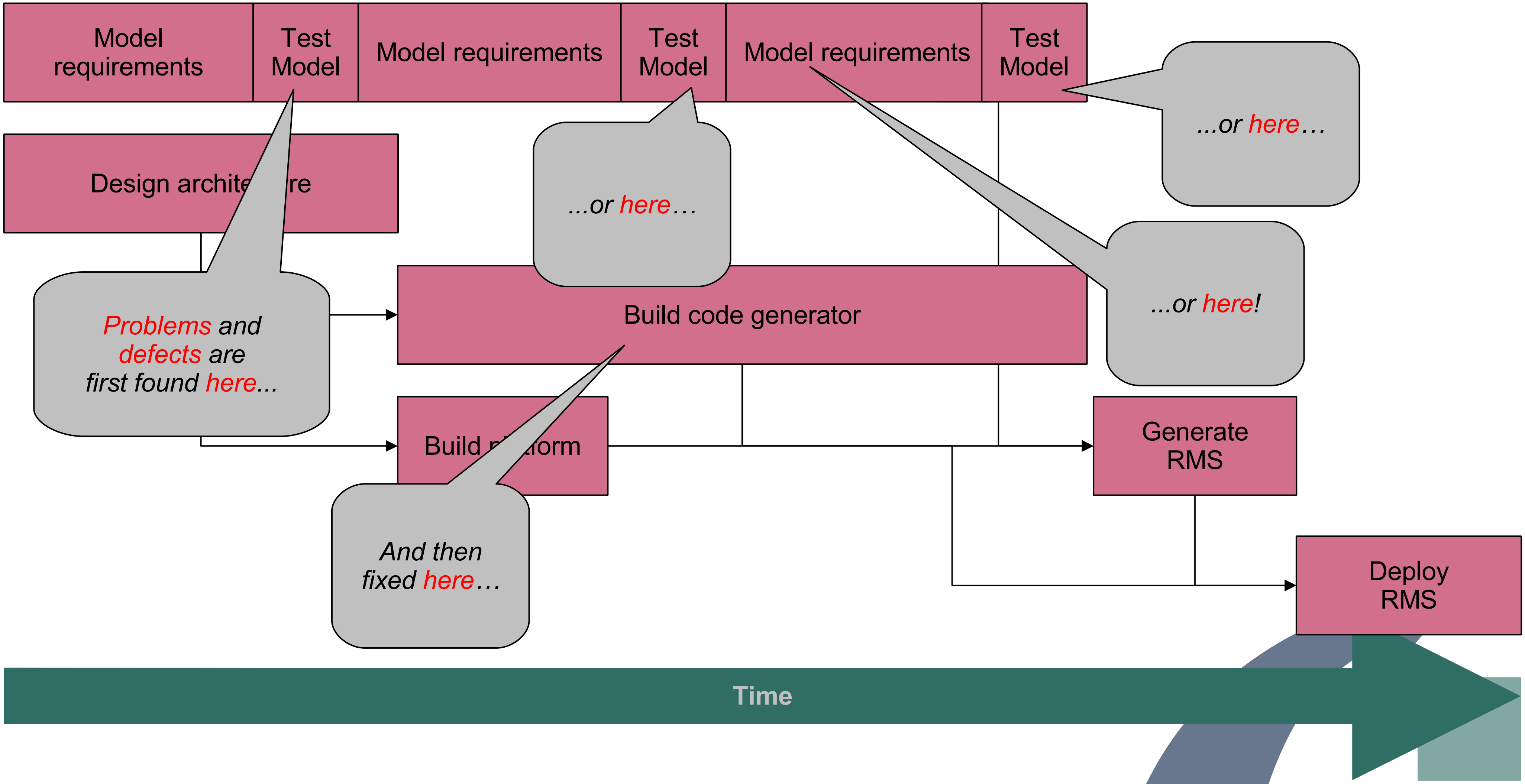
Hand-written code



Timeline: Traditional Approach



Timeline: Model Driven Approach



The Economy of Defects...

- Defect distribution is different
  - Either in the model (requirements defects), or...
  - ... in the code generator (architectural defects)
- Requirements defects...
  - ...are defects in your analysis
- Architectural defects...
  - are easy to find...
    - as they are likely to manifest all over the place
  - ... and easy to fix!
    - as you only fix them once to fix them everywhere

Does all this actually work?

Results

- xtUML Model...
  - – Captures the business' requirements, classes, relationships, attributes, operations, state machines, etc.
- J2EE/EJB Code Generator
  - – Generates entity beans and session beans, value objects, behaviours, administration application, etc.
- SQL Code Generator
  - – Generates tables, columns, foreign key constraints, additional constraints, triggers, consistency report, etc.

Statistics – Phase 1
The Input

- The model
  - Classes: 125 (13 of which are “switched off”)
  - Attributes: 503
    - Referential attributes: 198
    - Non-referential attributes: 304
  - Relationships: 137
    - Generalisations: 15
    - Associations: 112
  - Synchronous operations: 138 (3,361 lines of ASL total)
  - State machines (asynchronous operations): 0

Project Team

- One xtUML modeller – 14 months
- One J2EE software engineer – 8 months
- One web developer – 6 months
- One database administrator – 9 months (eff.)

- *Business experts – continuous/embedded*
- *One solution architect*
- *One project manager*
- *One test coordinator*

Statistics – Phase 1
The Output

- Web tier
  - Generated by Code Generator: 0 lines (not counting value objects)
  - Handwritten: 7,562 lines
    - Screen layouts (JSPs): 1,963 lines
    - JavaScript for components: 3,062 lines
    - Java backing beans: 2,537 lines
  - Mechanisms: 3,264 lines

Numbers include comments

Statistics – Phase 1
The Output

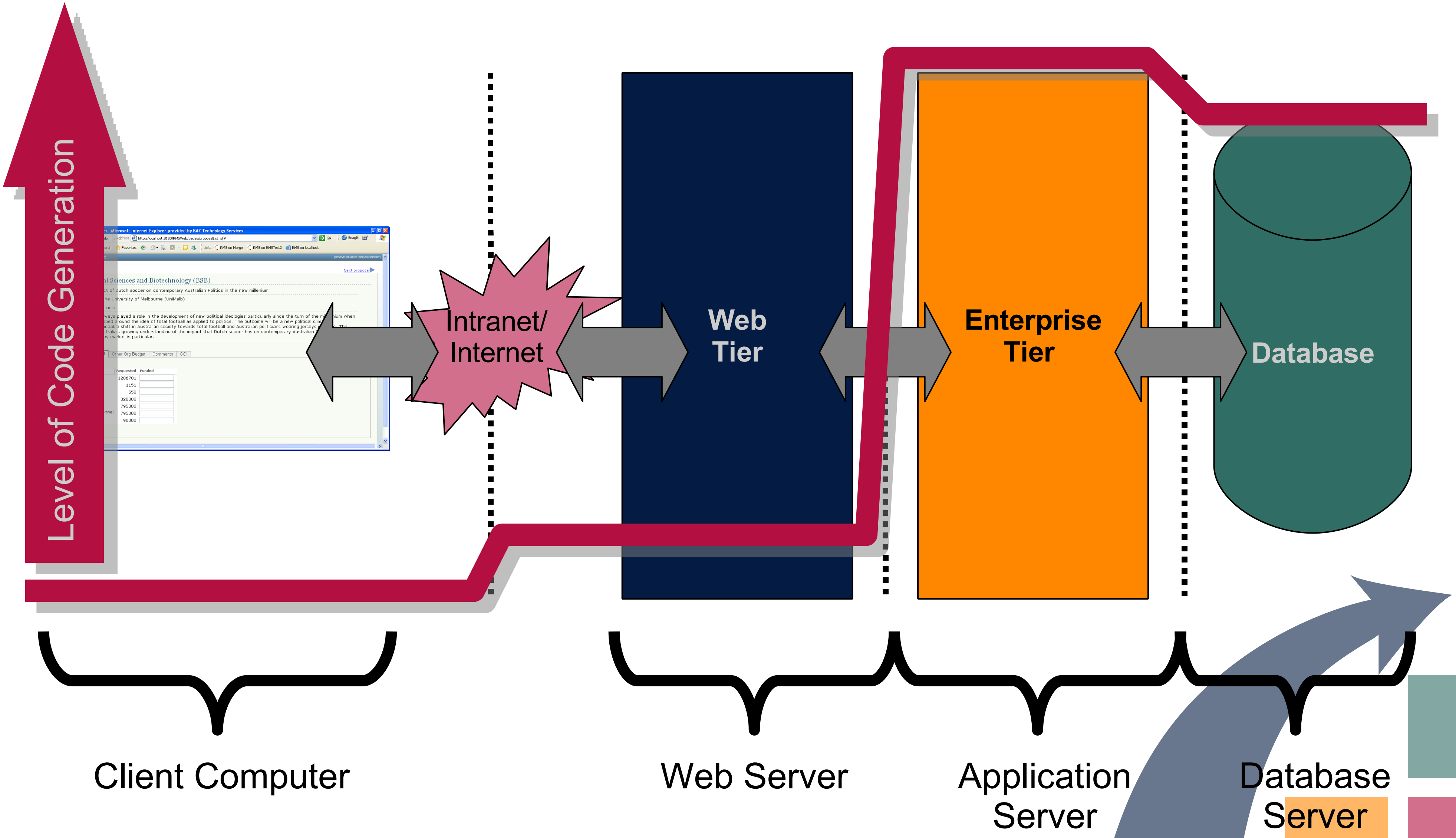
- Application/EJB tier
  - Generated by Code Generator: 270,665 lines (100%)
    - EJBs (excluding behaviours): 139,980 lines
    - EJB behaviours: 59,875 lines
    - Value objects: 4,051 lines
    - Administration application: 62,907 lines
  - Generated by XDoclet: 226,520 lines
  - Handwritten: 0 lines
  - Mechanisms: 2,047 lines

Numbers include comments

Statistics – Phase 1
The Output

- Database tier
  - Generated by Code Generator: 2,309 lines (78%)
  - Handwritten: 656 lines (Fast Data Readers)
  - Mechanisms: 257 lines

Enterprise Application Architecture


Level of Code Generation
Intranet/ Internet
Web Tier
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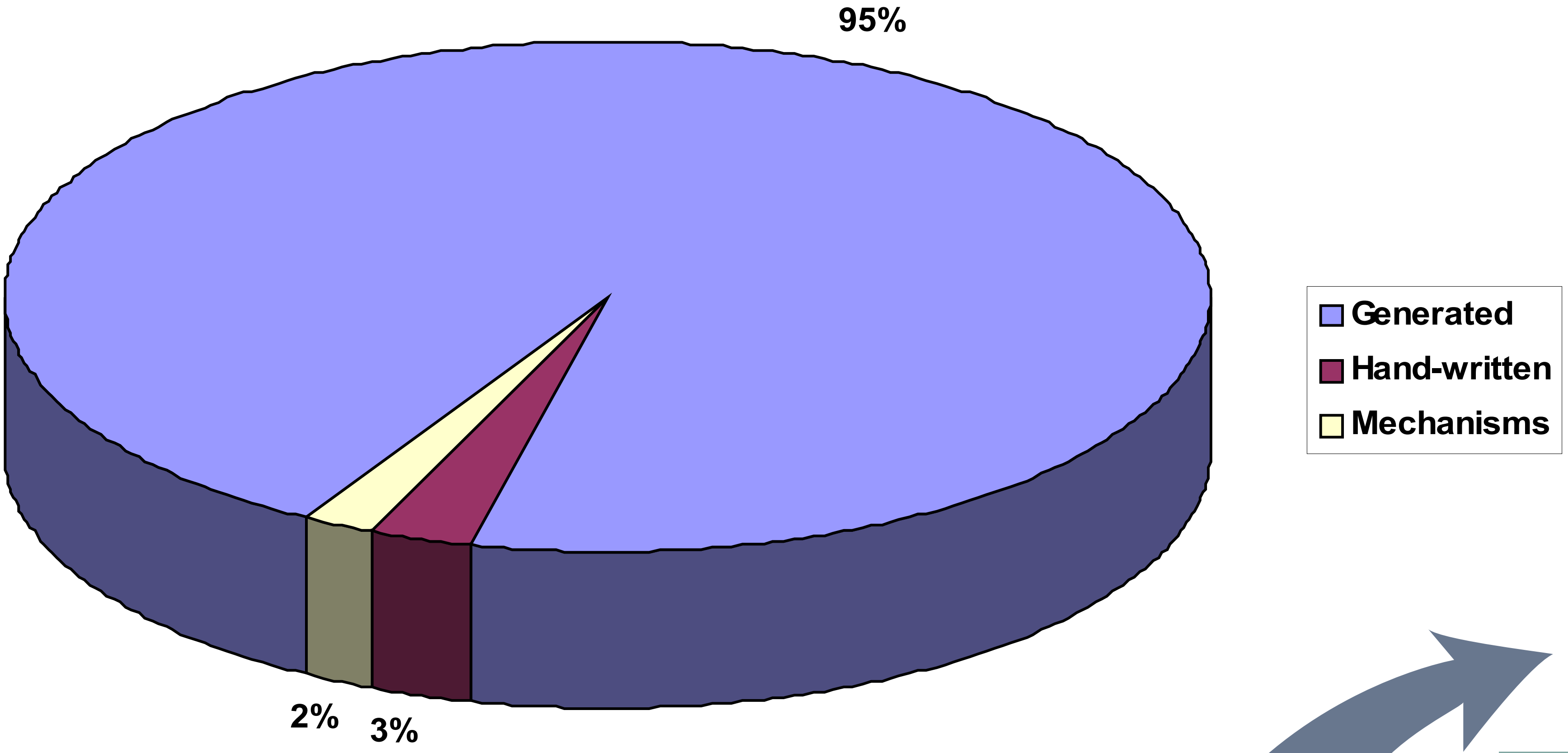
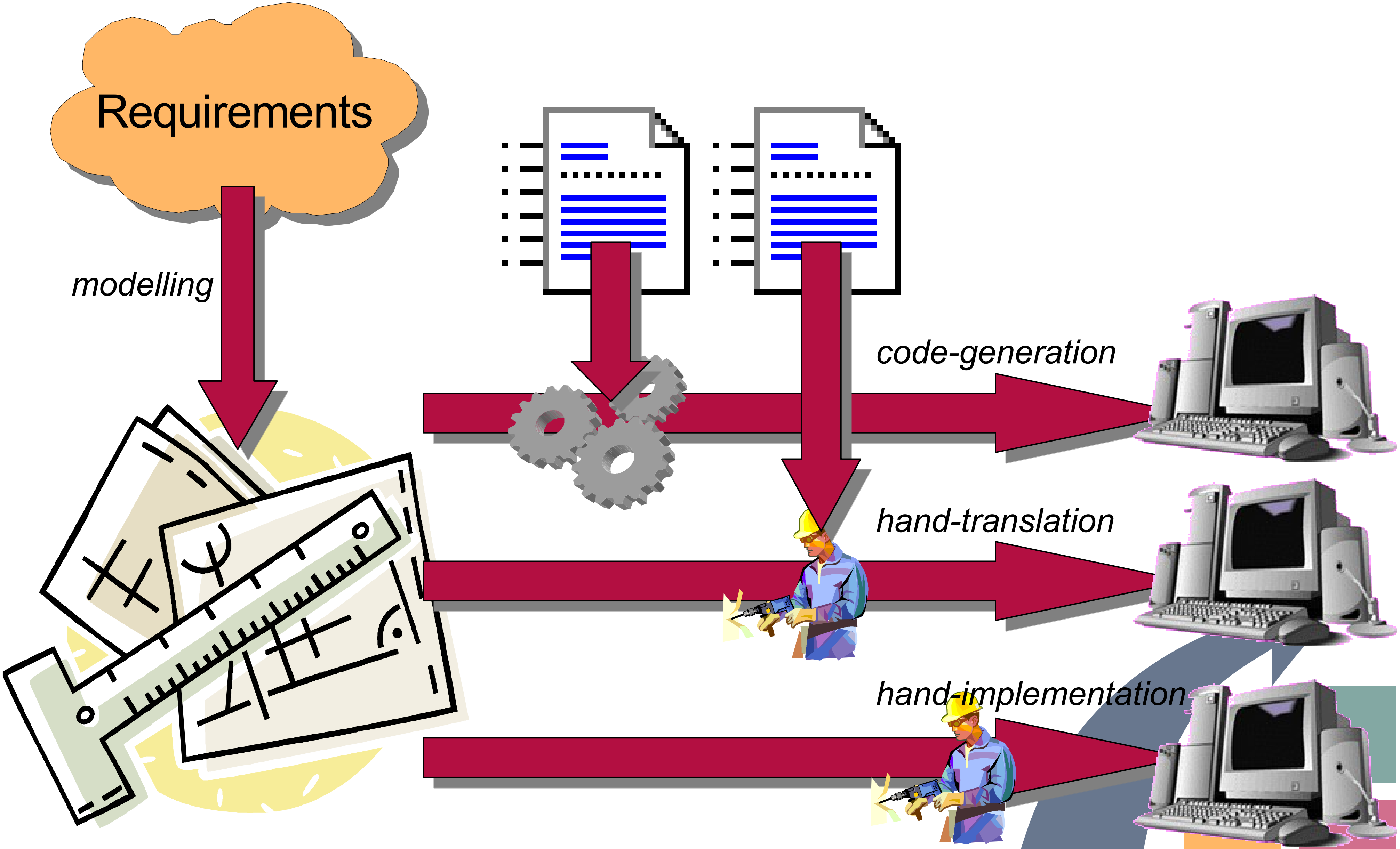
Statistics – Phase 1



Numbers include the administration application and exclude XDoclet generated code

Code generation or not...?



Thank you – some time for discussion...?

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