Model-driven software engineering: Engineering or not?

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think forward

- What characterises “Engineering”?
- What is model-driven software engineering?
- Some Examples
- Is MDE really “Engineering”??
- Future directions

What is “Engineering”?

- Wikipedia:

  “Engineering is the discipline, art and profession of acquiring and applying technical, scientific, and mathematical knowledge to design and implement materials, structures, machines, devices, systems, and processes that safely realize a desired objective or invention.”

- ABET:

  “… creative application of scientific principles to design or develop structures, machines, apparatus, or manufacturing processes, or works utilizing them singly or in combination; or to construct or operate the same with full cognizance of their design; or to forecast their behavior under specific operating conditions; all as respects an intended function, economics of operation and safety to life and property”

- Problem needing solving
- Requirements & Specifications
- Designs – usually multiple options; function & aesthetics & safety & …
- Mathematical models
- Scientific theories/principles underlying models
- Analysis of models to predict outcomes of different options
- Computer-aided design, manufacturing, analysis, processes
- Repeatable processes, project management principles
- Sharing of best practices, professionalism, ethical behaviors, …

- No “physical” models to ground, constrain, inform
- Artefacts highly changeable through engineering lifecycle [Note: just because CAN change, doesn’t mean SHOULD!]
- What are appropriate models/modelling languages?
- Where does “design” end and “construction” begin?
- Are our solutions/processes repeatable?
- Can we evaluate results – before and/or after construction?
- Can (and do) we capture “best practice”?
- Widespread practices of professionalism and ethics?

- Wikipedia ☺:

  MDE is a software development methodology which focuses on creating models, or abstractions, more close to some particular domain concepts rather than computing (or algorithmic) concepts. It is meant to increase productivity by maximizing compatibility between systems, simplifying the process of design, and promoting communication between individuals and teams working on the system.

- Doug Schmidt, COMPUTER Guest Intro on MDE:

  Model-driven engineering technologies offer a promising approach to address the inability of third-generation languages to alleviate the complexity of platforms and express domain concepts effectively.

- Programming languages (3GLs) too low-level to describe many abstractions in software engineering
- SE models too disconnected from 3GLs (program code) e.g. traditional analysis & design languages
- BUT: such models CAN be used to "construct" software directly
- Need high-level modelling languages to better express requirements, architectures, designs, tests etc BUT that can be directly turned into/related to code constructs
- Need to provide ways to build, reason with models, translate models to(/from) code
- BUT: working directly with code (3GLs) still very useful!!!

Overview of MDE concept

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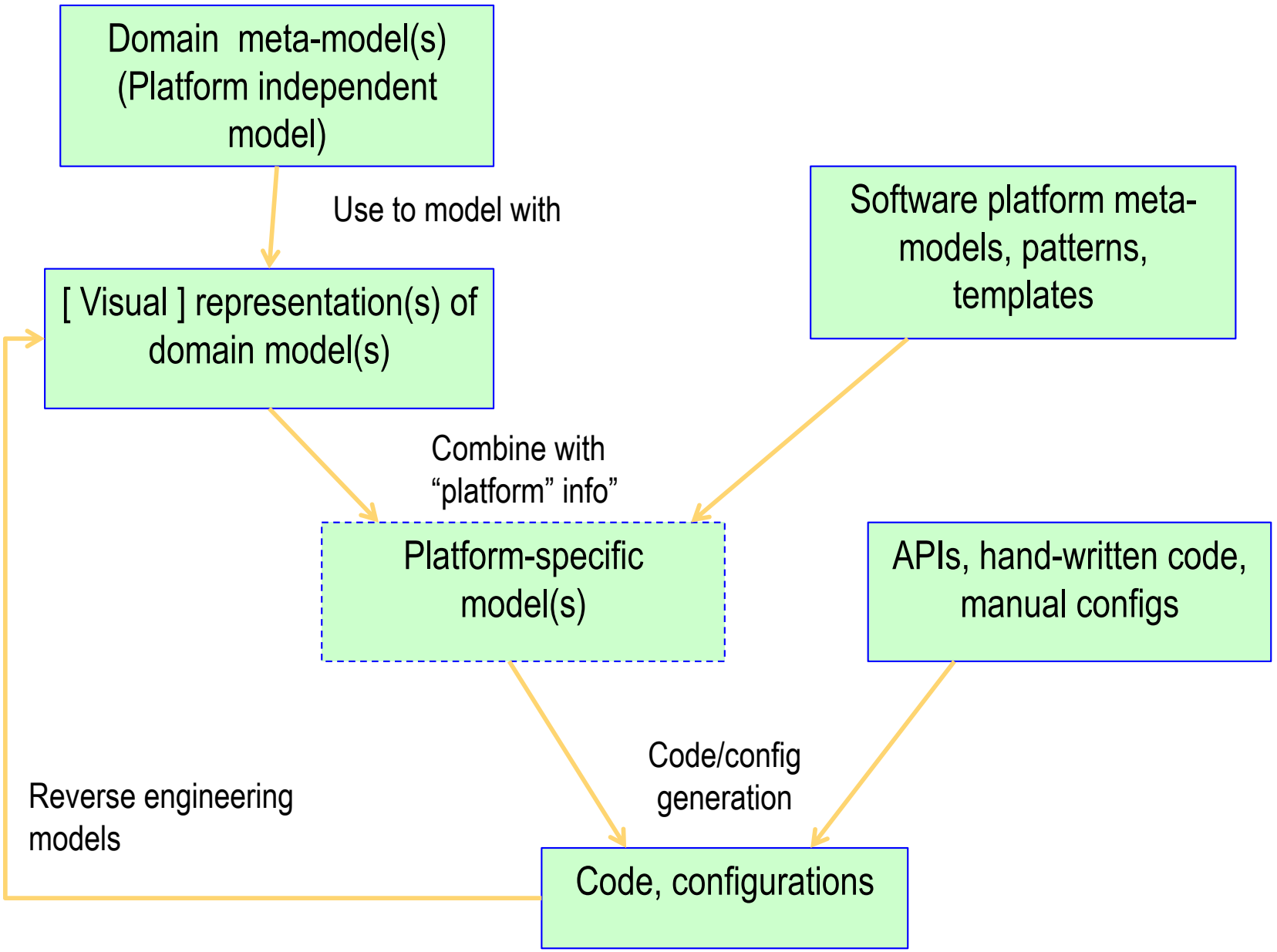

- Domain meta-model(s), models
- Visualisation(s) of domain models – textual and graphical
- Mapping between models
- Editing tools for models
- Transformation support i.e. model->model, model -> code
- Visualisation support e.g. code/data -> model
- Reasoning support e.g. analysis of models – completeness, correctness, consistency
- Model management support e.g. version control, diffing/merging, etc

- MaramaMTE (Performance Engineering)
- Form-based Mapper (Complex Data Mapping)
- MaramaVCPML (Personal Care Plan App generator)
- MaramaEML (Enterprise Modelling Language)
- MaramaAI (Requirements capture)
- VikiBuilder (Visual Wiki generation)

- Performance test generator from high-level architectural models
- Domain models = architecture, usage models
- Platform models = web domain, multi-tier domain, J2EE, .NET architectures and APIs
- Code, configs = Java, C#, JMeter, MS ACT, Selenium
- Visualisation = performance data on architecture data
- With CSIRO and several small-to-medium companies

Example

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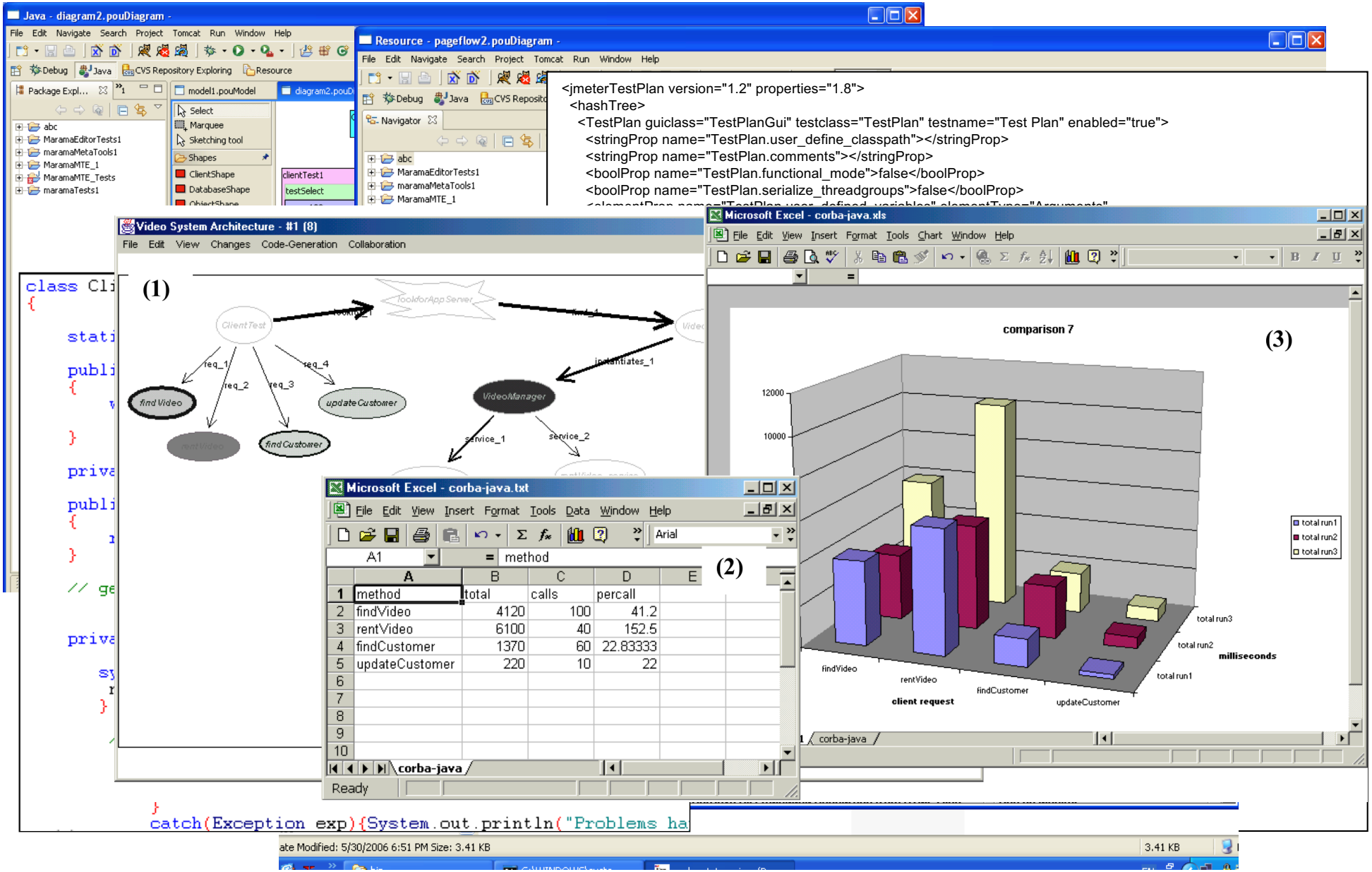

MTE – The Next Generation: “StressCloud”

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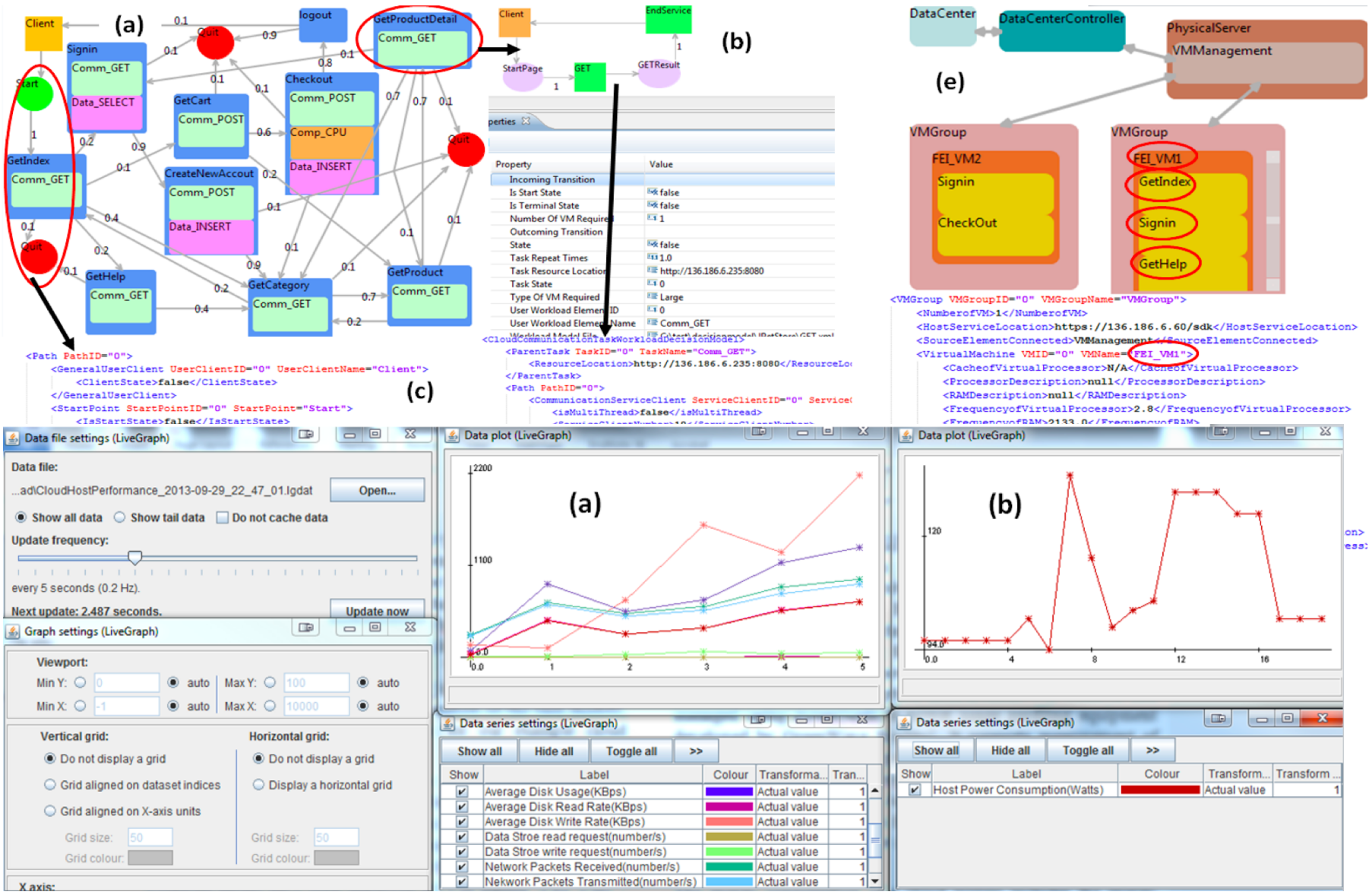

- Scenario: complex XML or EDI message format; want to translate into a different format; many to process
- Traditionally: write QVT/ATL/XSLT/code to do
- Alternative: model transformation visually and generate these transformation implementations
- Meta-model = source/target and mappings
- Visual models might include forms, trees, concrete data visualisations
- MDE = generate XSLT, ATL, Code (C++, Java),…
- Done various with Orion Health Ltd, XSOL Ltd, NICTA

Examples

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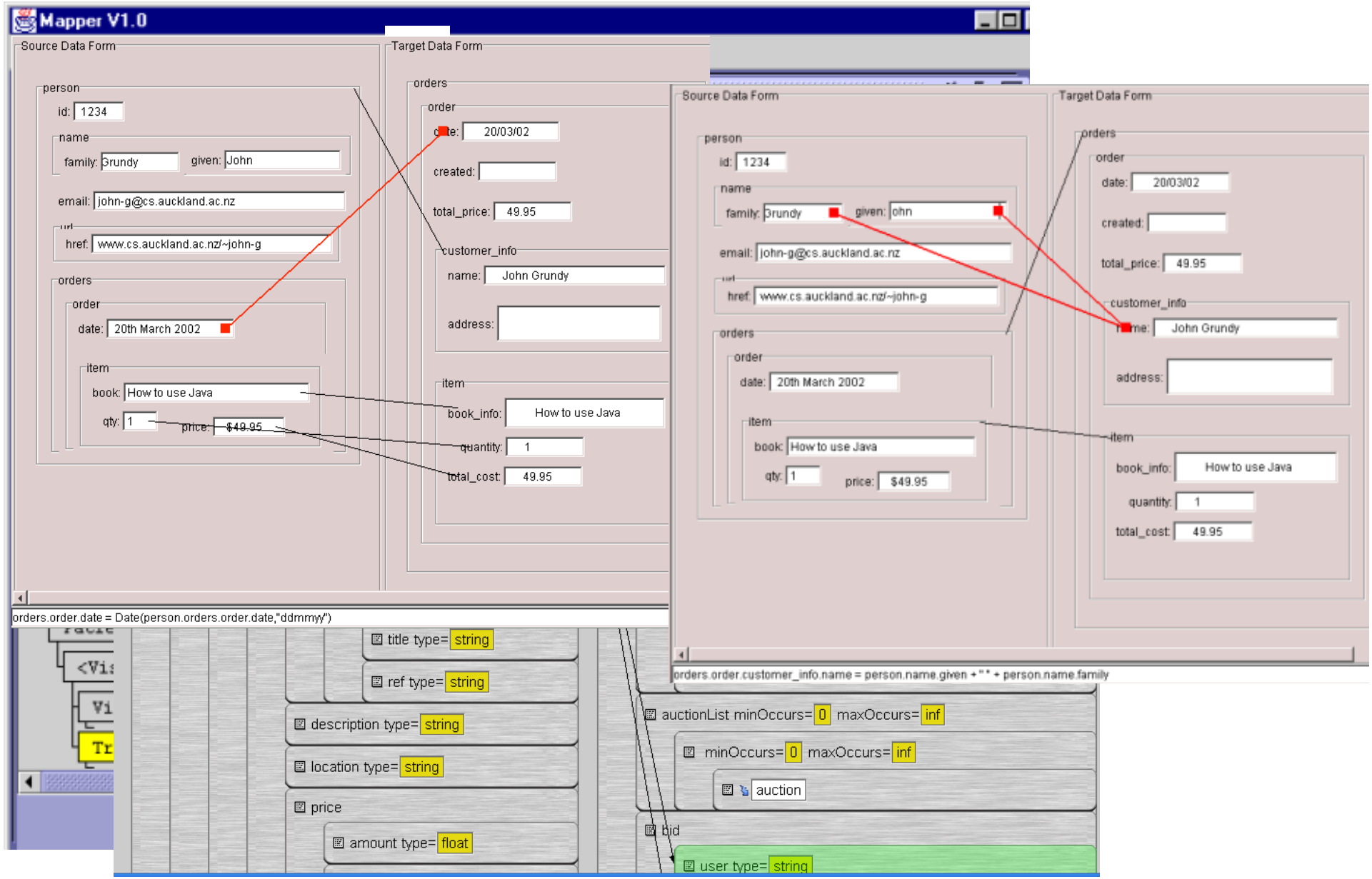

The Next Generation #2: CONVErT

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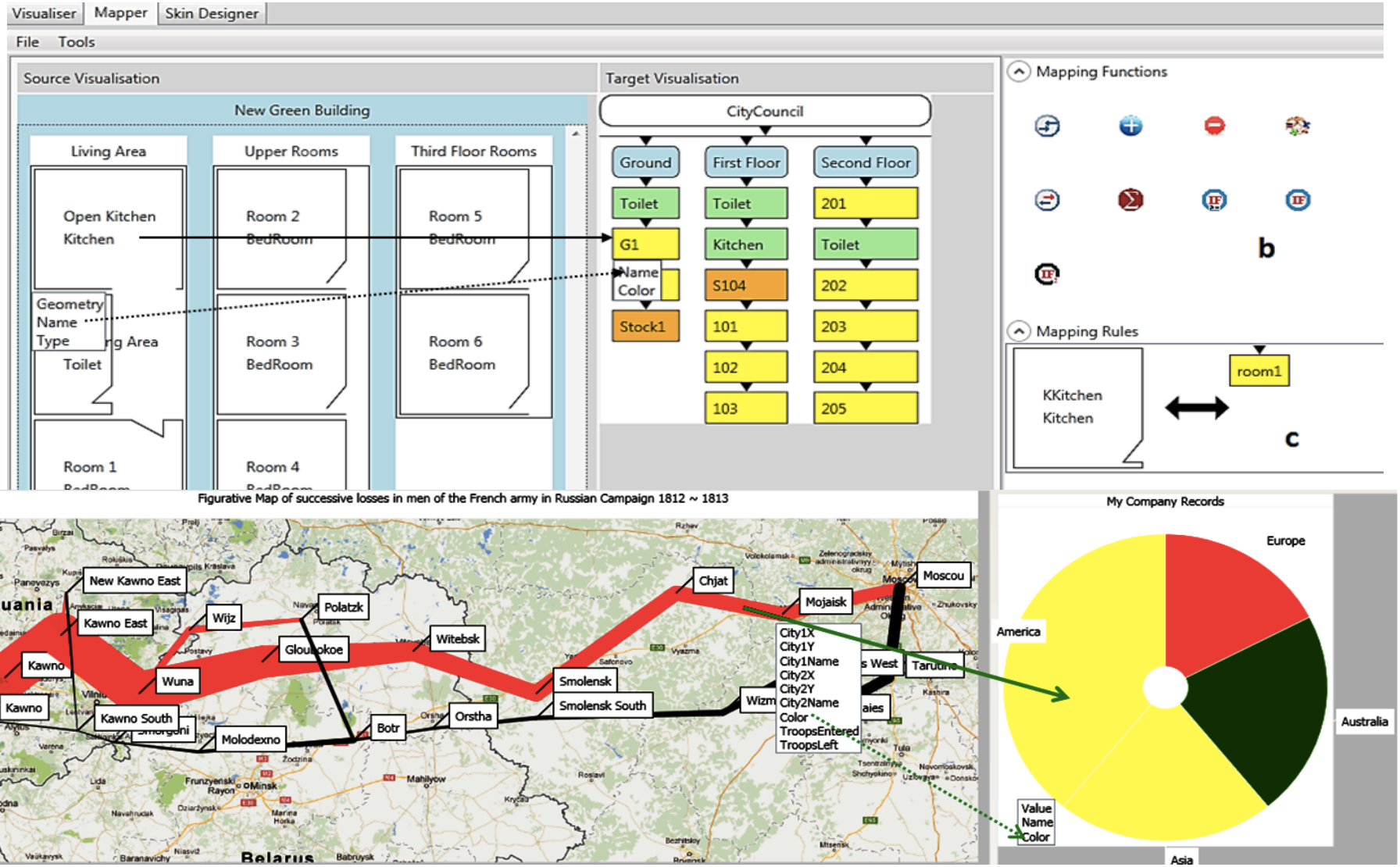
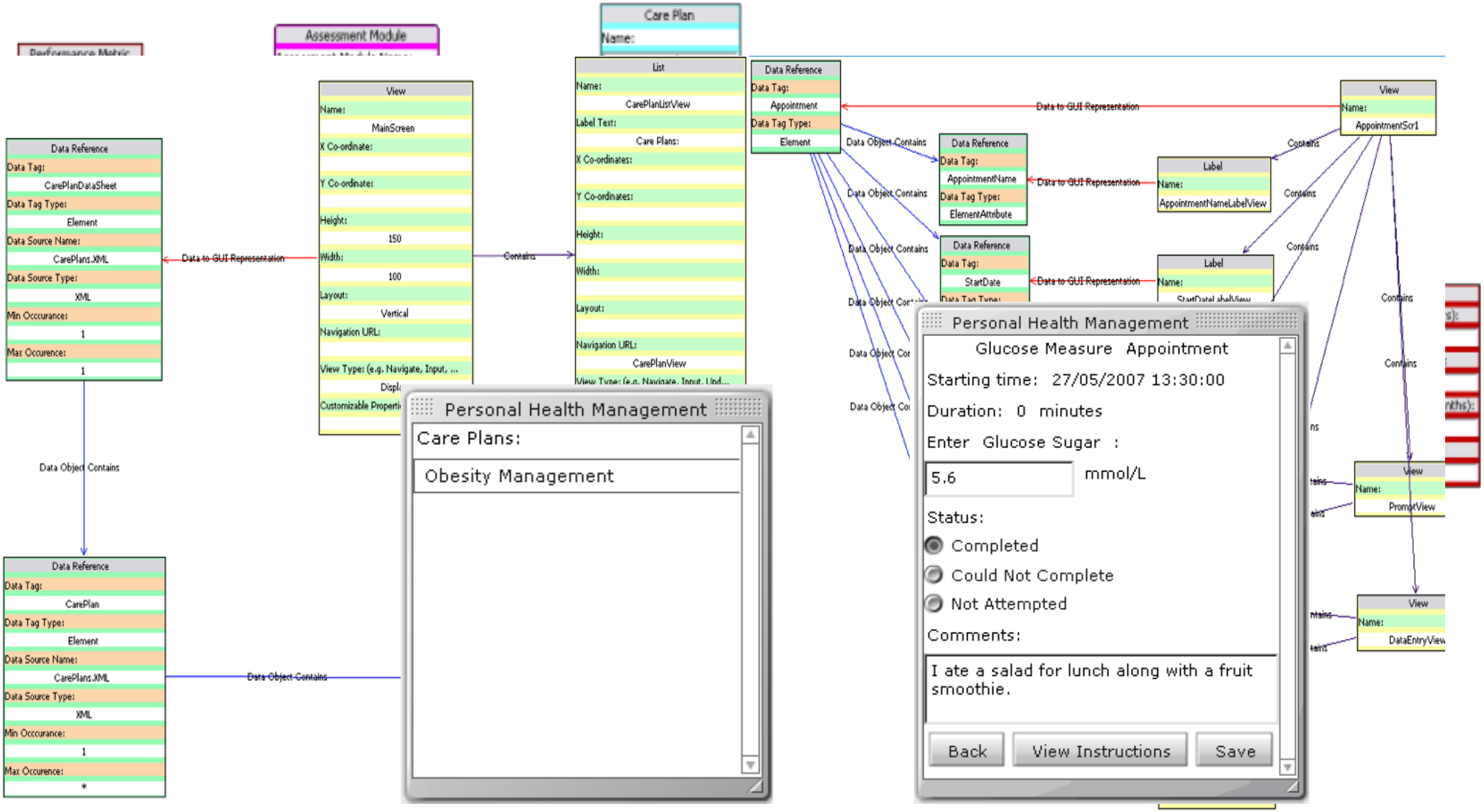


- Mobile phone-based personal health care planning applications
- Two meta-models with associated DVSLs: Visual Health Care Planning Language, Visual Care Application Model
- Model generic care plan with a visual DSVL tool
- Configure generic care plan for individual
- Model mobile app UI for individual from tailored care plan with a visual DSVL tool
- Generate Flash, Windows Mobile, iPhone app code


Assessment Module
Care Plan
Name:
Data Reference
Data Tag:
CarePlanDataSheet
Data Tag Type:
Element
Data Source Name:
CarePlans.XML
Data Source Type:
XML
Min Occurance:
1
Max Occurence:
1
Data to GUI Representation
View
Name:
MainScreen
X Co-ordinate:
Y Co-ordinate:
Height:
150
Width:
100
Layout:
Vertical
Navigation URL:
View Type: (e.g. Navigate, Input, ...
Contains
List
Name:
CarePlanListView
Label Text:
Care Plans:
X Co-ordinates:
Y Co-ordinates:
Height:
Width:
Layout:
Navigation URL:
CarePlanView
Data Object Contains
Data Reference
Data Tag:
CarePlan
Data Tag Type:
Element
Data Source Name:
CarePlans.XML
Data Source Type:
XML
Min Occurance:
1
Max Occurence:
*
Personal Health Management
Care Plans:
Obesity Management
Data Reference
Data Tag:
Appointment
Data Tag Type:
Element
Data Reference
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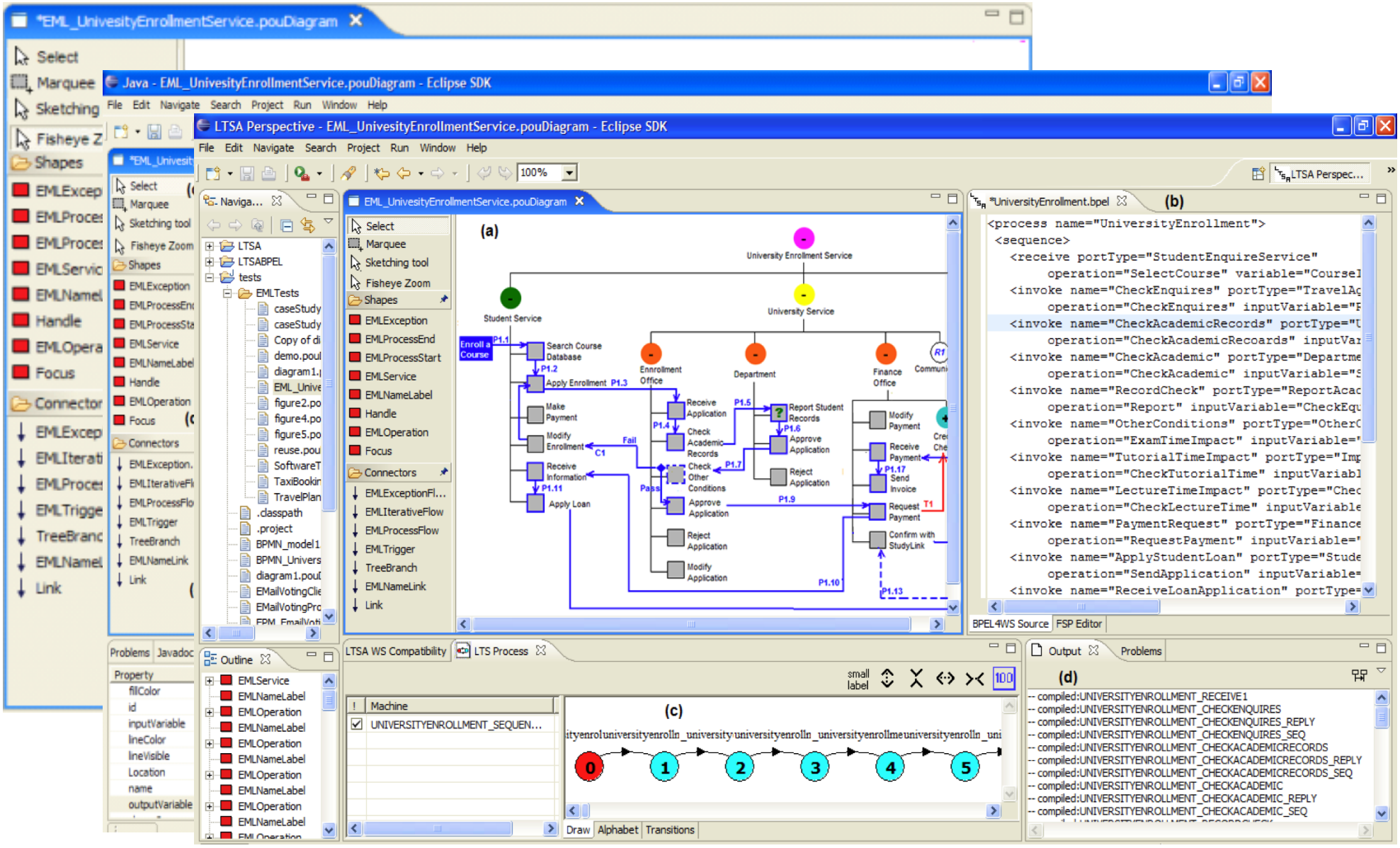
AppointmentName
Data Tag Type:
ElementAttribute
Label
Name:
AppointmentNameLabelView
Data Reference
Data Tag:
StartDate
Label
Name:
View
Name:
AppointmentScr1
View
Name:
PromptView
View
Name:
DataEntryView
Personal Health Management
Glucose Measure Appointment
Starting time: 27/05/2007 13:30:00
Duration: 0 minutes
Enter Glucose Sugar :
5.6
mmol/L
Status:
Completed
Could Not Complete
Not Attempted
Comments:
I ate a salad for lunch along with a fruit smoothie.
Back
View Instructions
Save

- Enterprise modelling tool
- Integrated domain meta-model synthesized from several existing & new models (BPML, EML, ViTABaL-WS, …)
- Multiple views with different DSVLs
- Platform meta-model & “code” = BPEL – executable process modelling language (a DSL)
- Tool support for large scale diagram management
- Tool support for model checking for integrated LTSA tool


*EML_UnivesityEnrollmentService.pouDiagram
Java - EML_UnivesityEnrollmentService.pouDiagram - Eclipse SDK
LTSA Perspective - EML_UnivesityEnrollmentService.pouDiagram - Eclipse SDK
File Edit Navigate Search Project Run Window Help
(a)
(b)
(c)
(d)
University Enrollment Service
University Service
Student Service
Enroll a Course
Search Course Database
Apply Enrollment
Make Payment
Modify Enrollment
Receive Information
Apply Loan
Enrollment Office
Receive Application
Check Academic Records
Check Other Conditions
Approve Application
Reject Application
Modify Application
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Send Invoice
Request Payment
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FSP Editor
LTSA WS Compatibility
LTS Process
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Draw
Alphabet
Transitions
Output
Problems
-- compiled:UNIVERSITYENROLLMENT_RECEIVE1
-- compiled:UNIVERSITYENROLLMENT_CHECKENQUIRES
-- compiled:UNIVERSITYENROLLMENT_CHECKENQUIRES_REPLY
-- compiled:UNIVERSITYENROLLMENT_CHECKENQUIRES_SEQ
-- compiled:UNIVERSITYENROLLMENT_CHECKACADEMICRECORDS
-- compiled:UNIVERSITYENROLLMENT_CHECKACADEMICRECORDS_REPLY
-- compiled:UNIVERSITYENROLLMENT_CHECKACADEMICRECORDS_SEQ
-- compiled:UNIVERSITYENROLLMENT_CHECKACADEMIC
-- compiled:UNIVERSITYENROLLMENT_CHECKACADEMIC_REPLY
-- compiled:UNIVERSITYENROLLMENT_CHECKACADEMIC_SEQ

- Requirements capture and analysis tool
- Textual requirements -> essential interactions -> Essential Use Cases -> UIDs, OOAs
- Domain meta-models include natural language (!), EUCs, UML etc
- Textual and visual representations of domain models
- Transformation of text to/from EUC-based DSVL models
- Analysis of consistency between models, completeness/correctness of models via EUC pattern library

Examples

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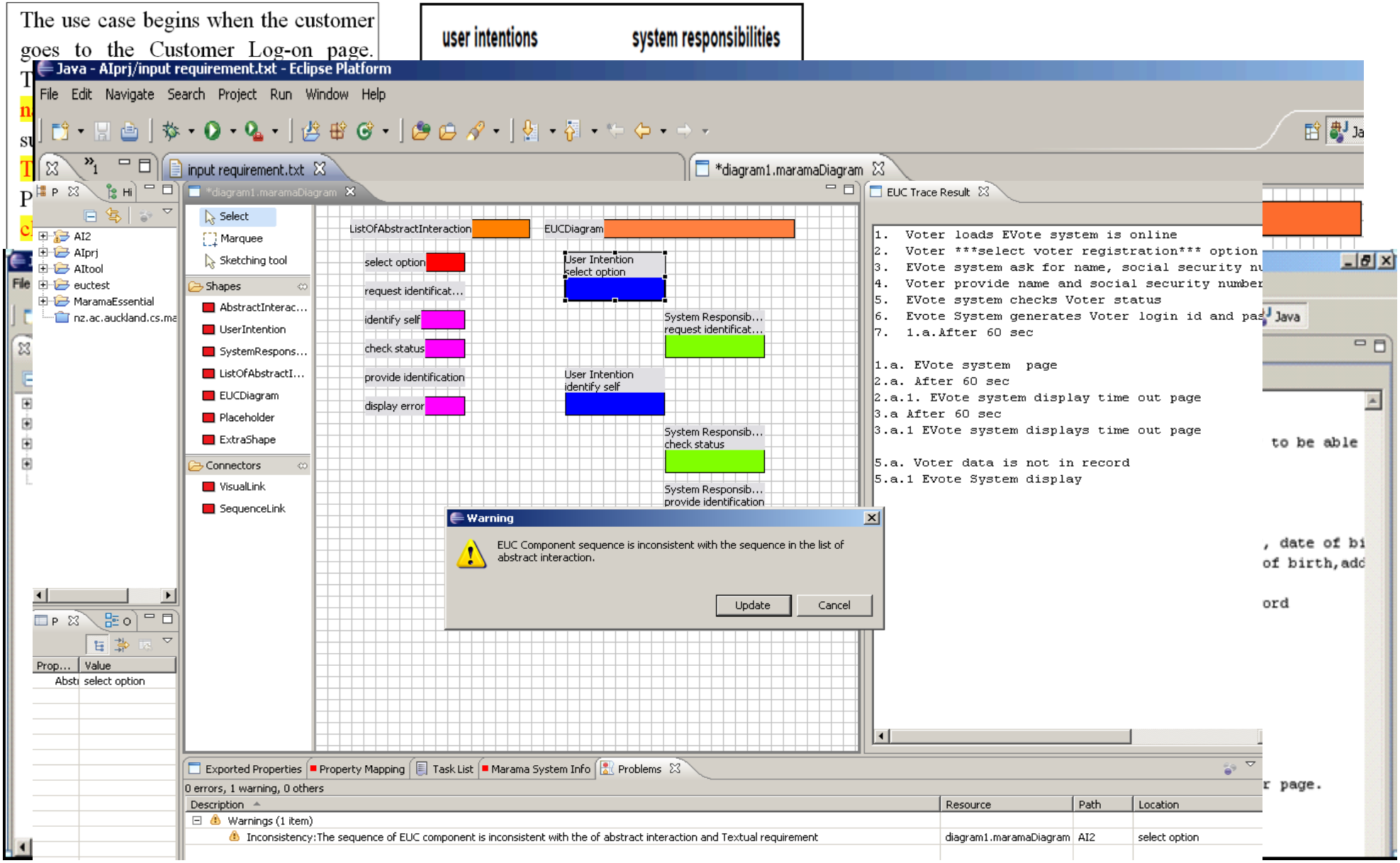

Visual Wikis (“Vickis”) & VickiBuilder

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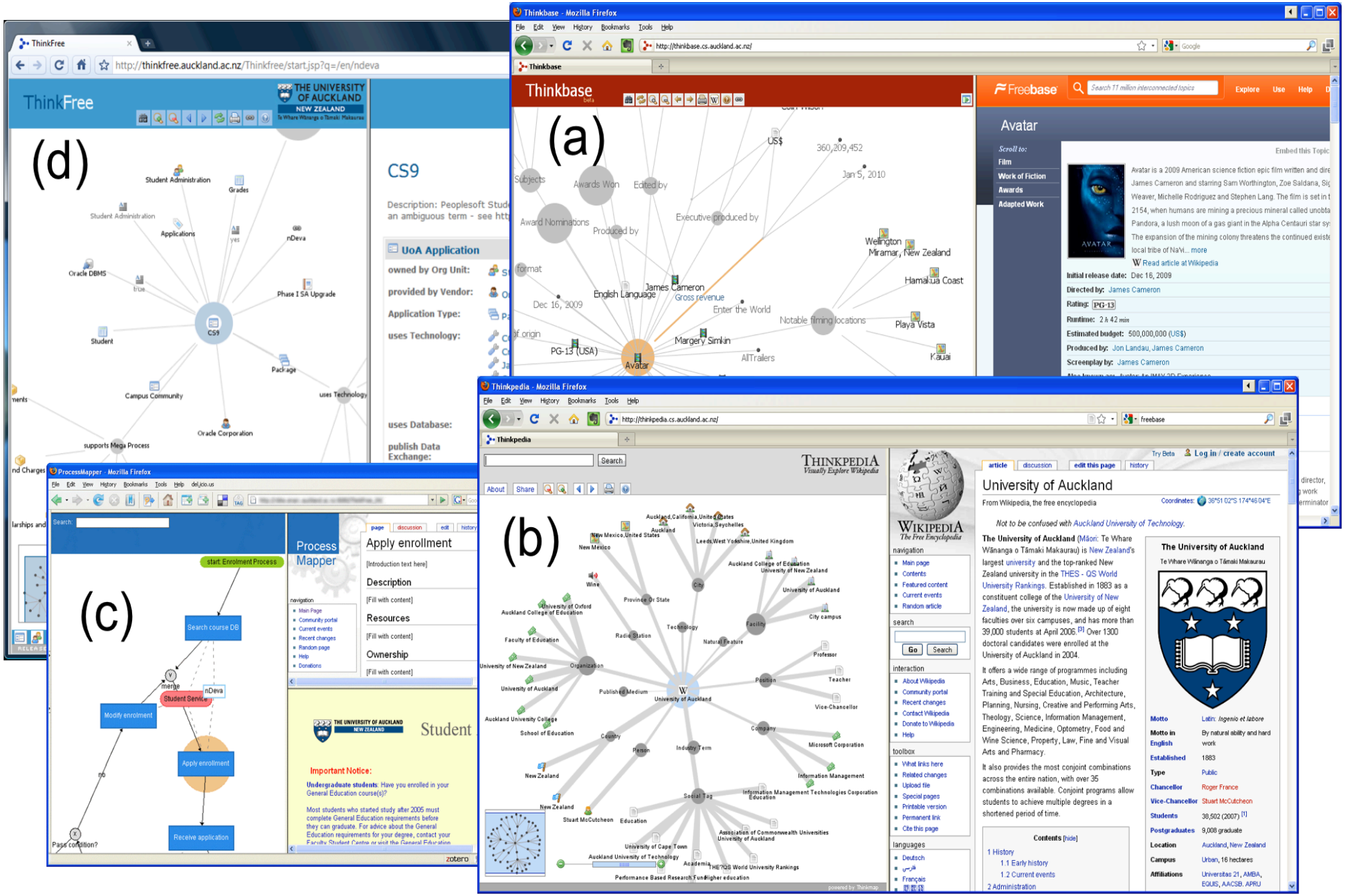

Example

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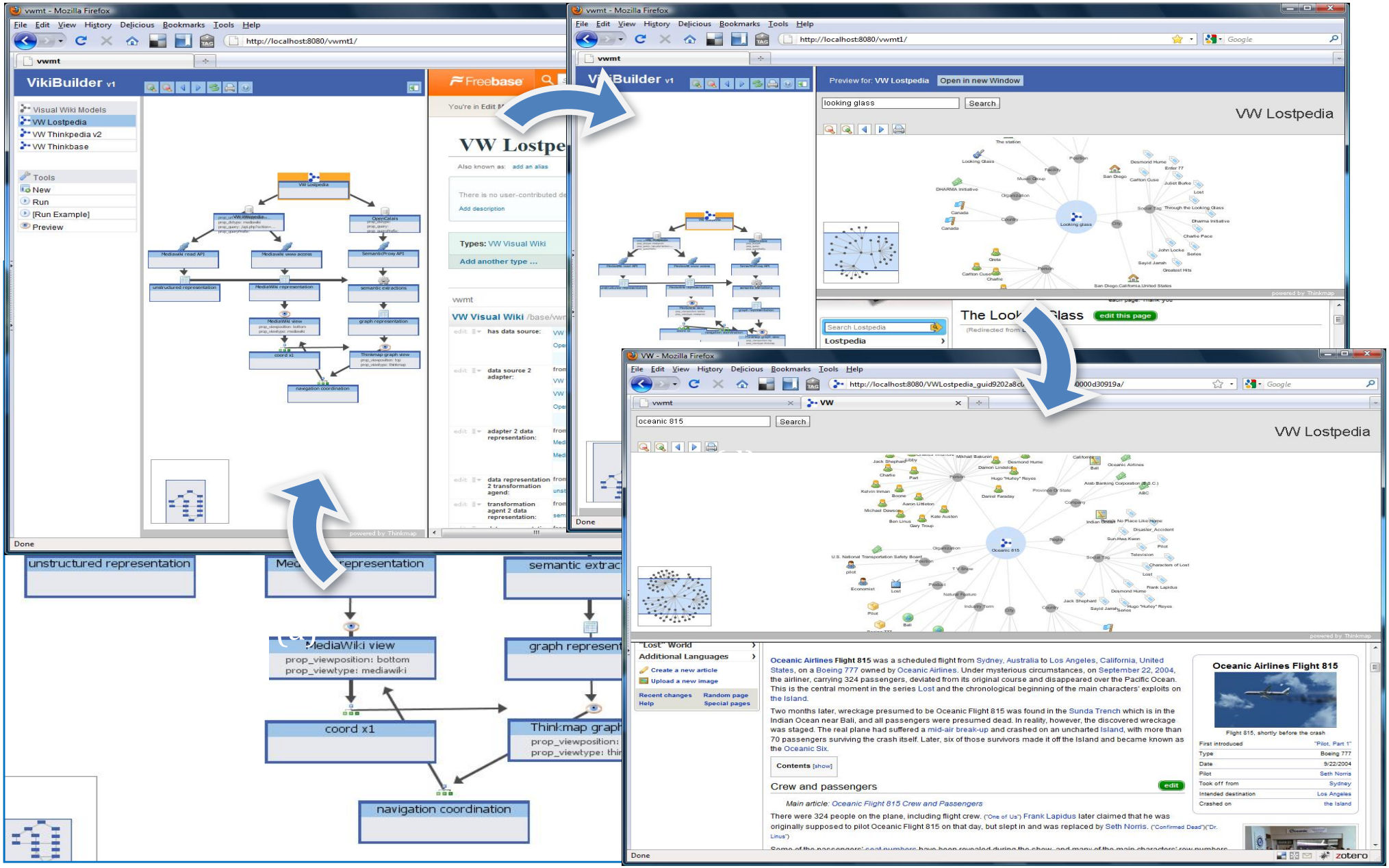

- Higher level models to work with – easier to create, understand, modify, do analysis on than 3GL code
- Can refine models, ultimately to code/configurations
- Repetitive stuff (“construction”) can be largely (sometimes completely) automated

- Models get complex, need good tools to work with them
- Hard to agree on standards esp. in new areas
- Model and tool evolution gets very tricky
- Trade-off between flexibility (code) and productivity (MDE)…

Is MDE “Engineering”?

- Using meta-models, model representations
- Can check (some aspects of) models in tools
- Repeatable processes
- Productivity, quality improvements
- “Construction” becomes push-a-button

- Best practices in MDE?
- Dynamic MDE (change while running)?
- Proactive MDE (change while running in anticipation of problems…)??

Future work

- Improve design of meta-models including specify complex constraints
- Improve design and evaluation of DSVLs
  - Physics of Notations Tool – new PhD project
- Improve specification of transforms e.g. by using CONVErT ☺
- Improve tool support for DSVLs, transforms, “design critics”
  - Horus – our next-generation Web-based DSVL tool
- Support other things via MDE e.g. security, HPC, cloud platforms
  - Horus HPC, MDSE @ Runtime, TOSSMA, SMURF
- Proactive adaptation of complex systems via MDE
  - My 2016 DP application... ☺
- Assess MDE on range of real-world problems
- Identify when “best practice” to use, when not to use…

Thank yous

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- John Hosking – most of these projects
- Jun Huh, Karen Li – Marama meta-tools
- Rainbow Cai, Feifei Chen – MaramaMTE, StressCloud
- Abizer Khambati – VCPML etc
- Michael Li – Form-based Mapper
- Massila Kalmalrudin – MaramaAI
- Christian Hirsch – VisualWikis, VickiBuilder
- Iman Avazpour – CONVErT
- Mohamed Almorsy – Horus, Horus HPC, MDSE @ R, …
- Many other contributors over many years…

In case your are interested…

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Thanks!

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