Building domain-specific, visual language software engineering tools

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Outline

- What are domain-specific visual language software tools?
- Examples of some DSVL tools:
  - Data mapping
  - Process management/tool integration
  - Project management
  - User interface design
  - DSVL tool event specification ☺
- Some approaches to building DSVL tools
- Evaluation & future work
- Conclusions

Models in Software Engineering

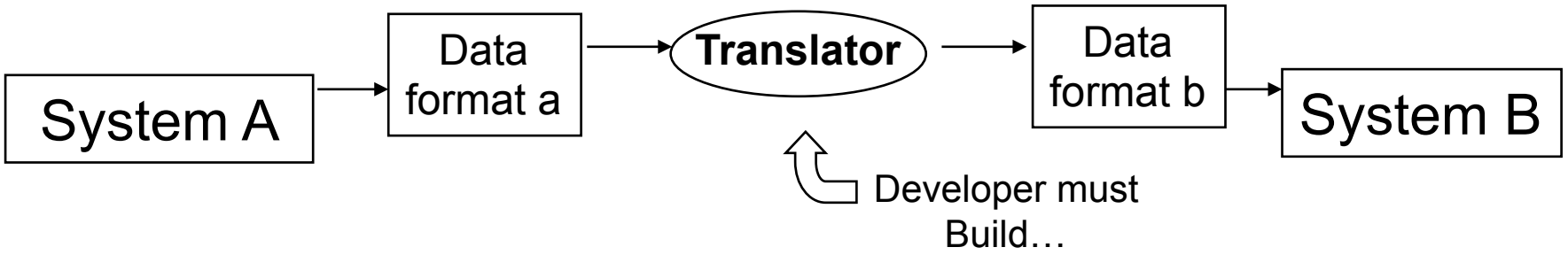
- Much of Engineering is about developing models of engineered products (or rather, models of products to engineer…)
- We've developed models for a whole range of SE "products" and activities:
  - Software processes
  - Requirements
  - Software design
  - Data structures
  - Software architecture
  - Software behaviour
  - Interface design
  - …
- We've also developed visual representations of these models – some are "abstract" (UML, ADLs); some are "concrete" e.g. WYSIWYG UI design…

But…

- Our models often get too complex, too unwieldly, hard to understand/maintain using only "abstract" or "general-purpose" model representations
- Example: any non-trivial Model-Driven Architecture application…
- Domain-specific languages (DSLs) – models that focus on expressing problems in a PART of software engineering, using less general but more expressive constructs
  - E.g. a scripting language for handling event responses
- Domain-specific visual languages provide way to represent such domain-oriented models using a wide variety of visual "metaphor(s)"
- Idea is to have a metaphor providing closer mapping to the problem domain than vanilla, general-purpose abstract model
  - E.g. show event-condition-action rules as flow charts
- DSVL tools provide environment to construct these models, configure existing components, generate code etc.

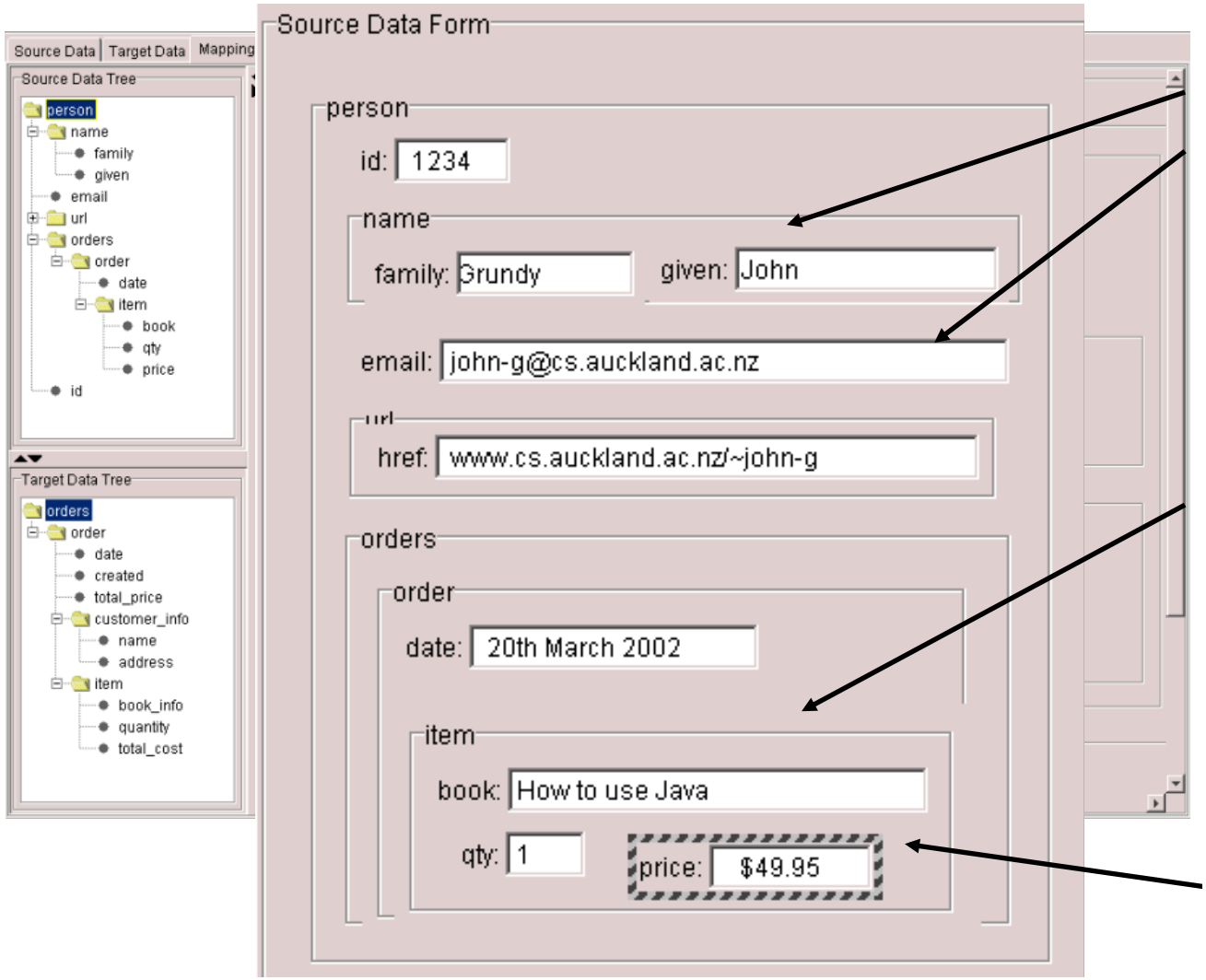
An Example: the Form-based data mapper

- Consider problem of "data mapping" between enterprise systems:



- Development of data translator tools is very tedious, time consuming and error prone using general-purpose langs/tools
- In enterprise system integration, often have "business analysts" who understand meaning of data in each domain, but not how to implement mapping tools using XSLT, Java, or even XML Spy etc.
- Idea: a new tool for translator generation – uses concept of "business forms" as the metaphor to represent source/target system data, and "mappings" between form components…

Form-based data mapping

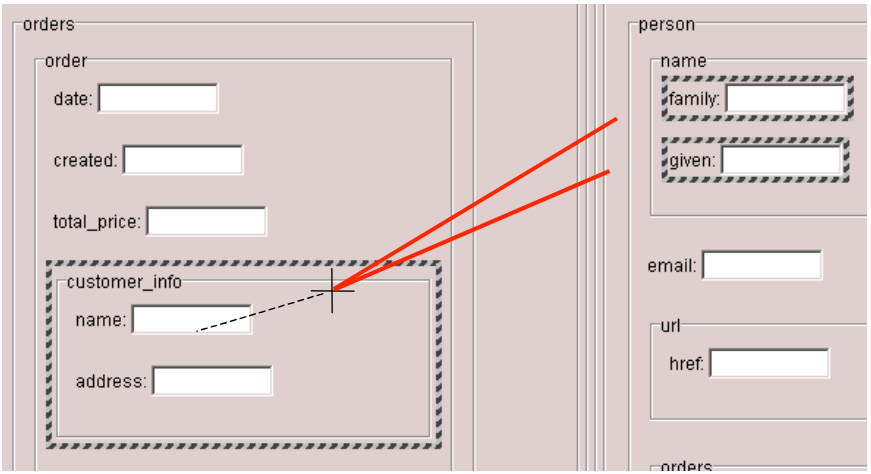


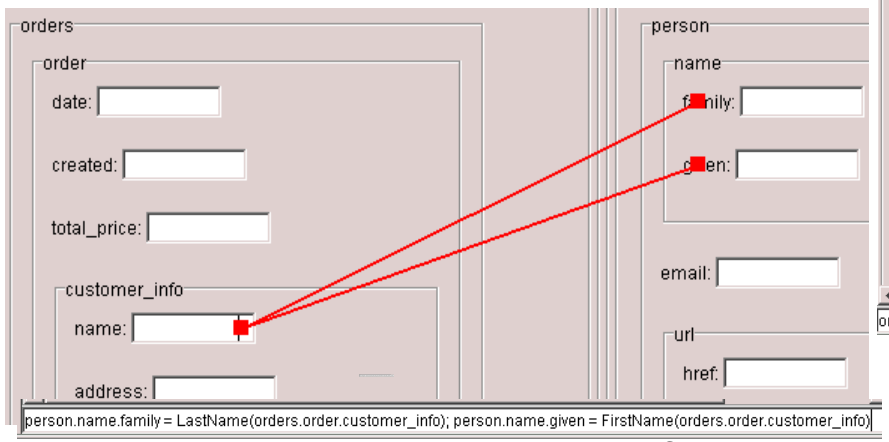
Resize

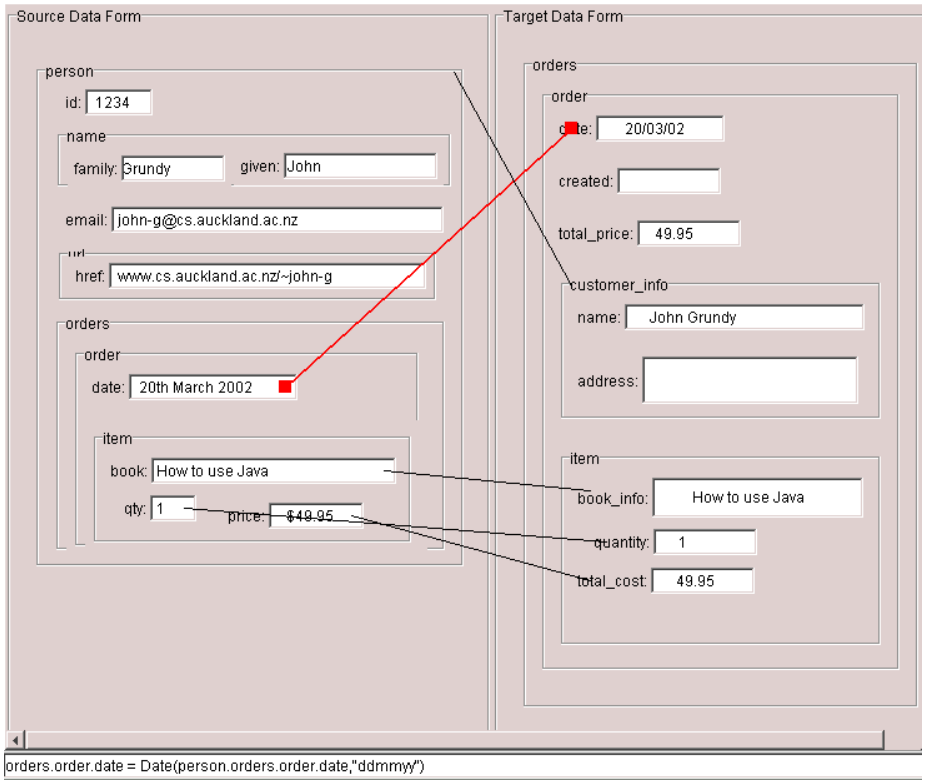
Add sub-structure

Rearrange layout

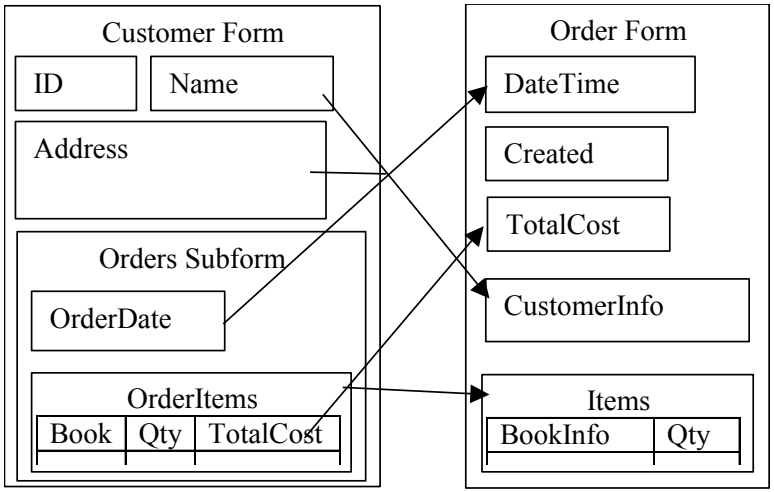
Data mapping







Code generation…



Order:
1

2

3

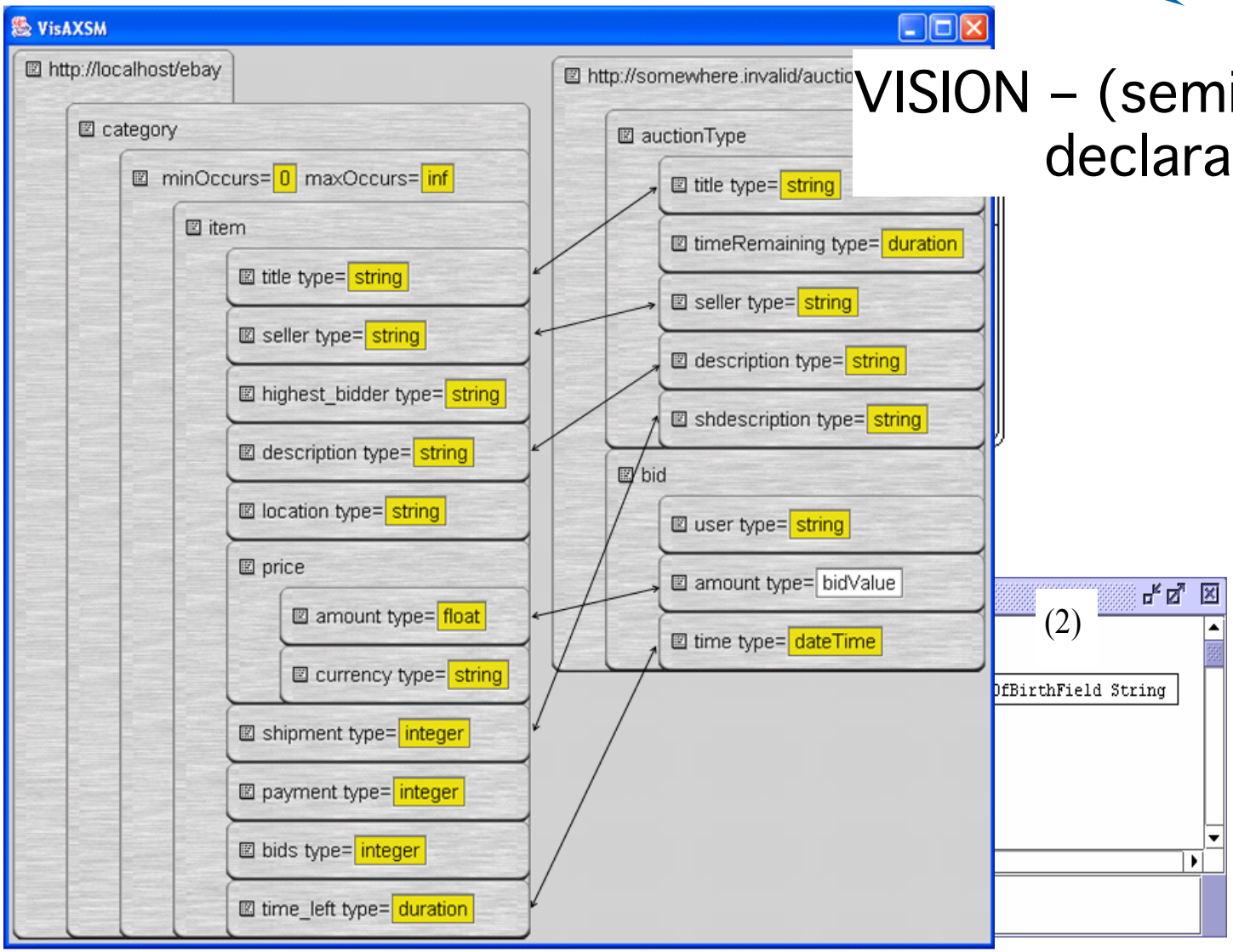
XSLT transformation script generation

4

```
<xsl:template match="/">
 <Order>
  <Number>…</Number>
  <DateTime><xsl:value-of select="/Order[1]/Order/Date"/>
    </DateTime>
  <Created>
    <xsl:value-of select="date:to-string(date:new())"/>
  </Created>
  <TotalCost><xsl:value-of
    select="sum(//OrderItem/TotalCost)"/> </TotalCost>
  <xsl:variable name="customer_id" select=
    "/Order/OrderItem[1]/CustomerSID"/>
  <CustomerInfo>
    <xsl:apply-templates select="//Customer [@id =
    $customer_id]"/>
  </CustomerInfo>
  <Items>
   <xsl:apply-templates select="//OrderItem"/>
  </Items>
 </Order>
</xsl:template>
…
```

Form-based mapper is "concrete", "Semi-declarative" DSVL…

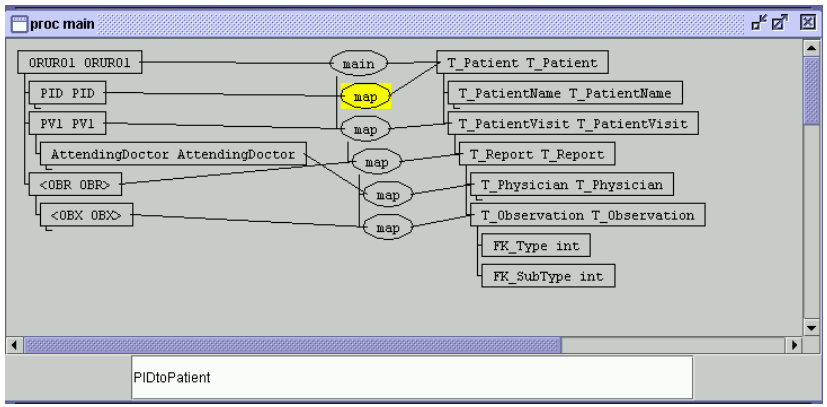
Other DSVL data mappers…

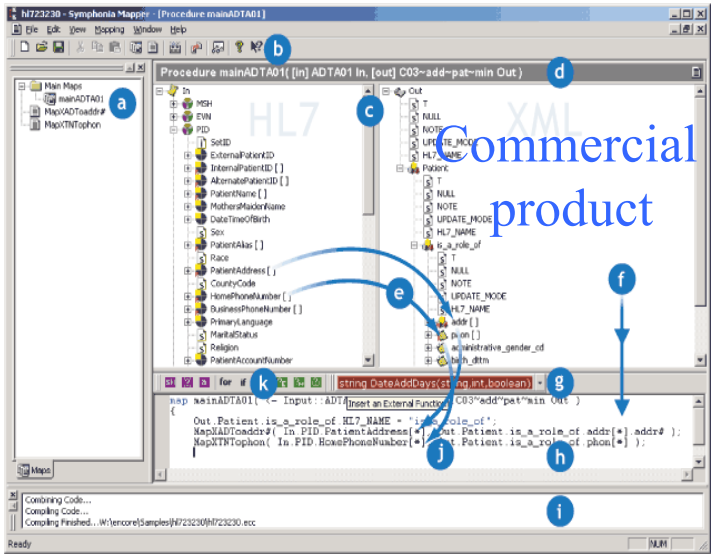


VISION – (semi-)abstract, declarative

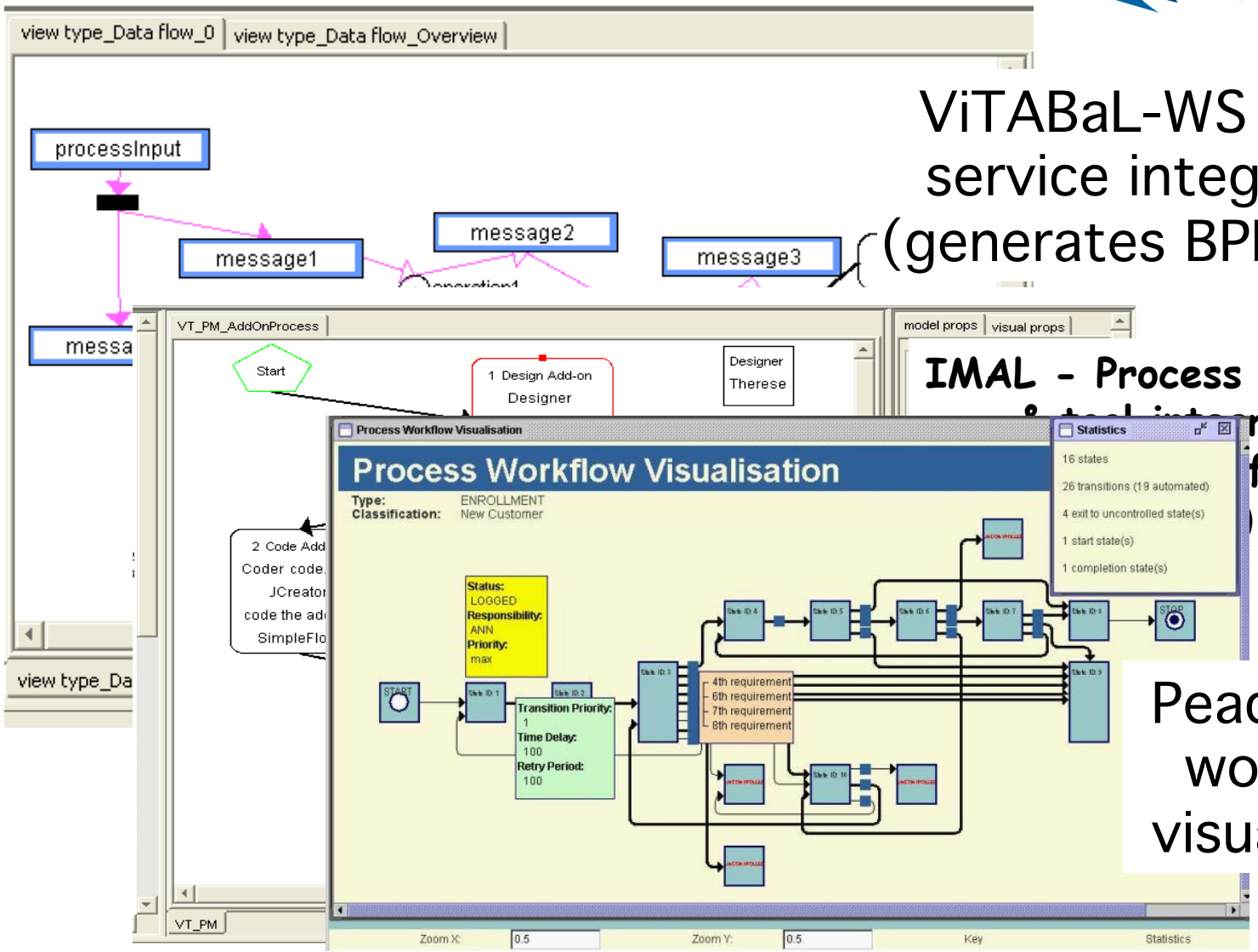
Example: Orion Systems Ltd Symphonia Message Mapper

- Health message mapping
  - Orion developed Rhapsody product from proof of concept systems
  - Large NZ software export earner
  - Follow-up DSVL tools underway





Process Management DSVLs



ViTABaL-WS – web service integration (generates BPEL4WS)

IMAL - Process modelling & tool integration foPath,

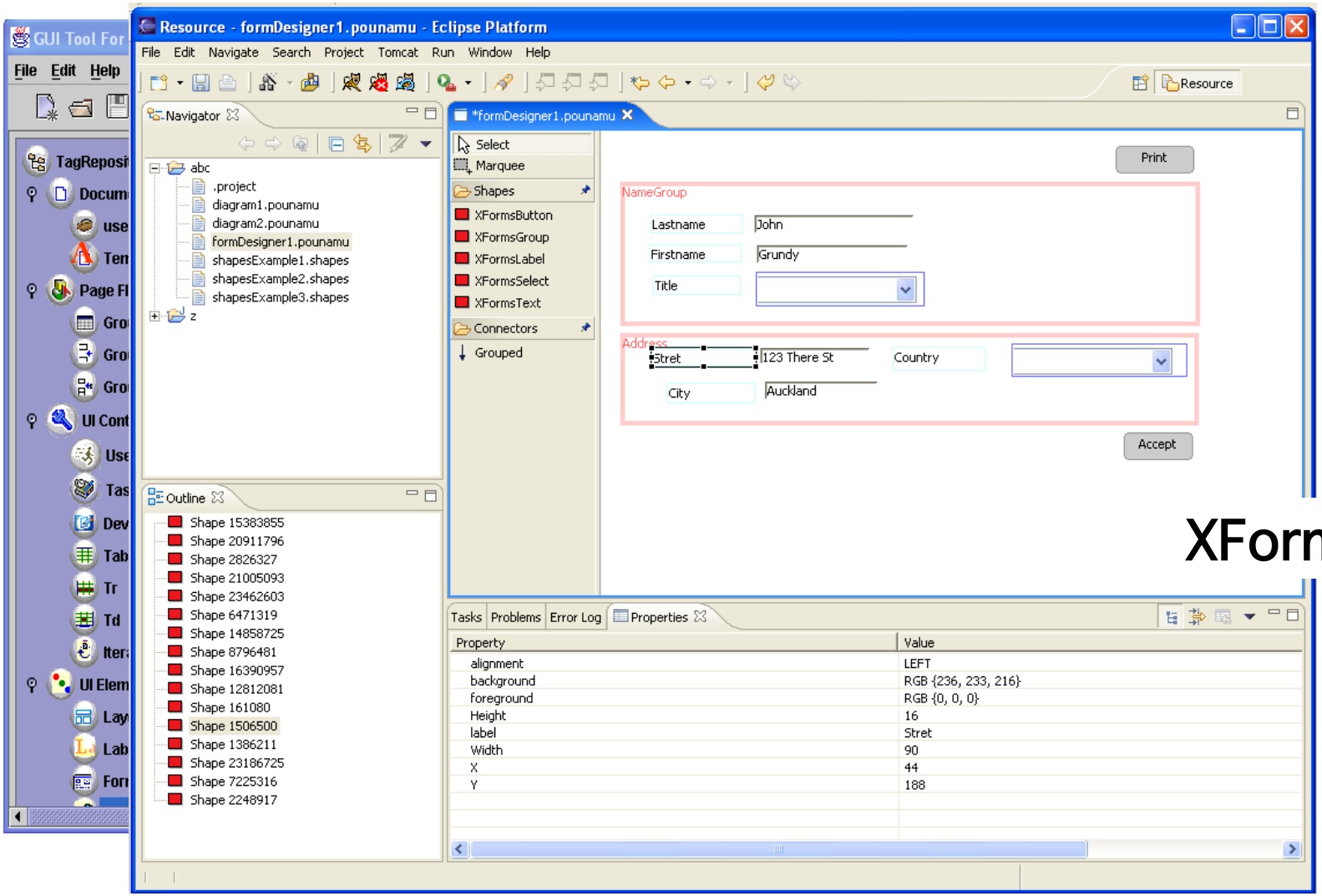
Peace WF – workflow visualisation

Project Management DSVLs

Running in a web browser...

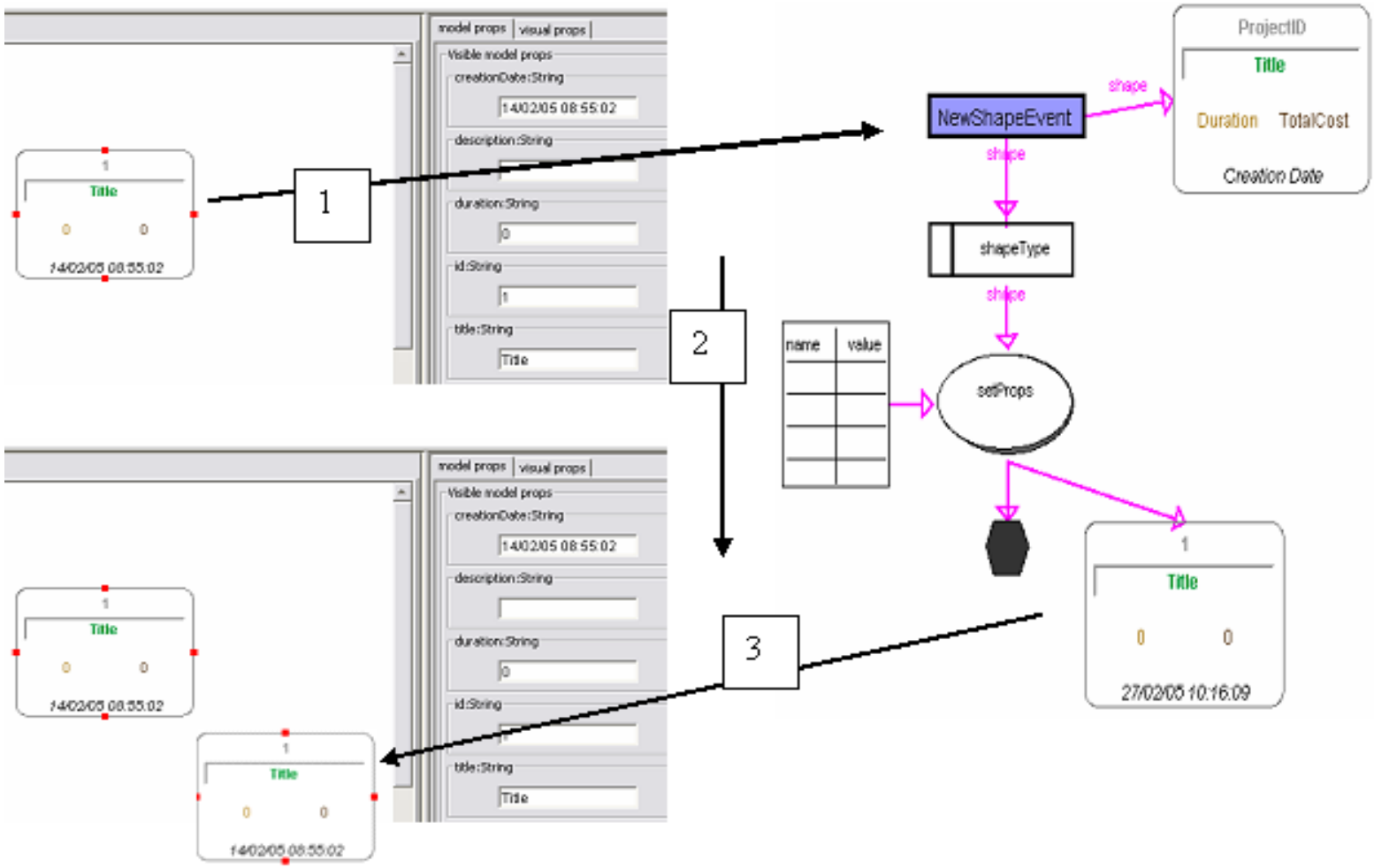
CityVis – PM data ☺

UI Design

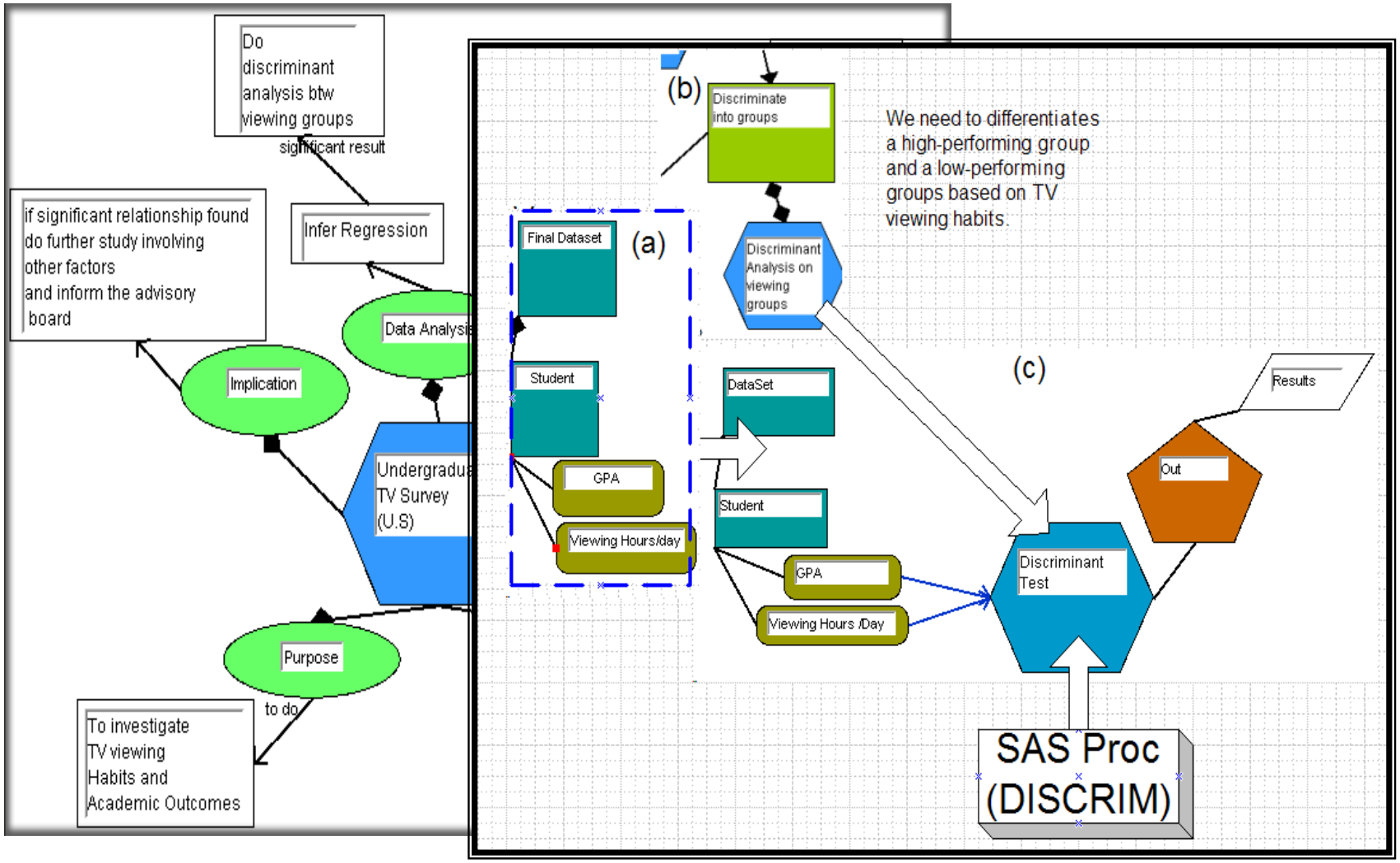


XForms

Visual event handling specification for DSVL tools



And not just for software…

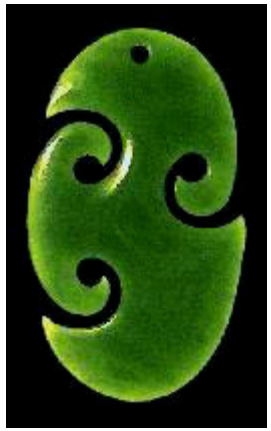


Designing DSVLs

- Little-understood…
- Our approach:
  - Identify key abstractions ("building blocks") in the target domain – leads to Domain-Specific Language
  - Identify candidate visual metaphors for DSL
  - Rapid prototype DSVL tools
  - Evaluate via:
    - Cognitive Dimensions (Greene, Blackwell)
    - Target user groups
    - Comparison to use of "conventional" languages, models, tools

Building DSVL Tools…

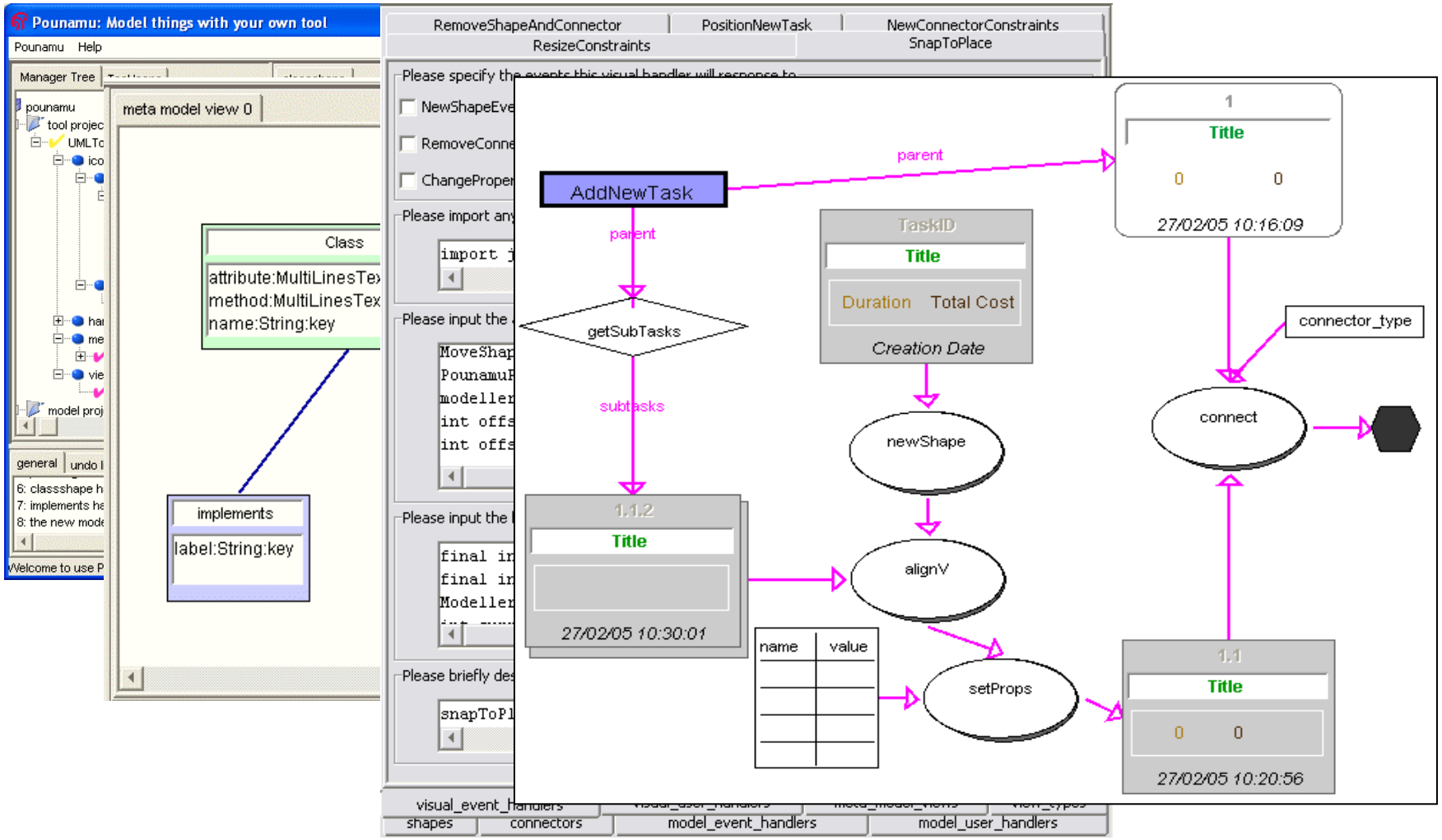
- Its hard to build these things…
  - Visual metaphor
  - Model to represent/build
  - Generate code/configurations/etc from model
  - Integrate with other tools
- Our current approach:
  - Meta-tool – visual models/meta-model
  - Import/export from model (XMI, Java, BPEL, WSDL, etc)
  - Web service/RMI APIs for other tools/plug-ins
  - Web browser, phone, Eclipse, collaboration plug-ins



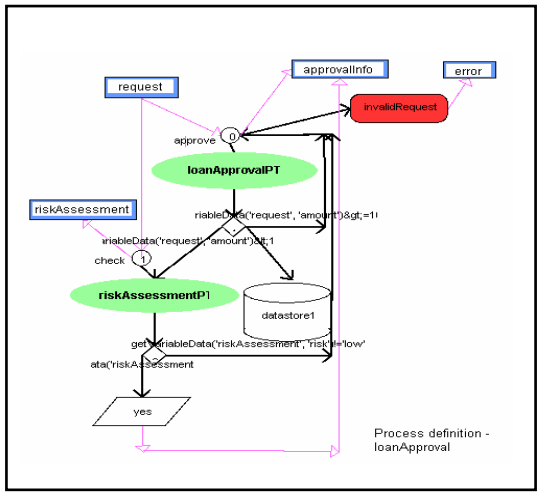
Pounamu

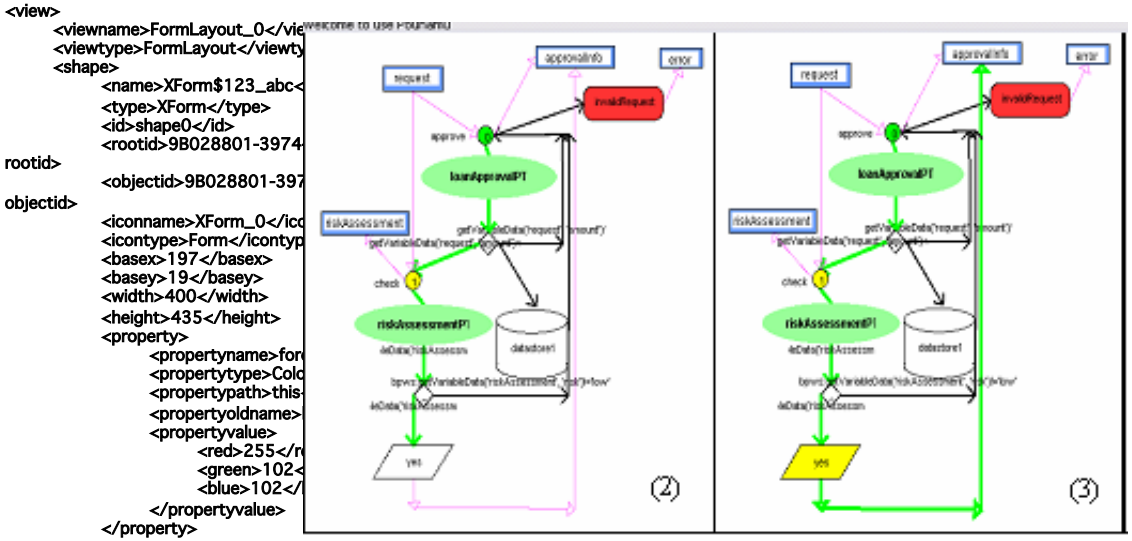
Pounamu Meta-tool Application
Specification Tools
Shape Designer
Meta-model Designer
Event handler Designer
View Designer
Modelling Tools
Modelling Views
Event Handlers
Model Entity instances
Eclipse
Eclipse Plug-in
Tool Specifcations – XML documents
Plug-ins
Web Browsers
Mobile Phones
Web editing plug-in
Web server components
Tool specification projects (XML)
Modelling projects (XML)
Web Services APIs

Meta-tools (themselves DSVLS!)



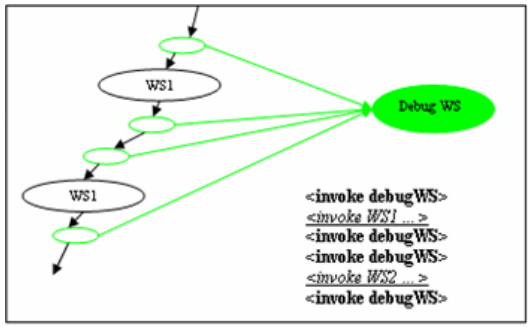
Code (data) generation



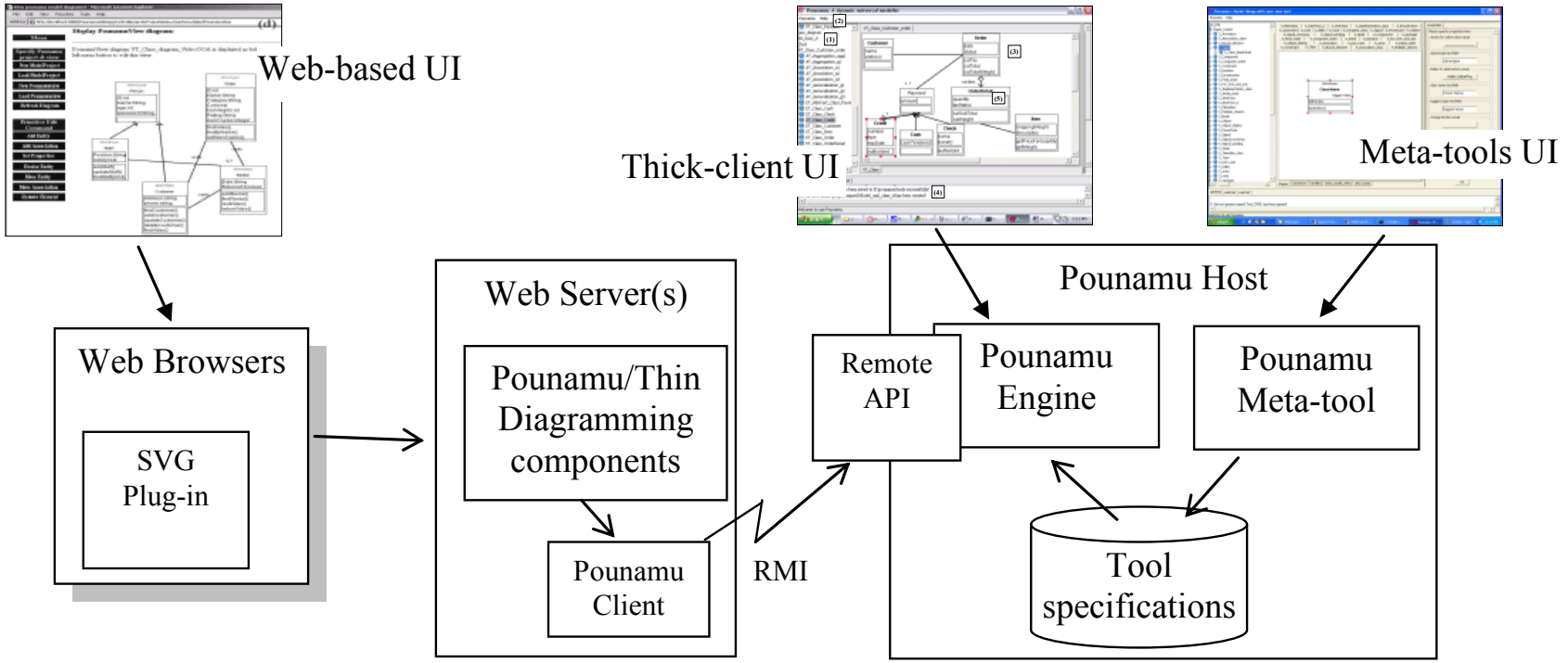


Via XSLT

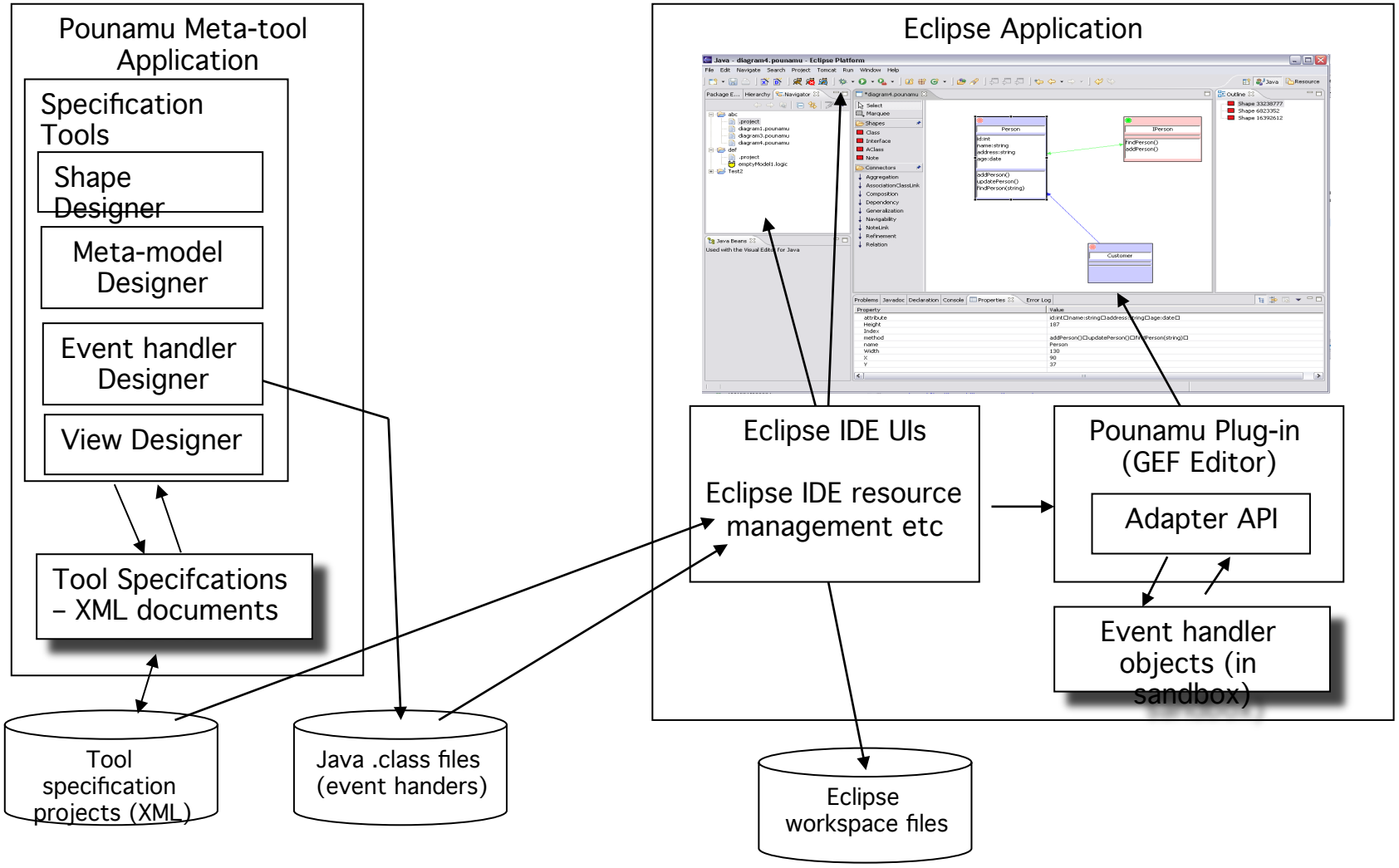
```
<receive name= "receive" partnerLink="customer"
         portType="loanApprovalPT"
         operation="approve"
         variable="request"
         createInstance="yes">
         <!-links-->
</receive>
<invoke name="invokeapprover" partnerLink="approver"
         portType="loanApprovalPT"
         operation="approve"
         inputVariable="request"
         outputVariable="approvalInfo">
         <!-links-->
</invoke>
<invoke name="invokeassessor" partnerLink="assessor"
         portType="riskAssessmentPT"
         operation="check"
         inputVariable="request"
         outputVariable="riskAssessment">
         <!-links-->
</invoke>
```



Web-based diagramming



Eclipse Plug-in



Evaluation

- Used to build range of academic & proof-of-concept industrial DSVL tools
- Proven useful for rapid prototype/evaluation of metaphors, meta-models
- Limited industrial deployment – use as modelling tool
- Still too difficult to express model transformation and code generation (ironically, data mapping… ☺)
- Closer integration with other tools needed (hence Eclipse plug-in; web services API)
- Need richer meta-model & constraint specification
- Need improved event handling specification (hence DSVL for meta-tool itself…)

Conclusions

- Our software models using general-purpose visual notations can get too complex, unwieldy, unsuitable for expressing models in various domains
- Domain-specific languages enable purpose-built model specification; DSVLs provide visual mepahor for these building these models
- DSVL tools support DSL model construction, visualisation and code/data generation/component configuration
- We're still learning how to design appropriate visual metaphors for DSVLs; building DSVL tools is hard
- Pay-off can be high…

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