Designing a DSL for Information Systems Architecture

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Timetable

09:00 – 09:10	**Introductions**
09:10 – 09:25	**Presentation**: Architectural Description
09:25 – 09:40	**Exercise 1**: *What Do We Need?*
09:40 – 09:50	Collect outputs of exercise
09:50 – 10:10	**Presentation**: Architectural Notations
10:10 – 10:25	**Exercise 2**: *Quivering at Arrows*
11:00 – 11:20	Collect outputs of exercise
11:20 – 11:30	Summary and recap
Optional	Exercise 3: Testing Your Vision

Goals

- Existing description notations have proved to be weak in practice
- Architectural constructs lost as we move to implementation
- Could something better be done?
- We'll explore this during the session

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What is Software Architecture

- The common definition:
  - *The software architecture of a program or computing system is the* ***structure or structures*** *of the system, which comprise software* ***elements*** *the externally visible* ***qualities*** *of those elements, and the* ***relationships*** *among them*
    - Len Bass, Paul Clements and Rick Kazman
      Software Architecture in Practice, 2nd Edition

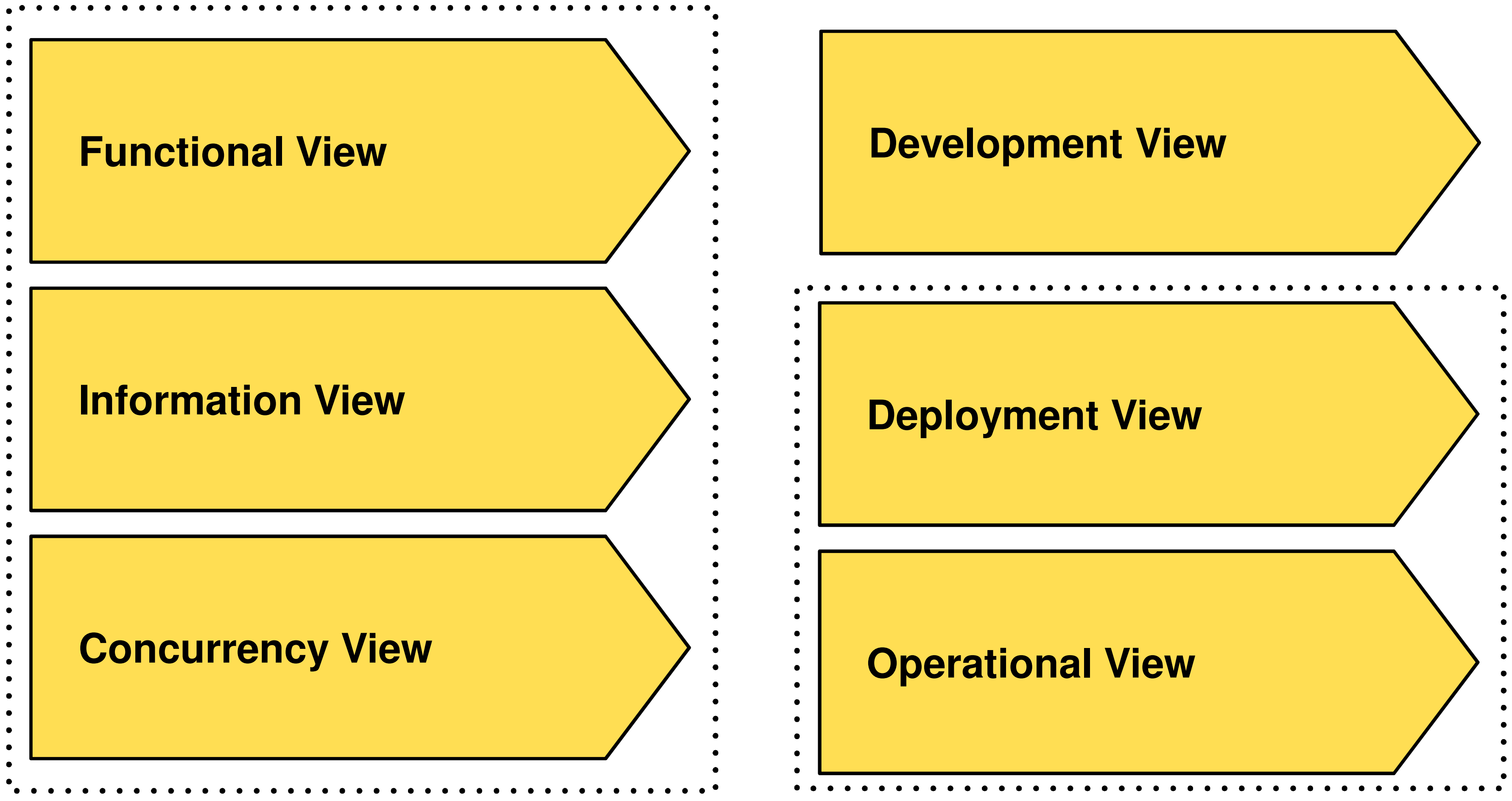
What is Software Architecture

- An alternative definition …
  - *The set of system design decisions that dictate the fundamental structure and properties of a system*
  - *Thus, the set of decisions that will cause the system to fail if made incorrectly*
  - *The set of design decisions which, if made wrongly, cause your project to be cancelled!*

Architectural Views

- Decompose an architectural description
- Target one or more concerns
- Focus attention on one piece of the problem (one type of structure)
  - functional, deployment, information, …
- Aid effective communication
  - appropriate representations for the view

Architectural Views



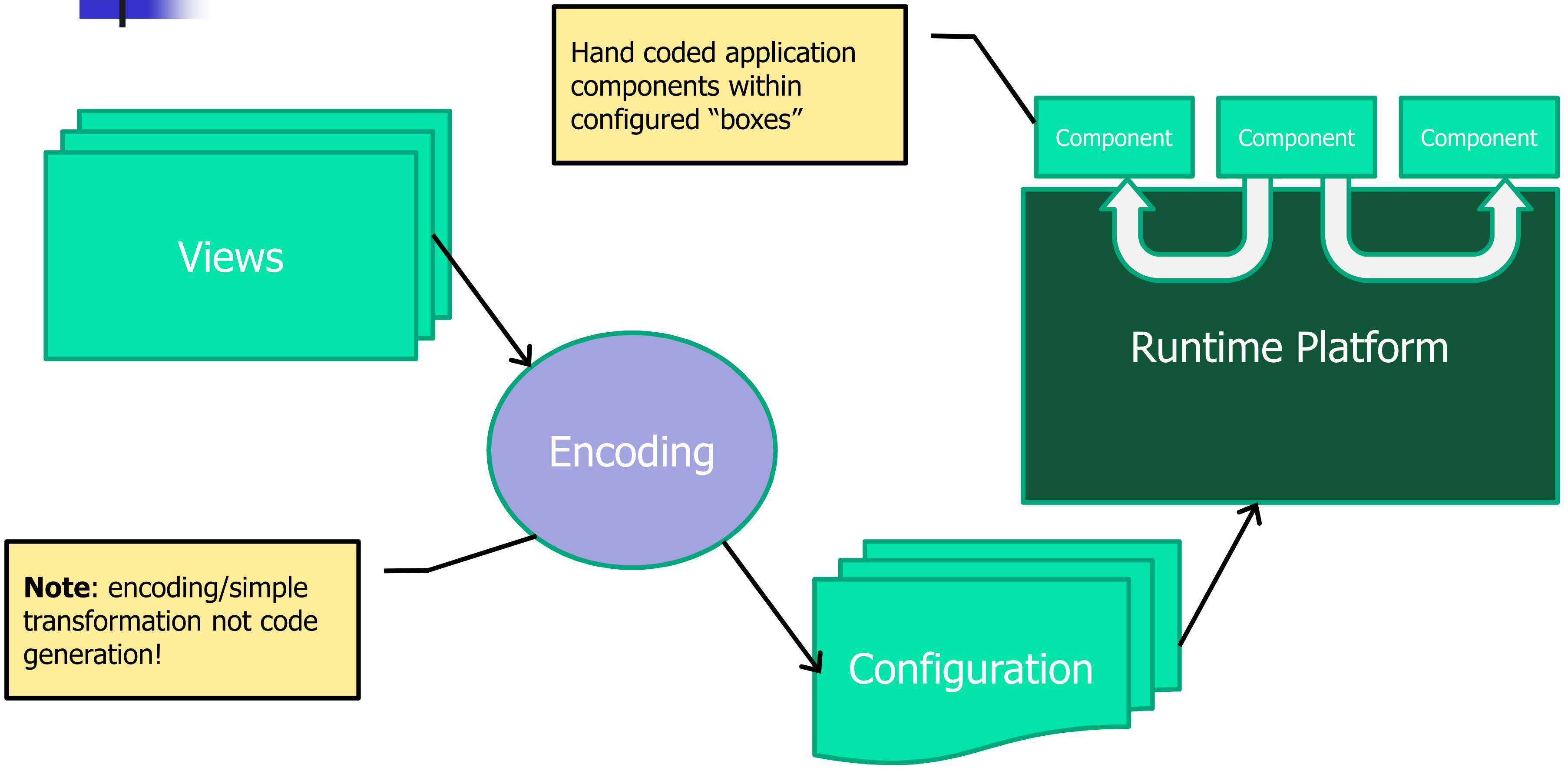
Role of the Description

- Communicate the architecture
  - System overview (with selected detail)
- Ongoing reference documentation
  - For architects, developers, testers, support staff,...
- Analysis of the architecture
  - Performance, availability, evolution, …
- Could it also be the basis of the implementation?
  - And so survive at runtime

Descriptive Difficulties

- An AD contains *architectural* elements
  - Middleware, hardware, component types, connectors, information flows, …
- The content required varies by context
  - Varying type, precision, detail
- No link from AD to implementation

Possible Future Approach


Hand coded application components within configured "boxes"
Component
Component
Component
Views
Runtime Platform
Encoding
Note: encoding/simple transformation not code generation!
Configuration

Note subtle difference from MDA/MDD – architectural description configures a runtime platform directly rather than trying to generate artefacts for a general purpose runtime environment like J2EE.

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Exercise 1 – What Do We Need?

- Consider **what** needs to be described for the architecture of an information system
  - Modules? Connectors? Functions? Nodes? Technologies? Data Stores? Constraints?
- **How** you could use such a description?
  - Static documentation?
  - Analysis / simulation? (Of what? Why?)
  - Code generation?
  - Configuration of runtime environment?

Exercise 1 – What Do We Need?

- Collect Outputs

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Notations – 3 Approaches

- Formal textual languages
  - Architecture Description Languages
    - ACME, Wright, xADL, …
  - General purpose DSLs for the architectural domain
- Specific graphical notations
  - “Boxes and Lines” usually ad-hoc notations
  - Usually very specific to a particular situation
- Tailored general purpose notations
  - i.e. UML the de-facto standard

Notations - ADLs

- Many exist in the research domain
  - Wright, ACME, UniCon, xADL, …
  - www.sei.cmu.edu/architecture/adl.html
- Few (none) have seen industrial use
  - Restrictive assumptions
  - Lack of multiple views
  - Lack of domain/technology specifics
  - Tools
  - Technology transfer

Notations - ADLs

A simple C/S System described in ACME (from CMU) …

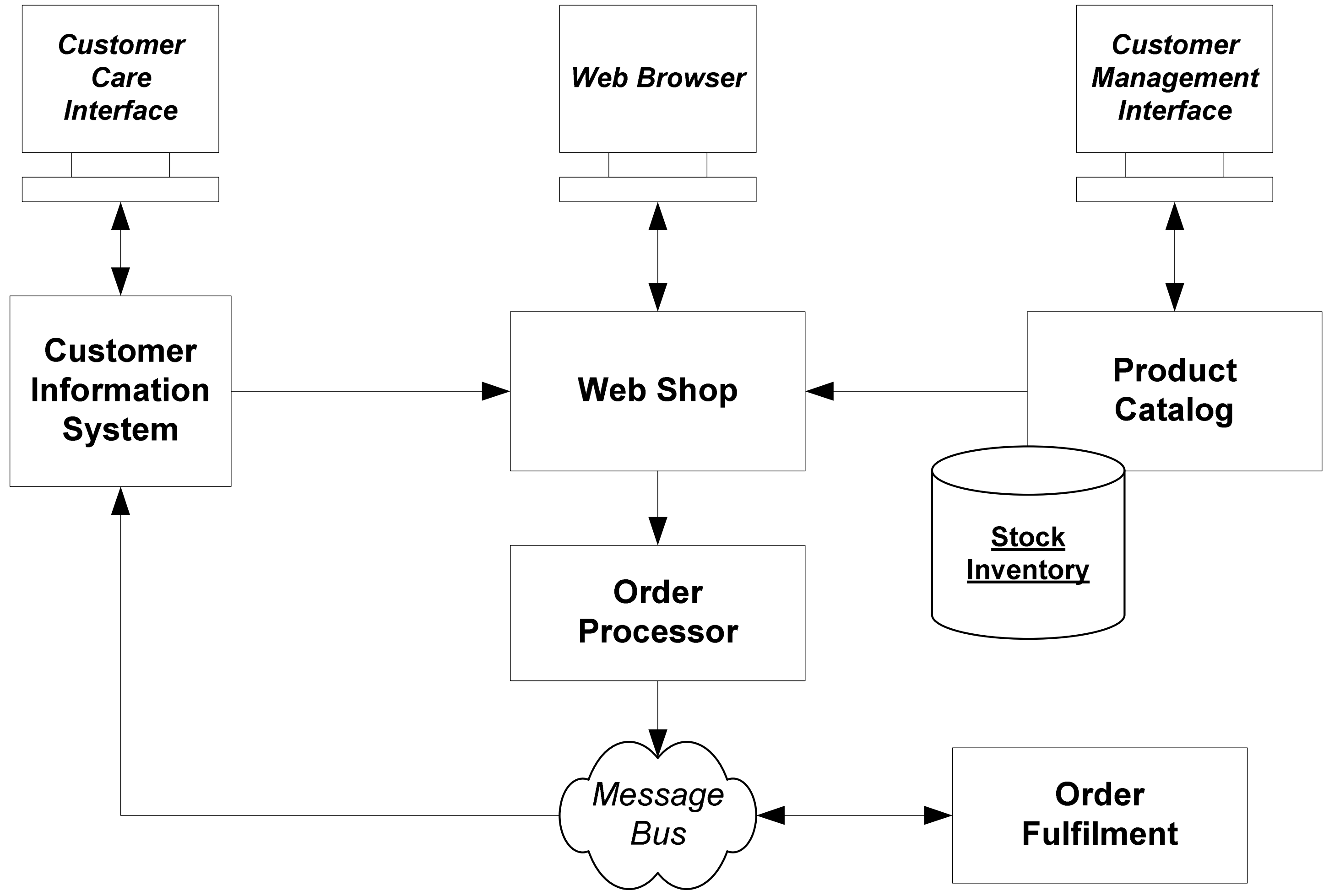
```
System simple_cs = {
  Component client = {
        Port send-request;
        Properties { Aesop-style : style-id = client-server;
                     UniCon-style : style-id = cs;
                     source-code : external = "CODE-LIB/client.c" }}

  Component server = {
        Port receive-request;
        Properties { idempotence : boolean = true;
                     max-concurrent-clients : integer = 1;
                     source-code : external = "CODE-LIB/server.c" }}

  Connector rpc  = {
        Roles {caller, callee}
        Properties { synchronous : boolean = true;
                     max-roles : integer = 2;
                     protocol : Wright = "..." }}

  Attachments {
     client.send-request to rpc.caller ;
     server.receive-request to rpc.callee }
}
```

http://www.cs.cmu.edu/~acme/

Notations - Boxes and Lines

- The most popular architectural notation
  - Flexible
  - Good tool support
  - Low learning curve
- Limitations
  - Ambiguity
  - Need to explain notation
  - Time to design notation

Notations - Boxes and Lines

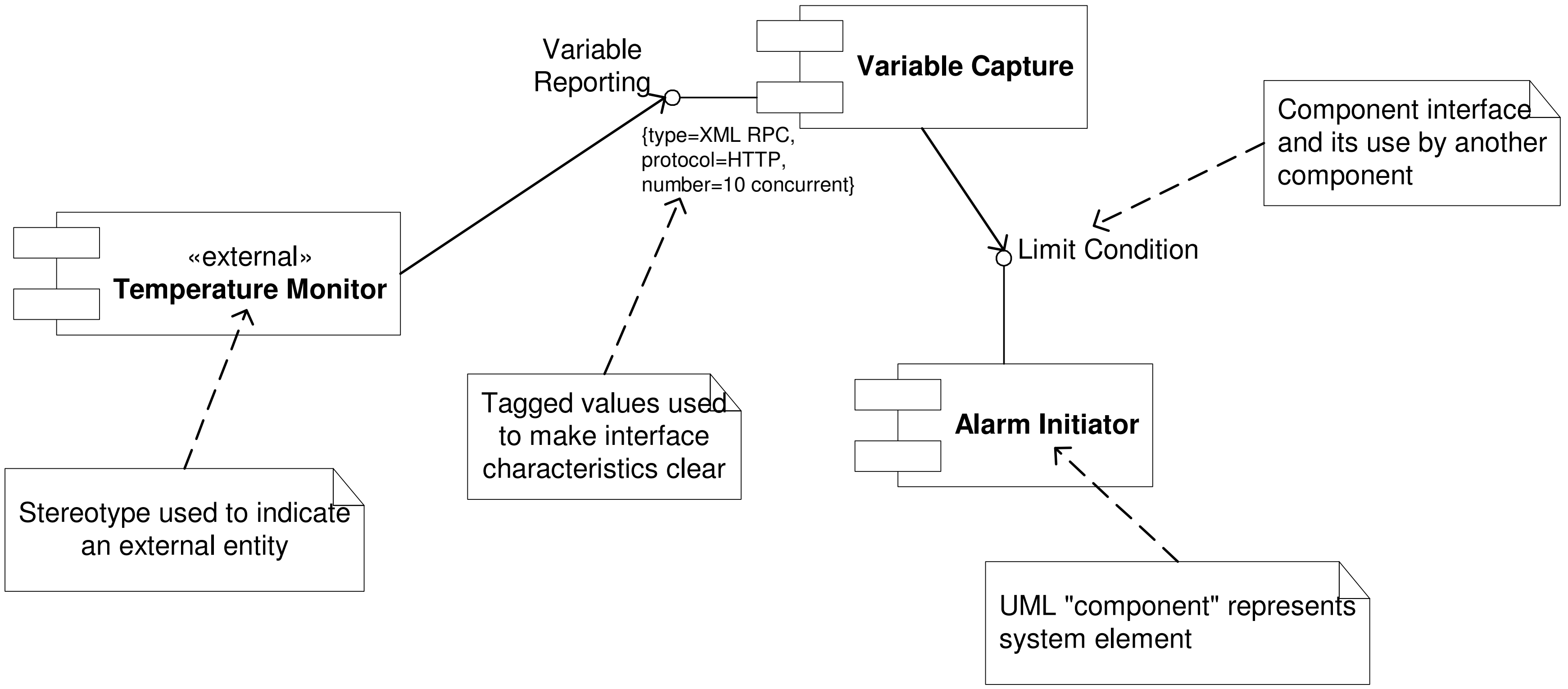


Notations - UML

- The de-facto “formal” notation
- General purpose software modeling language
  - Little specific architecture support
  - Needs abused or extended for architecture
- Widely understood, wide tool support
  - Although depth of understanding varies

Notations - UML

The UML component model … one of UML's fairly useful architectural models



Variable Reporting
Variable Capture
{type=XML RPC, protocol=HTTP, number=10 concurrent}
Component interface and its use by another component
Limit Condition
«external» Temperature Monitor
Alarm Initiator
Tagged values used to make interface characteristics clear
Stereotype used to indicate an external entity
UML "component" represents system element

UML as an ADL

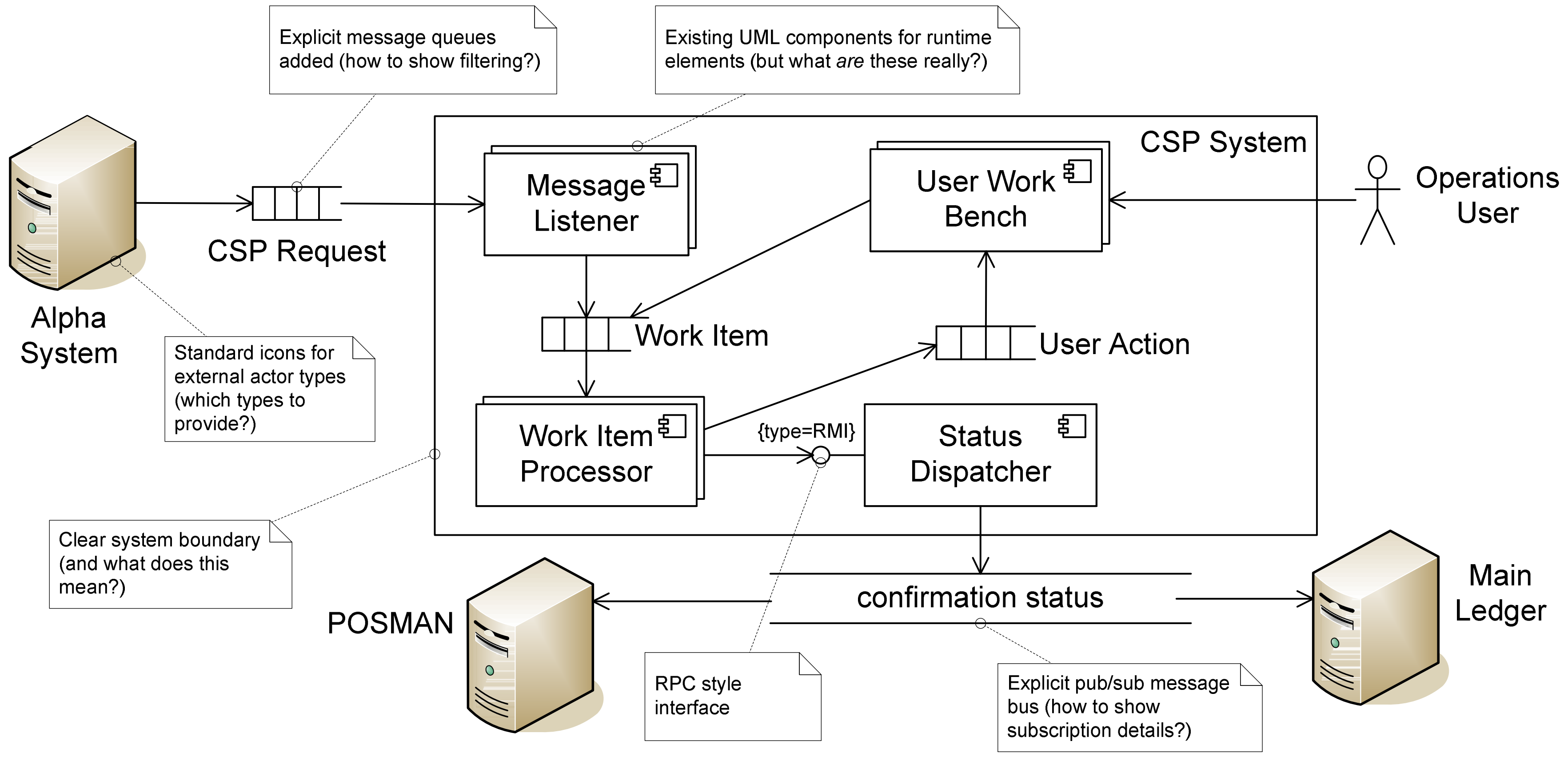
- UML is really an OOD notation
  - Grown over the years
  - Everything is a class
- Architectural constructs are basic
  - "Component", interface, dependency
  - Node, link
- Architects lean heavily on extensions
  - Stereotypes, tagged values, notes(!)
- Yet it is the de-facto standard

An Ideal ADL

- What would our ideal notation look like?
- What element types would it contain?
- What could it be used for?
- Whose needs would it address?
- What would make it different from existing approaches?

A Proto-ADL

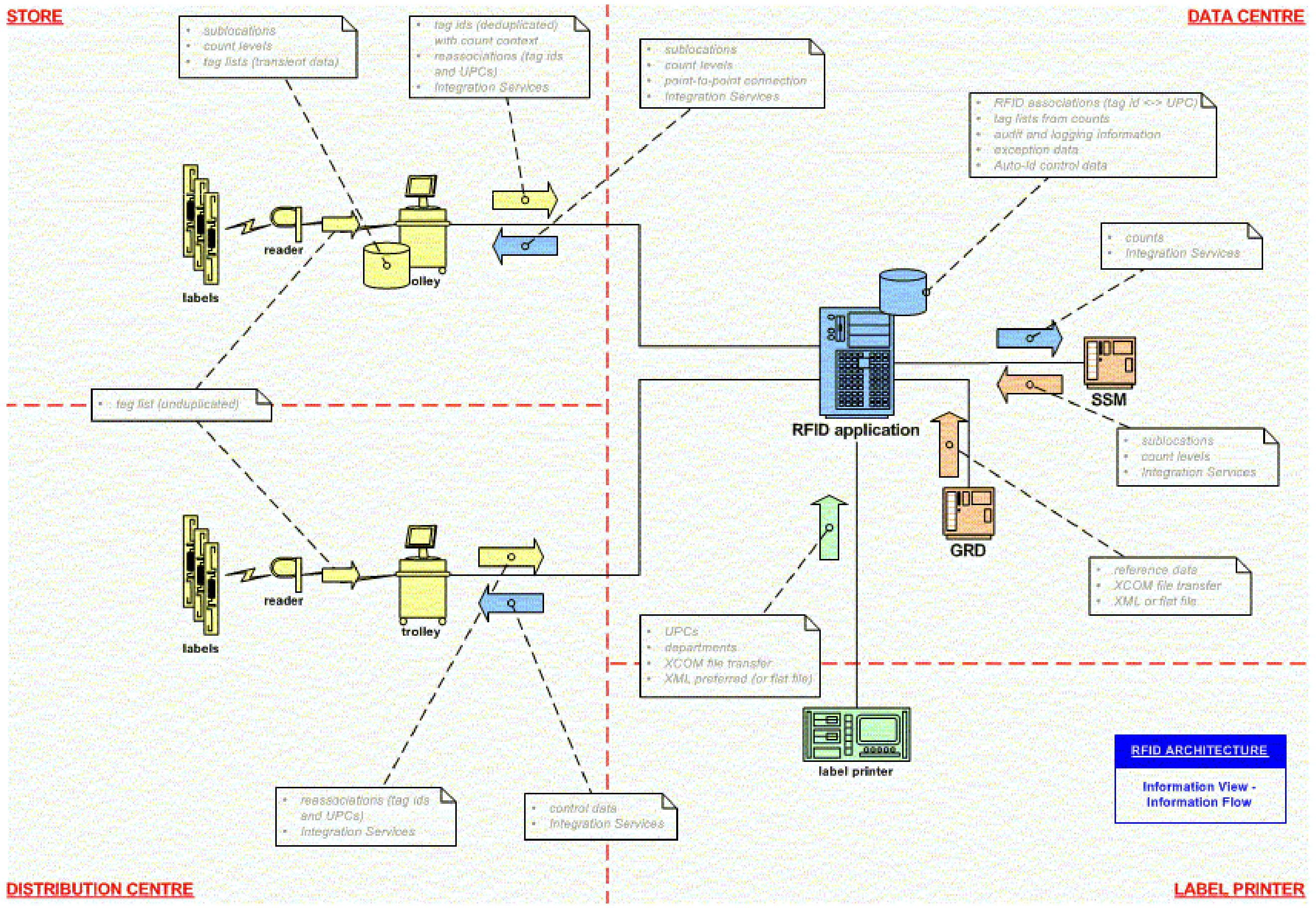
One possibility … a simple evolution and specialisation of UML



Explicit message queues added (how to show filtering?)
Existing UML components for runtime elements (but what *are* these really?)
CSP System
Alpha System
CSP Request
Message Listener
User Work Bench
Operations User
Work Item
User Action
Standard icons for external actor types (which types to provide?)
Work Item Processor
{type=RMI}
Status Dispatcher
Clear system boundary (and what does this mean?)
POSMAN
confirmation status
Main Ledger
RPC style interface
Explicit pub/sub message bus (how to show subscription details?)

A Proto-ADL

Another example, for stakeholders who need a more informal and "pictorial" style



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Exercise 2: Quivering at Arrows

- Attempt to design our own language for information systems architectural description
  - Pick a fairly narrow domain to keep the problem manageable
- Sketch a graphical ADL language considering
  - Component types you'll need
  - Connector types needed to link components
  - How to define deployment to runtime nodes
  - Defining environmental constraints
  - Environment configuration

Exercise 2: Quivering at Arrows

- Try to define some of the following:
  - Language entities, relationships & semantics
  - Syntax (graphical and/or textual)
  - What it can be used for?
  - What tools would you need to provide?
  - Examples
- Focus on architectural constructs
  - Don’t worry about business logic
  - Assume manual coding of components

Presentations

- Each group to present their language
- Keep presentations to about 5 minutes

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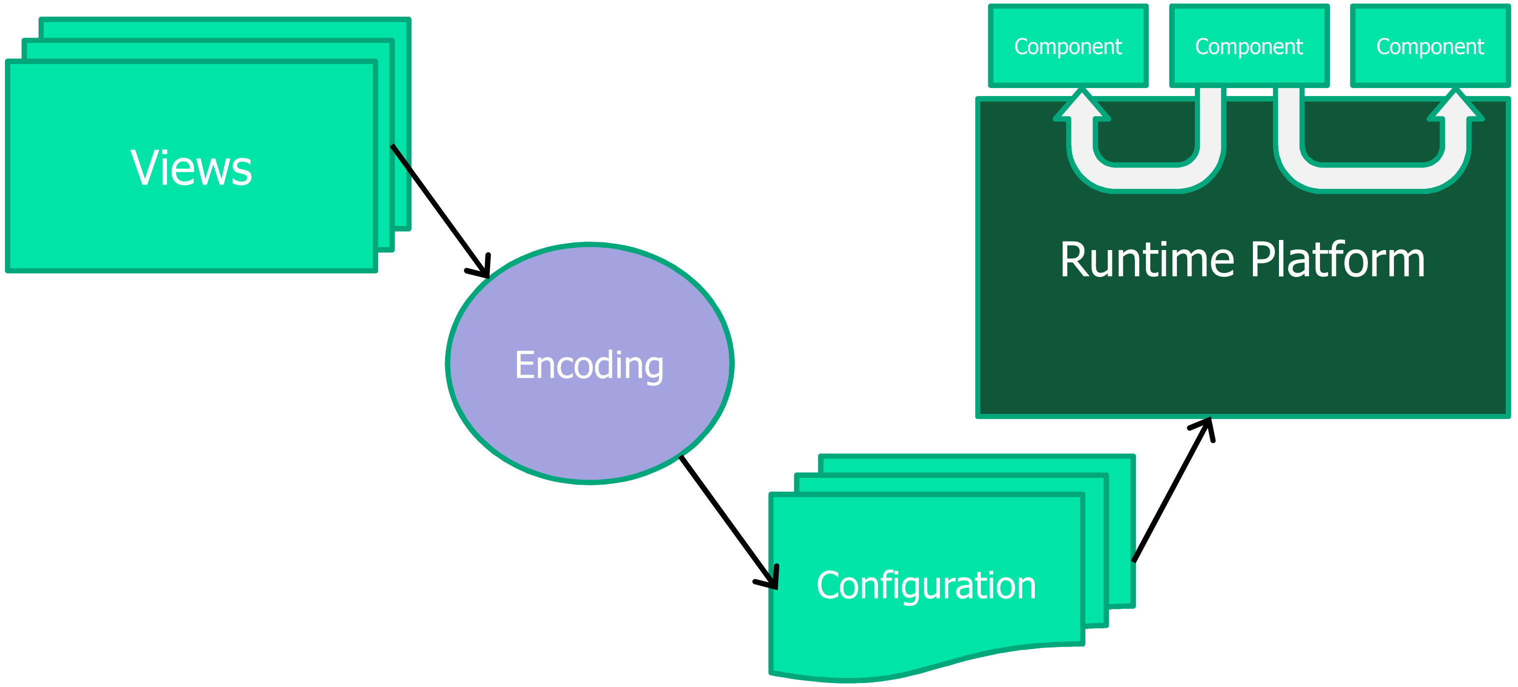
Bringing It To Life

Going back to our possible future architecture environment ...



What would the runtime platform need to provide?
=> Types of component, connector, declarative services, monitoring, reflection,...

An Architecture Runtime Platform

- An runtime platform would provide architecture constructs as first class elements
  - Component, interface, queue, message bus, node, information store, ...
- This would allow system architecture to be extracted from running systems
  - Reverse engineering
  - Monitoring and analysis
  - System management
  - Developer support (in IDEs, debuggers, ...)

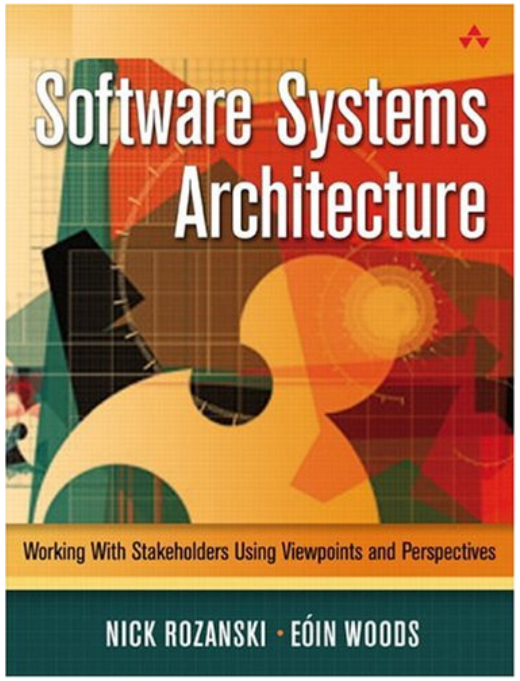
Summary

- Today we lose most of our architectural constructs when we get to runtime
  - Current approaches don't change this significantly
- DSLs (ADLs) may give us better architectural description techniques
  - More natural and effective descriptions than UML
- If we could create the matching runtime platform, the architectural constructs would live on at runtime

For Help With Today's Realities ...

Software Systems Architecture: Working With Stakeholders Using Viewpoints and Perspectives

Nick Rozanski & Eoin Woods
Addison Wesley, 2005


Software Systems Architecture
Working With Stakeholders Using Viewpoints and Perspectives
NICK ROZANSKI · EÓIN WOODS

`http://www.viewpoints-and-perspectives.info`

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Thank you

Appendix
Exercise 3 (Optional)

Exercise 3: Testing Your Vision

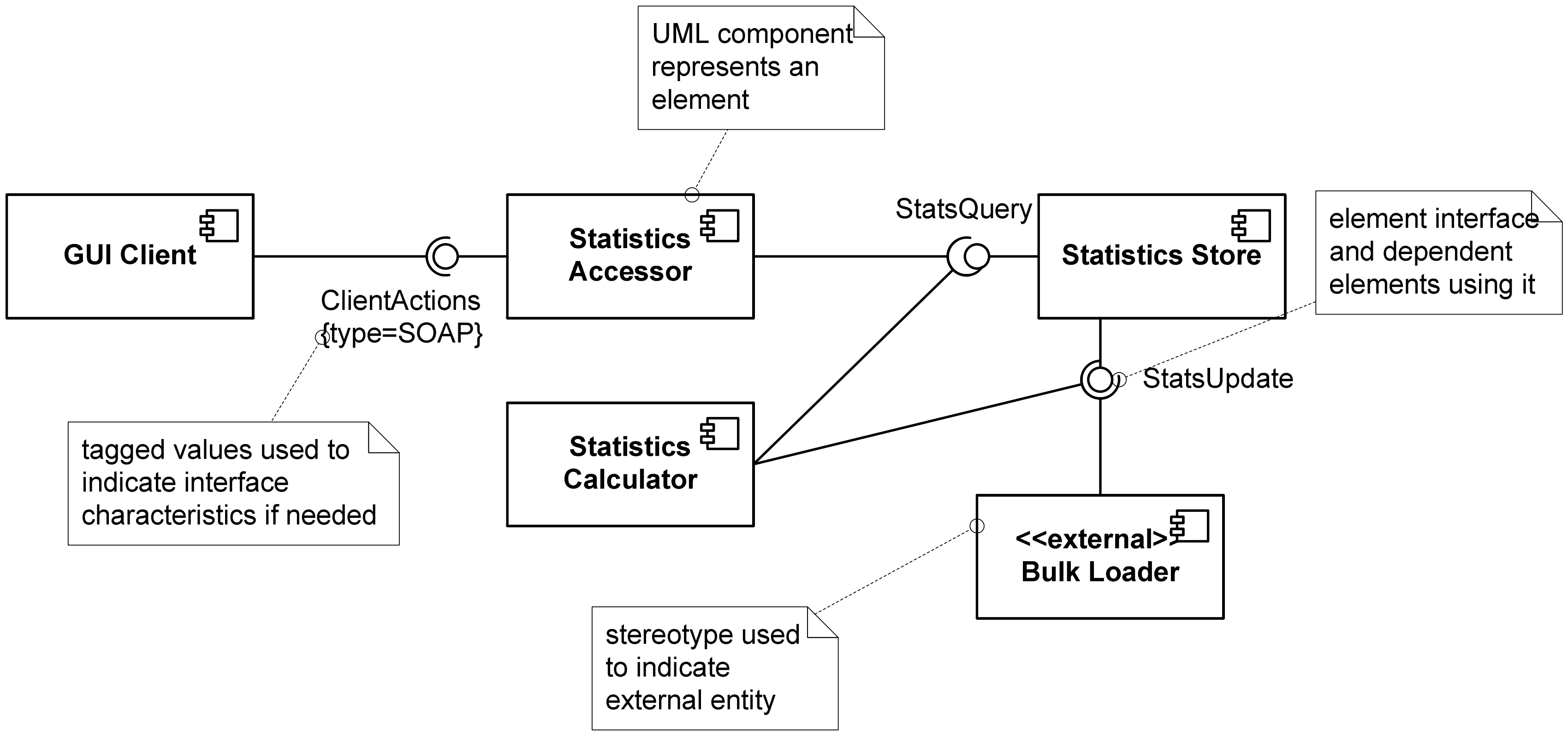
- Given your DSL, what primitives would a supporting runtime platform need to provide?
  - Presumably the set of primitives in the DSL
  - Plus a set of services to support applications
- Define what your runtime would provide
- Try to represent a *small* system in your DSL
  - Would your system actually run on your platform?
  - What are you missing in your DSL or platform?
- List anything else needed that is out of scope
  - How would you provide these missing pieces?

Experience Reports

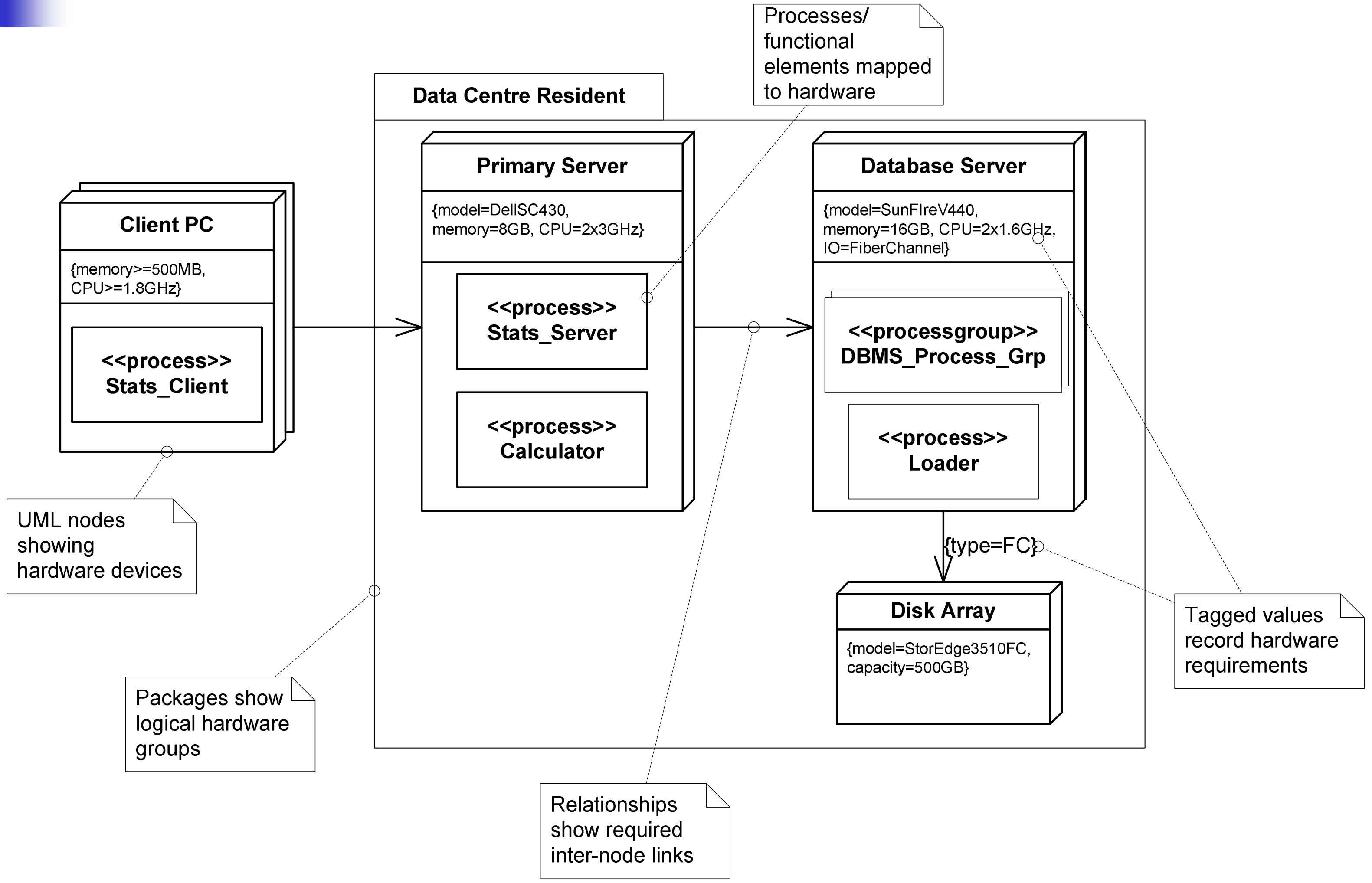
- Did your DSL / platform combination hang together and allow a system to be created?
- What were you missing that you needed to add?
- What was out of scope and how would you provide these aspects of the system definition?

Appendix
UML for Architectural Description

UML for Functional Structure

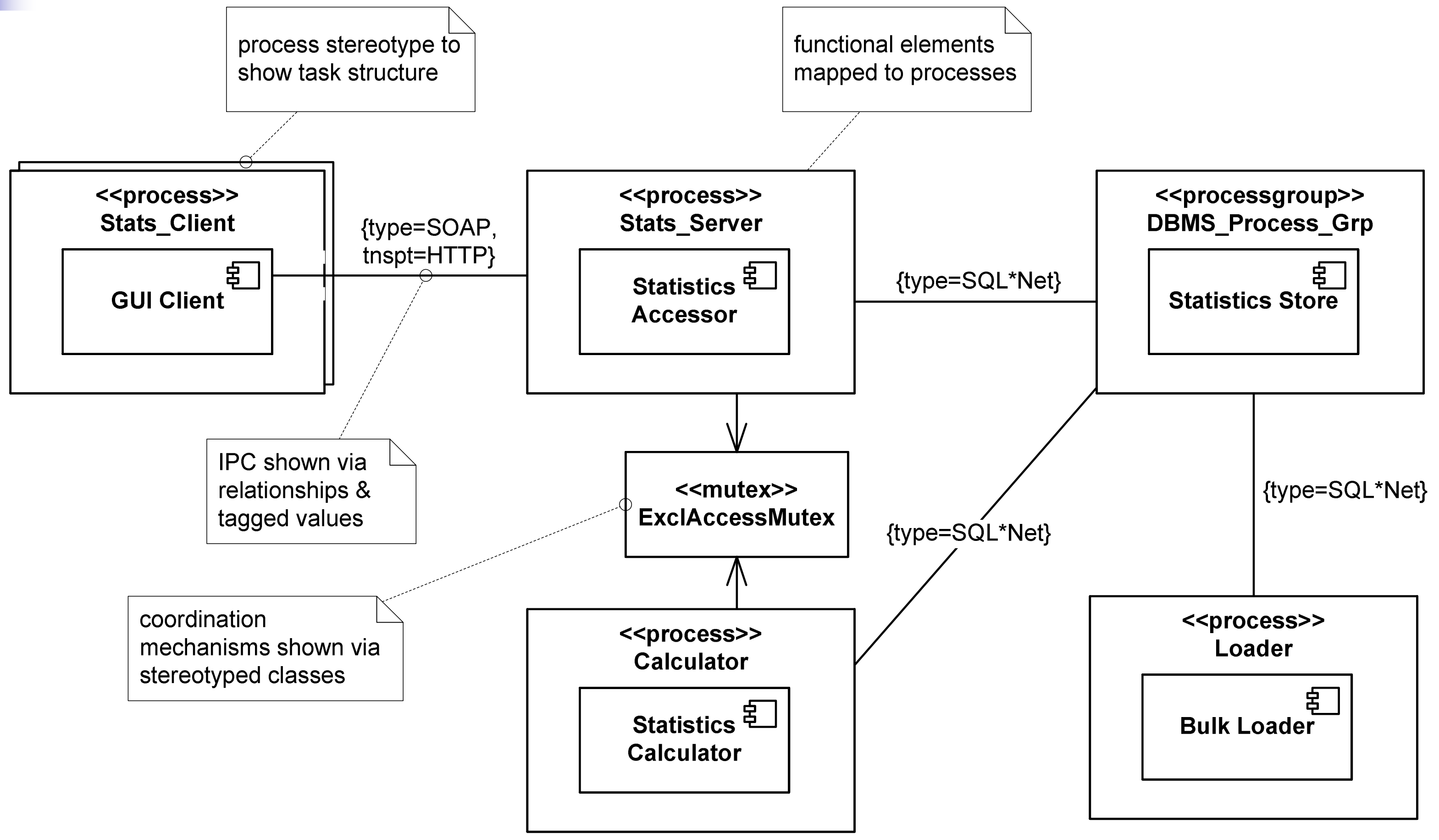

UML component represents an element
GUI Client
Statistics Accessor
StatsQuery
Statistics Store
element interface and dependent elements using it
ClientActions {type=SOAP}
StatsUpdate
Statistics Calculator
tagged values used to indicate interface characteristics if needed
<<external>> Bulk Loader
stereotype used to indicate external entity

UML for Deployment Structure

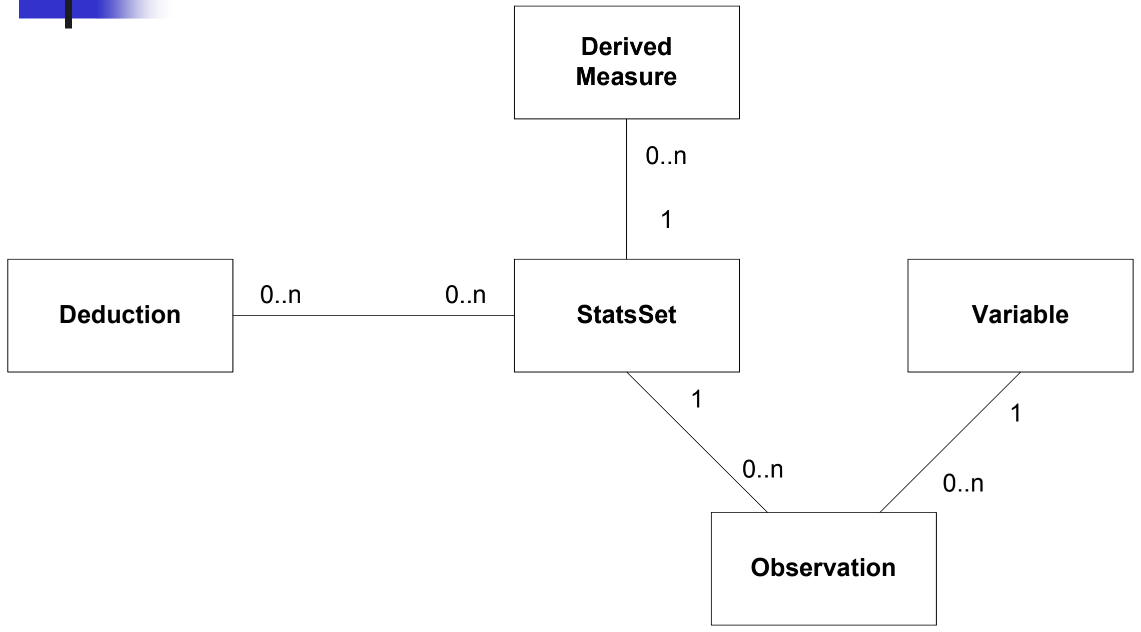


Processes/ functional elements mapped to hardware
Data Centre Resident
Primary Server
{model=DellSC430, memory=8GB, CPU=2x3GHz}
<<process>> Stats_Server
<<process>> Calculator
Database Server
{model=SunFIreV440, memory=16GB, CPU=2x1.6GHz, IO=FiberChannel}
<<processgroup>> DBMS_Process_Grp
<<process>> Loader
Client PC
{memory>=500MB, CPU>=1.8GHz}
<<process>> Stats_Client
UML nodes showing hardware devices
{type=FC}
Disk Array
{model=StorEdge3510FC, capacity=500GB}
Tagged values record hardware requirements
Packages show logical hardware groups
Relationships show required inter-node links

UML for Concurrency Structure


process stereotype to show task structure
functional elements mapped to processes
<<process>> Stats_Client
GUI Client
{type=SOAP, tnspt=HTTP}
<<process>> Stats_Server
Statistics Accessor
{type=SQL*Net}
<<processgroup>> DBMS_Process_Grp
Statistics Store
IPC shown via relationships & tagged values
<<mutex>> ExclAccessMutex
{type=SQL*Net}
{type=SQL*Net}
coordination mechanisms shown via stereotyped classes
<<process>> Calculator
Statistics Calculator
<<process>> Loader
Bulk Loader

UML for Information Structure



But how about

- Entity life history?
- Data flow?
- Volumetrics?
- Ownership?