GGF10 - The Tenth Global Grid Forum
Berlin, Germany

Teuta: UML-based Modeling and Specification of Grid Workflow Applications

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ASKALON: A Program Development Environment and Tool Set for Cluster and Grid Architectures

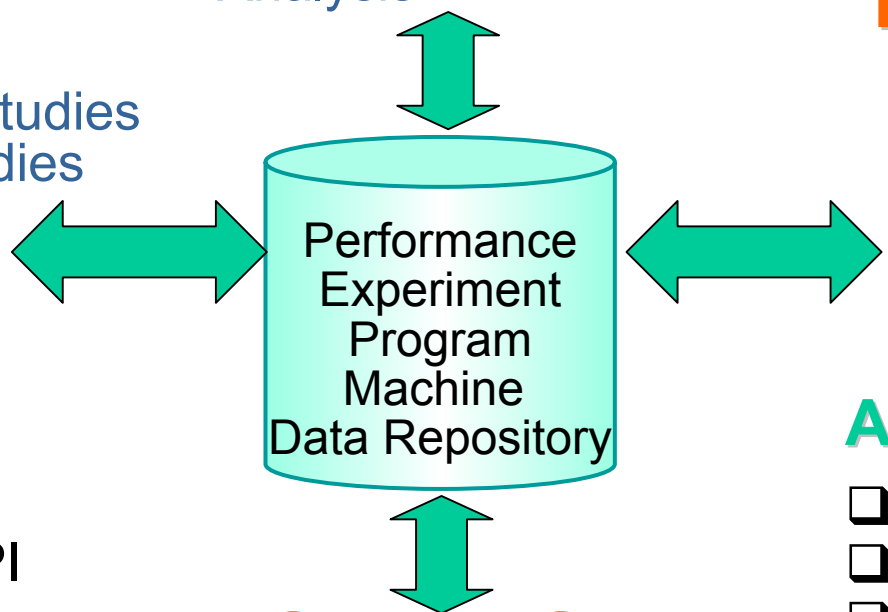
http://www.par.univie.ac.at/project/askalon

Aksum

- Automatic Bottleneck Analysis

Zenturio

- Performance Studies
- Parameter Studies
- Experiment Management



Performance Prophet

- Modeling
- Teuta
- Simulation
- Performance Prediction

Programming Paradigms

- MPI,GlobusMPI
- OpenMP/MPI
- HPF/OpenMP
- JavaSymphony
- Grid Workflow

Scalea-G

- Instrumentation
- Measuring
- Performance Analysis

Architectures

- NOWs
- PC-Clusters
- SMP Clusters
- GRID Systems
- DM/SM Systems

Outline

- An UML - Based Graphical Representation of Grid Workflow Applications
- A-GWL: Abstract Grid Workflow Language
- Tool support: Teuta
- Case Study:
  - Advanced 3D Medical Image Reconstruction
  - WIEN2k

Motivation

- **The issue:** The lack of standard abstractions for describing Grid applications

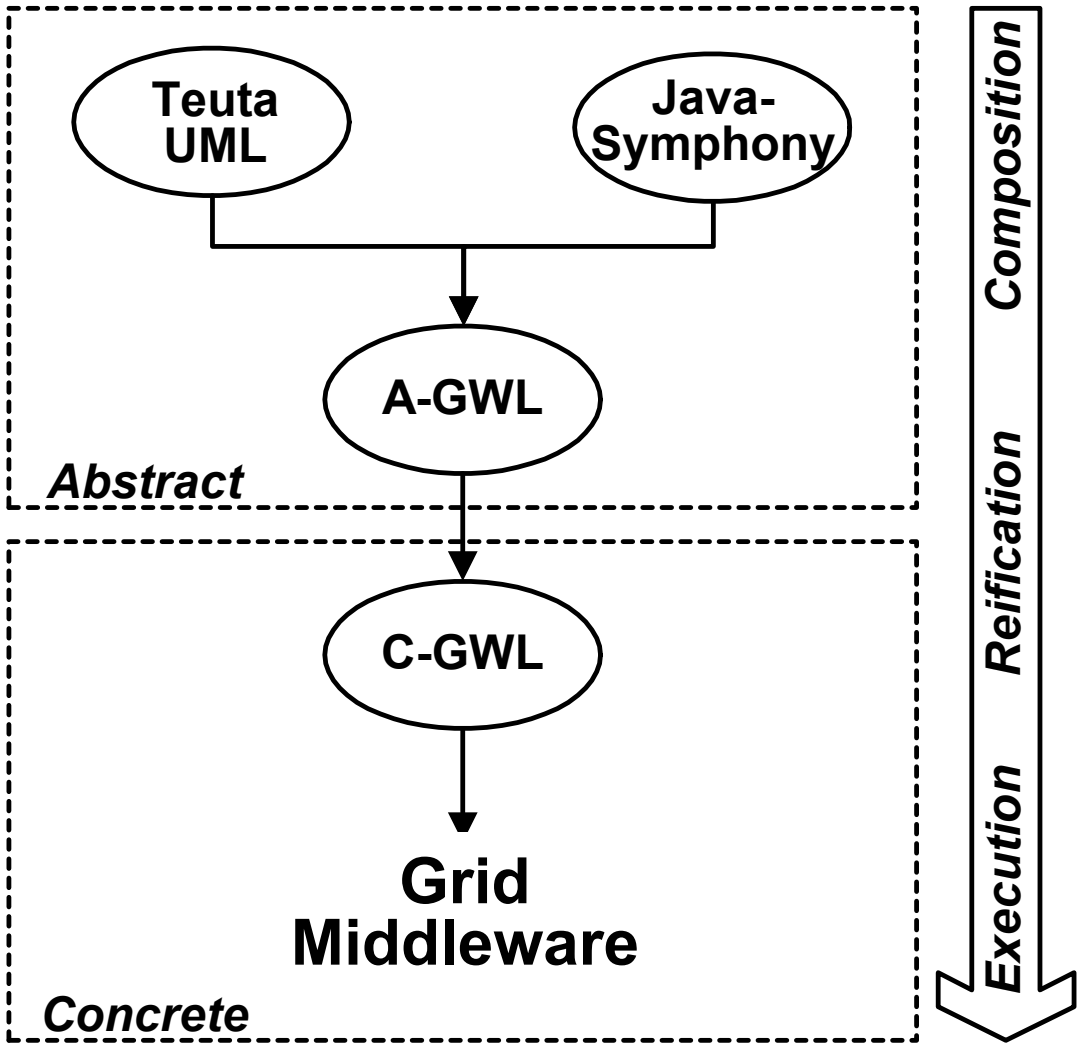
- **The context:** The emergence of workflow as one of the most interesting programming models for Grid

- **The vision:** Based on the Unified Modeling Language (UML)
  - Define a set of abstractions for graphical representation of Grid workflow applications

Why we are Using UML?

- “A picture is worth a thousand words”
- Standard of OMG
  - Industrialization
- Included in the curriculum of many universities
- UML will continue to evolve
  - The unit of the application development is evolving
  - class ⇒ component ⇒ web service

Modeling, Specifying, and Building Grid Workflow Applications under ASKALON

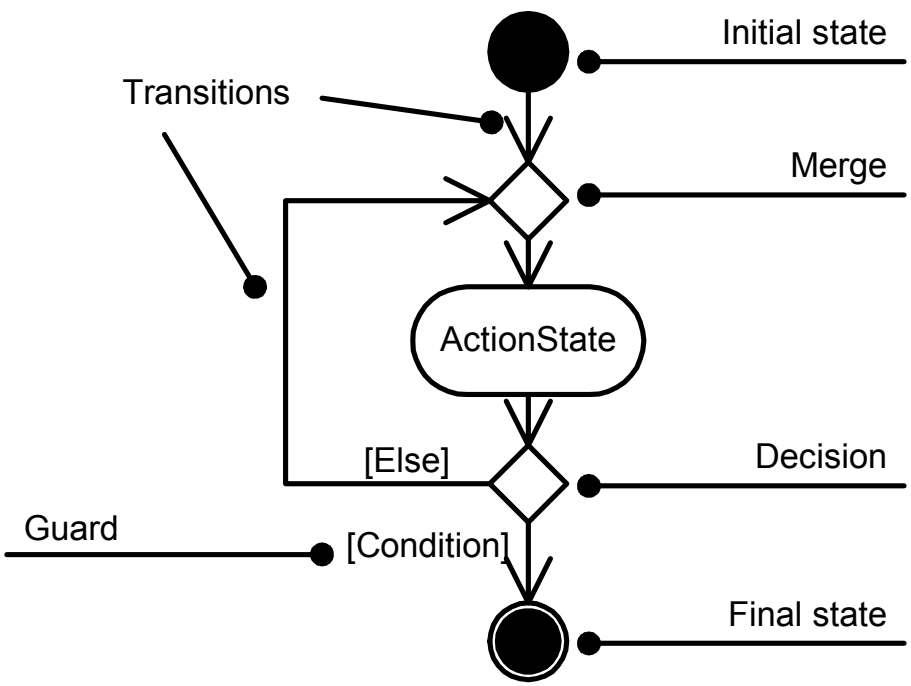


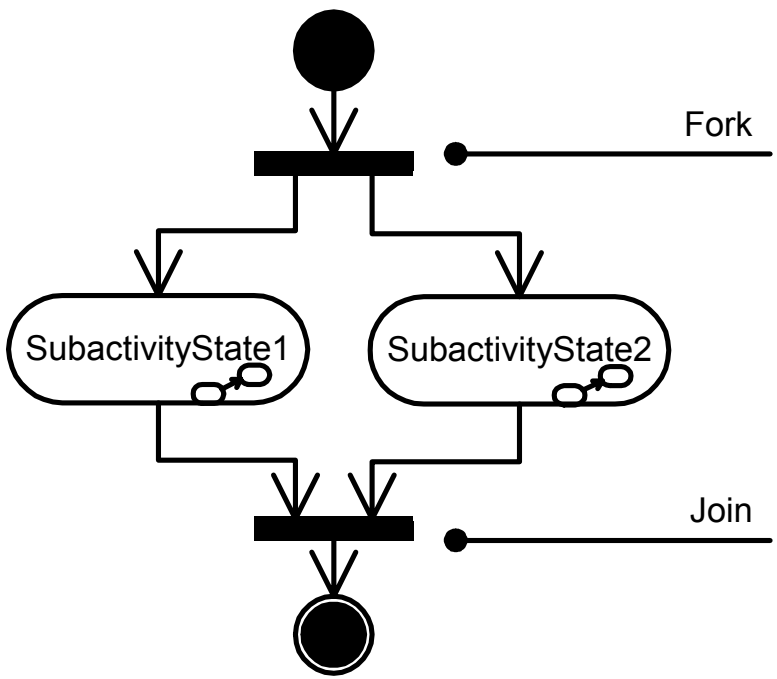
GWL: Grid Workflow Language HTR: High-level Textual Representation

An UML Based Graphical Representation of Grid Workflow Applications

The UML Activity Diagram

- Representation of the flow of activities

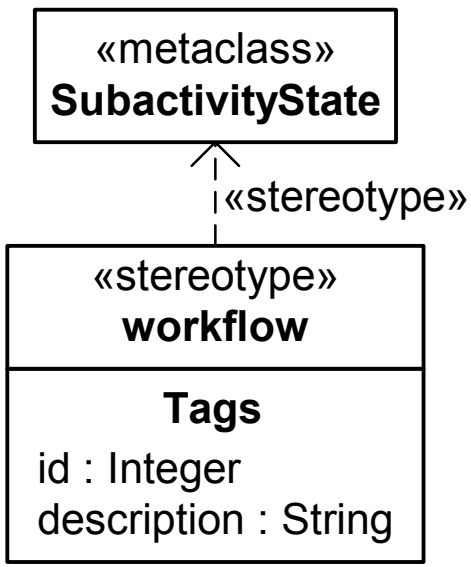




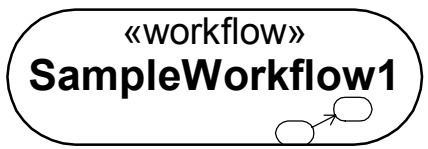
Workflow Hierarchical Decomposition

- Description of the workflow at different levels of abstraction

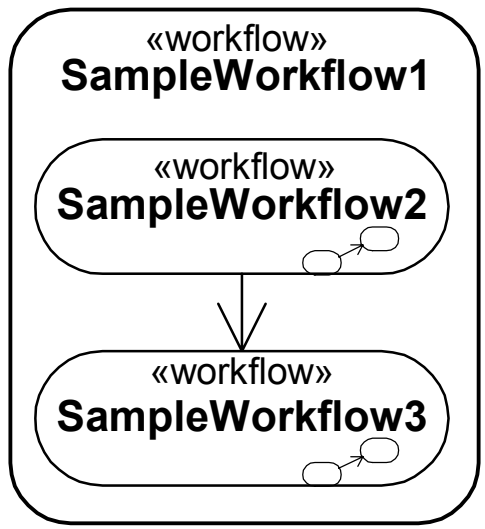
(I) Stereotype definiton



(II) Usage



(III) Decomposition



Elemental Operations

- Compute
  - Computational intensive activity
- TransferData
  - Represents the transfer of data

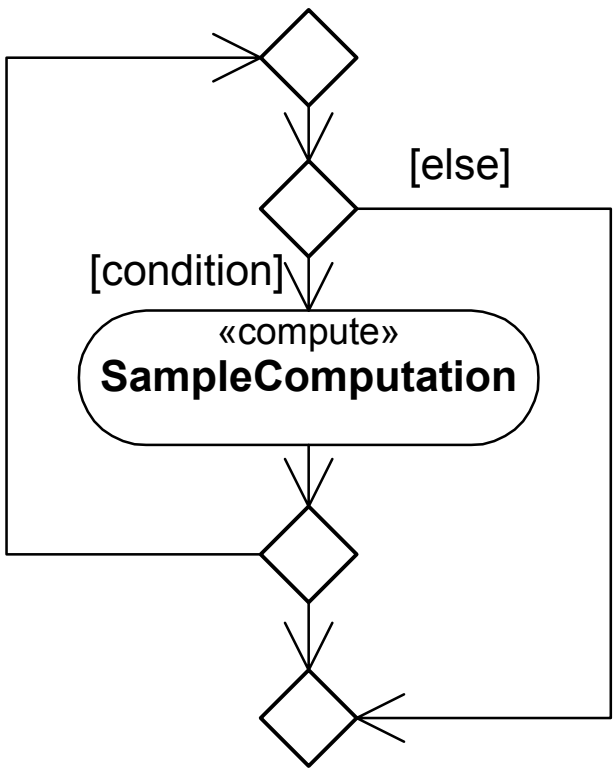
(I) Compute

(II) TransferData

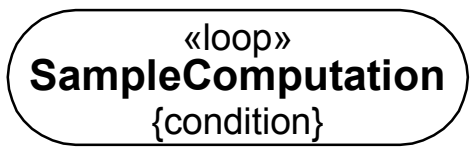
Control Flow: Loop

- UML activity diagrams
  - Provide elements for representing control flow

(I) Decision and Merge

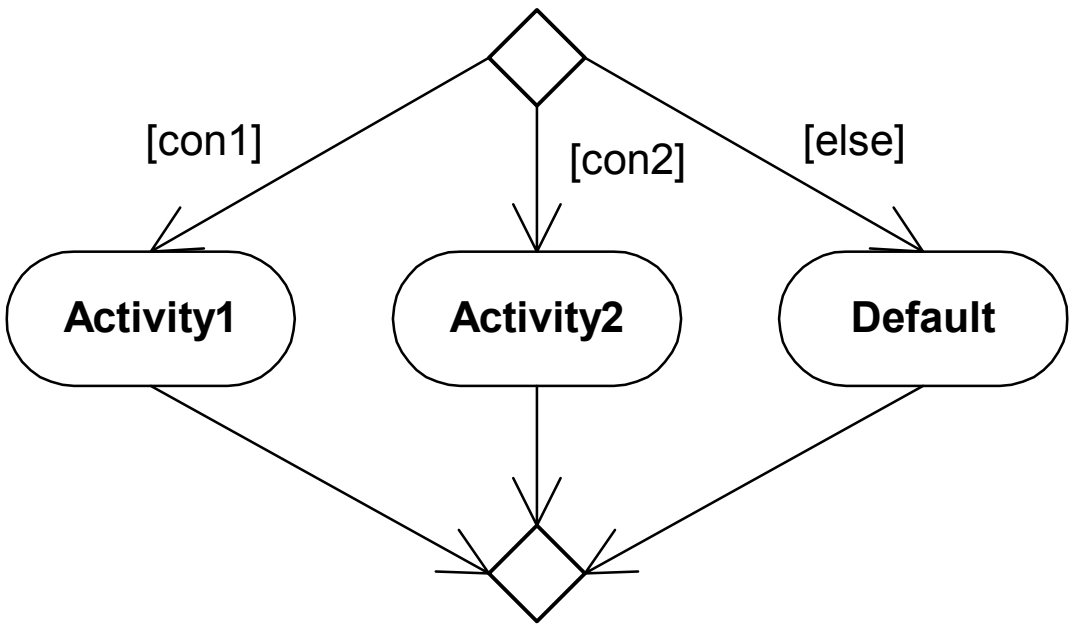


(II) Loop Stereotype



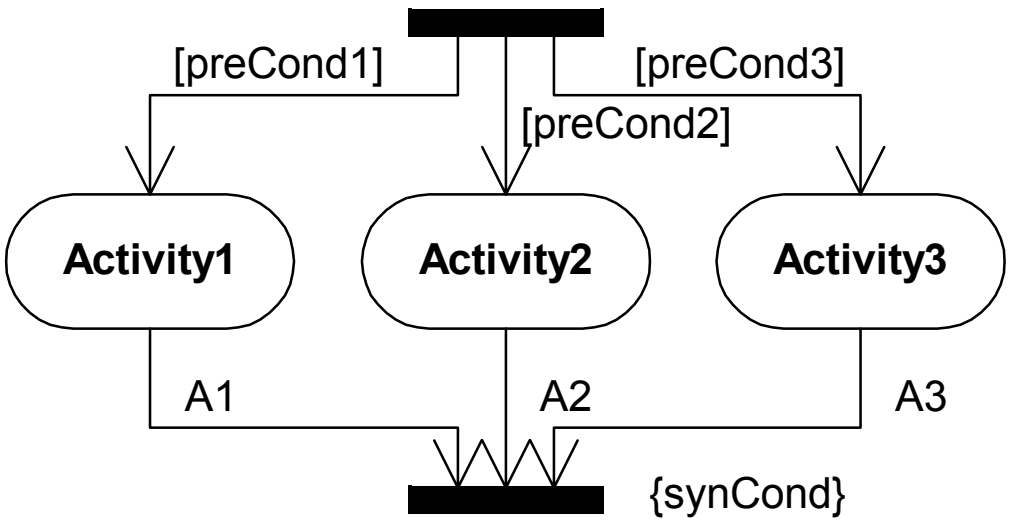
Control Flow: Switch

- Selects an activity for execution based on the condition



Control Flow: Parallel

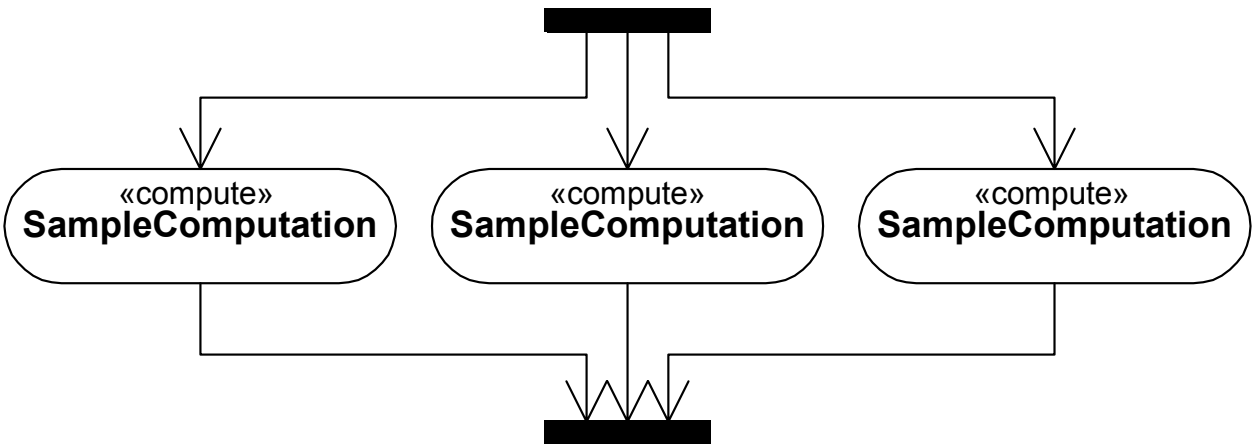
- Parallel execution of multiple activities
- Precondition is evaluated before the activity is executed
- Synchronization condition
  - for instance {join = A1 or A2 or A3}



Control Flow: Parallel Loop

- Parallel execution of a large number of activities

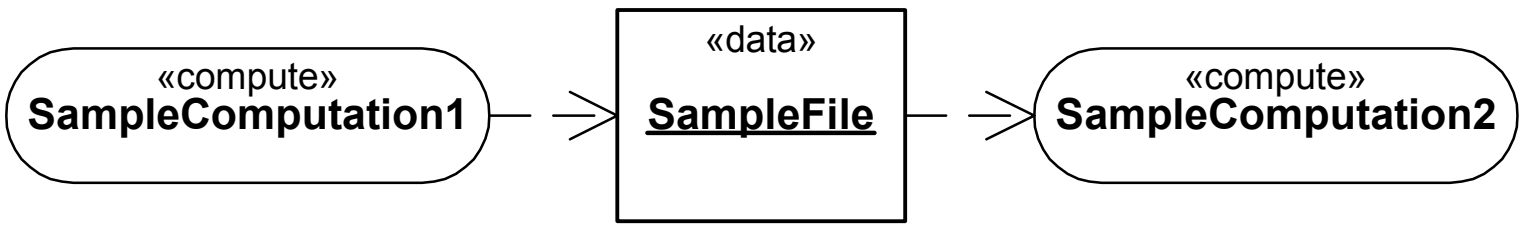
(I) Fork and Join



(II) Parallel Loop Stereotype

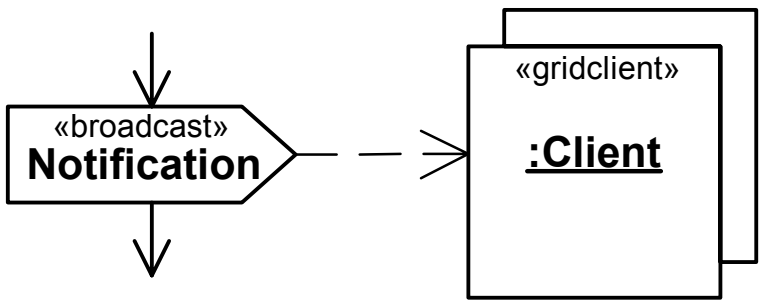
Data Flow

- Representation of the movement of a large amount of data



Notification Mechanism

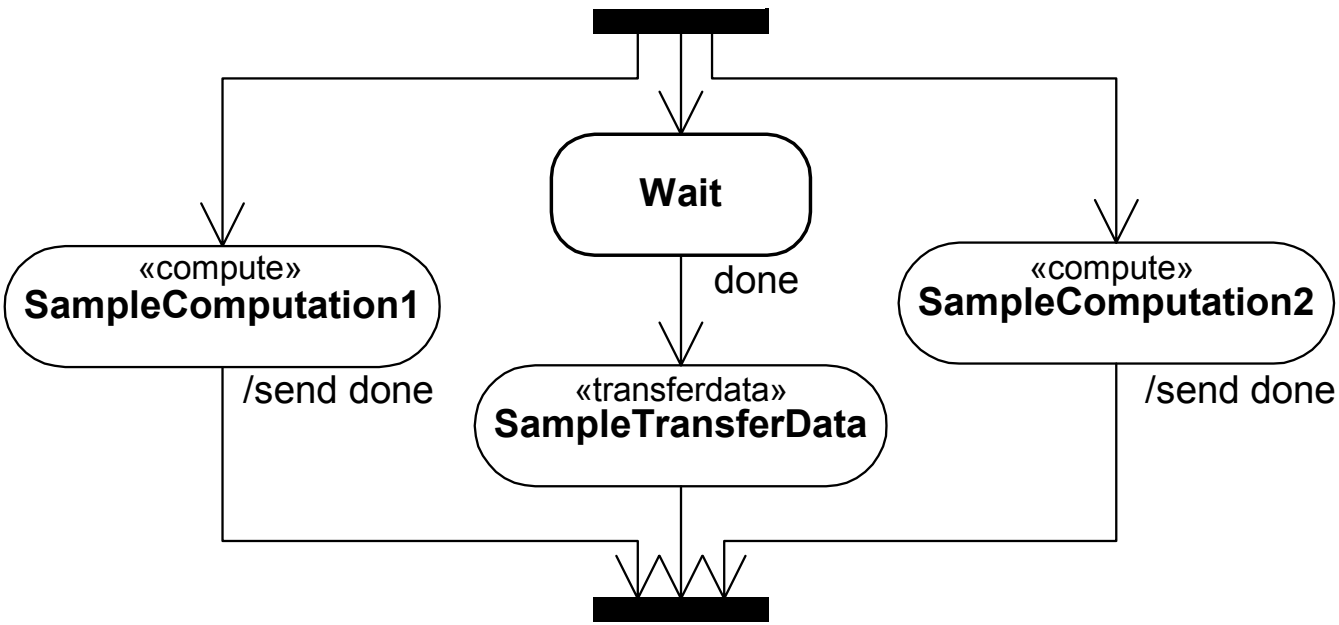
- Notification source
- Notification sink
- Broadcast concept



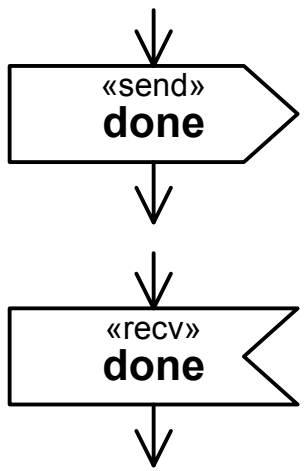
Synchronization with Events

- Complex workflow patterns
  - Event-based synchronization mechanism

(I) Parallel Flows of Control

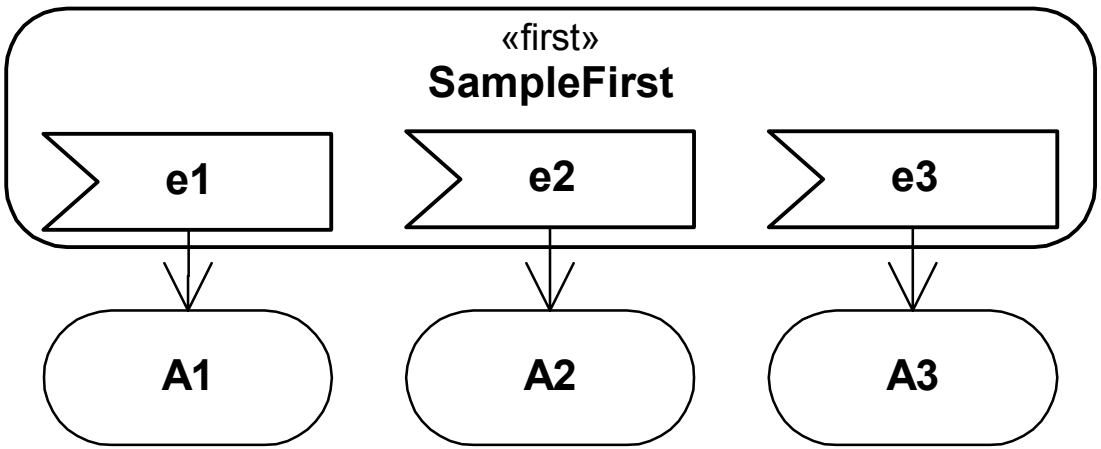


(II) Send and Receive Notation



Synchronization: First

- Selects one activity from a set of activities
  - based on the occurrence of a specific event



Constraints and Properties

- User-specified information
  - performance contracts
  - costs models
- UML constraints
  - Condition that must be true for a modeling element
  - middleware should honor constraint
- Properties through UML tags
  - additional information the middleware can rely on

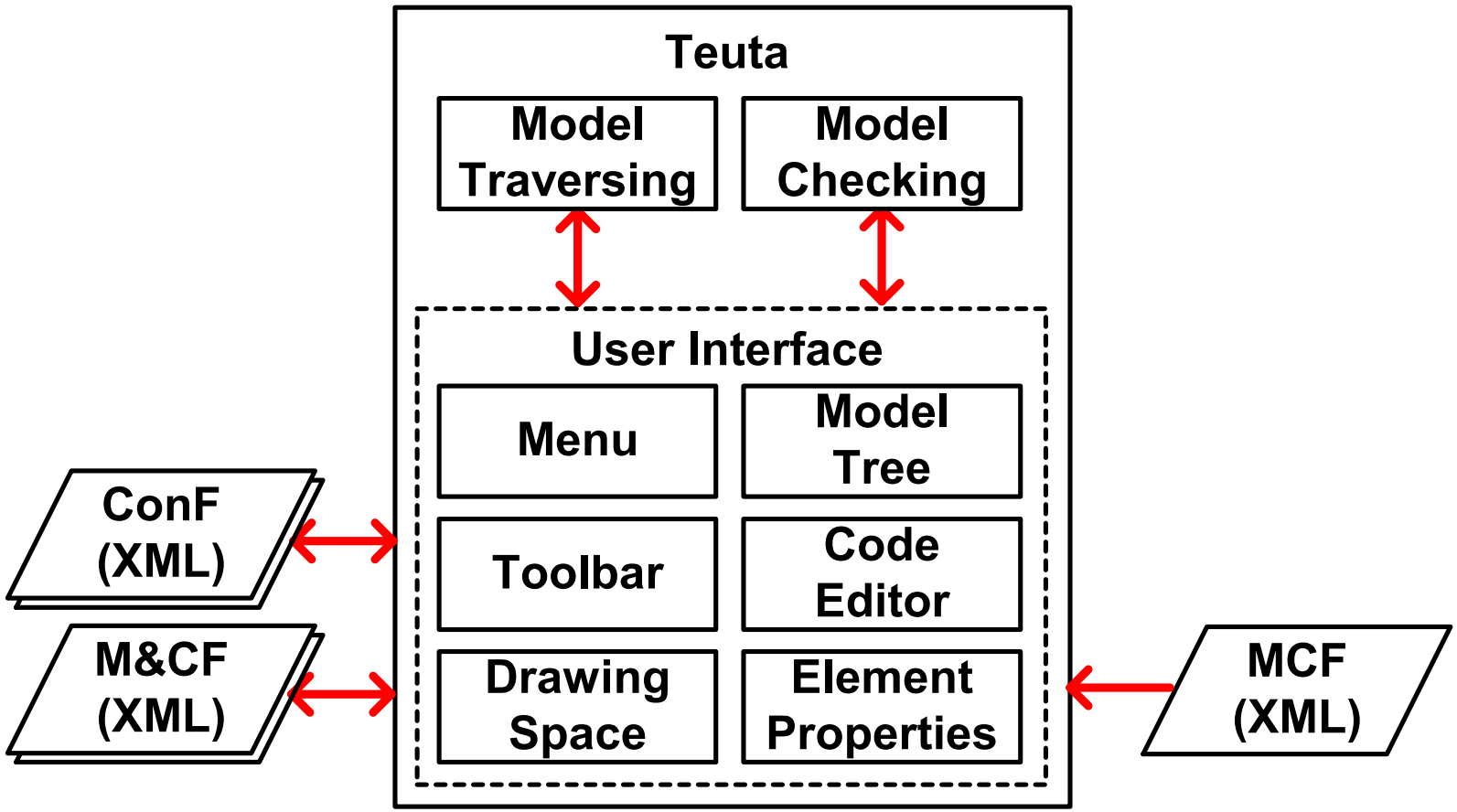
    e.g. estimated nr. of floating point operations

«compute»
SampleComputation

{executionTime.LT.10}

Tool Support: Teuta

Teuta: The Architecture



ConF - Configuration Files
M&CF - Model and Construct Files
MCF - Model Checking File

Teuta: Model Traversing

- API for model traversing
- Within Teuta
  - Input: actual Diagram
- Outside Teuta
  - Input: model in XML file
- Access to element properties
  - Name, Stereotype, Tagged Values
  - Code, Cost-Function
  - Geometry information
- Generation of various model representations: XML, C++, …

Teuta: Model Checking

- Verify whether the model conforms to the UML specification

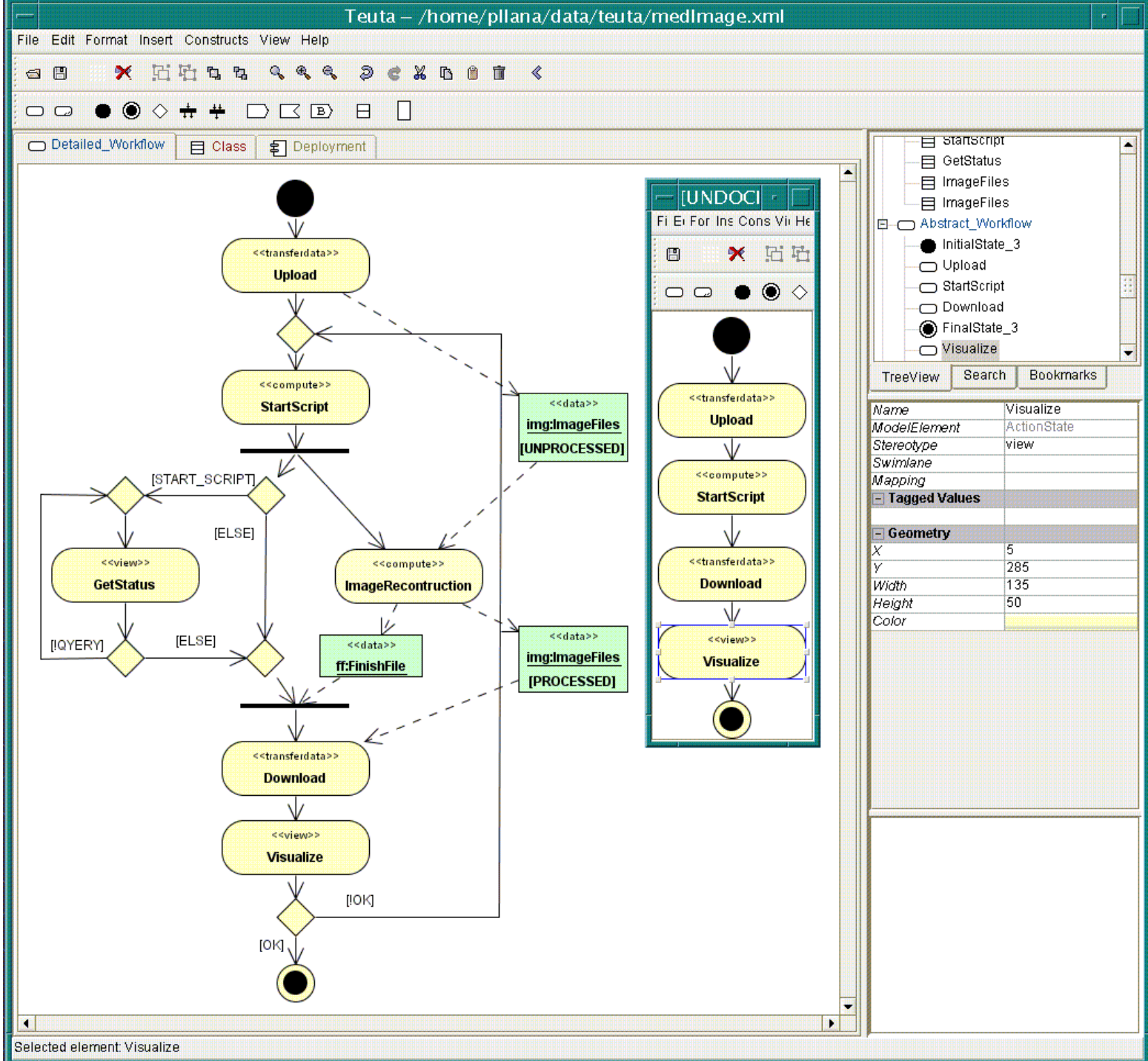
- We devised Model Checking Language (MCL)
  - XML based
  - Specify a set of diagrams and modeling elements
  - Specify a set of rules to ensure that the model is well-formed

- Check the model
  - When is loaded or saved
  - While the user is drawing it

(I) Case Study: Advanced 3D Medical Image Reconstruction

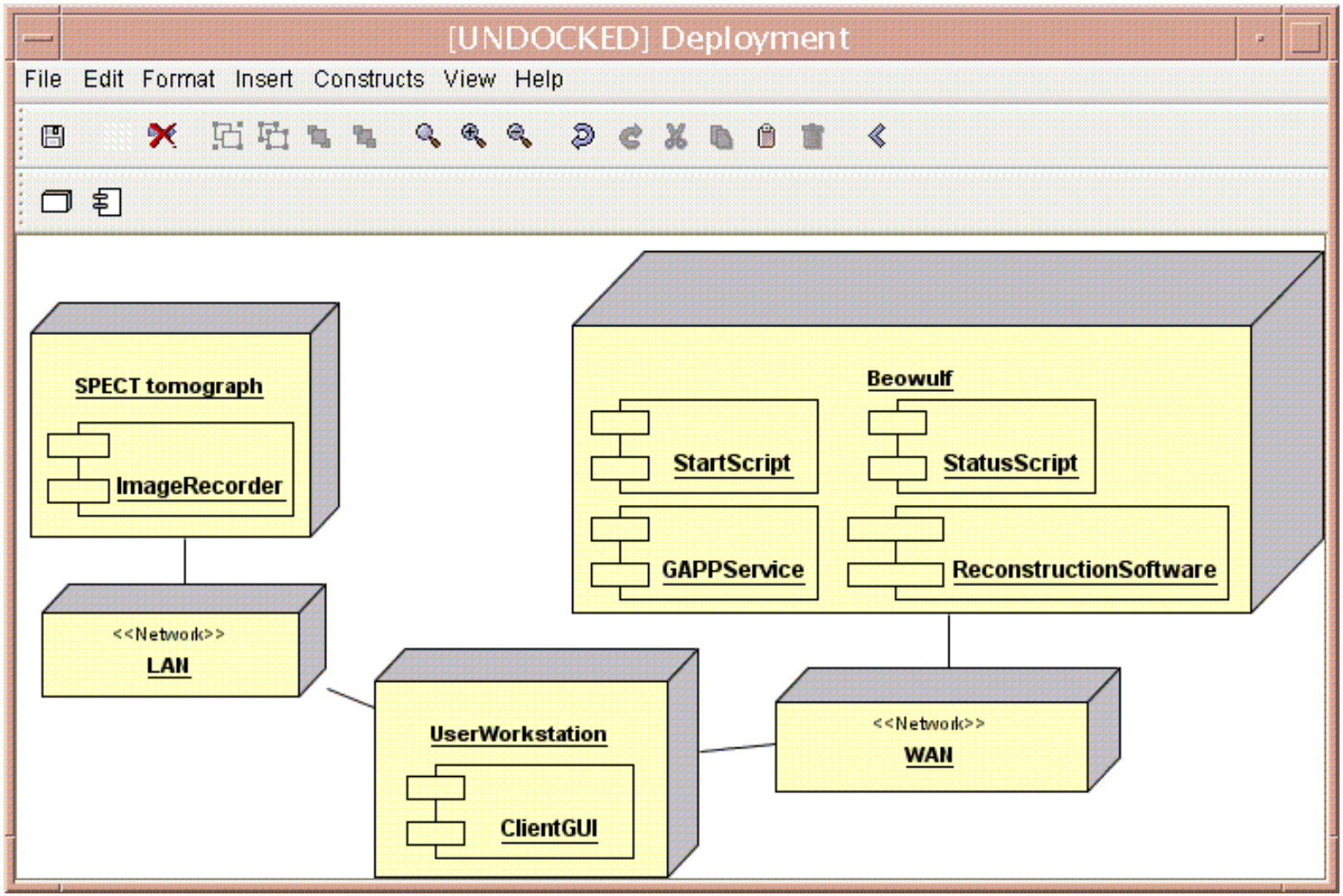
(EU GEMSE project
with S. Benkner and I. Brandic
Univ. of Vienna)

(I) Case Study: Activity Diagram



Thomas Fahringer

(I) Case Study: Deployment Diagram



Conclusions

- Application developers should be shielded from implementation technologies (web services, grid services, Corba, etc.)
- Provide specification and orchestration language for Grid workflow applications at a high level:
  - Teuta (UML)
  - JavaSymphony (workflow class library)
  - A-GWL (abstract grid workflow language)
- map high level language to lower level IR (C-GWL) that is forwarded to the Grid middleware for application building and execution.

More information?

Teuta

www.par.univie.ac.at/project/prophet

T. Fahringer, S. Pllana, J. Testori. Teuta: Tool Support for Performance Modeling of Distributed and Parallel Applications. International Conference on Computational Science, Tools for Program Development and Analysis in Computation Science. Krakow, Poland, June 2004, Springer Verlag

Askalon

www.par.univie.ac.at/project/askalon