Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Information and Communication Systems Research Group

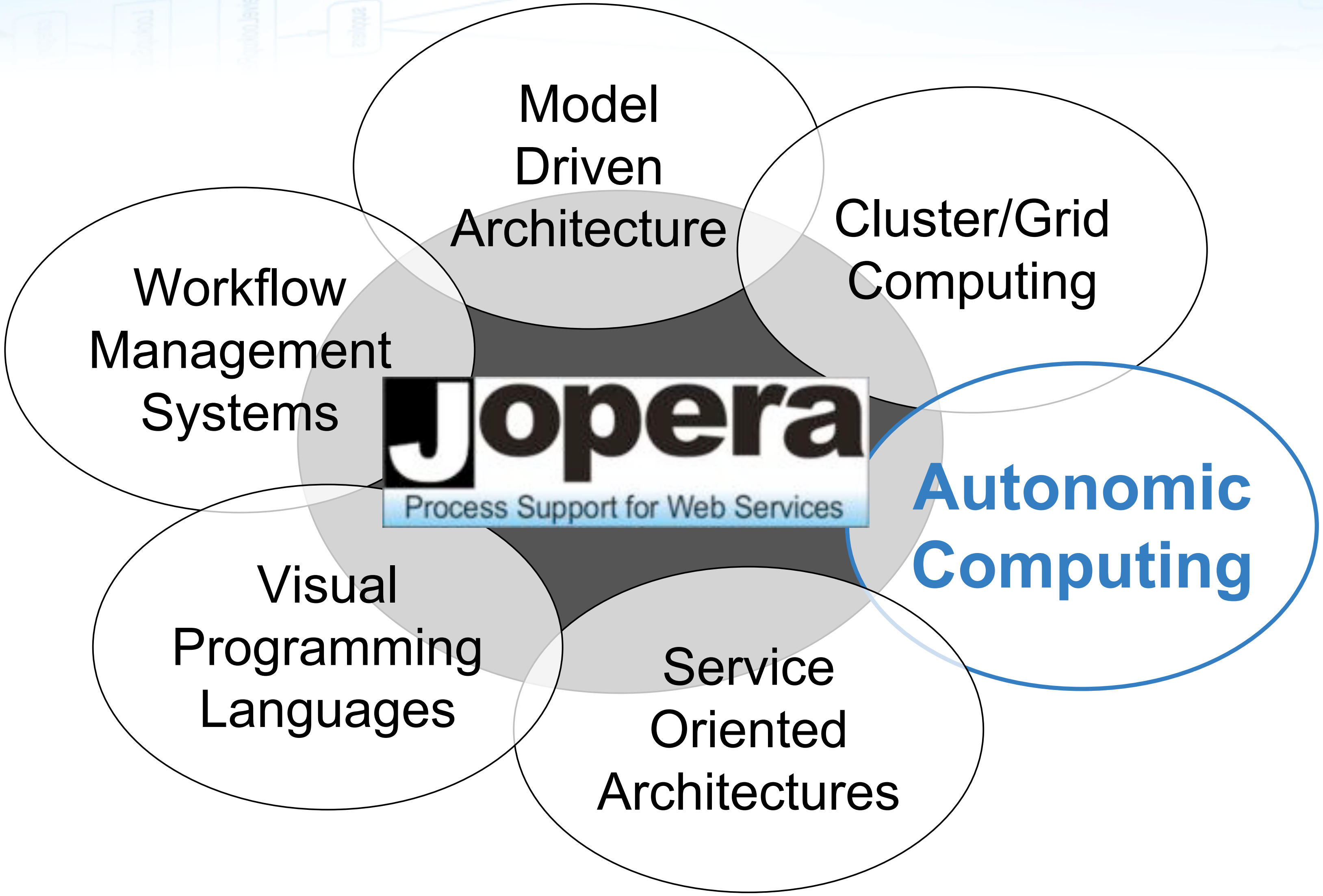
Introduction to JOpera

Dr. Cesare Pautasso
Department of Computer Science,
ETH Zurich, Switzerland
pautasso@inf.ethz.ch – **www.jopera.org**

JOpera is kindly supported by:

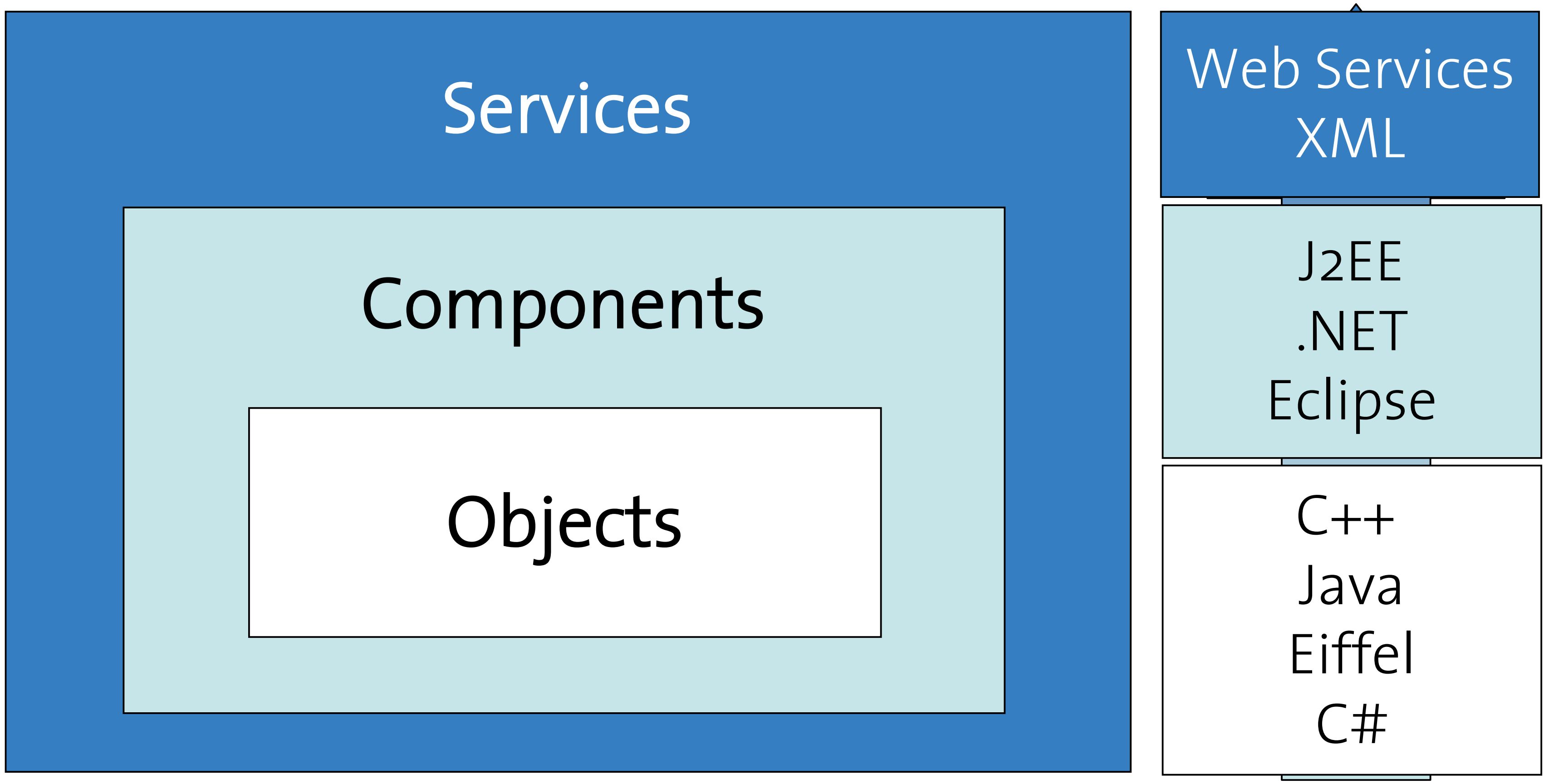
- ETH Zurich
  - **IKS Group**, Prof. Gustavo Alonso (since 2000)
- European Union
  - **ADAPT** - Middleware Technologies for Adaptive and Composable Distributed Componer
    (finished 2005)
  - **SODIUM** - Service Oriented Development in a Unified Framework (until 2007)
  - **AEOLUS** FET Project - Algorithmic Principles for Building Efficient Overlay Computers
    (until 2009)
- Hasler Stiftung
  - DICS Project: **Dependable Computing in Virtual Laboratories** (finished 2005)
  - MANCOM Project: **Compiling Optimized Service Architectures** (starting 2007)

My Research Interests



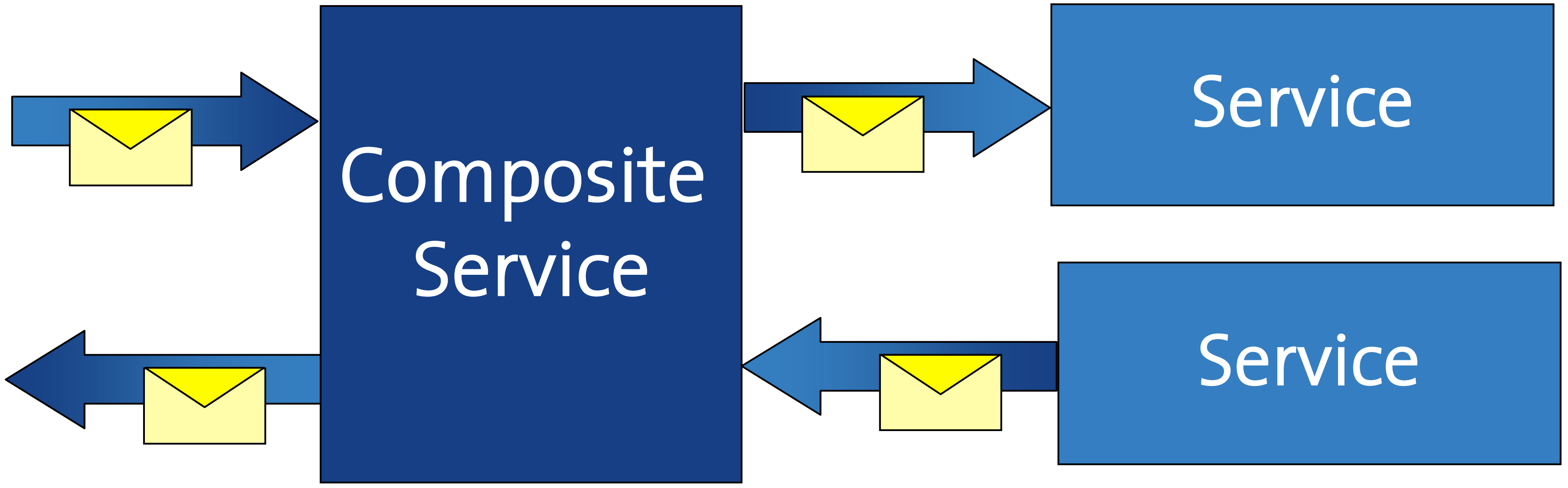
Model Driven Architecture
Cluster/Grid Computing
Workflow Management Systems
Jopera
Process Support for Web Services
Autonomic Computing
Visual Programming Languages
Service Oriented Architectures

New Abstractions for Application Integration



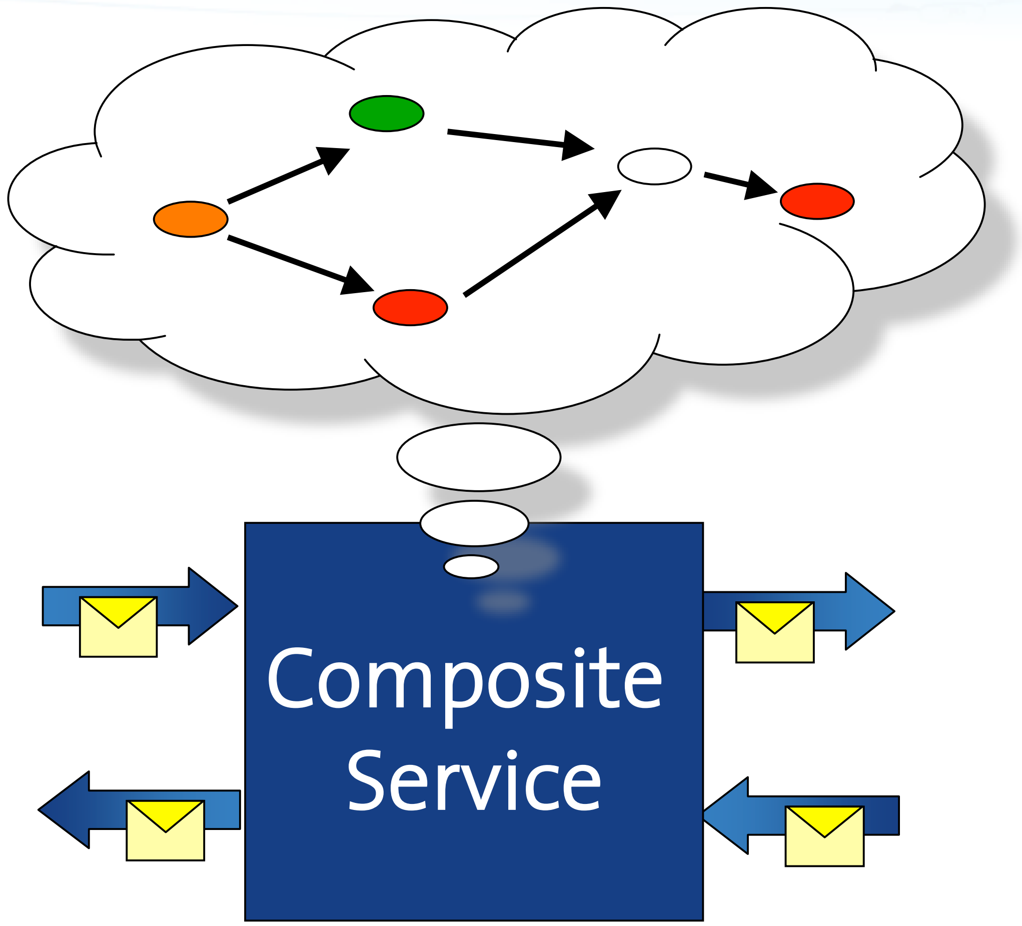
The Problem of Service Composition

- How to build an application by reusing existing components delivered as a service?
- How to script the exchange of messages between a set of services?

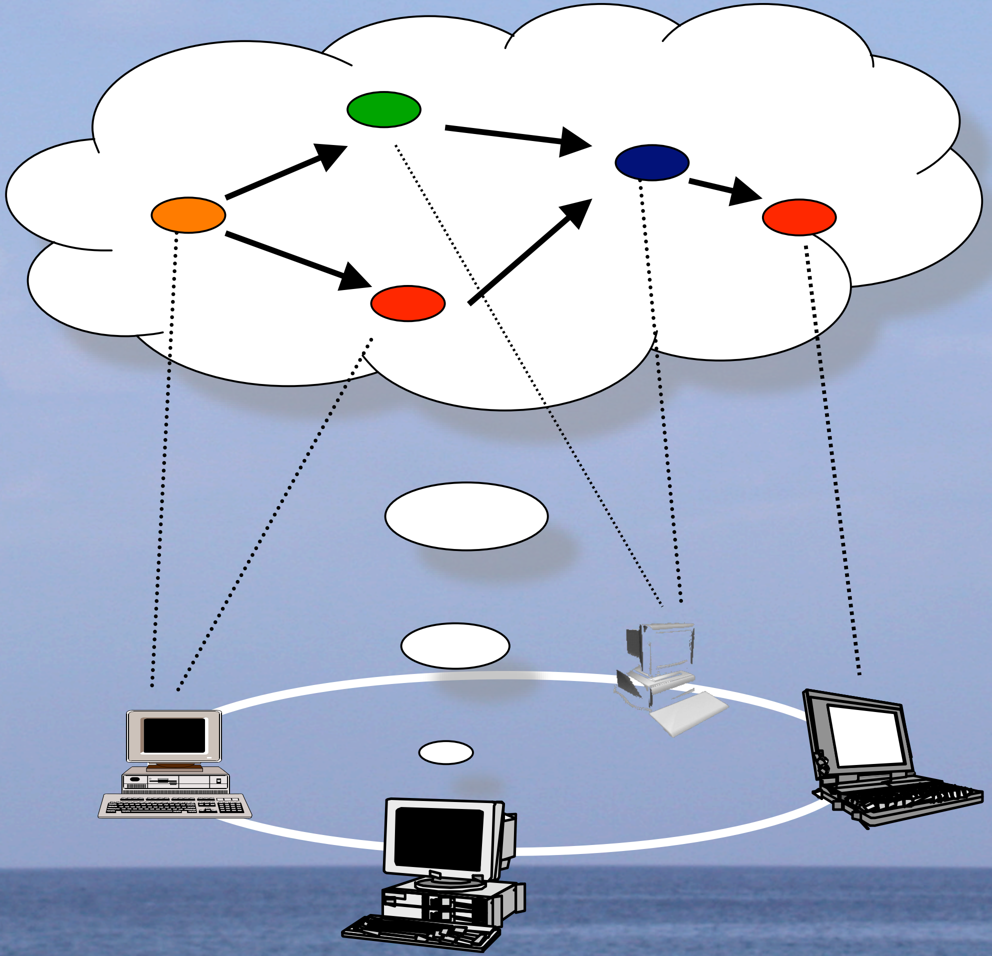


The Model is the Code

- How to model a composition?
- How to execute such a model?
- What kind of services can be composed?



How to model a Service Composition with JOpera?



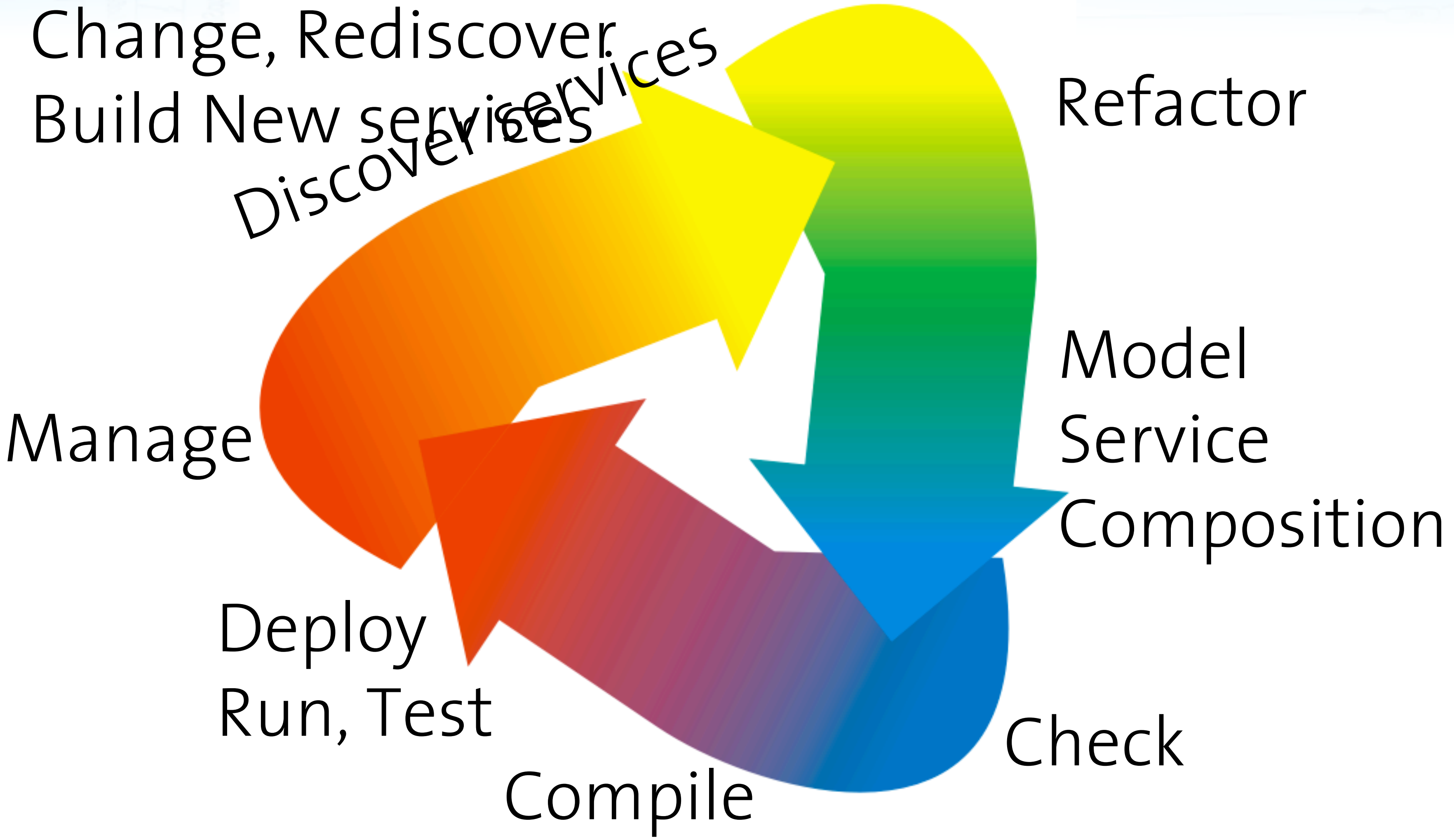
Bottom-up Composition

4. Share and Publish it as Web Service
3. Run, Test, and Debug the execution **within the same modeling environment**
2. Build a composition using a drag, drop and connect **modeling** environment
1. Select component services from a **library**
   - Lookup in a UDDI registry
   - Import from external WSDL
   - Search the standard JOpera library

Top-down Composition

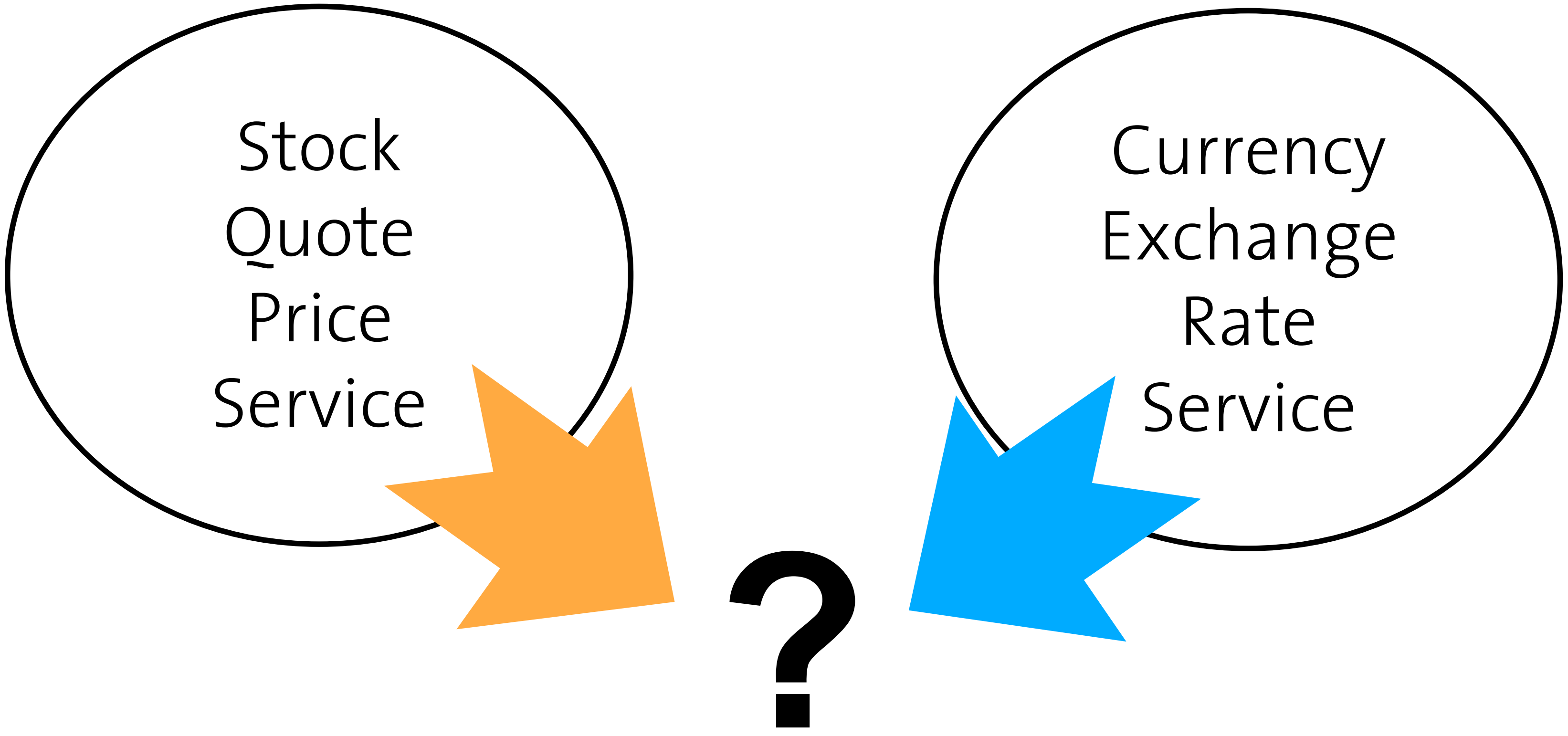
1. Define a **goal** and Draw a *skeleton of the composition* that satisfies it
2. Refine it and **Bind** services into it:
   - Search for existing matching services
   - Build missing services (if necessary)
   - Add required data transformations
3. Run, Test, and Debug the execution **within the same modeling environment**
4. Share and Publish it as Web Service

Iterative Composition

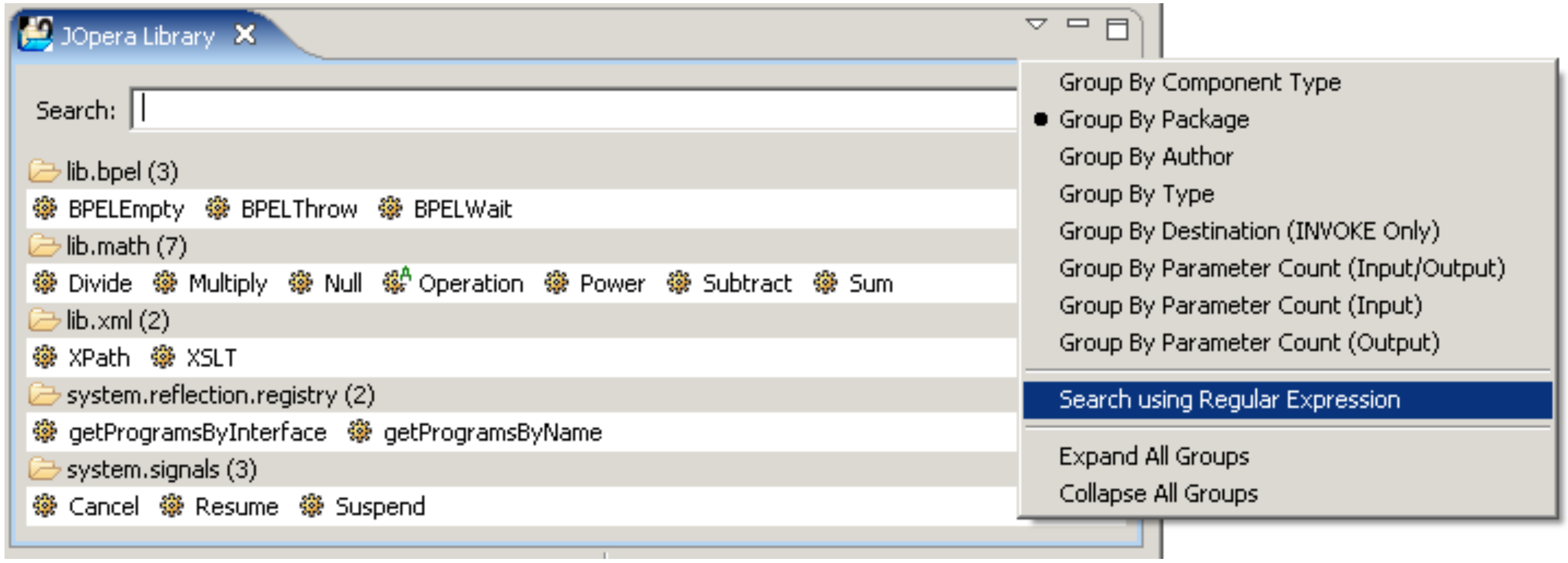


Demo 1

- Stock Quote Currency Conversion

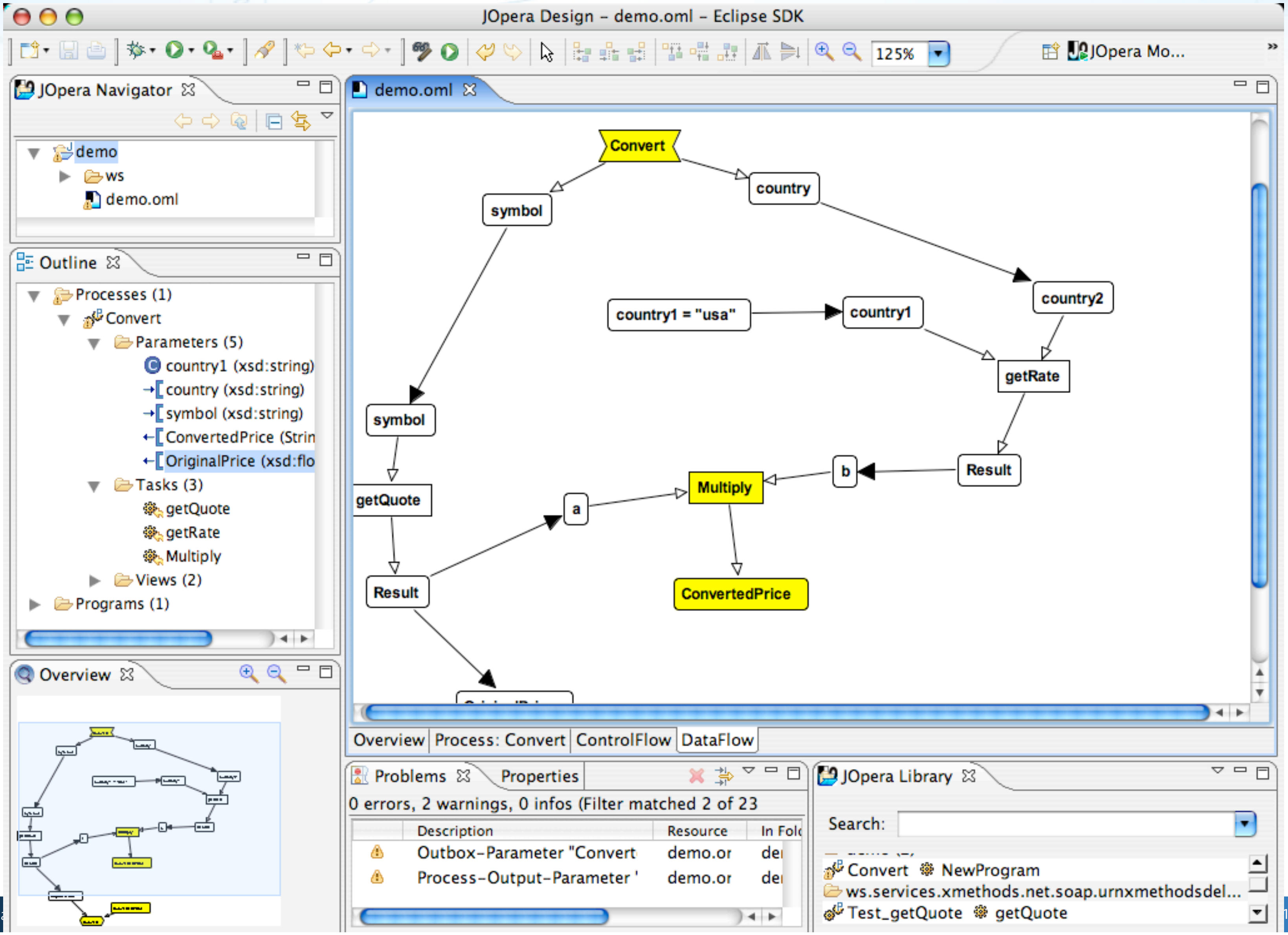


Service Library



1. Search services as you type (also with regex)
2. Group services by different (orthogonal) criteria

Drag, Drop and Connect

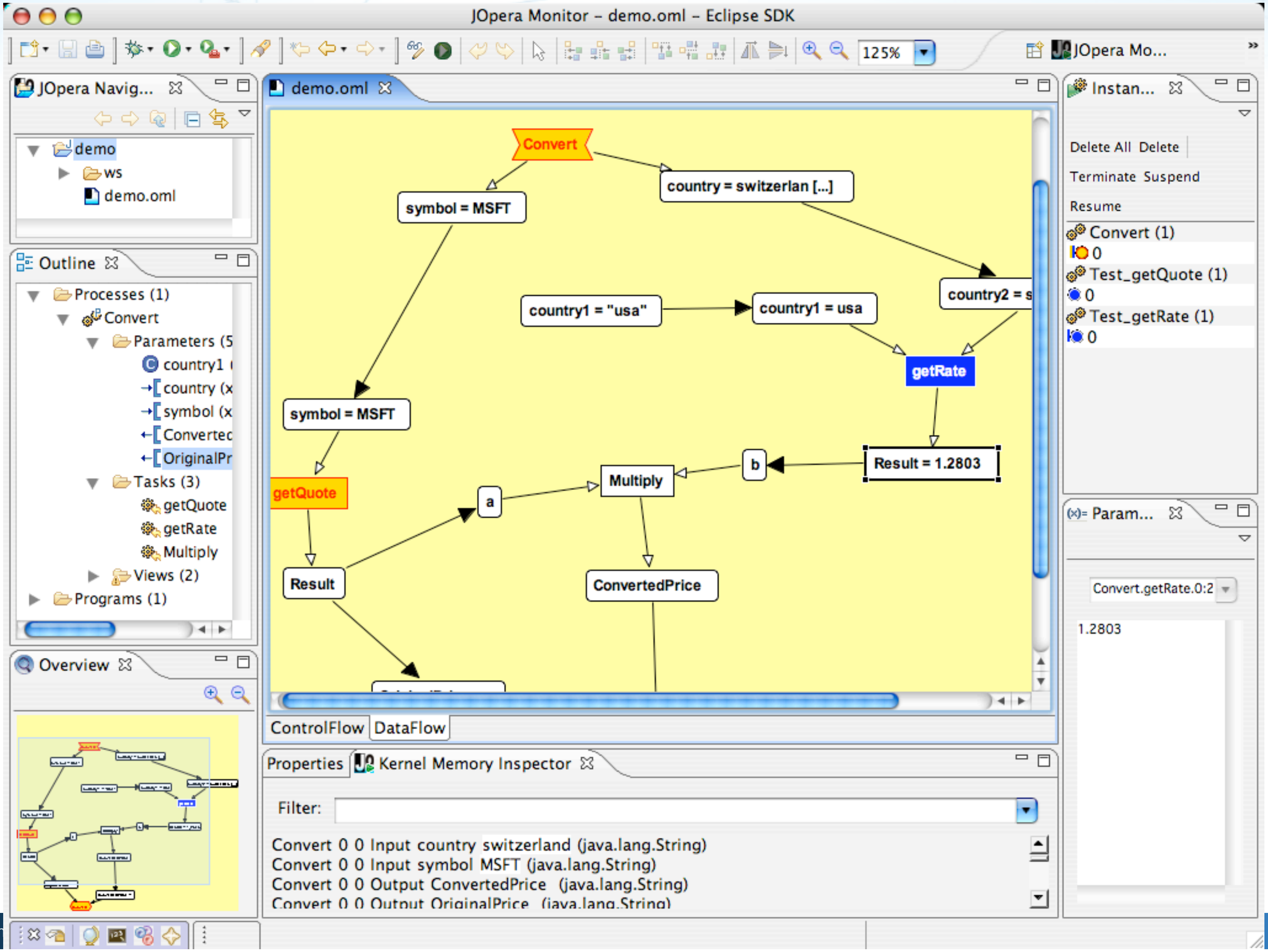


0 errors, 2 warnings, 0 infos (Filter matched 2 of 23

Description	Resource	In Fold
Outbox-Parameter "Convert	demo.or	de
Process-Output-Parameter '	demo.or	de

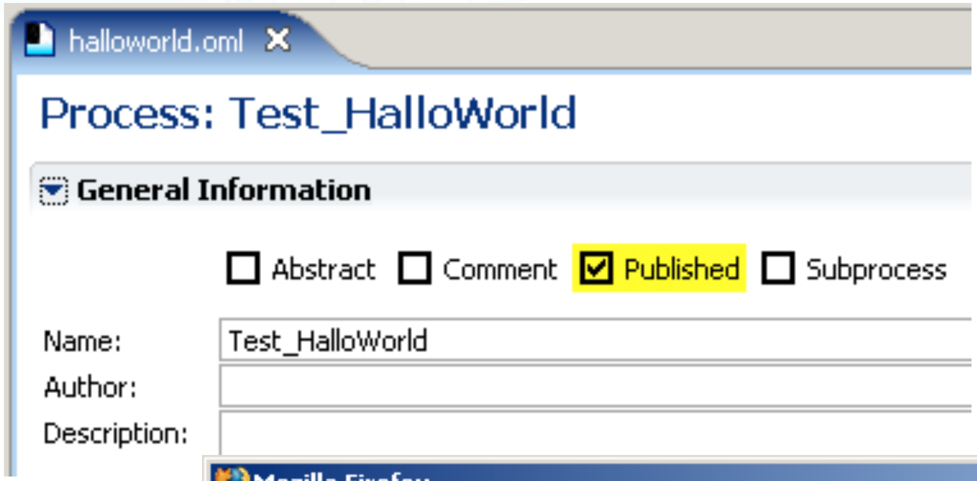
Convert NewProgram
ws.services.xmethods.net.soap.urnxmethodsdel...
Test_getQuote getQuote

Run, Monitor, Steer and Debug



```
Convert 0 0 Input country switzerland (java.lang.String)
Convert 0 0 Input symbol MSFT (java.lang.String)
Convert 0 0 Output ConvertedPrice  (java.lang.String)
Convert 0 0 Output OriginalPrice  (java.lang.String)
```

Publish as a Web/Grid service



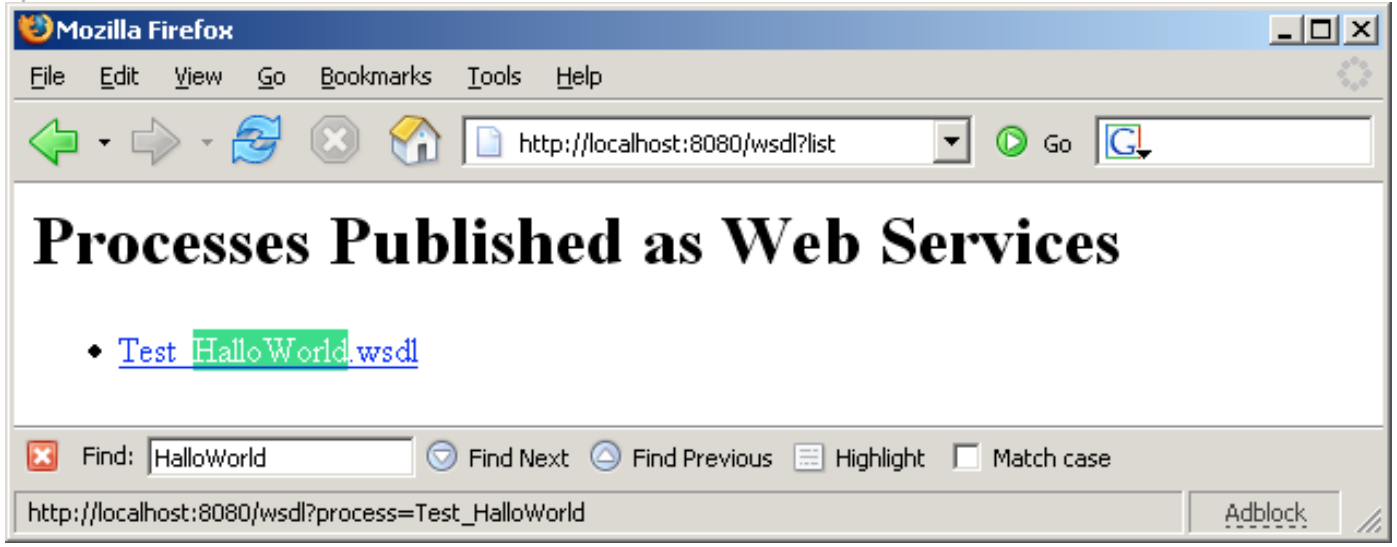
halloworld.oml

Process: Test_HalloWorld

General Information

☐ Abstract ☐ Comment ☑ Published ☐ Subprocess

Name:	Test_HalloWorld
Author:	
Description:	



http://localhost:8080/wsdl?list

Processes Published as Web Services

- Test_HalloWorld.wsdl

Find: HalloWorld Find Next Find Previous Highlight ☐ Match case

http://localhost:8080/wsdl?process=Test_HalloWorld

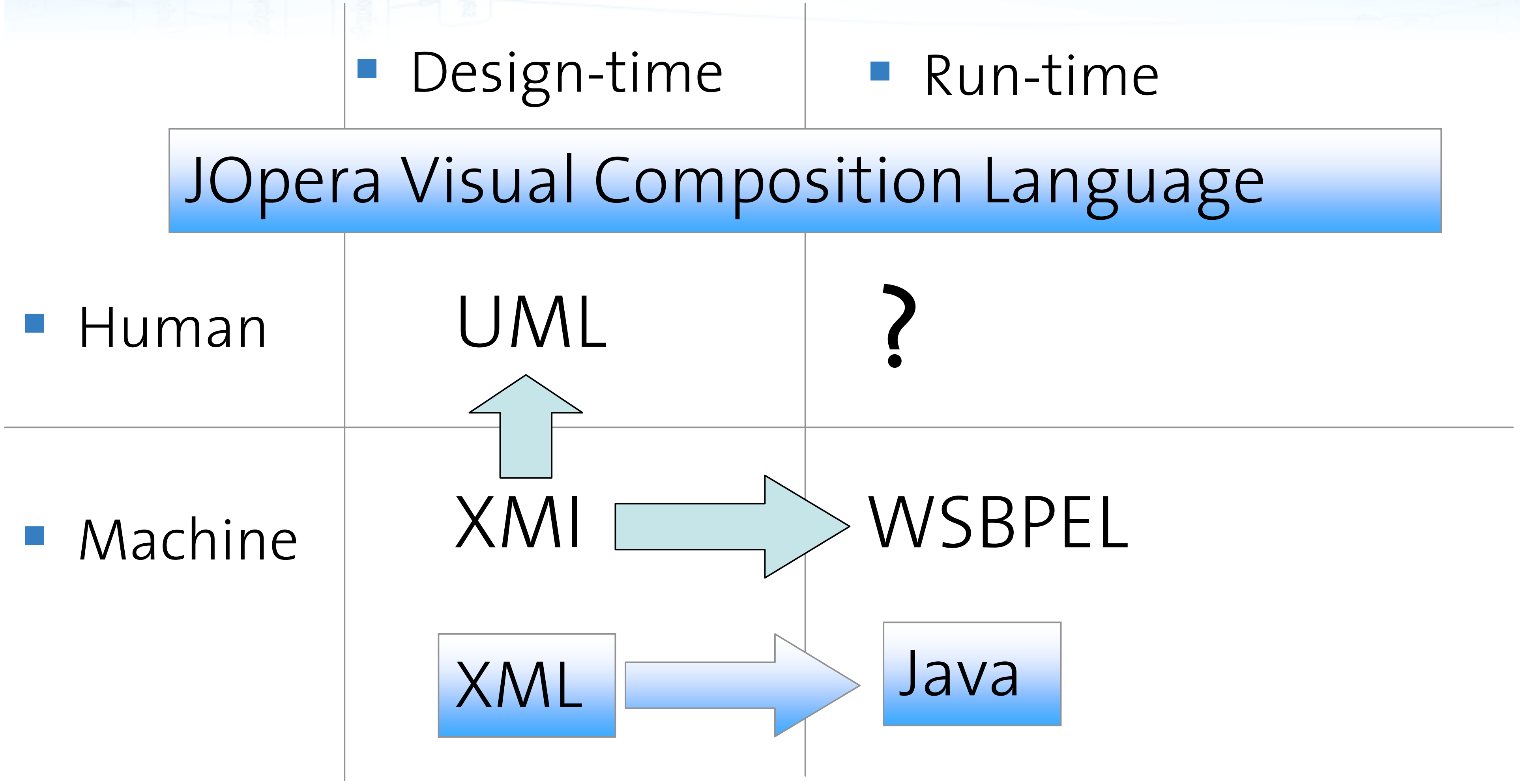
With one mouse click!

[e-Science2005]

Modeling Service Compositions

- What are good abstractions for modeling service composition?
  - Structure (UML, Architectural Description Languages)
  - Behavior (BPM, Activity Diagrams, Business Rules)
- What about the syntax?
  - Visual, Textual (XML), or both
- What about the semantics?
  - Formal, Verifiable, and Executable

Modeling Service Compositions



Model Transformation in JOpera

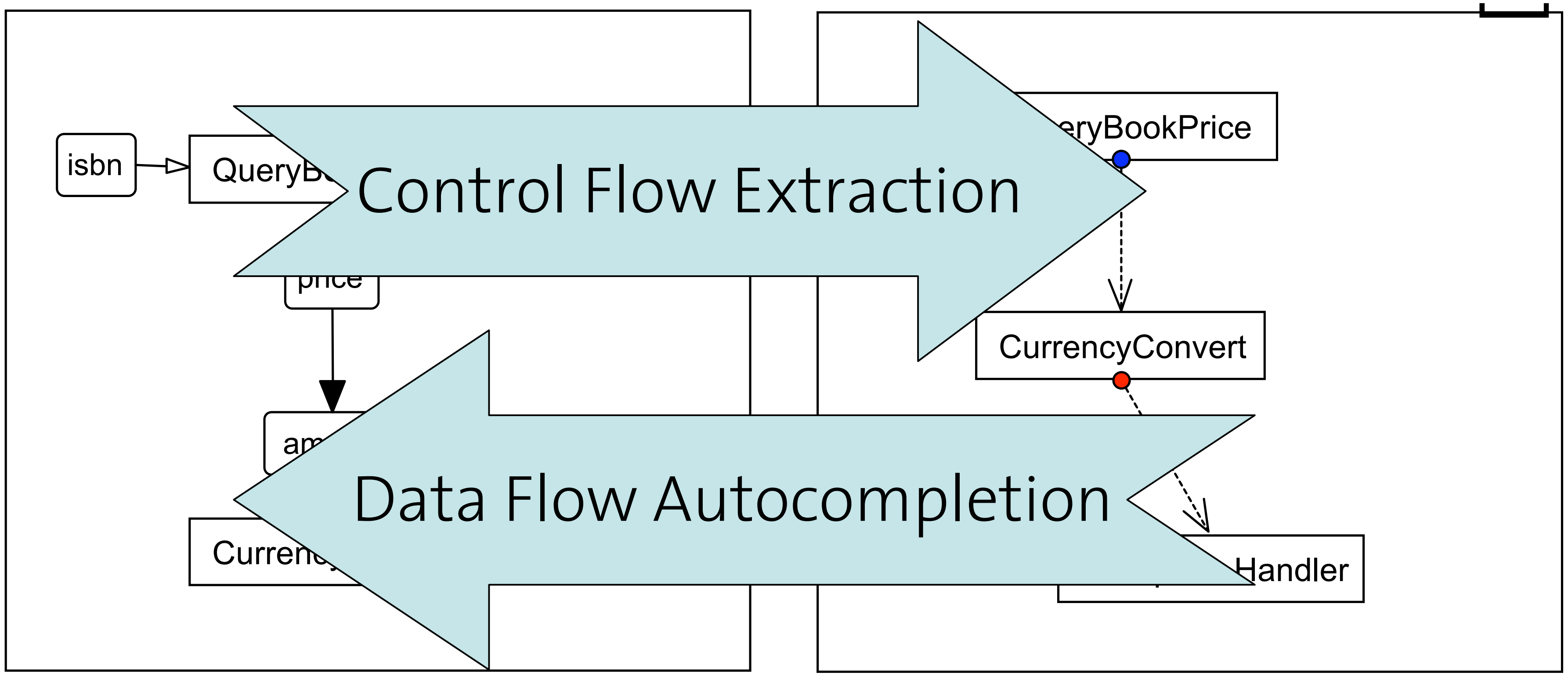
- What are good abstractions for modeling a service composition? **It depends**

▪ End user	JOpera Visual Composition Language
▪ Developer	Graphs and Dependency Rules
▪ Storage	XML (OML)
▪ Compiler	Intermediate Representation (FSM)
▪ Execution	Java Bytecode

JOpera Visual Composition Language Overview

[HCC2003]

- Services are composed using processes, which define their interactions using two graphs:
  - Data Flow
  - Control Flow



JOpera Visual Composition Language Features

- Processes model generic service composition
  - **Data flow** as the primary representation
  - Explicit **control flow** (branch, synchronization, exception handling, loops, pipeline, workflow patterns)
- **SubProcesses**: Modularity, Nesting and Recursion
- **First order functions**
  - Map (parallel/sequential/discriminator) and Reduce
- **Reflection** (introspection)
  - Dynamic late binding
  - Quality of Service monitoring

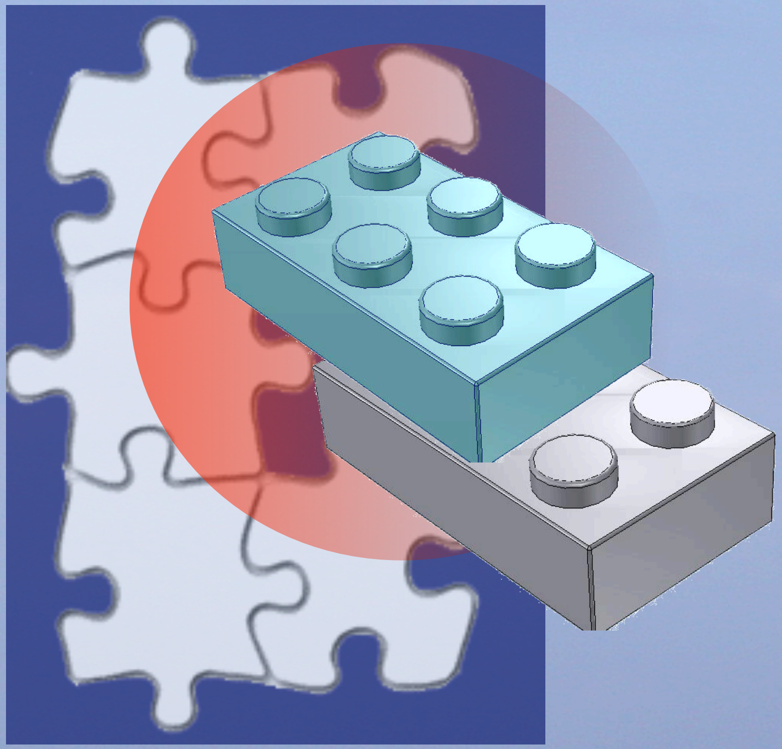
[JVLC2005]

Modeling Service Compositions

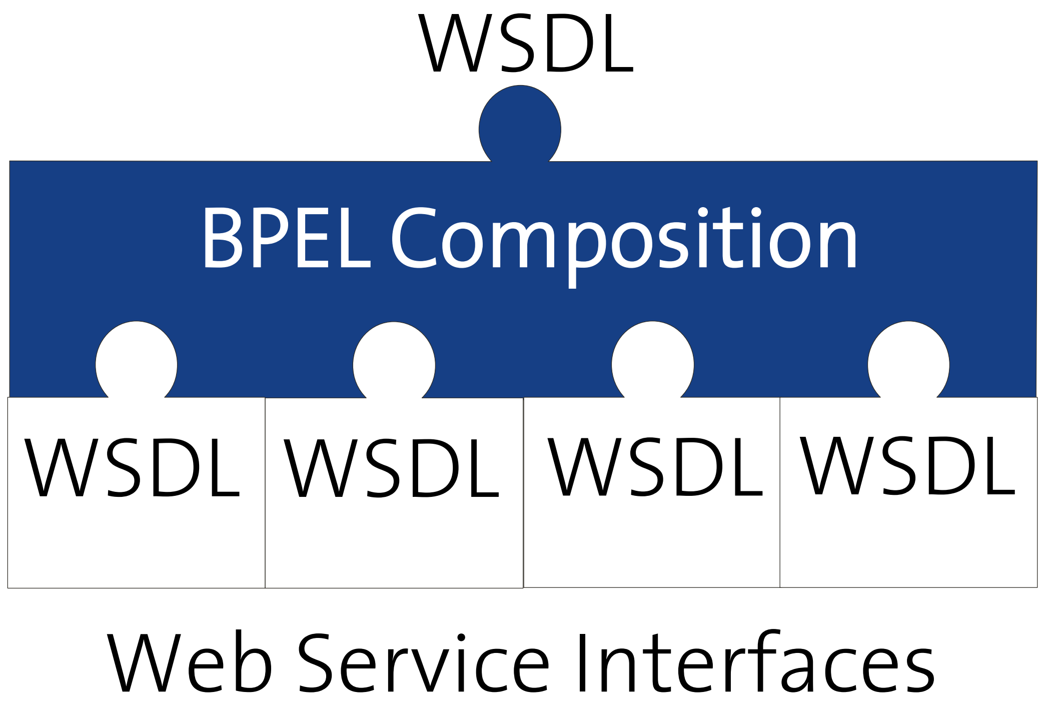
- What are good abstractions for modeling a service composition?
- Business Process Modeling Languages
  - Service invocation treated as *task*
  - *Control flow* (branches, loops, synchronization)
  - *Data flow* (and data *transformations*)
  - *Exception Handling*
  - *Dynamic Late Binding*
- Syntax
  - Textual, Visual, XML, UML

[HCC2003]

What kinds of Services can you compose with JOpera?



What kind of services can you compose with WS-BPEL?



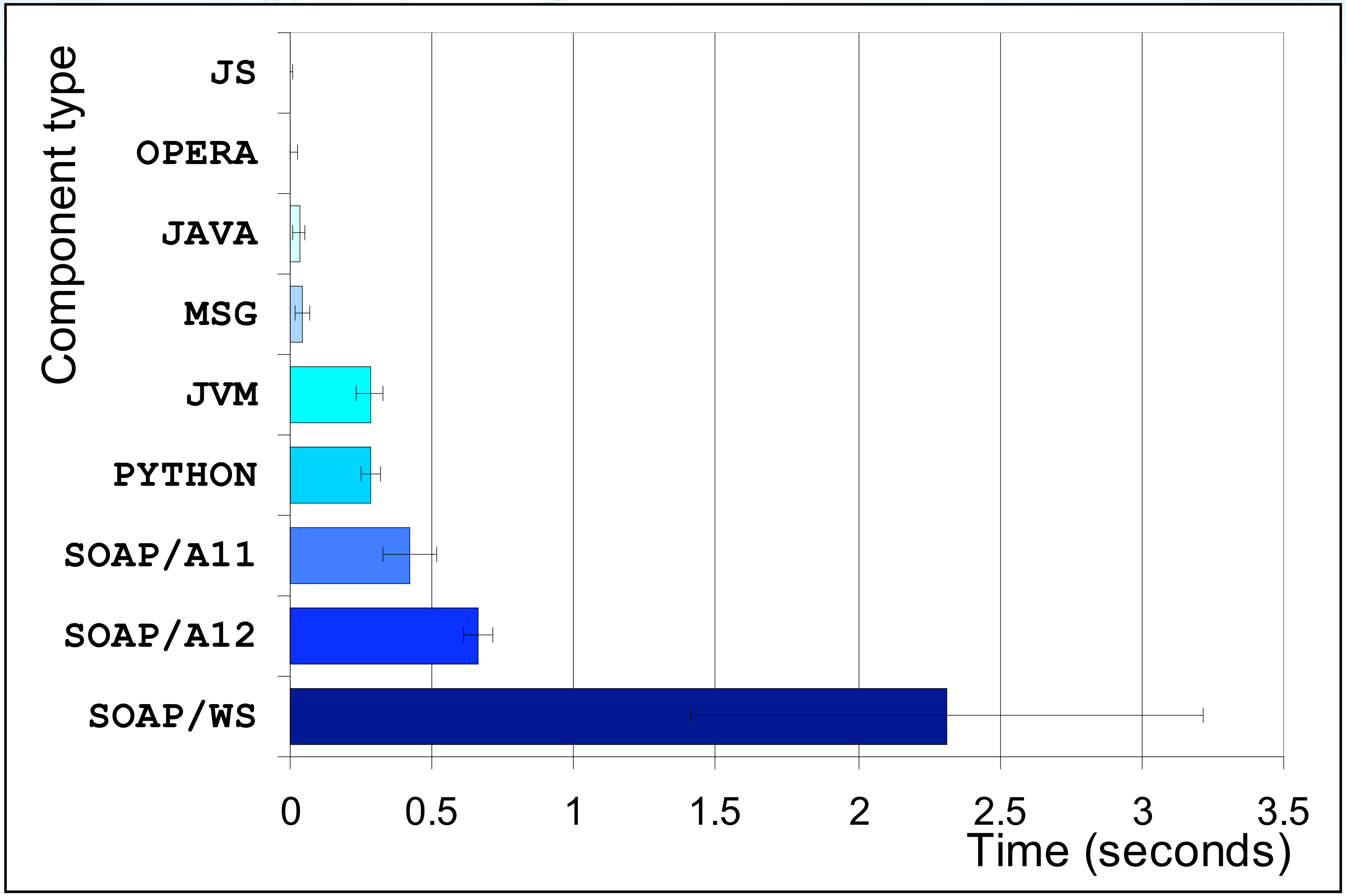
Assumption:
Web Services (SOAP/WSDL) are the only kind of services to be composed

Problem:
extensions to the BPEL standard are needed to support code snippets (BPELJ) and human tasks (BPEL4PEOPLE)

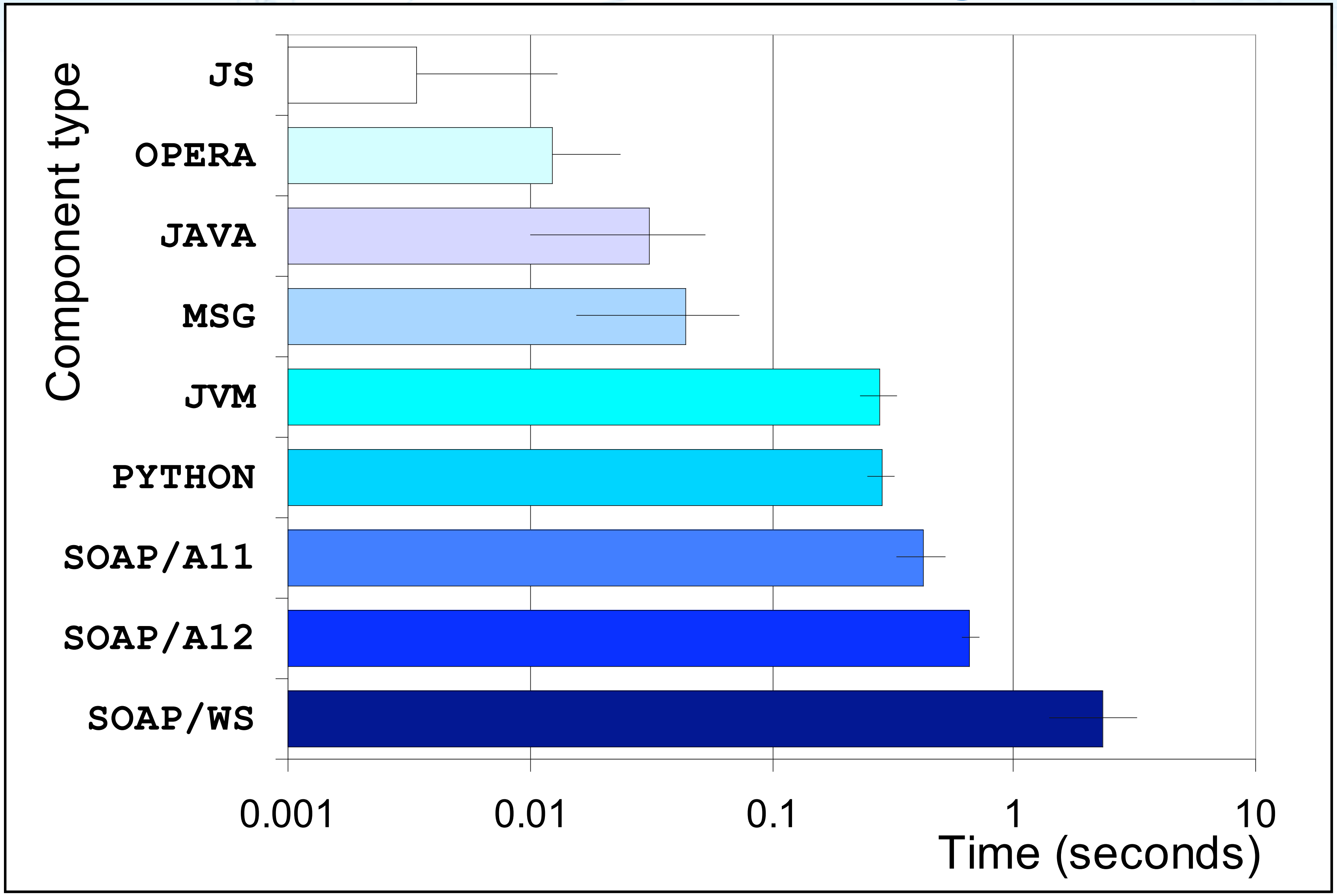
Problems of composing *only* Web Services

- Web Services are **coarse-grained**
- All existing heterogeneous systems must be **wrapped** as a Web Service
  - Wrapping imposes both a performance penalty and additional development & maintenance costs
- The **adapter/mediator** between mismatching Web services must also be a Web service
- Offline testing difficult
- Web services standards are not stable

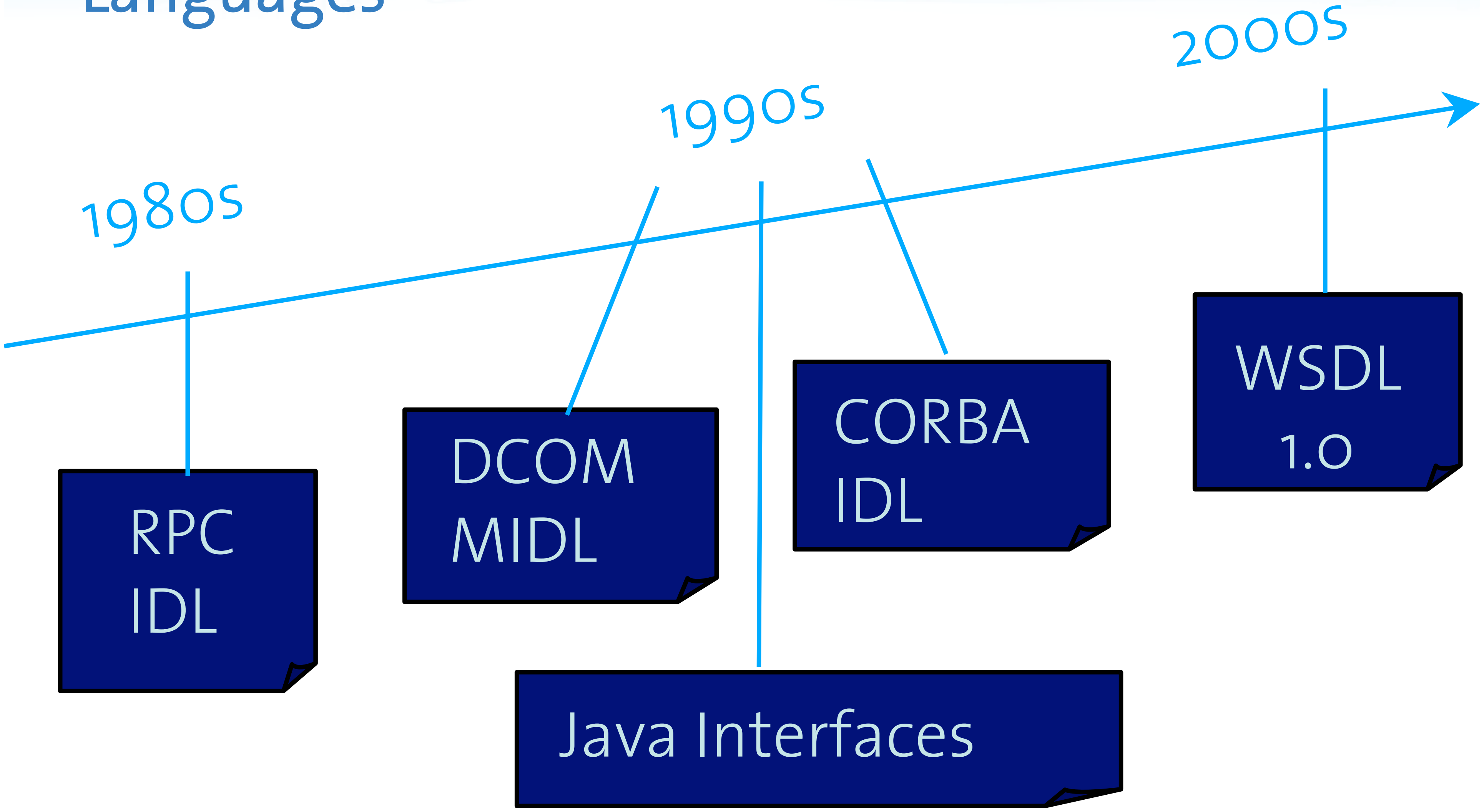
Service Invocation Overhead



Service Invocation Overhead (Log)



A Brief History of Interface Description Languages



Generalizing service composition

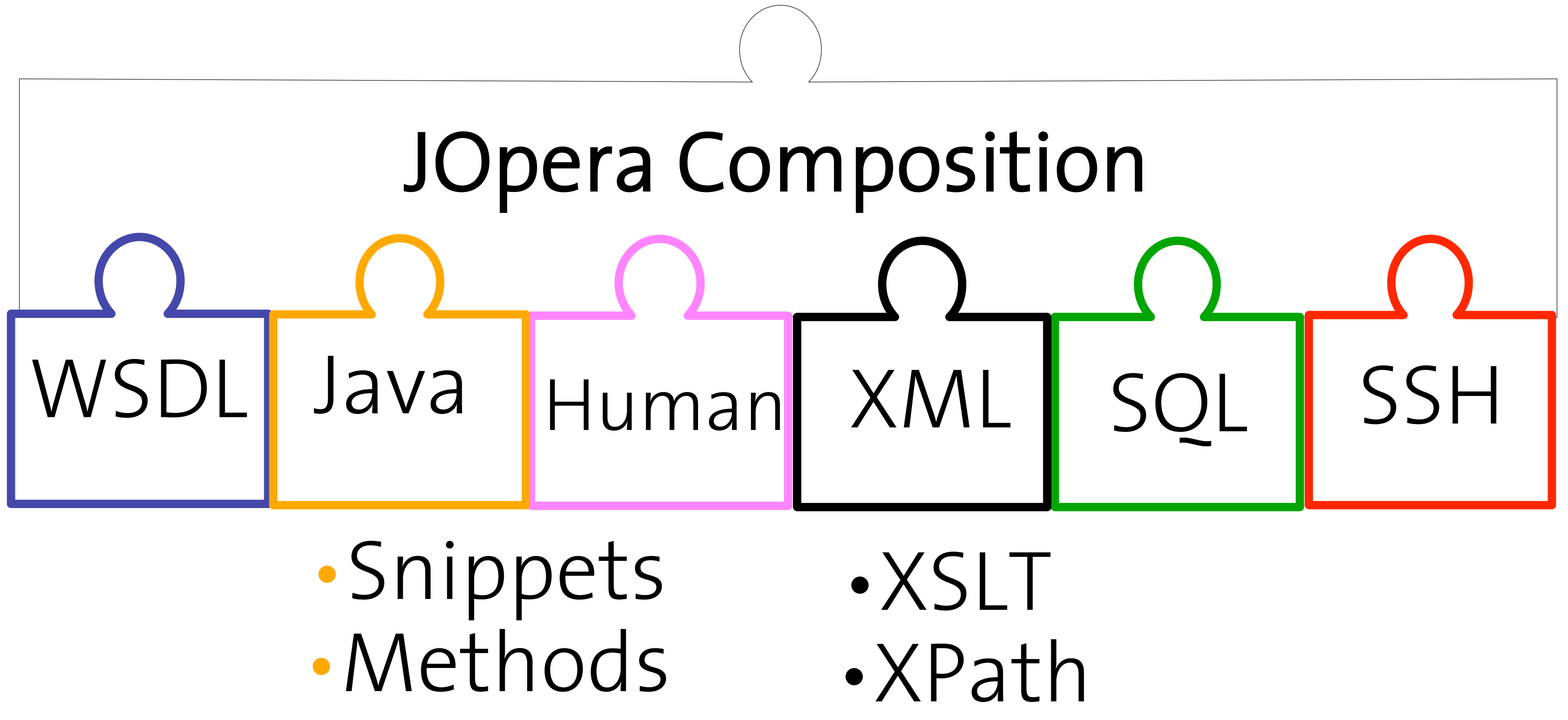
- How to design a language independent of the kinds of services to be composed?

1. Separate the description of the process from the description of how to invoke each of its tasks
2. A process should make minimal assumptions about its tasks (i.e., data flow signature)
3. Bind tasks to different invocation mechanisms without affecting the process definition

[VLDB/TES2004]

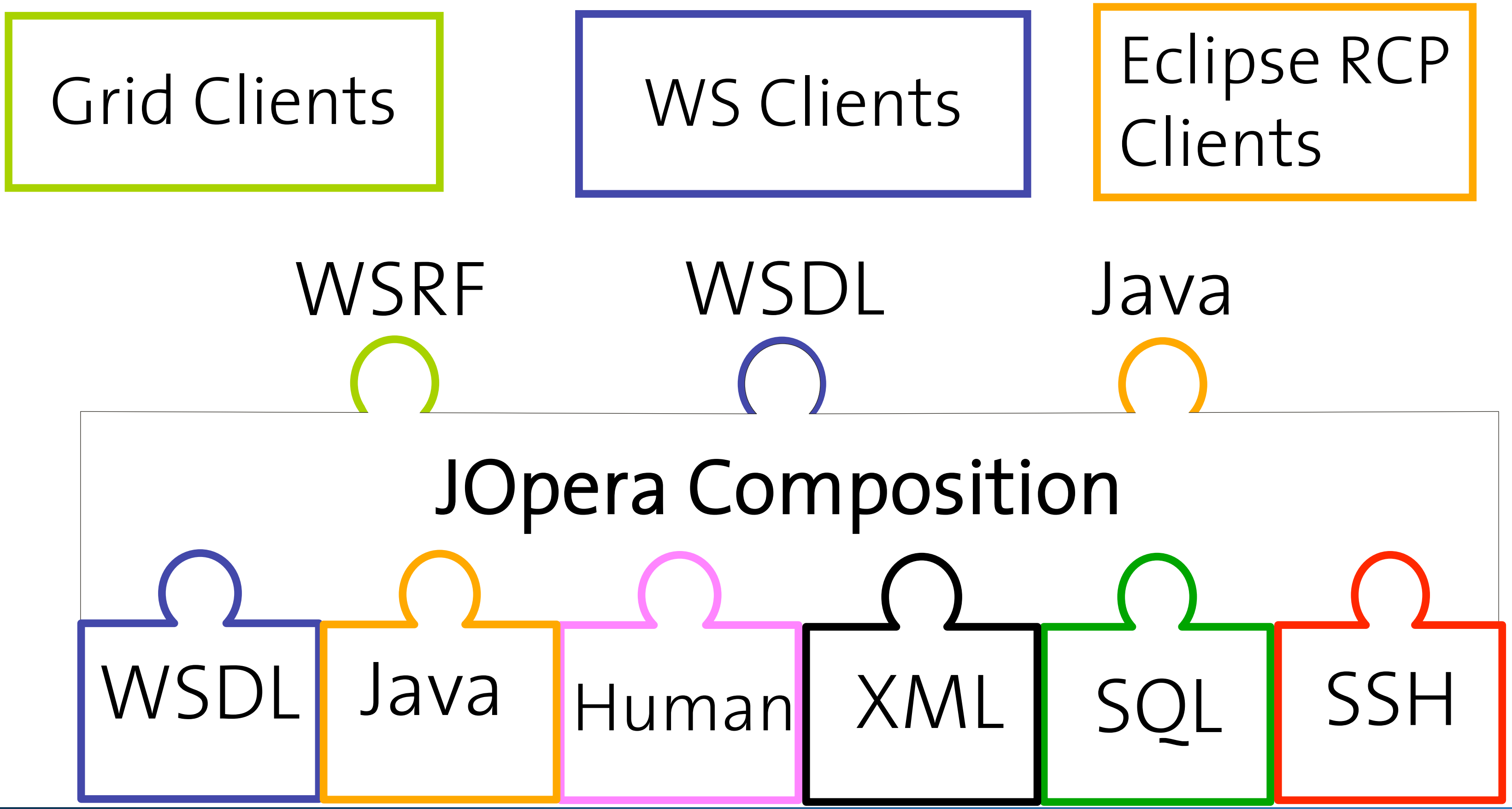
Dealing with heterogeneity in JOpera

- The JOpera composition language does not have to be changed when adding a new kind of service



Publishing a composition with JOpera

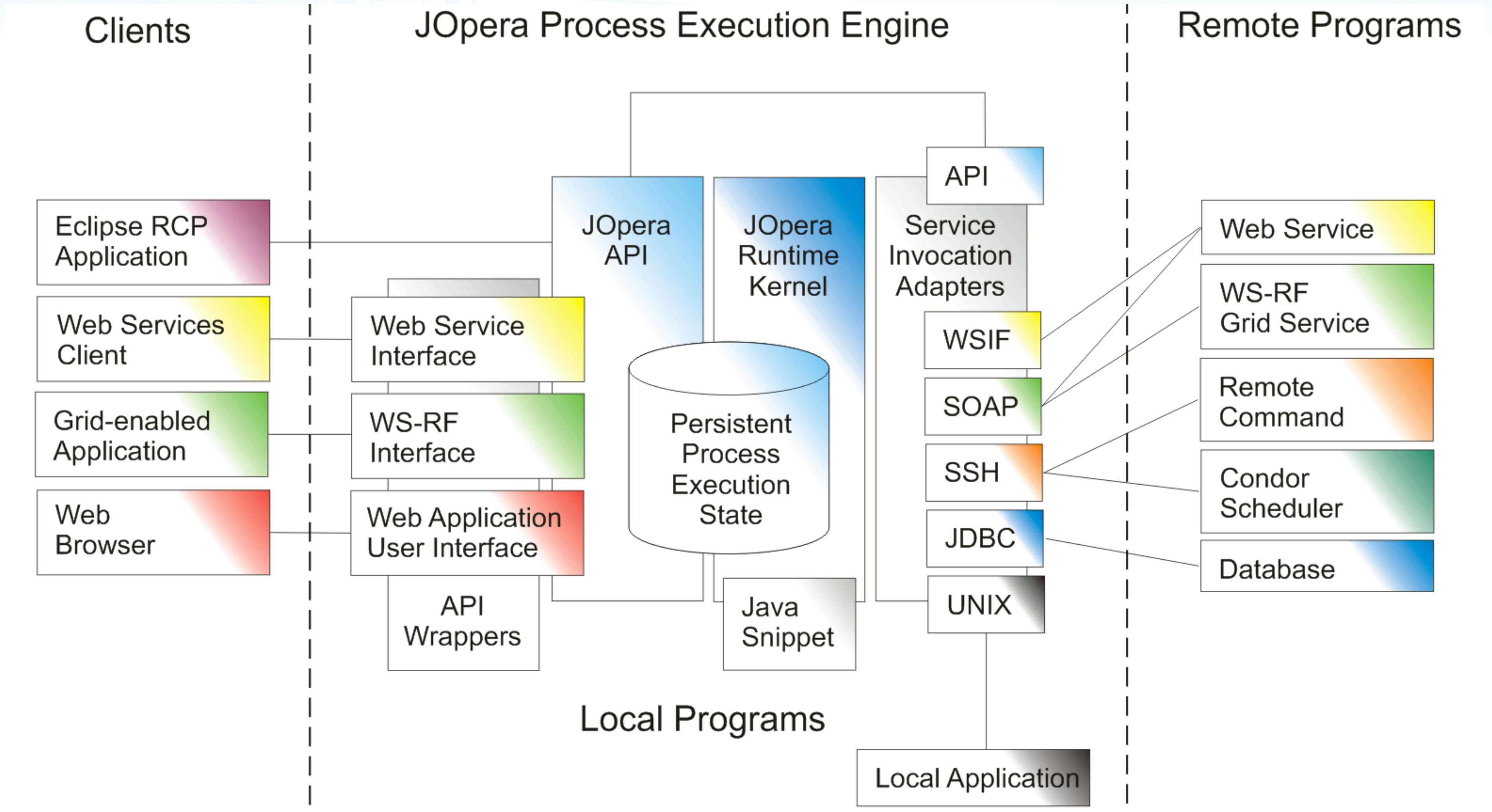
- JOpera processes are automatically published to clients using a variety of access protocols

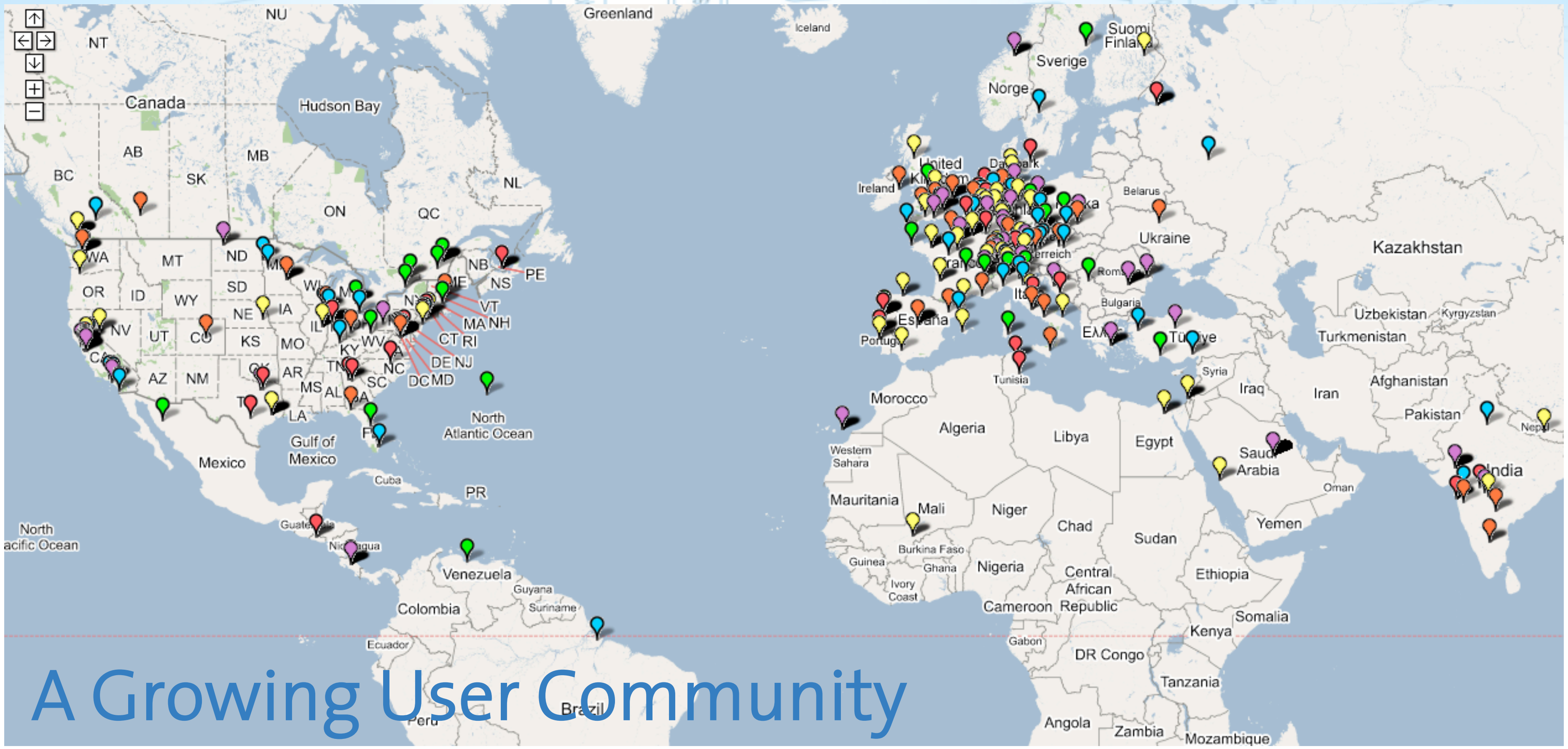


[eScience2005, CCGrid2006]

Executing Service Composition Models with JOpera for Eclipse

Architecture of JOpera for Eclipse



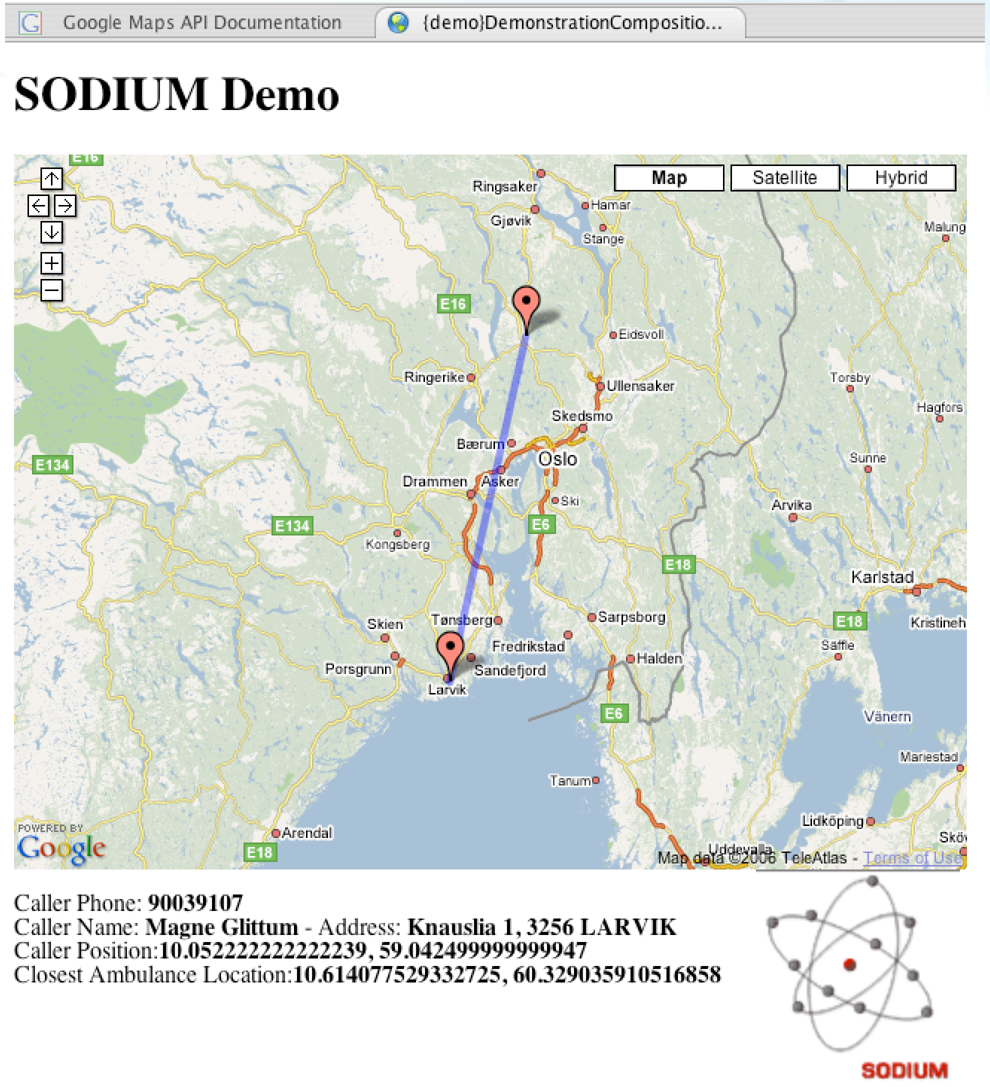


A Growing User Community

ETH Zurich, Swiss Bioinformatics Institute, Swiss National Supercomputing Center, European Synchrotron Radiation Facility, Purdue University, McGill University (Montreal), Singapore Mgmt University, National University of Defence Technology (China), Arjuna (UK), SINTEF (No), Locus (No), NCSA

LOCUS, Norway

- SODIUM EU Project
- Service Oriented Development in a Unified Framework
- Pilot application in GIS, e-Health and emergency rescue services


Google Maps API Documentation
{demo}DemonstrationCompositio...
Map
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Hybrid
Oslo
Larvik
POWERED BY Google
Map data ©2006 TeleAtlas - Terms of Use
SODIUM

SODIUM Demo

Caller Phone: **90039107**
Caller Name: **Magne Glittum** - Address: **Knauslia 1, 3256 LARVIK**
Caller Position:**10.052222222222239, 59.042499999999947**
Closest Ambulance Location:**10.614077529332725, 60.329035910516858**

PURDUE UNIVERSITY Rosen Center for Advanced Computing RCAC

JOpera Process Support for Web Services

Climate Modeling on TERAGRID

- Continuous processing of satellite feeds for climate modeling and weather forecasting
- JOpera a key part of the infrastructure to glue together the data and analysis services into Grid workflows

Cyberinfrastructure for e-Science at the National Center for Supercomputing Applications

- Grid Workflows important part of the Service Oriented Grid middleware stack
- JOpera Pilot Application: porting the data flow based “Data 2 Knowledge” toolkit to Eclipse

Why users like JOpera

- **High Level Workflow Language**
  - Data and Control Aspects (Graphical Representation)
  - Recursion, Iteration, Parallelism and Pipelining Constructs
- **Open and Extensible Component Model**
  - Run existing code without changes
  - Synchronous, Asynchronous, Streaming interaction
  - Web services support (Axis, WSIF)
  - Secure access to remote file systems and hosts (SSH, SCP)
  - Easy to integrate with existing schedulers (Condor already supported)

Why users like JOpera

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  - Secure access to remote file systems and hosts (SSH, SCP)
  - Easy to integrate with existing schedulers (Condor already supported)
- Strong Eclipse Foundation
  - Platform Independent (Eclipse/Java)
  - Flexible, Extensible, Modular and Embeddable

JOpera Roadmap

- Standalone JOpera Server
  - Remote Monitoring Client
- Streaming Support
  - Pipelining over RSS feeds (or other data stream sources)
- Lineage Tracking Perspective
  - Data Provenance Queries over Process Execution History
- Axis2 Upgrade (WSS, WSR)
- AJAX Web Monitor

Conclusion

- **Modeling** service composition behavior
  - Flow-based **composition language** (Visual & XML)
  - Development and Debugging tools for Eclipse
  - Composition not limited to Web services
- **Execution** of the composition models
  - Efficiency (compiled to Java bytecode)
  - Distributed engine (on a cluster of computers)
  - Autonomic platform (self-healing, self-tuning)
  - Extensibility (Eclipse plug-ins to provide custom service publishing and invocation adapters)

References on the language

[VL/HCC2005] Cesare Pautasso, **JOpera: an Agile Environment for Web Service Composition with Visual Unit Testing and Refactoring**, In Proceedings of the 2005 IEEE Symposium on Visual Languages and Human Centric Computing (VL/HCC'05), Dallas, TX, September 2005.

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JOpera Team

Cesare Pautasso Thomas Heinis Bioern Bioernstad

Andreas Bur Fabian Pichler Patrick Jayet

Adrian Listyo Sandra Brockmann Christoph Schwank

Dennis Rietmann Dominique Schneider Markus Egli

Michael Lorenzi Christian Rupp Markus Haller Axel Wathne

Antonio Caliano Oliver Deak Reto Schaeppi

Nicholas Born Philip Frey Patrick Moor

Special Thanks

Claus Hagen Win Bausch Gustavo Alonso Michael Hallett

Cesare Pautasso Thomas Heini

Thank you for your feedback:

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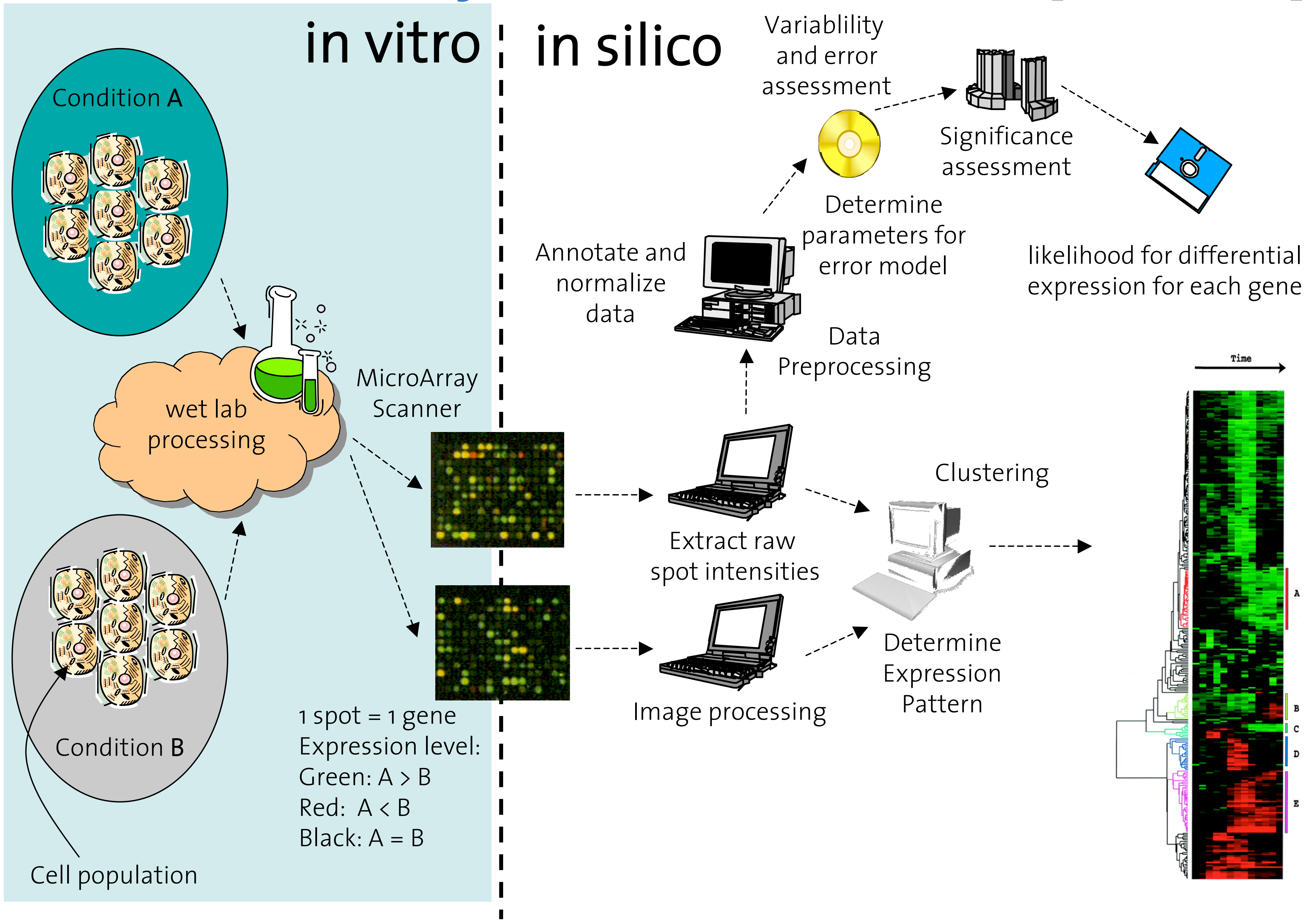
Free Download

Virtual Laboratory Workflow

[ICDE2001]


in vitro
in silico
Condition A
wet lab processing
MicroArray Scanner
Condition B
Cell population
1 spot = 1 gene
Expression level:
Green: A > B
Red: A < B
Black: A = B
Extract raw spot intensities
Image processing
Annotate and normalize data
Data Preprocessing
Determine parameters for error model
Variablility and error assessment
Significance assessment
likelihood for differential expression for each gene
Clustering
Determine Expression Pattern
Time
A
B
C
D
E