

CARDIFF
UNIVERSITY
PRIFYSGOL
CAERDYDD

Welsh e-Science Centre

Canolfan e-Wyddoniaeth Cymru

Regional Grid Centre

Automated Composition of Semantic Grid Services

Shalil Majithia, David W.Walker, W.A.Gray
Cardiff School of Computer Science, Cardiff University



Plan

- Semantic Grids
- Workflow Composition in Semantic Grids
- Our Framework
- Components of our Framework
- Implementation
- Experiments
- Future Work

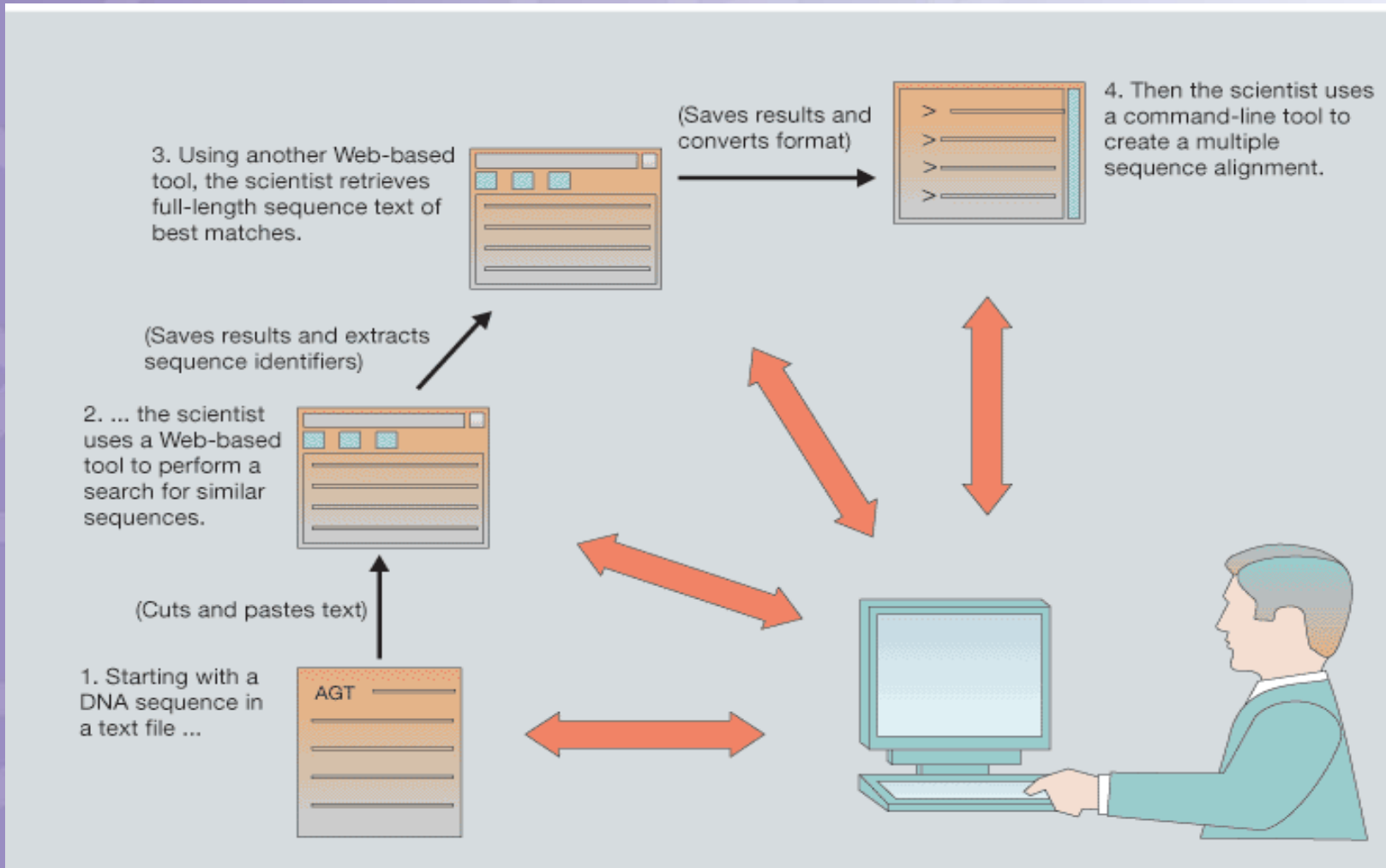
Semantic Grid – in a nutshell

- Semantic Grid concept represents the use of Semantic Web technologies in Grid Computing.
- Enables automation at several levels – automated resource discovery, selection, management, service composition, execution.
- Promises automated seamless interoperation of autonomous, heterogeneous distributed applications.

Workflow Composition in Semantic Grids

- Composition refers to combining and linking together existing services (atomic or composite) to create new processes.
- Makes it possible to create complex hierarchical processes
- Our focus is on the use of Semantic Web technologies to automate this process in Grid environments.

A Typical Scientific Process



Requirements

Need to make it easier for users to:

- Create new services which offer more functionality.
- Share and reuse workflows.
- Easily carry out 'what-if' analysis by altering any part of a workflow
- Automatically substitute resources to satisfy requirements.

Types of Workflow Composition

Manual

User generates workflow graphically or through text editor.

Triana
BPWS4J
Self-Serve

Semi-automated

“Semantic suggestions”
User still has to select the service required from a shortlist.

Cardoso & Sheth
GEODISE
myGRID
Sirin , Hendler et al.,

Automated

The entire composition is automated using AI technologies.

SHOP2
Pegasus – ISI
McIllraith
IRS-II

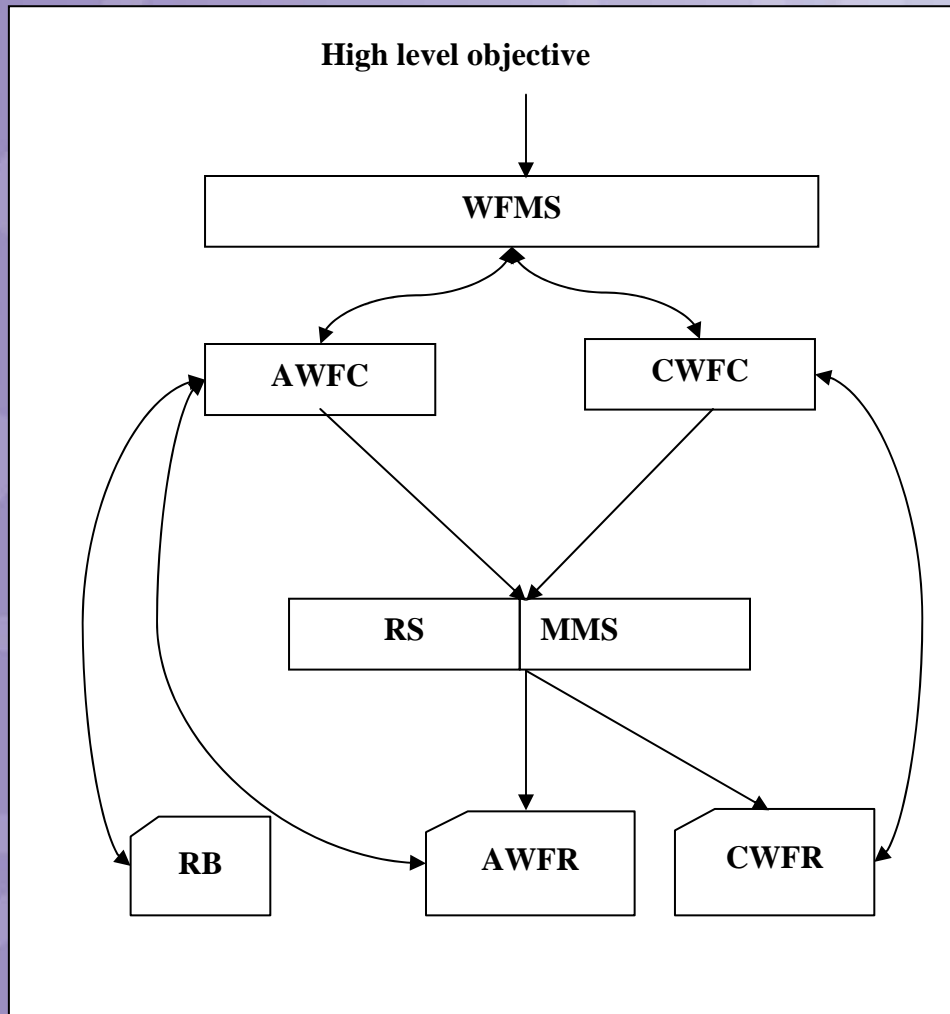
Problems with current techniques

- Manual techniques: un-scalable in resource-rich environments, require users to have low-level knowledge of resources.
- Semi-automated: Solves some problems of manual techniques – but still expect the user to select the resources required.
- Automated: Most systems make simplistic assumptions e.g. static environments, difficult to re-use workflows.

Key Features of Our Framework

- Adaptive: Automatically discover, select and use resources to meet user specified policies.
- Fine granularity: Allow users to share abstract and concrete workflows.
- Allow specification and refinement of high-level user objectives

Framework - Overview



WFMS – Workflow Manager Service

AWFC – Abstract Workflow Composition Service

CWFC – Concrete Workflow Composition Service

RS – Reasoning Service

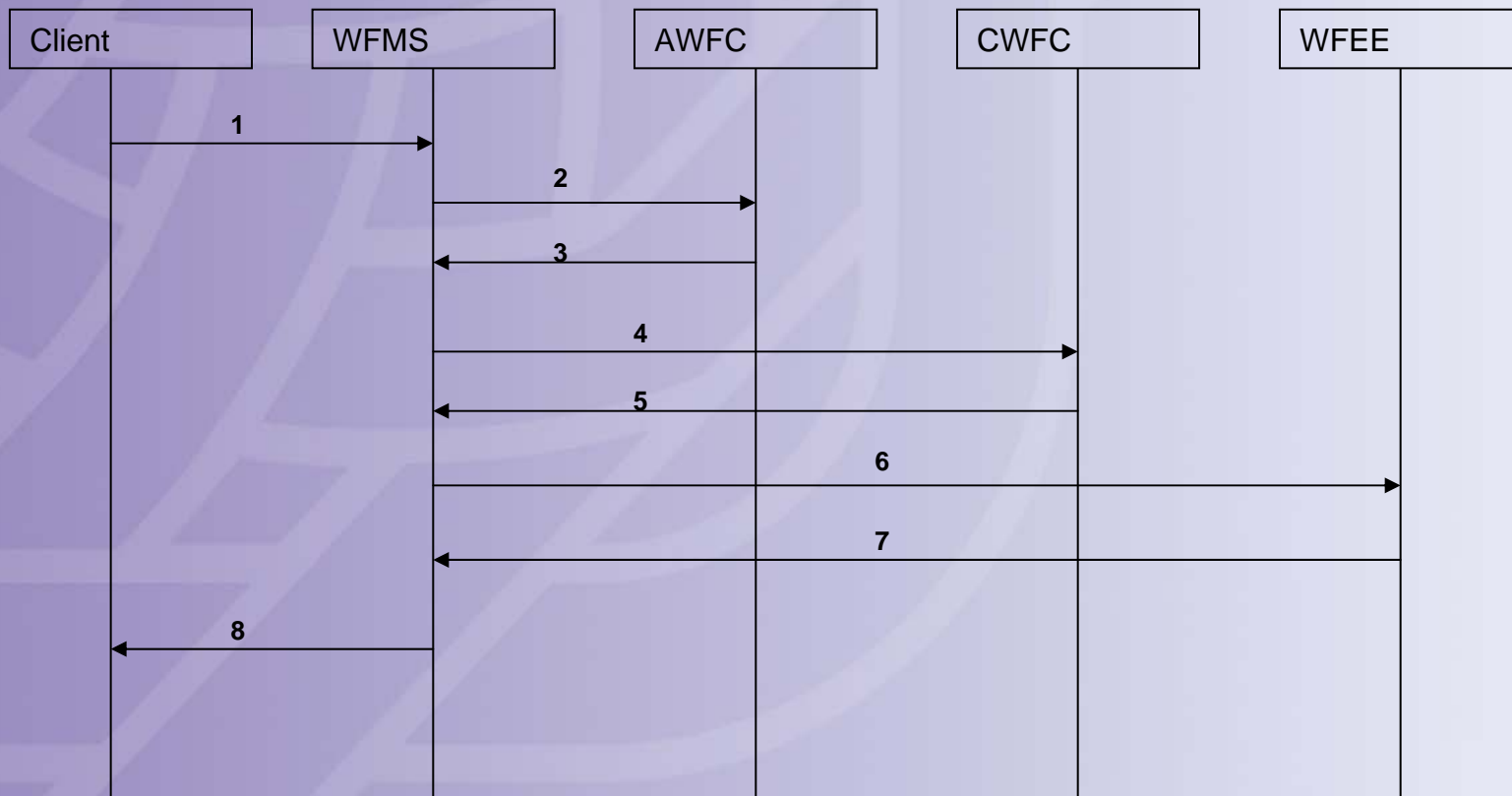
MMS – Matchmaking Service

AWFR – Abstract Workflow Repository

CWFR – Concrete Workflow Repository

RB - Rulebase

Framework - Interactions



1. High Level Request
2. Request for Abstract WF
3. Composed Abstract WF
4. Request for Concrete WF

5. Composed Concrete WF
6. Request for Execution
7. Results or Request for Alternatives
8. Final Results

Abstract Composer

- An abstract workflow specifies a workflow without referring to a specific service implementation .
- The Abstract Composer tries to generate an abstract workflow by using:
 - AWF Repository – stores semantically annotated descriptions of services and workflows. Use ontology to match services.
 - Rulebase – A rulebase specifies the “recipe” to achieve an objective
 - Chaining services – Try and chain services by matching service outputs and inputs.

Concrete Composer

- A concrete workflow specifies an executable workflow by referring to specific service implementations.
- The Concrete Composer tries to generate an executable workflow by using:
 - Matchmaking – match abstract workflow with service implementations available at that time.
 - Chaining services – Try and chain services by matching service outputs and inputs.

Other Components

- Matchmaker service – based on that of Paolucci et al. – adapted for dynamic substitution.
- Chaining service – backward chaining service based on domain ontologies.
- Repositories – store semantically annotated abstract and concrete workflows.

Implementation

- All components implemented as Web services using Axis server.
- Services and workflows described using OWL-S.
- DQL/JTP server used for subsumption reasoning
- Rulebase implemented in RuleML
- Plug-in module enables generation of concrete workflows in BPEL4WS.

```
<profileHierarchy:SignalProcessing rdf:ID="FFT">
  <profile:input>
    <profile:ParameterDescription rdf:ID="FFTInput">
      <profile:restrictedTo
        rdf:resource="Concepts.owl#VectorType"/>
    </profile:ParameterDescription>
  </profile:input>
  <profile:output>
    <profile:ParameterDescription rdf:ID="FFTOutput">
      <profile:restrictedTo
        rdf:resource="Concepts.owl#ComplexSpectrum"/>
    </profile:ParameterDescription>
  </profile:output>
</profileHierarchy:SignalProcessing>
```

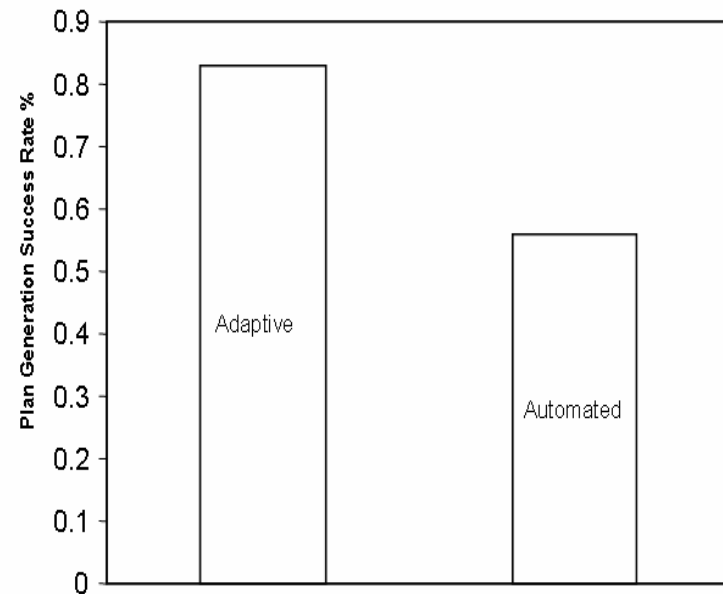
Snippet of OWL-S Profile for FFT

Experiments

- Detection of gravitational waves from coalescing binary stars.
- Processing of raw data requires about 50 services e.g. FFT, Conjugate, Scalar, Wave etc.
- Algorithm developed at School of Physics and Astronomy, Cardiff University.
- Assess workflow generation success rates.
- Assess workflow generation times

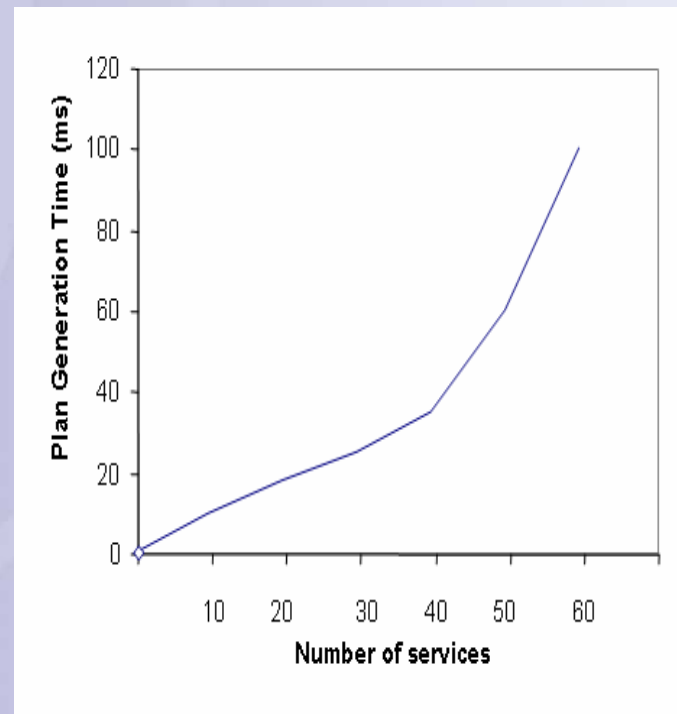
Experiments – Success Rate

- Preliminary tests show that our framework has a higher success rate than an automated back-chaining algorithm.
- Based on 50 requests, 40 requests were successful vs 30 requests for the back-chaining algorithm.
- Further experiments to determine the range over which the results apply.



Experiments – Plan Generation Times

- Preliminary tests show an exponential relationship between the number of services available and the plan generation time.
- Current algorithm not performance-optimized



Future Work

- Optimize algorithm to overcome performance issues.
- Incorporate user-specified policies to guide decisions.
- Incorporate provenance tracking.

More Information

- Demo at the WeSC booth.
- More information, documents at:
www.cs.cf.ac.uk/user/Shalil.Majithia
- www.wesc.ac.uk

Welsh e-Science Centre Canolfan e-Wyddoniaeth Cymru

