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# Welsh e-Science Centre

## Canolfan e-Wyddoniaeth Cymru

**Regional Grid Centre**

# Automated Composition of Semantic Grid Services

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# Plan

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

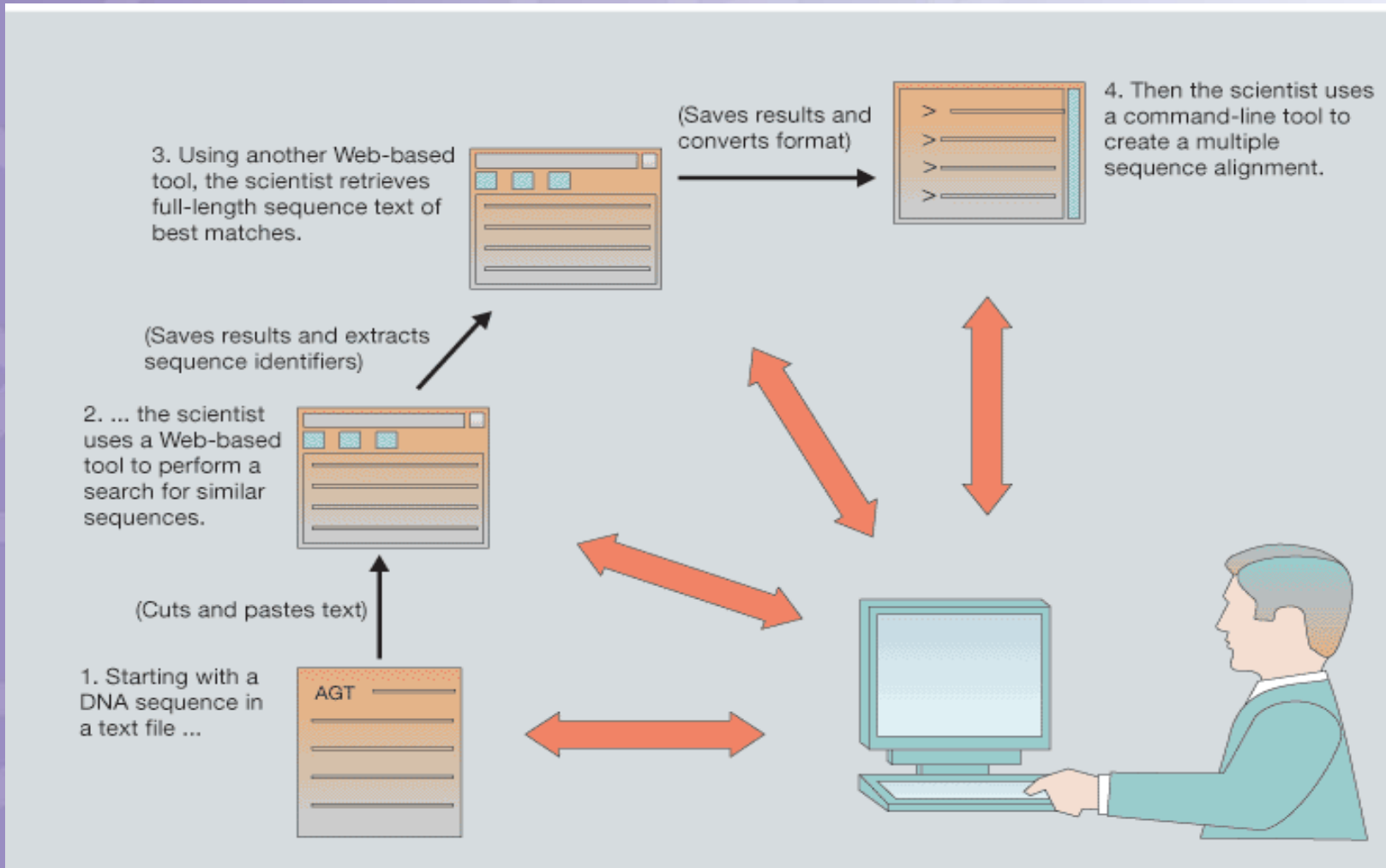
# Semantic Grid – in a nutshell

- 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

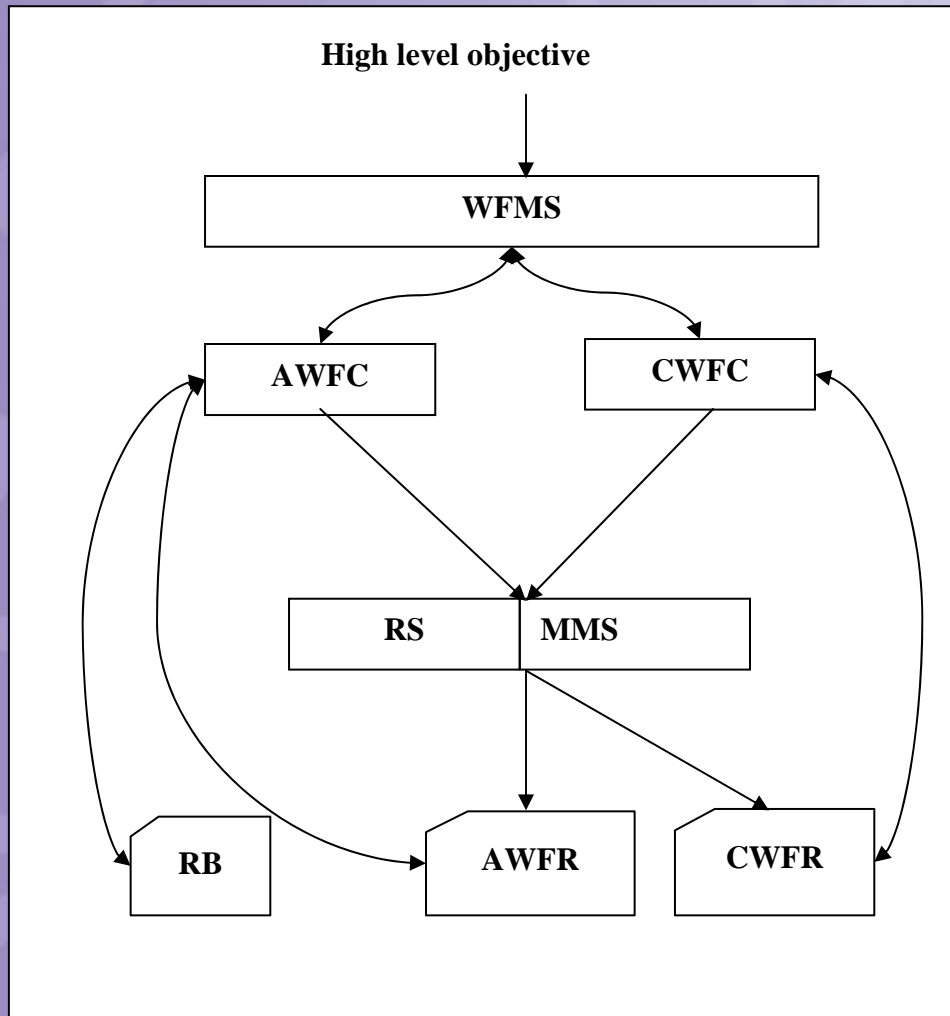
# Problems with current techniques

- 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**

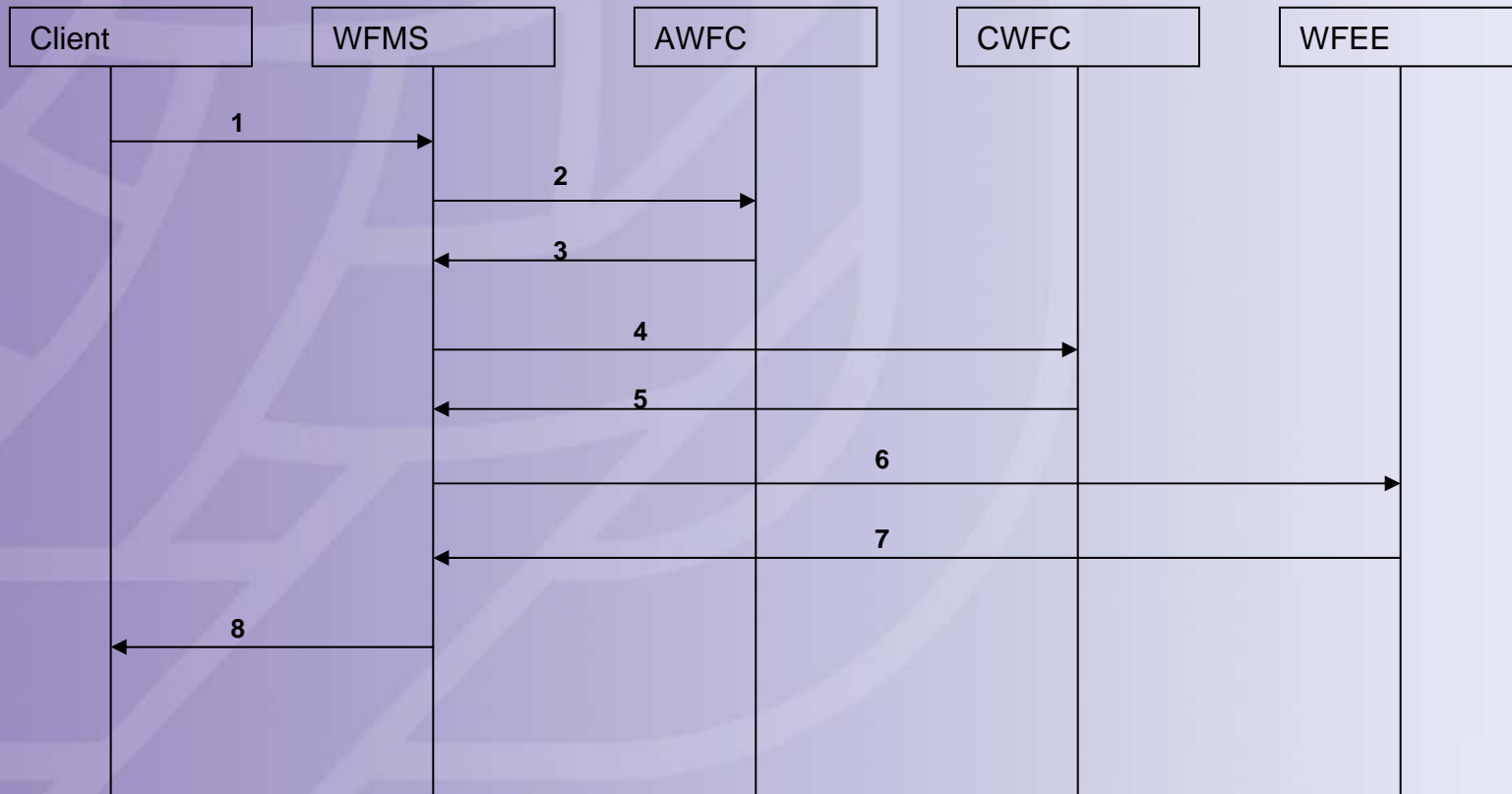
**MMS – Matchmaking Service**

**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.

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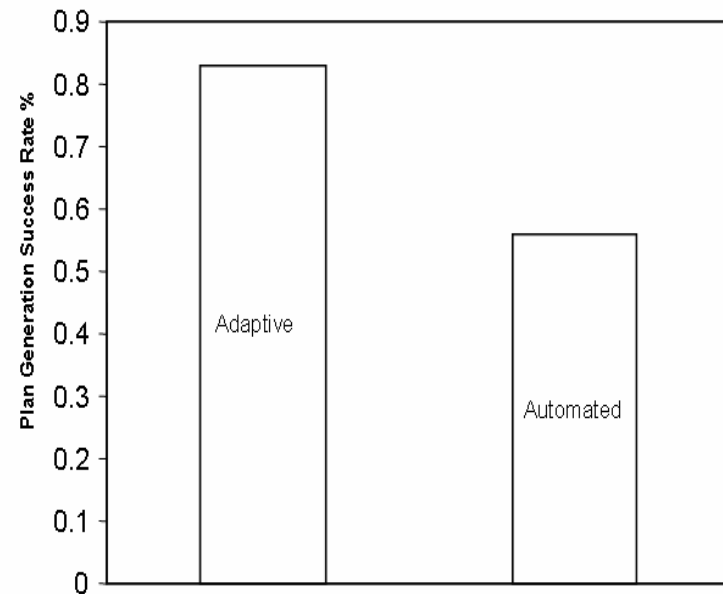
**Snippet of OWL-S Profile for FFT**

# 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

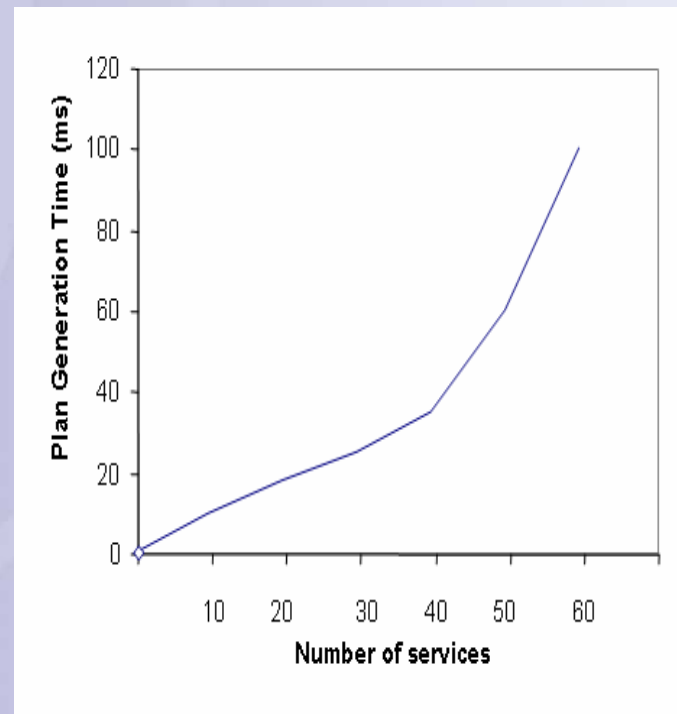
# Experiments – Success Rate

- 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](http://www.cs.cf.ac.uk/user/Shalil.Majithia)
- [www.wesc.ac.uk](http://www.wesc.ac.uk)

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