



Agents, Consumers of Service Oriented Architectures

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Overview of Talk

- Motivation
- Scientific Workflow
- Agency
 - Definition of an Agent
 - MultiAgent Systems
 - Agent Coordination
- Web Service Composition
- SOA
- Coordination Work
 - Framework Overview
- Application to Astronomy
 - Application to Iterative Scenarios
 - Application to Reactive Scenarios
 - High Level Composition
- Conclusions

Motivation

■ Problem Statement

- Most astronomy is **currently** not processed in Real-Time
- Scientists compose virtual experiments to enact distributed workflows

■ Motivation

- Application of Agent Technology can help to provide Real-Time analysis and processing of this data
- Offering Flexible, Reactive Composition in a constantly changing environment
- Current scientific workflow systems do not address this problem
 - A gap we are working to fill

Scientific Workflow

- Most workflow engines focus on **Business Process Modelling**
- Scientific Workflow has an **extra** set of requirements:
 - Rapid prototyping of experiments
 - User Interaction with the scientist
 - Reliability and Fault Tolerant execution
 - Transparent access to resources
 - Repeatability, Smart re-runs and parameterisation
 - Provenance information crucial
 - Presentation of the results
- Control Flow vs. Data Flow
 - **myGrid** Bioinformatics in-silico experiment builder
 - **Kepler** Open source Scientific workflow engine
 - **ICENI** London e-Science centre programming model for the Grid

An Agent

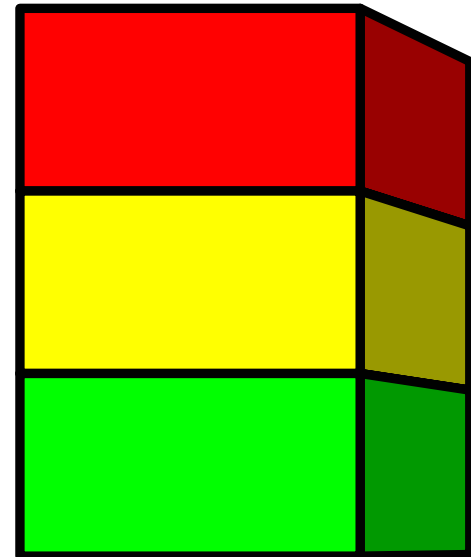
- An agent is a computer system that is capable of independent (**autonomous**) action on behalf of its user or owner (figuring out what needs to be done to **satisfy its design objectives**, rather than constantly being told) – Michael Wooldridge
- An agent usually takes sensory input from the environment (which is assumed to be non-deterministic) and produces as output actions that affect it. The interaction is usually an ongoing non-terminating one
- Agents tend to be (**reactive**, **pro-active**, **social**)

MultiAgent Systems

- Popular slogan in the Agents community, 'there is no such thing as a single agent system'
- A system that consists of a number of agents, which **interact** with one-another
- In the most general case, agents will be acting on behalf of users with different goals and motivations
- To successfully interact, they will require the ability to **cooperate**, **coordinate**, and **negotiate** with each other, much as people do
- Typical example:
 - Auction house - Laws of trade predefined

Agent Coordination

- Dialogue Protocols **define**
 - Collection of conventions that allow cooperation between agents in a MultiAgent System within a certain domain
 - A recipe for communication!
 - Defines 'if and when' an agent can communicate
 - Order and kind of messages relating to a certain domain
- Dialogue Protocols **do not define**
 - Low level issues, e.g. communication method
 - High level issues, how the agent rationalises



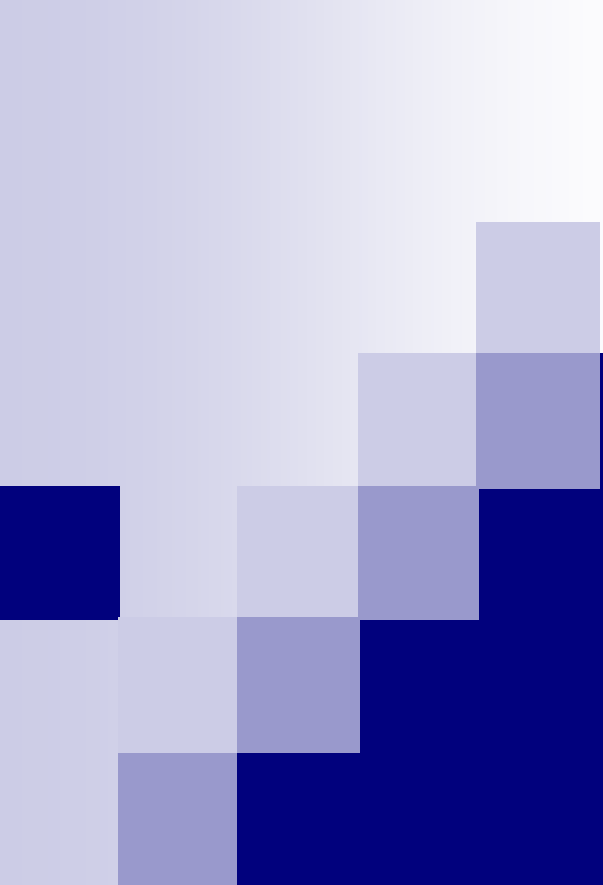
Web Service Composition

■ Service Oriented Architectures

- Distributed computing platform targeted at the web
- Define a standard way to perform program to program interaction
- Can tie together any OS, application, data store, programming language, device etc.
- Defined using: XML, SOAP, WSDL etc.

■ Currently many methods of composing Web Services

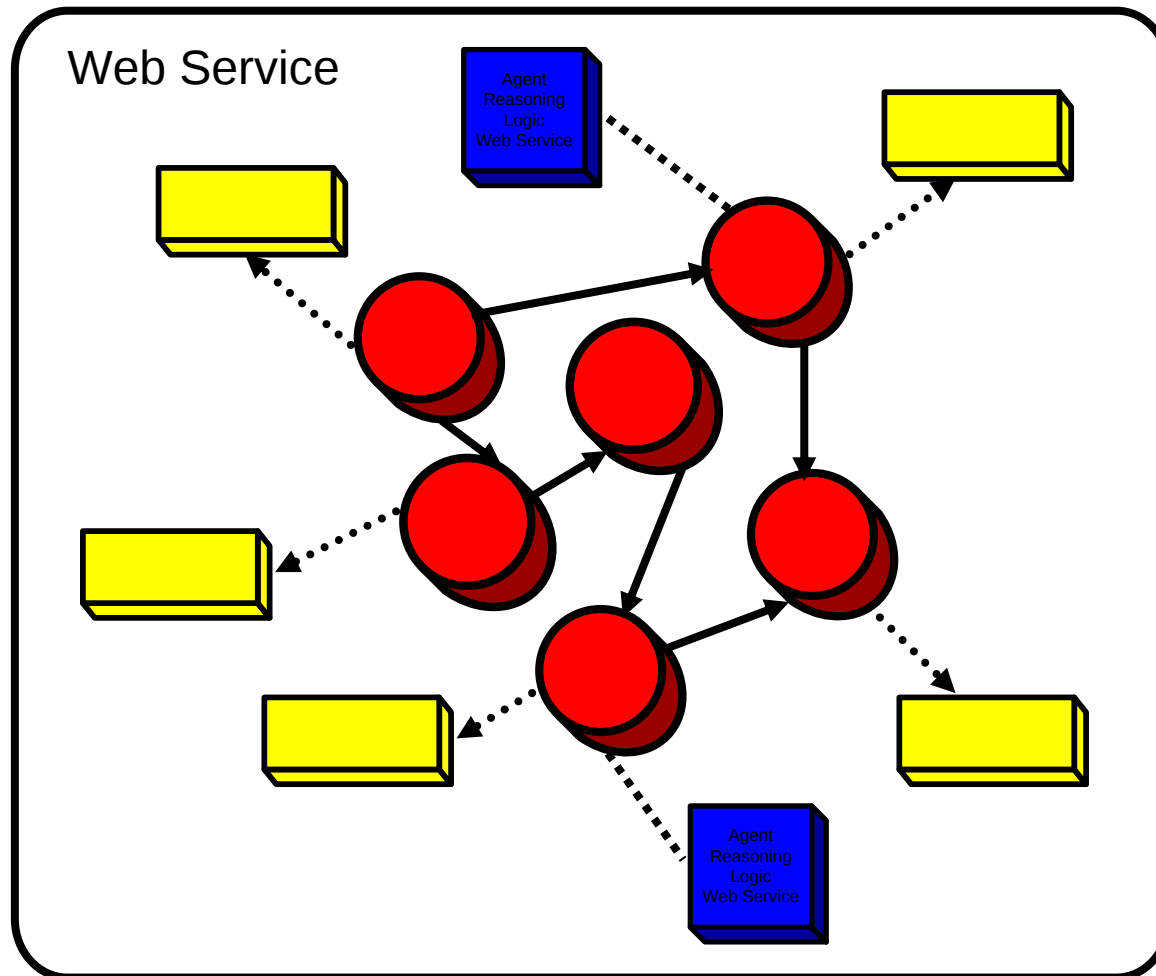
- Workflow Languages: Business Process Execution Language (BPEL), Web Services Flow Language (WSFL), Web Services Choreography Language (WSCI)
- Web Service Frameworks: WS Coordination, Web Services Coordination Application Framework (WS-CAF)



Development of Agent Technology

P2P workflow, Reactive
Agents, High-level
composition

Agent Coordination Web Services



Multi-Agent Protocol Language (MAP)

$P \in \text{Protocol} ::= n(r\{\mathcal{M}\})^+$ (Scene)

$M \in \text{Method} ::= \text{method}(\phi^{(k)}) = op$ (Method)

$op \in \text{Operation} ::= \alpha$ (Action)

| $op_1 \text{ then } op_2$ (Sequence)

| $op_1 \text{ or } op_2$ (Choice)

| $op_1 \text{ par } op_2$ (Parallel)

| $\text{waitfor } op_1 \text{ timeout } op_2$ (Iteration)

| $\text{invoke}(\phi^{(k)})$ (Recursion)

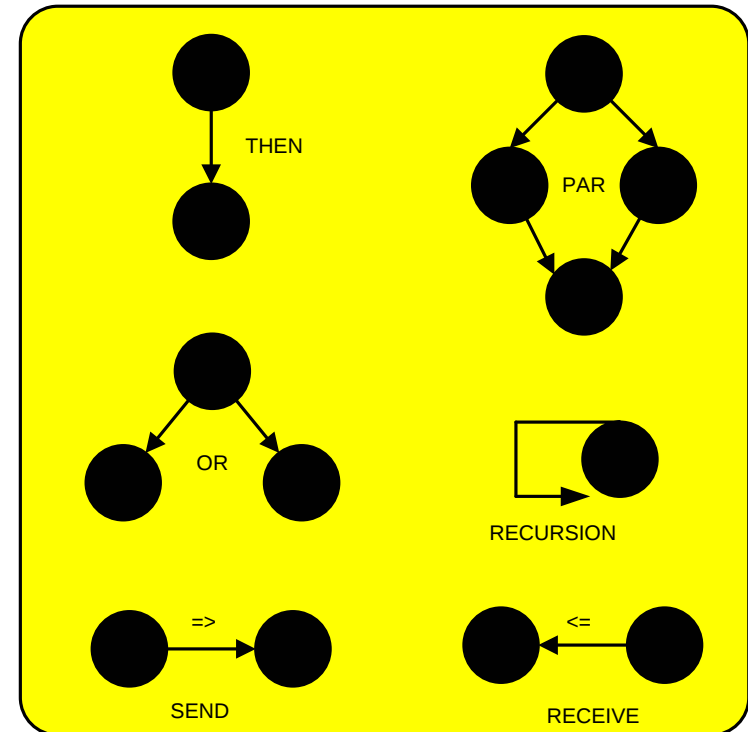
$\alpha \in \text{Action} ::= \epsilon$ (No Action)

| $\phi^k = p(\phi^l) \text{ fault } \phi^m$ (Procedure)

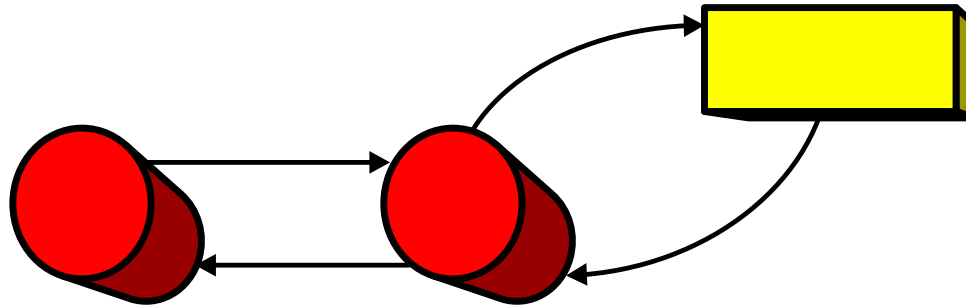
| $\rho(\phi^{(k)}) \Rightarrow \text{agent}(\phi_1, \phi_2)$ (Send)

| $\rho(\phi^{(k)}) \Leftarrow \text{agent}(\phi_1, \phi_2)$ (Receive)

$\phi \in \text{Term} ::= _ \mid a \mid r \mid c \mid v$

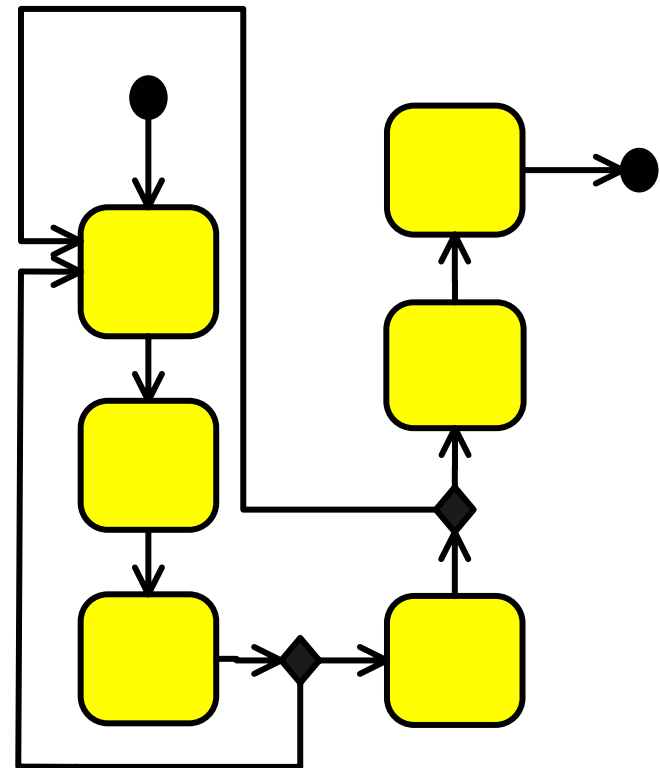


Simple Protocol Example

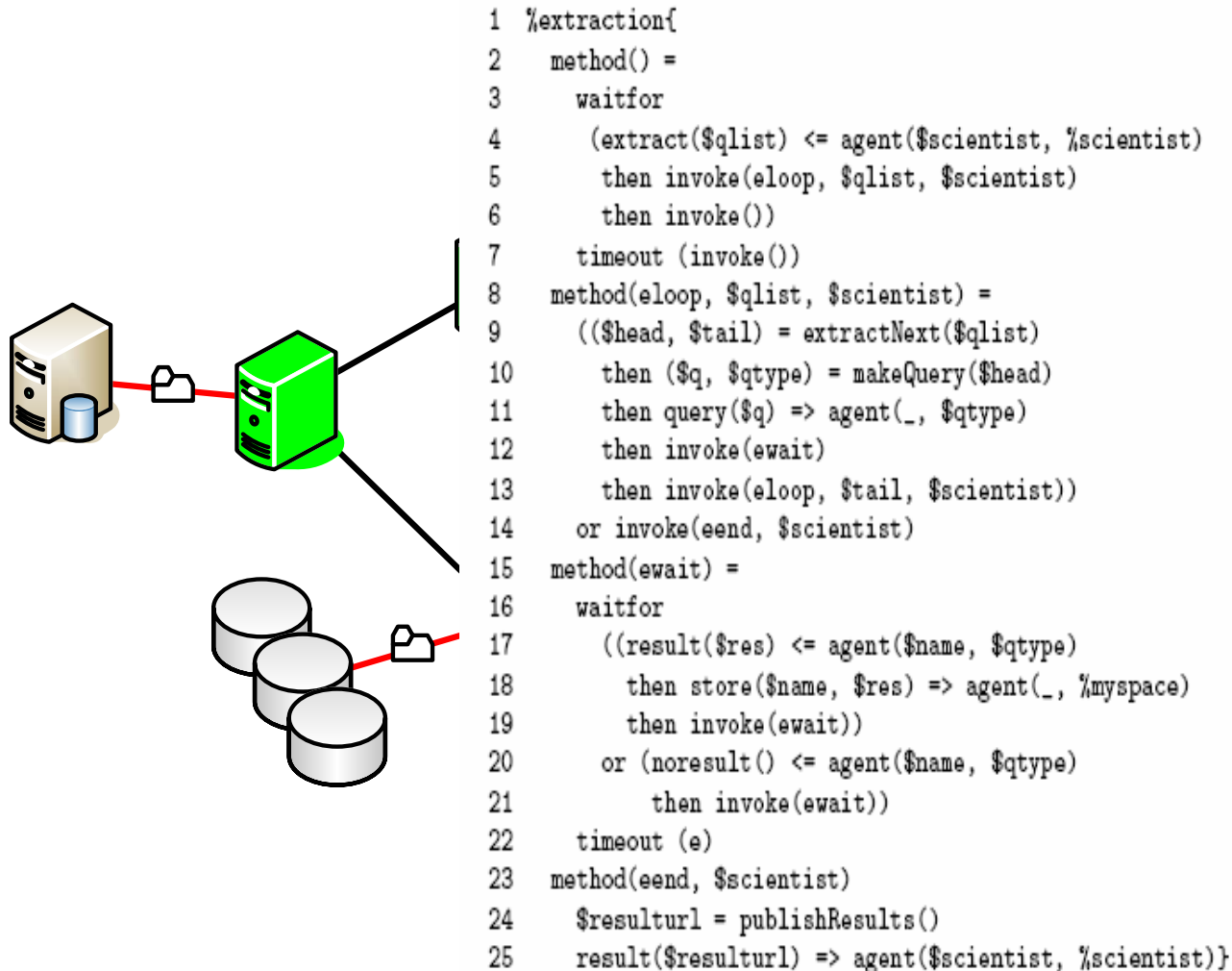


AstroGrid: Static Scenario

- UK based e-Science project
 - Middleware development
 - Providing uniform access to Astronomical distributed data, software tools and instrumentation
 - AstroGrid forms the UK contributed to the Global Virtual Observatory
 - Live science use-cases, data and instrumentation
 - Workflow Set and application domain
 - Brightest Cluster Galaxies



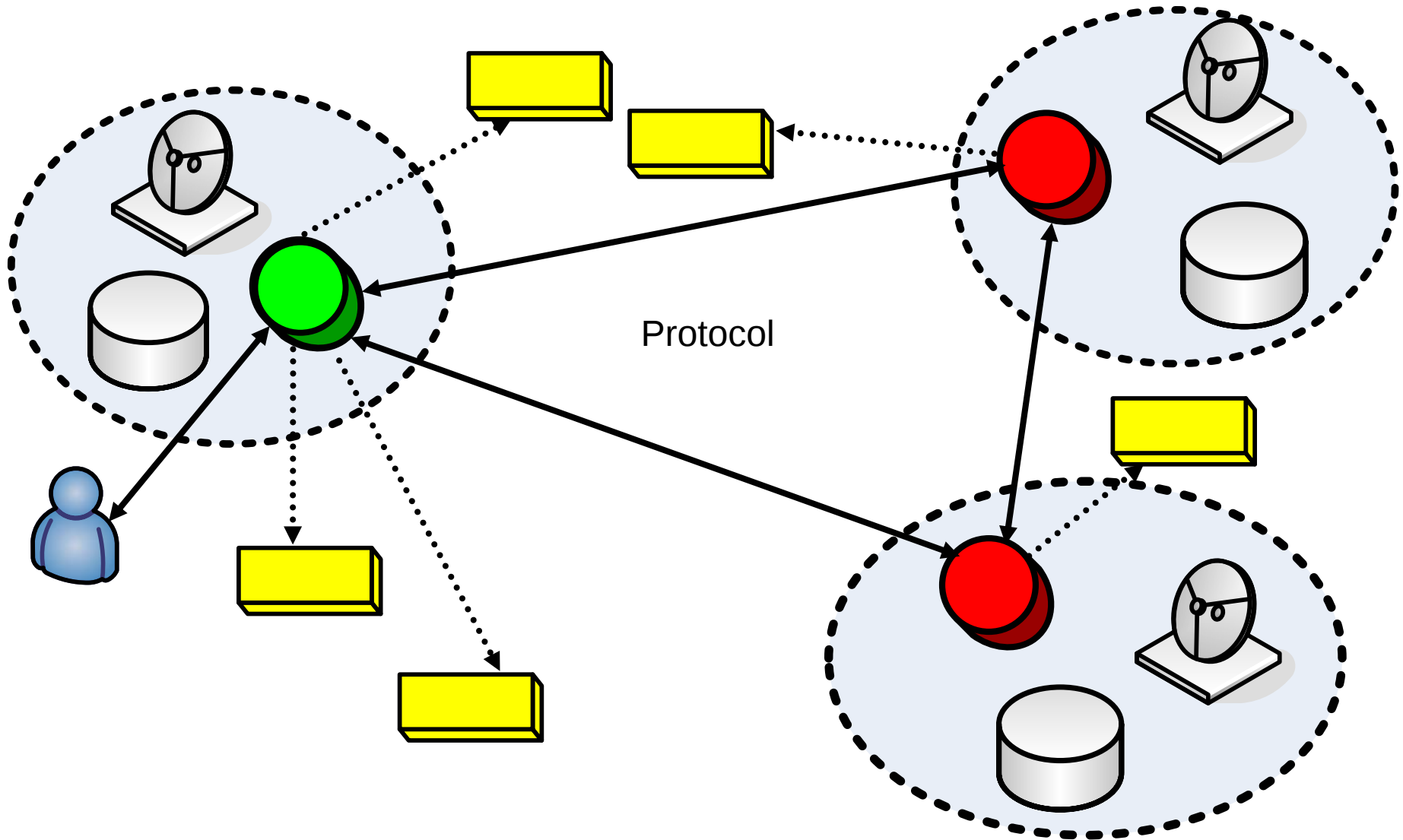
Agent Based Implementation



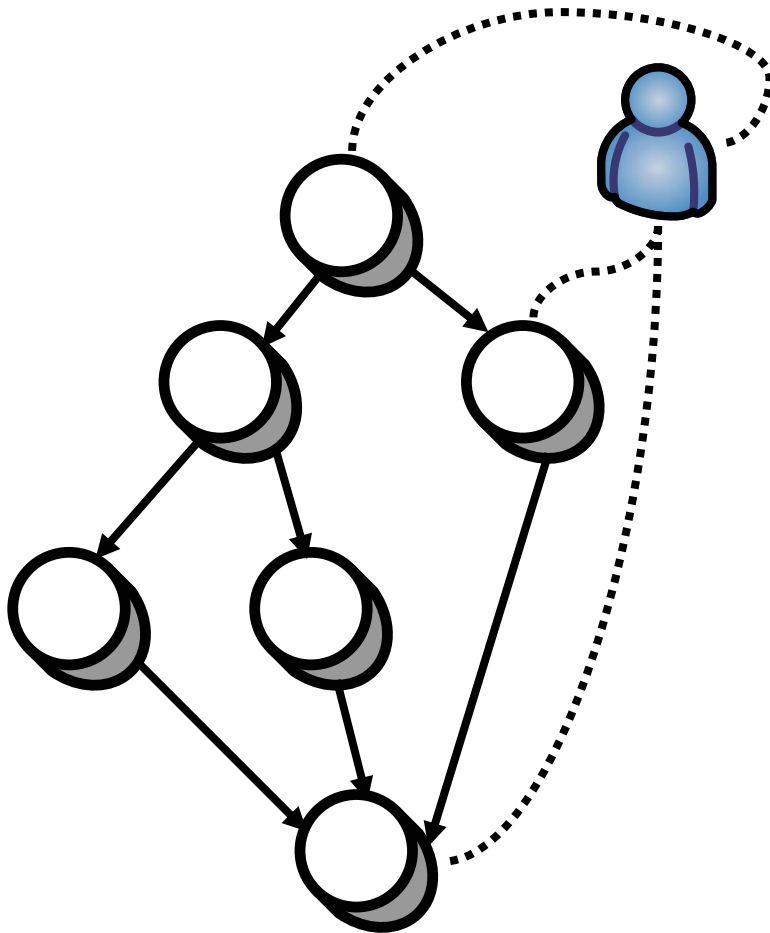
AstroGrid: Future Scenario

- Agents have the ability to work in a constantly changing dynamic environment
 - React to changing circumstances
 - Behaviour which is not pre-defined
 - Truly open systems
 - Peer to Peer Architecture
- eSTAR
 - Transient Object Detection
 - Time Sensitive Data
 - Follow up observations

AstroGrid: Future Scenario



Higher Level Composition Tools



- High Level language for use by Scientists
- Scientists can compose Agent Coordination Web Services into higher level tasks
- Representing a description of an experiment
- Abstract Data-Flow Language
- Set of mappings
 - Output -> Inport
 - Interaction points
- Captures the requirements of Scientific Workflow

Conclusions

- Internet and Grid Systems are filled with passive objects (services)
- Agency paradigm offers a way of programming autonomous, social and active components which consume this SOA
- In a nut-shell agents add:
 - Decentralised - Peer to Peer Workflow
 - Flexible and Reactive behaviour - Making decisions at run-time
 - A degree of autonomy
 - Offer more than 'Just Coordination' as seen in many workflow tools
- Framework provides a way of layering the principles and well understood concepts of agency to the composition problem
- AstroGrid provides the live Science test bed
- Work in Progress!

Questions...

■ References:

☐ AstroGrid

- <http://www.astrogrid.org/>

☐ Agency

- <http://www.csc.liv.ac.uk/~mjw/pubs/imas/>

☐ SOA

- <http://java.sun.com/developer/technicalArticles/WebServices/soa2/>

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