



WHITESTEIN
Technologies

JADE Web Service Integration Gateway (WSIG)

Dominic Greenwood

JADE Tutorial, AAMAS 2005



Web Services

- ❑ WWW has increasing movement towards machine-to-machine models of interaction
 - i.e. Web services
- ❑ The W3C definition of a Web service as *“a software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-processable format (specifically WSDL). Other systems interact with the Web service in a manner prescribed by its description using SOAP messages, typically conveyed using HTTP with an XML serialization in conjunction with other Web related standards”*
 - Trend likely to be substantiated by Semantic Web technologies (e.g. OWL and OWL-S)
- ❑ WS are exerting increasing influence across commerce and industry
 - Business Rules & Business Process Management (e.g., WSBPEL)
- ❑ Approaching a point of critical inertia to becoming a mainstream technology



Web services and Agents

- ❑ There are clear benefits in connecting agents and Web services *transparently* and *automatically*
 - Brings the two worlds together
 - Allows more powerful operational modalities for both
 - A bridge through OWL(-S) to enable Semantic Web and Semantic Grid applications
- ❑ W3C Web Services Architecture clearly expresses the notion that, “... *software agents are the running programs that drive Web services - both to implement them and to access them as computational resources that act on behalf of a person or organisation.*”
- ❑ Our solution is the introduction of a Web Service Integration Gateway (WSIG) designed to encapsulate all functionality required to connect the two realms, whilst ensuring minimal human intervention and service interruption



The Basics

- ❑ Standalone intermediary gateway service
- ❑ Offers transparent, bi-directional transformations between FIPA compliant agents services and Web services employing the WSDL/SOAP/UDDI stack
- ❑ JADE selected as platform to host agents
- ❑ Intercepts calls from agents to Web services and Web service clients to agent services
- ❑ Contains two internal registries:
 - FIPA Directory Facilitator for agent services
 - UDDI for Web services
- ❑ Standard Register, Deregister, Modify and Search services are exposed



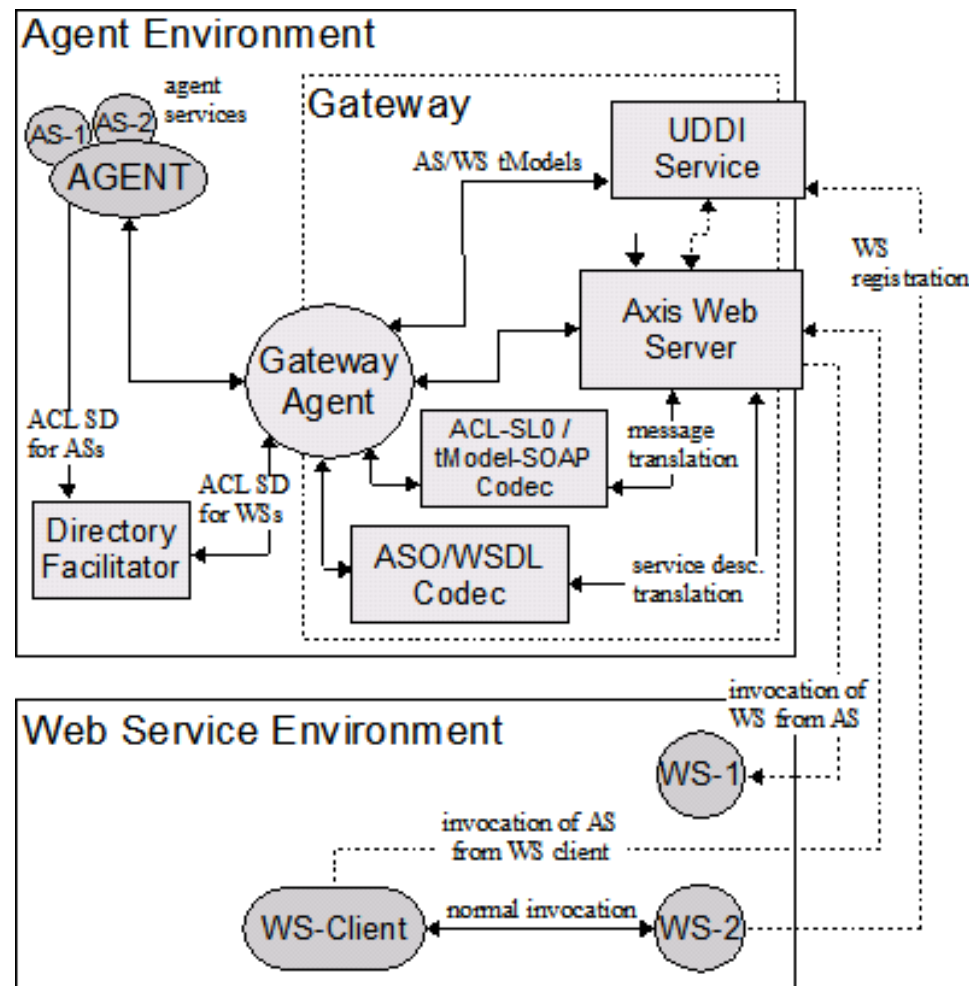
Requirements

- ❑ JADE v3.3
- ❑ Jakarta Tomcat (<http://jakarta.apache.org/tomcat/>)
- ❑ Apache jUDDI (<http://ws.apache.org/juddi/>)
- ❑ mySQL (<http://www.mysql.com/>)
- ❑ MySQL Connector/J (<http://www.mysql.com/products/connector/j/>)
- ❑ Apache Axis v1.1 (<http://ws.apache.org/axis/>)
- ❑ UDDI4J v2.0.2 (<http://www.uddi4j.org/>)
- ❑ WSDL4J v1.4 (<http://www-124.ibm.com/developerworks/projects/wsdl4j/>)
- ❑ Xerces v2.6.2 (<http://xml.apache.org/xerces-j/>)

WSIG Architecture (cont.)



Standard WSIG Architectural Model





Abstract Components

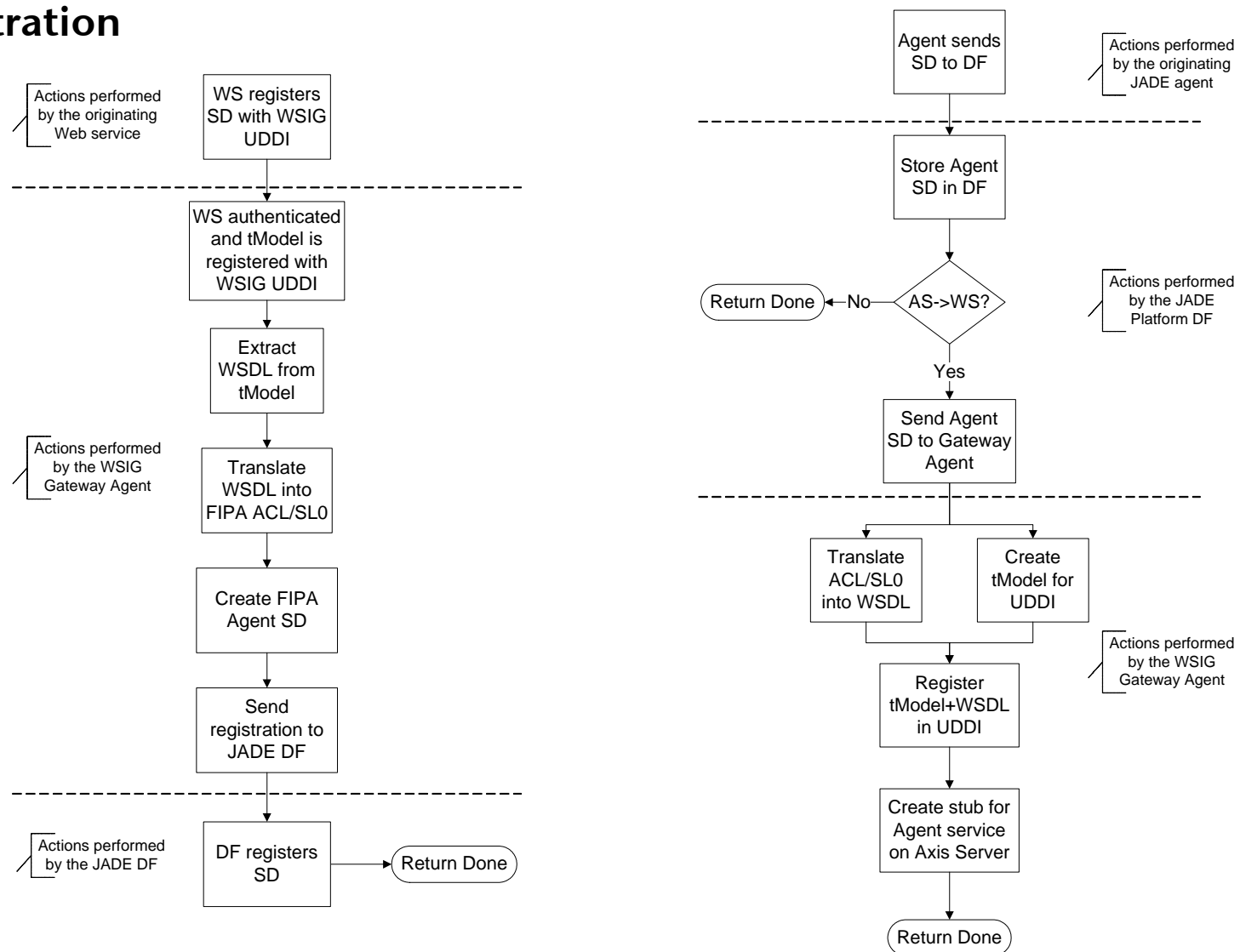
□ *The GatewayRegistry*

- Accepts external register, deregister, modify and search calls
 - ... From JADE agents
 - ... From external Web services
- Receives and processes incoming directory operations, thereby controlling access to the internal registries
- ACL encoded service descriptions stored in the JADE Platform DF
- WSDL encoded service descriptions stored in the internal UDDI
- Automatic translation between these performed by ServiceDescriptionTranslator

WSIG Architecture (cont.)



Registration

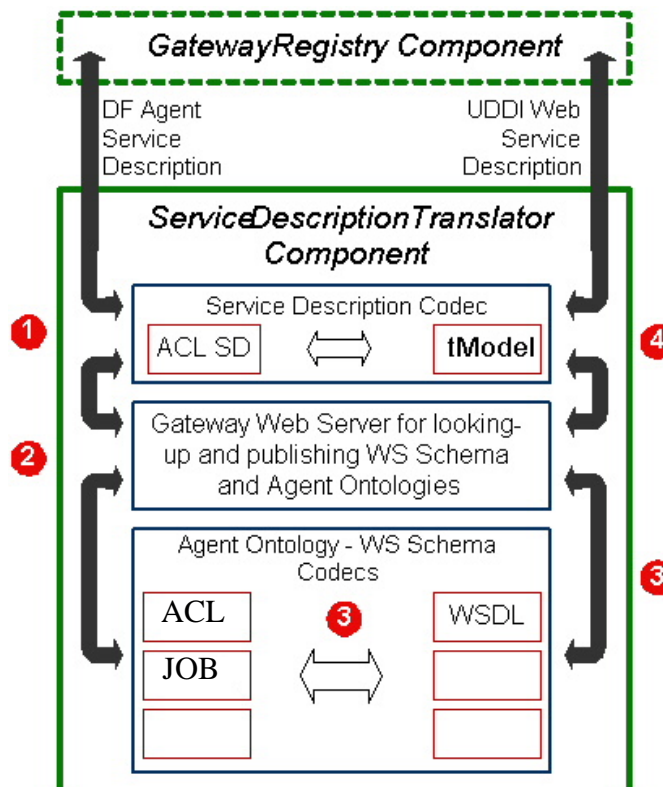




Abstract Components

□ *ServiceDescriptionTranslation*

- Translation of ACL Service Descriptions to WSDL and vice-versa





Abstract Components

□ *StubCreation*

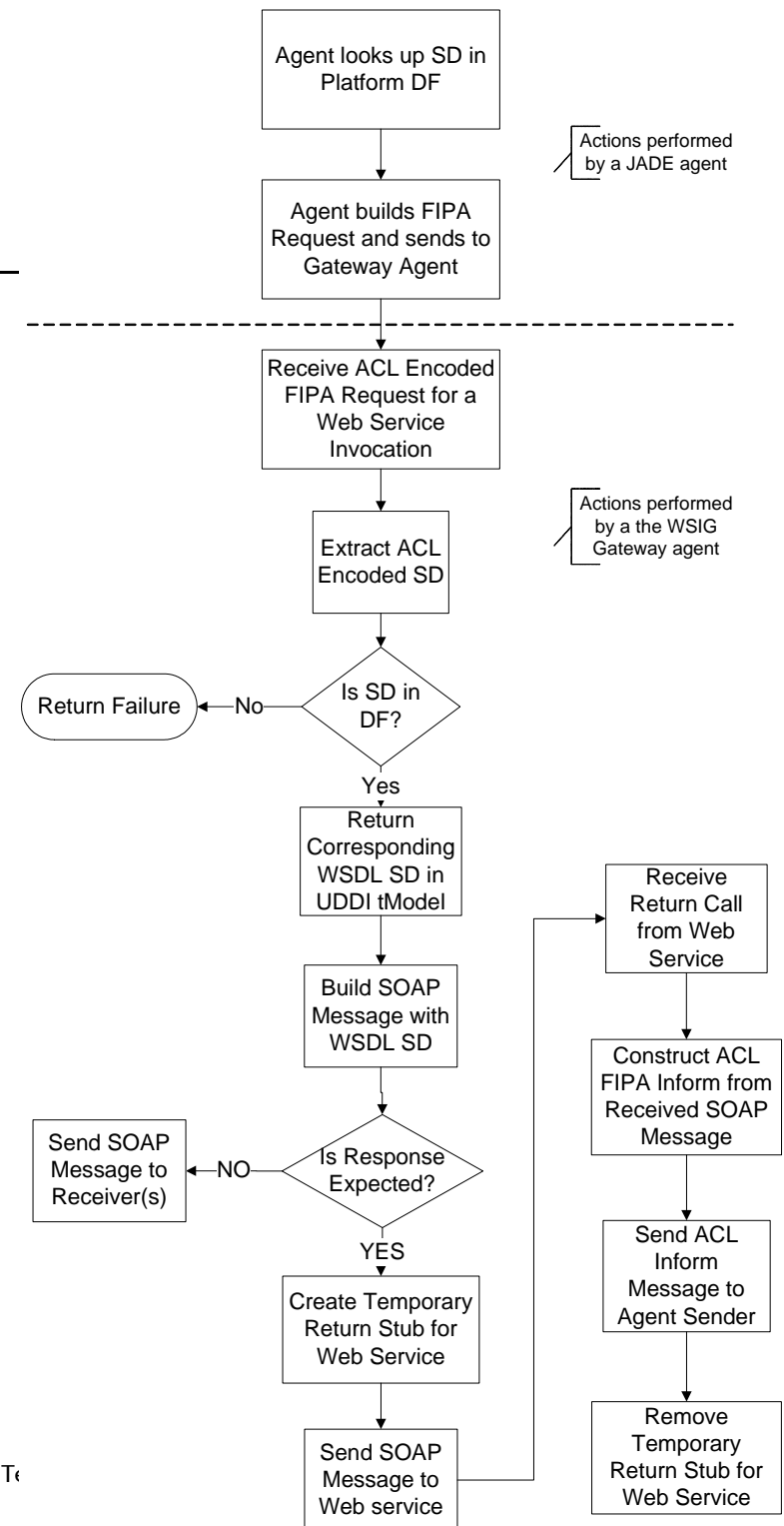
- Creates method stubs for Web services to call agent services via the gateway
- When a new agent service is registered with the WSIG, the Gateway Agent contacts Axis to expose a corresponding Web service stub
- Stub is built from the WSDL service description of the agent service held in the WSIG UDDI
- When an invocation is received from a Web service client stub is activated
 - Manages reception and processing of the incoming message
 - And any subsequent conversation context
- When an agent invokes a Web service, if a response is expected a temporary stub is created and removed once the reply is received

WSIG Architecture (cont.)

Abstract Components

❑ *WebServiceInvocation*

- Transforms an ACL request into a SOAP invocation and any return value from a Web service back into an ACL inform

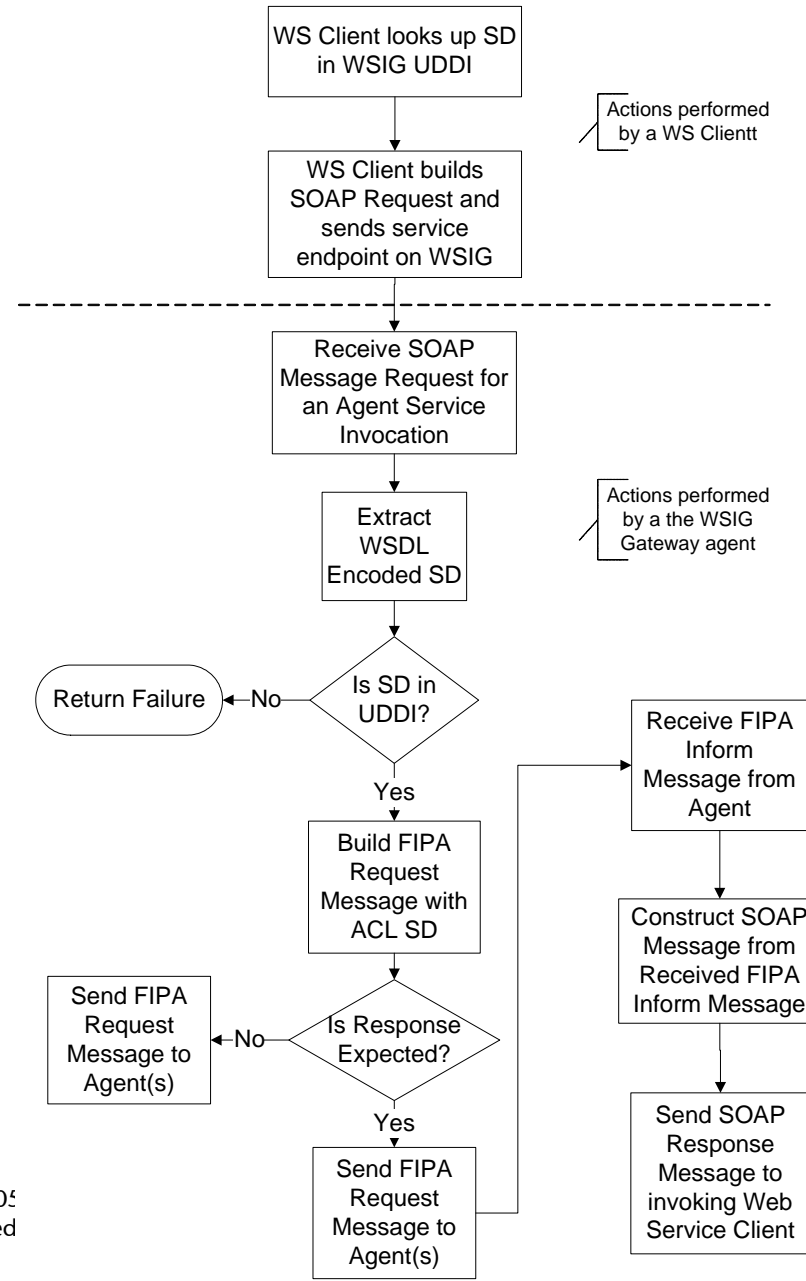


WSIG Architecture (cont.)



Abstract Components

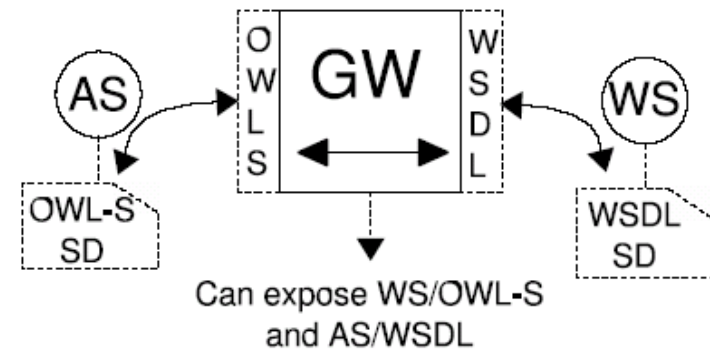
- ❑ *AgentServiceInvocation*
- ❑ Transforms a SOAP invocation onto an Agent service stub into an ACL request and any response from an ACL inform back into a SOAP encoded return value





Semantic Web Services

- ❑ WSDL is fundamentally limited in its ability to express semantic information about a service that could be used by an agent for intelligently manipulating it
 - Semantic Integration Gateway uses OWL-S
- ❑ Use of the OWL-S Grounding Ontology to map standard WSDL elements onto ontology elements
 - WSDL operations are mapped onto OWL-S atomic processes
 - WSDL message elements are mapped onto the inputs and outputs of the atomic process
 - OWL-S class types of the inputs and outputs of an atomic process are mapped onto the WSDL extensible concept of abstract type
- ❑ In the opposite direction the OWL-S WsdIGrounding class is used



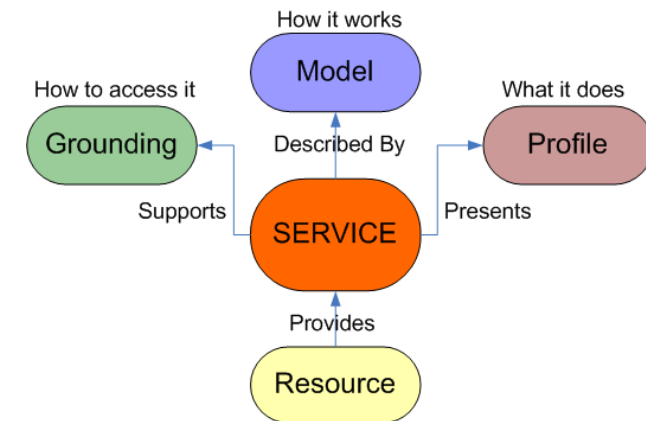
Semantic Coupling (cont.)



The Basics

- ❑ OWL-S provides the means to describe services according to three aspects:

- The service *profile* defines what the service expects of its consumers and what it provides for them
- The service *process model* defines how the service operates
- The service *grounding* defines how the service is accessed for use

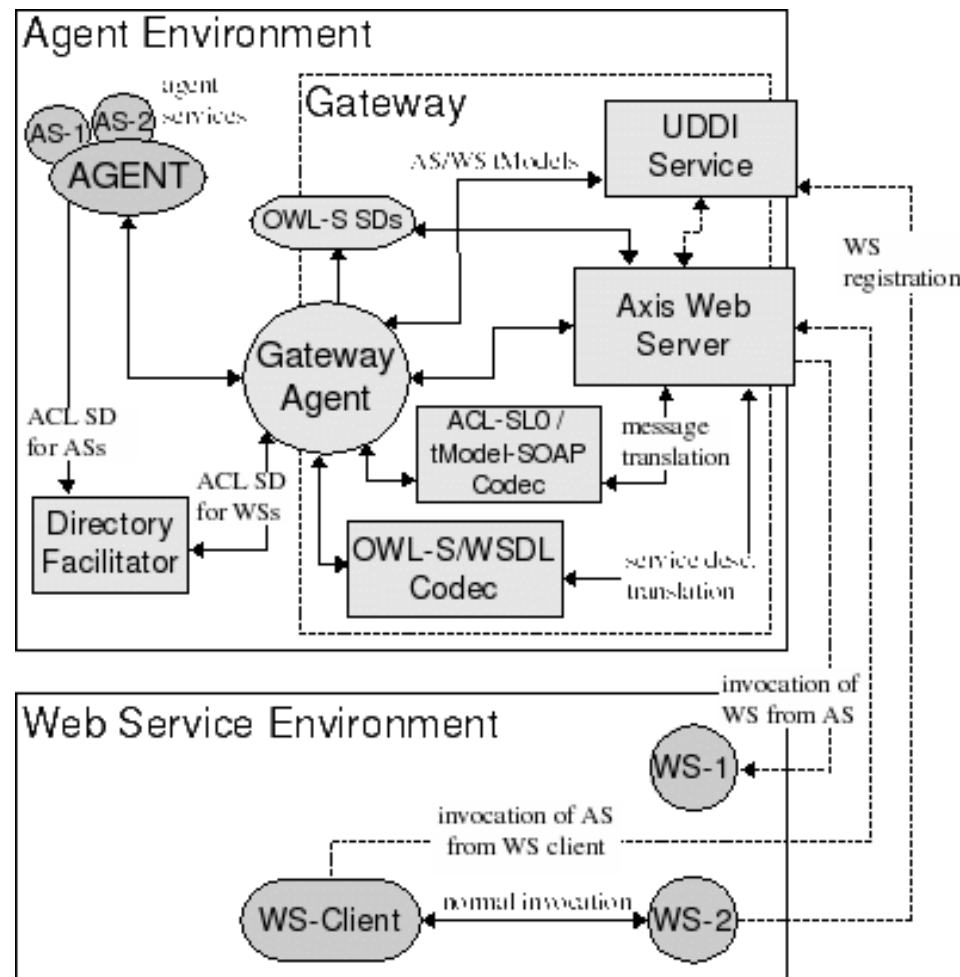


- ❑ Provides intrinsic support for more complex and dynamic service populations
 - Determining the best service to do the job
 - Determining how to create service chains according to goal specification and plan resolution
 - Improved resilience to failure by providing greater degrees of freedom to adapt

Semantic Coupling (cont.)



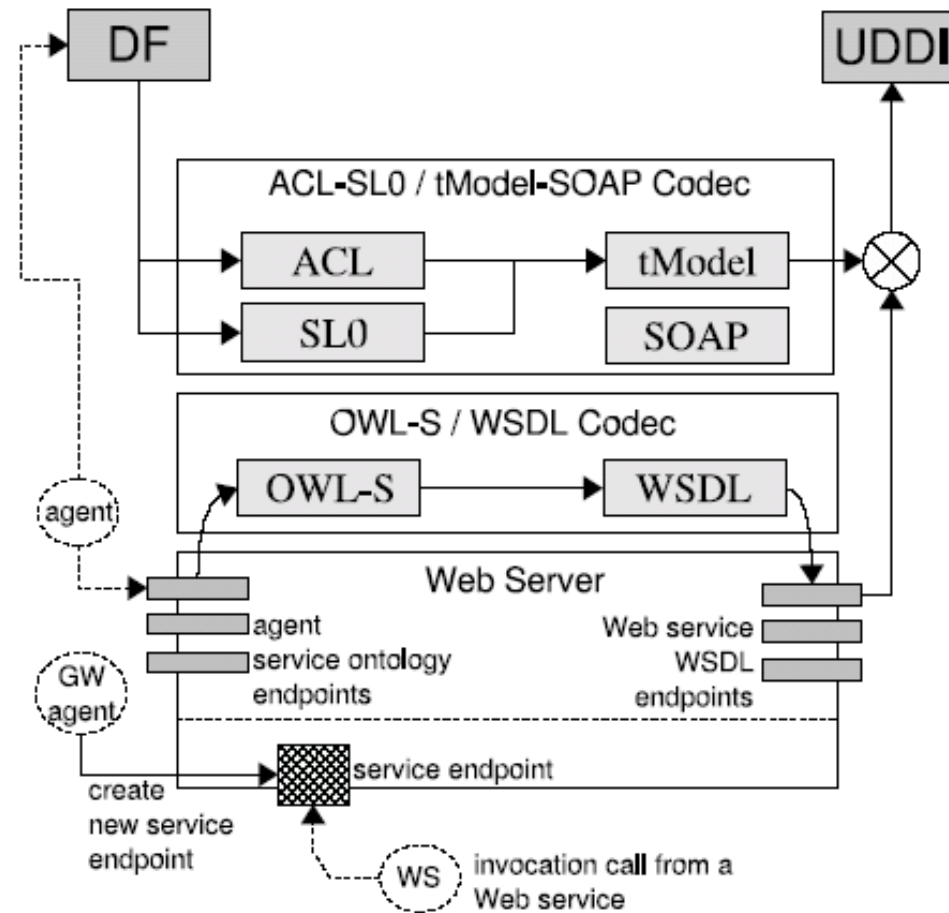
WSIG OWL-S Architecture



Semantic Coupling (cont.)



Registering an Agent Service

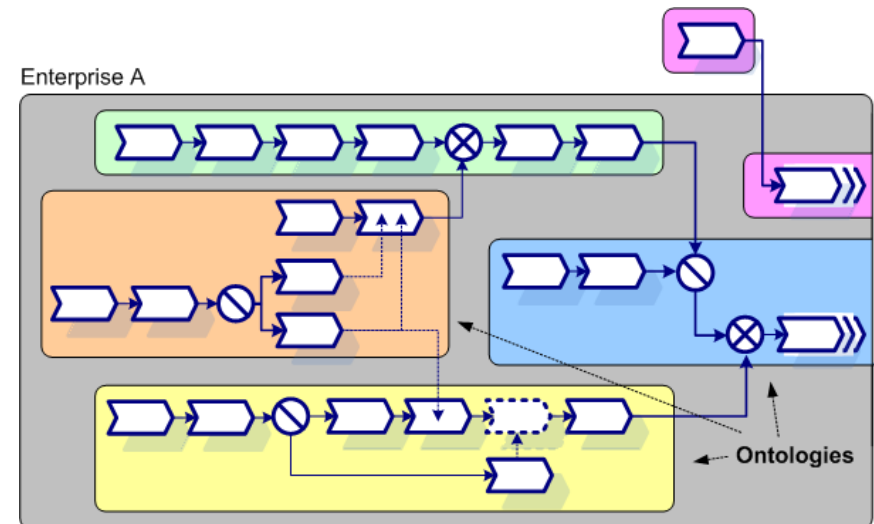
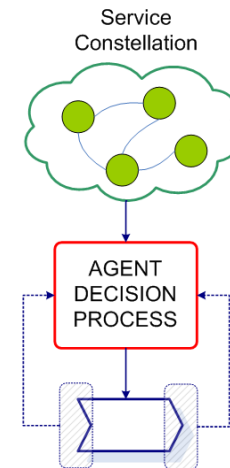


Closing Remarks



Are Semantic Web Services a Commercial Viability?

- ❑ Yes for many reasons, but here's one:
 - More companies are adopting Business Rules and BPM
 - Need to synthesise and enact *collaborating business processes*
 - Transition of *business semantics* along the value-chain
 - Need to create an *agile, collaborative service ecosystem*
 - Need to pervade business semantics throughout the service infrastructure
- ❑ Dynamic composition of Semantic Web services is a viable solution for BPM collaboration
- ❑ WSIG is an example of one of the tools required to realise this



Ongoing & Future Work



Directions

- ❑ Completion of JADE ontology bean publication as OWL-S ontologies
- ❑ Extension to support WSDL-S and WSMO series
- ❑ ME version planned for disconnected service with mobile devices
- ❑ Version with OWL-S support will be released shortly within WSIG add-on of JADE
- ❑ Sample application scenarios in development
 - Invocation of dynamically composed A/W service populations
 - BPM process collaboration system with WSBPEL
- ❑ We welcome interests in collaboration from the community