



Toward Web Services Interaction Styles

E. Michael Maximilien maxim@us.ibm.com
Munindar P. Singh singh@ncsu.edu



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Background

- **Key advantage of SOA is dynamism of resulting applications**
- **SOA supports socio-economic systems of interacting businesses and evokes such systems as a metaphor for software development**
- **Web services**
 - Expose business functions
 - Embody relationships of interacting parties
- **Interactions depend on usage patterns**

Problem and Contributions

- **Define usage patterns that lead to reusable business solutions**
- **Contributions**
 - Catalog of reusable interaction styles
 - Evaluation of styles
 - Show possible scenario usage
 - Initial pattern language for interaction styles

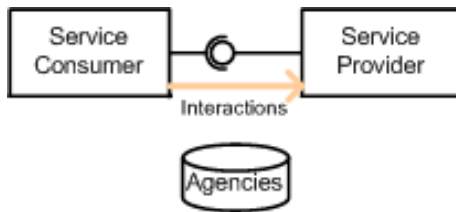
Web Services and Multi Agent Systems (MAS)

- **Web services are best modeled as agents**
 - Autonomy of service consumers and providers
 - Service implementations are policy-driven
 - Loose coupling and message-based communication
- **We overlay a MAS on top of Web services**
 - Attach agents both to consumers and providers
 - Expose service interface but add (agent-specific) capabilities
 - Share common vocabularies, i.e., ontologies
 - Introduce concept of *agency* as a rendezvous node in system
 - Helps us better understand and represent interactions between and among service consumers and providers

Web Services Interaction Styles

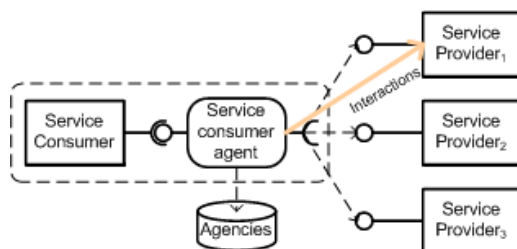
- **Following Garlan and Shaw's work on architectural styles and patterns**
- **Definition: *Web services interaction style***
 - Family of interaction patterns
 - Between and among consumer and provider agents, service implementations, and agencies
 - Accomplish high-level goals of service consumer or provider
 - Each style represents constraints in interactions between involved parties

IS 1 - Direct consumer-to-provider



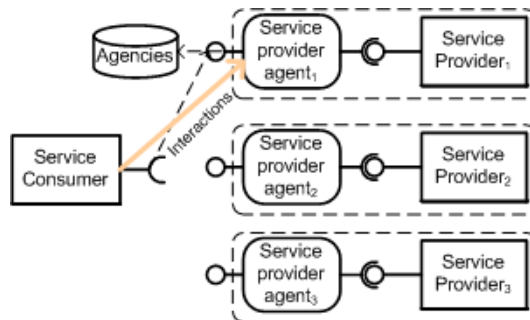
- **Classic SOA interaction style**
- **Publish-find-bind interactions**
- **Registries (or agencies) used for indirection**
- **Value**
 - Consumer discovers, selects, and binds to provider at design-time

IS 2 - Consumer agent mediated



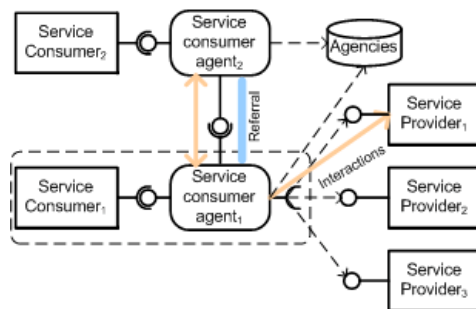
- **Employs a consumer service agent**
- **Agent automates some of consumer's tasks**
- **Consumers indirectly interact and collaborate by sharing via agencies**
- **Value**
 - Dynamic discovery, selection, and binding to service implementations
 - *Example:* bidding agent on eBay

IS 3 - Provider agent mediated



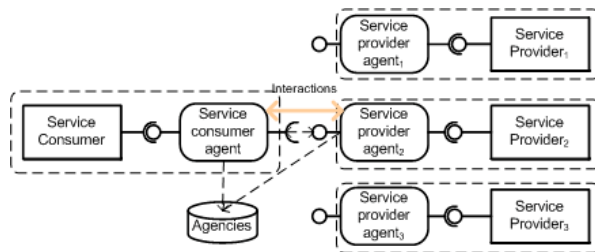
- Employs a provider service agent
- Agent can learn consumers' needs and preferences
- Provider agent indirectly interacts with consumers
- Value
 - Dynamic provisioning of provider service implementations
 - Provide services better matching consumers' preferences

IS 4 - Consumer agent mediated with collaboration



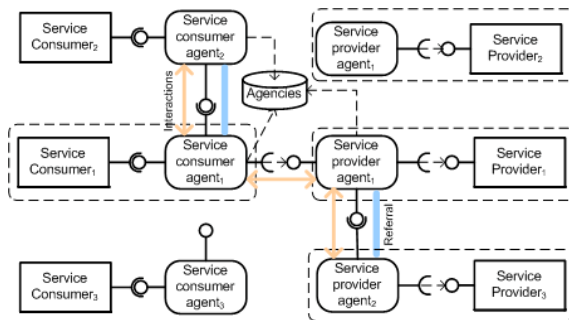
- Consumers' agents collaborate with each other
- Agents interact with peer agents
- Referrals may be used as a possible means of collaboration
- Value
 - Consumers selectively share expertise and knowledge from past interactions
 - *Example:* Amazon's zShop rating system

IS 5 – Consumer and provider agent mediated



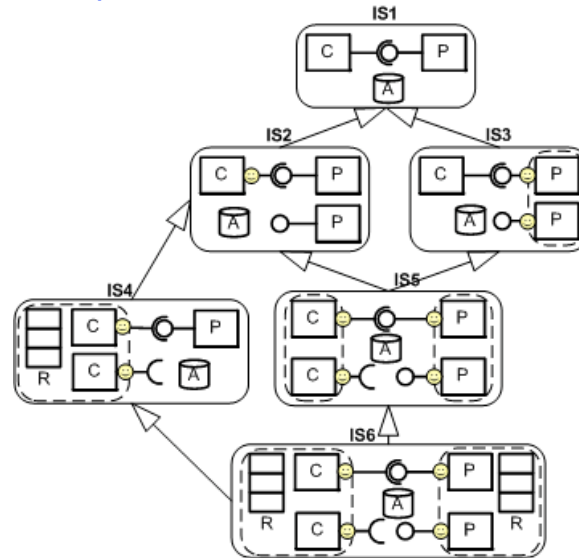
- **Employs agents for both consumers and providers**
- **Agents directly interact**
- **Value**
 - Dynamic negotiation
 - Dynamic SLA
 - Dynamic improvements of provider capabilities

IS 6 - Consumer and provider agent mediated with collaboration



- **Add agents to providers and consumers with peer collaboration**
- **Support interactions between and among consumer and provider agents**
- **Value**
 - Values from previous cases apply here
 - Providers collaborate to meet consumers' needs

Interaction Styles Overview



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Evaluation

- **Autonomic computing**
 - Dynamic service trust [IS2]
 - Dynamic service selection [IS2 and IS4]
 - *Runfiguration* or runtime configuration of consumer applications [IS2]
 - Service binding [IS2]
 - Dynamic and very late binding
 - Lazy binding
 - Rebinding (using policies)
 - Dynamic provisioning of service implementations [IS3]
- **Services ecosystem**
 - Monitoring service usage [IS2 and IS3]
 - Consumers indirectly interact and share opinions [IS2]
 - Provider can learn from consumers how to improve their implementations [IS3]

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Evaluation (cont.)

- **Dynamic service improvements**
 - Consumer agents [IS2]
 - Security
 - Transaction
 - Provider agents [IS3]
 - Provision implementation to meet consumers' need
 - Simplify interface for consumers, e.g., consumers with limited resources
- **Negotiation**
 - Service level agreement (SLA) [IS5]
 - Quality of service (QoS) [IS5]
 - Complement provider capabilities [IS6]
- **Referrals**
 - Consumer expertise market (emergence of authority) [IS4]
 - Market of specialized services [IS6]

Related Work

- **Patterns**
 - Software design and analysis patterns [Gamma et al. and Fowler]
 - Architectural styles and patterns [Garlan and Shaw]
 - Representational State Transfer (REST) [Fielding and Taylor]
 - Web services are dynamic Web resources
 - Web services have temporal characteristics
 - REST within multiple threads of interactions
- **MAS**
 - Agents as services and services as agents [Singh and Huhns]
 - Agent-based service selection [Maximilien and Singh]
 - Ontology for services [OWL-S]
 - Dynamic discovery and composition of services using agents [Sycara et al.]

Directions

- **Implementation challenges**
 - Negotiation and collaboration
 - Dynamic improvements of service implementation
 - Dynamic service composition
- **Specialized services**
 - How to advertise
 - How to share revenue
- **Complete pattern language for Web services interaction styles**

<http://maximilien.org>
(or google maximilien)

<http://www.csc.ncsu.edu/faculty/mpsingh/>
(or google singh)