

Agile Integration of Complex Systems

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2:40 PM - 3:25 PM

Outline

- Background and Problem
- Service Oriented Architecture (SOA) in DoD
- Baseline SOA
- Graphically enabled approach
 - Standard vs. Graphically Enabled Discovery
 - Standard vs. Graphically Enabled Messaging
 - Standard vs. Graphically Enabled Mediation
- Summary

Background and Problem

- SOA provides a powerful infrastructure for integrating disparate systems and technologies through services
- Current practice relies heavily on human intervention for such integration.
- This presentation describes a tool-assisted method for reducing and simplifying the human intervention required to integrate systems and technologies with SOA

Human intervention complicates SOA use

Background of Problem

- Quick ID of capabilities of interest
 - Systems
 - Technologies
 - Services
- Dynamic integration (orchestration) by mission integrators at all echelons
 - Mission planners
 - Edge users
- Agile adaptation as the mission evolves

Human intervention in using SOA can be reduced

SOA in DoD

- DoD has mandated that all systems support the Network-Centric Environment and SOA is fundamental to realizing DoD's Net-Centric Vision (DoDAF 1.5, volume 2, p. xiv)
- SOA is mandated by multiple policies, reference architectures and models, and the acquisition process (see notes view)

SOA is mandated by DoD

Baseline SOA

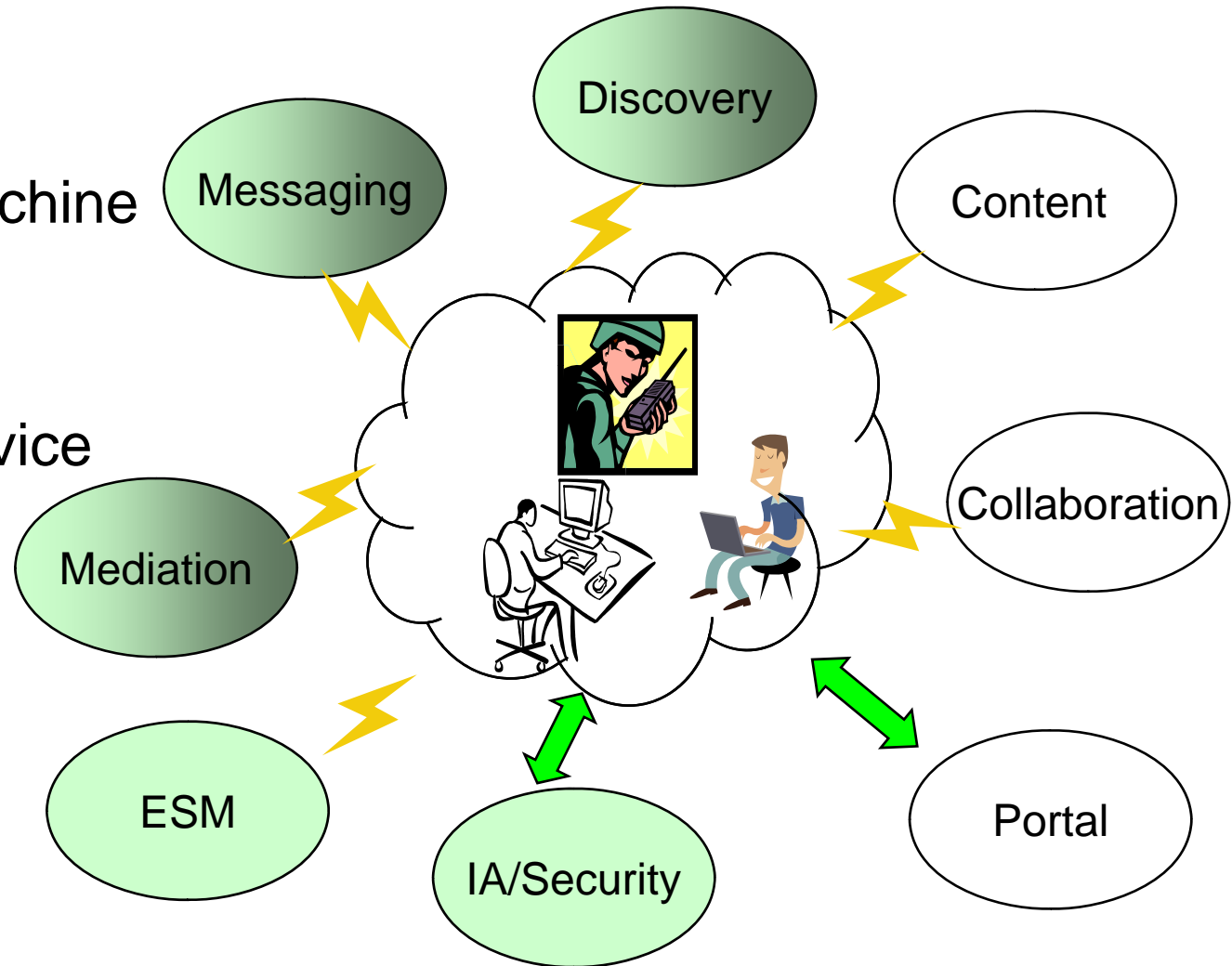
- DISA NCES CDD provides a good baseline and taxonomy that are independent of product implementations
- Describes Core Enterprise Services
- Describes SOA Foundation Services within the Core
- Graphical enablement modifies three foundation services

DISA. "Capability Development Document (CDD) for Net-Centric Enterprise Services (NCES)." Increment 1.0, Version 1.0, May 2006

DISA NCES CDD provides a good taxonomy

SOA Foundation (SOAF)

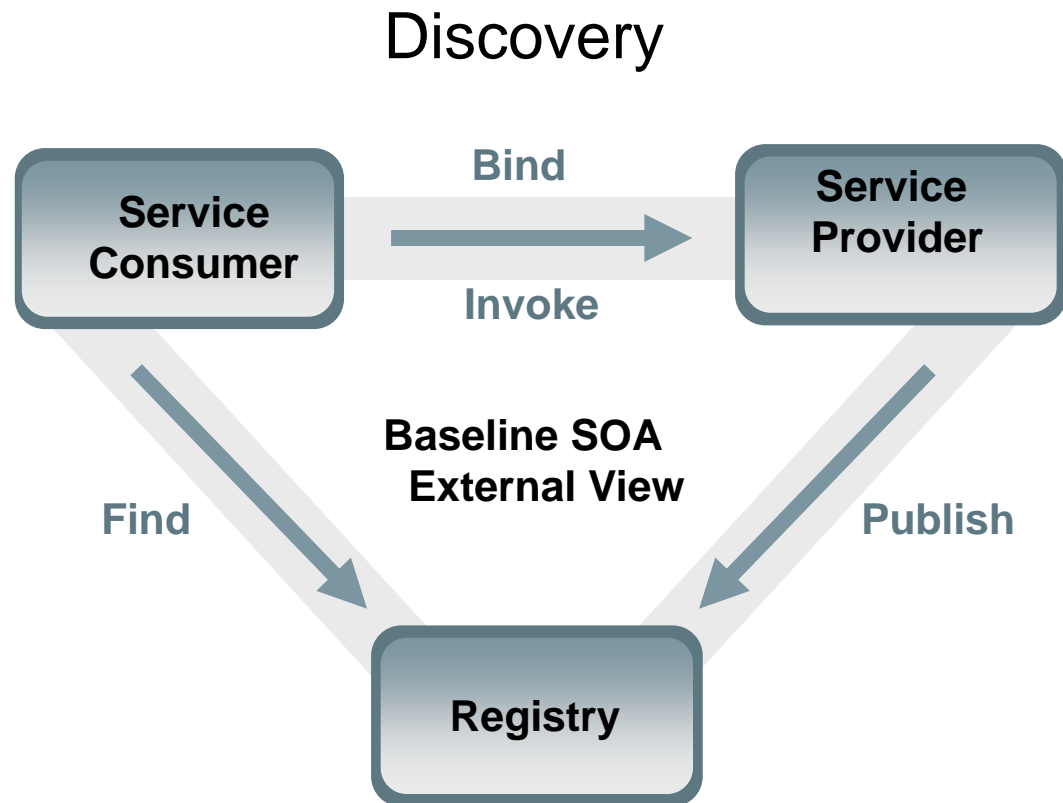
- Discovery
- Machine to Machine Messaging
- Mediation
- Enterprise Service Management
- IA/Security



Foundation services provide net-centric infrastructure

Discovery

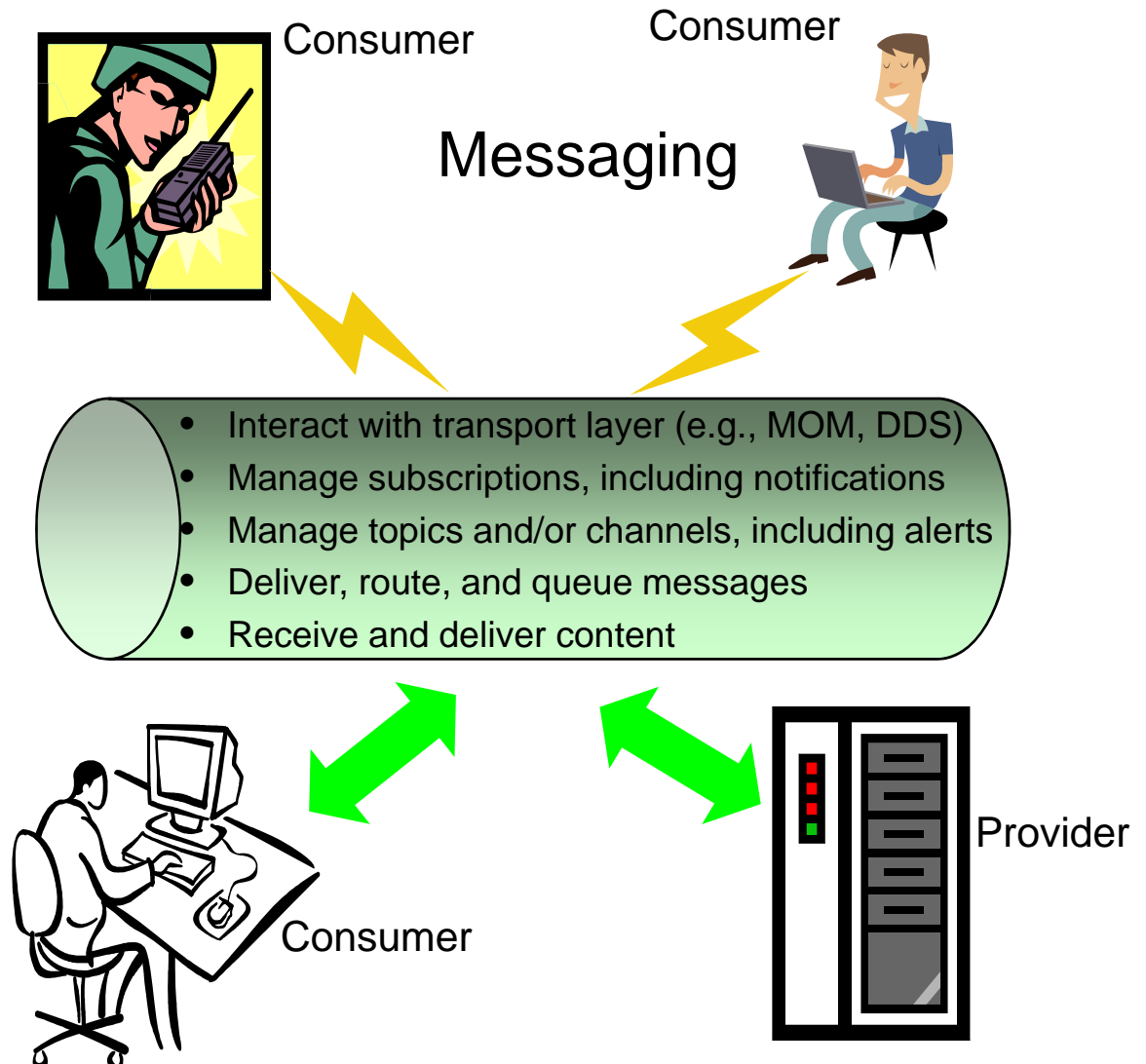
- Discovery
 - Registries
 - Find
 - Bind (assign)
 - Invoke



Discovery needed to link decoupled providers and consumers

Messaging

- Transport
- Subscriptions
- Topics
- Message queue
- Content

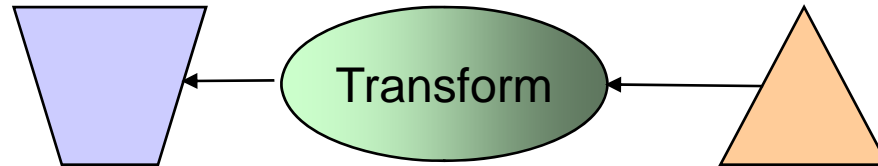


Messaging is more than a data bus

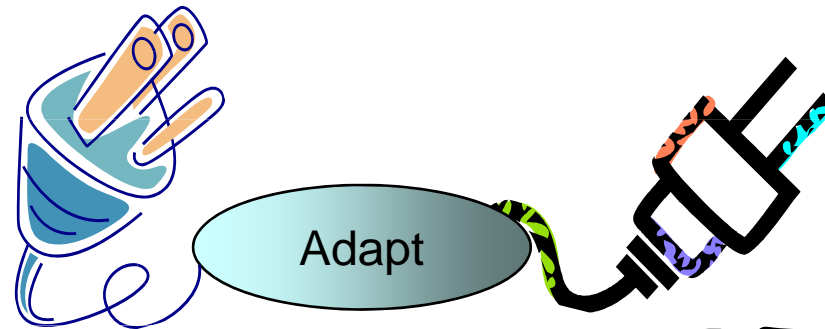
Mediation

- Transformation

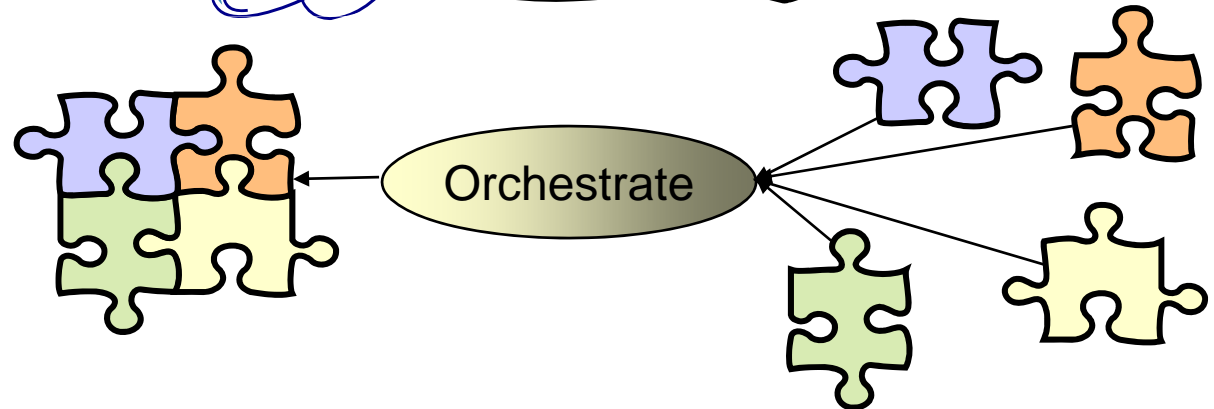
Mediation



- Adaptation



- Orchestration



Mediation enables integration of services from disparate systems

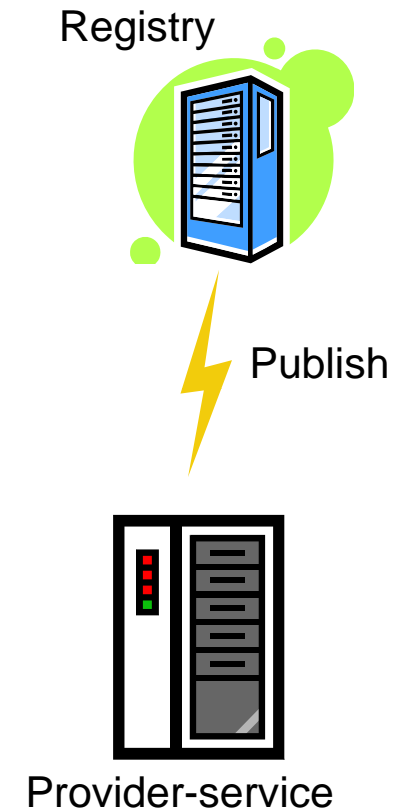
Graphically Enabled Approach

- Discovery
 - Change how provider registers
 - Change how consumer finds, binds, and invokes
- Messaging
 - Change subscription flow
 - Change alert flow
 - Change notification flow
- Mediation
 - Predetermined workflow for orchestration
 - Preprovision
 - Adaptors
 - Translators

Changed three foundation services

Standard Discovery

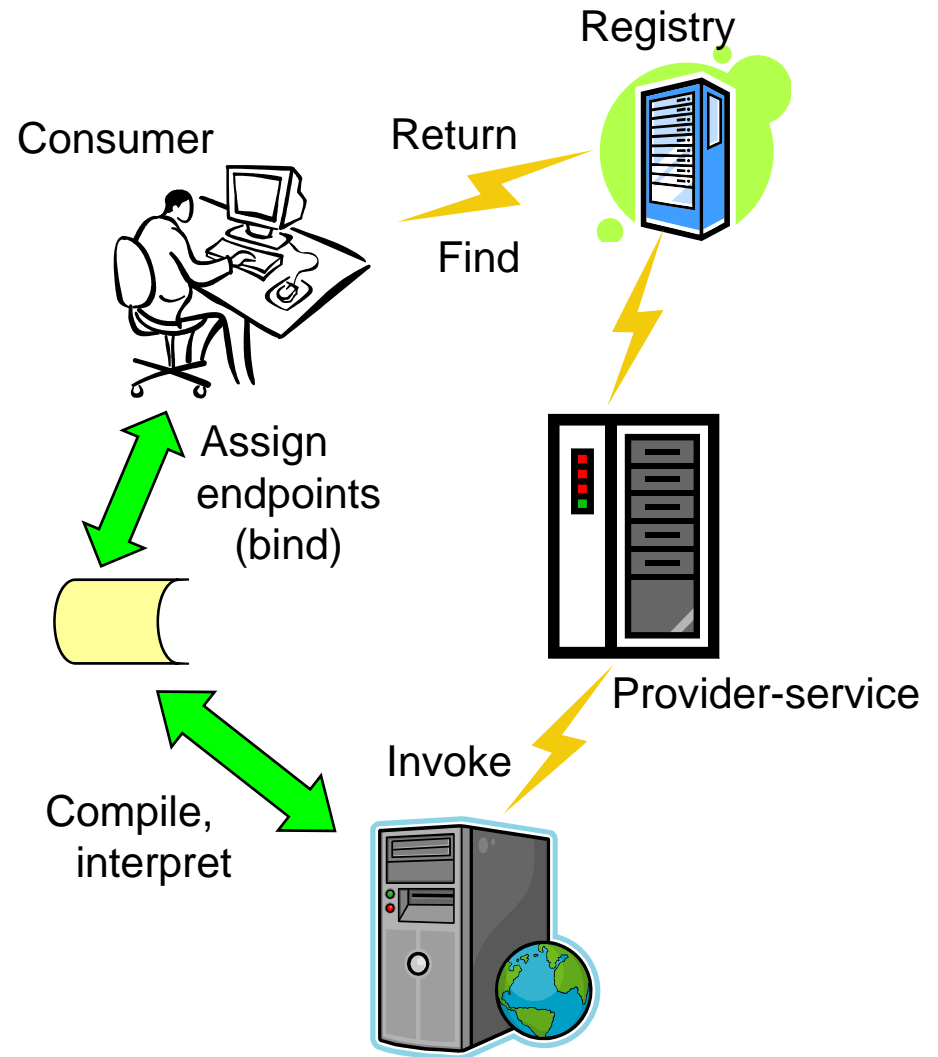
- Provider publishes endpoints and metadata
 - Use general registries
 - Widely accessible
 - Known locations
 - Time of access not known in advance
 - Consumer not known in advance



Providers publish to registry

Standard Discovery

- Consumer finds suitable services based on metadata in registries
 - Design time
 - Assigns endpoints in code and compiles (binds)
 - Runtime



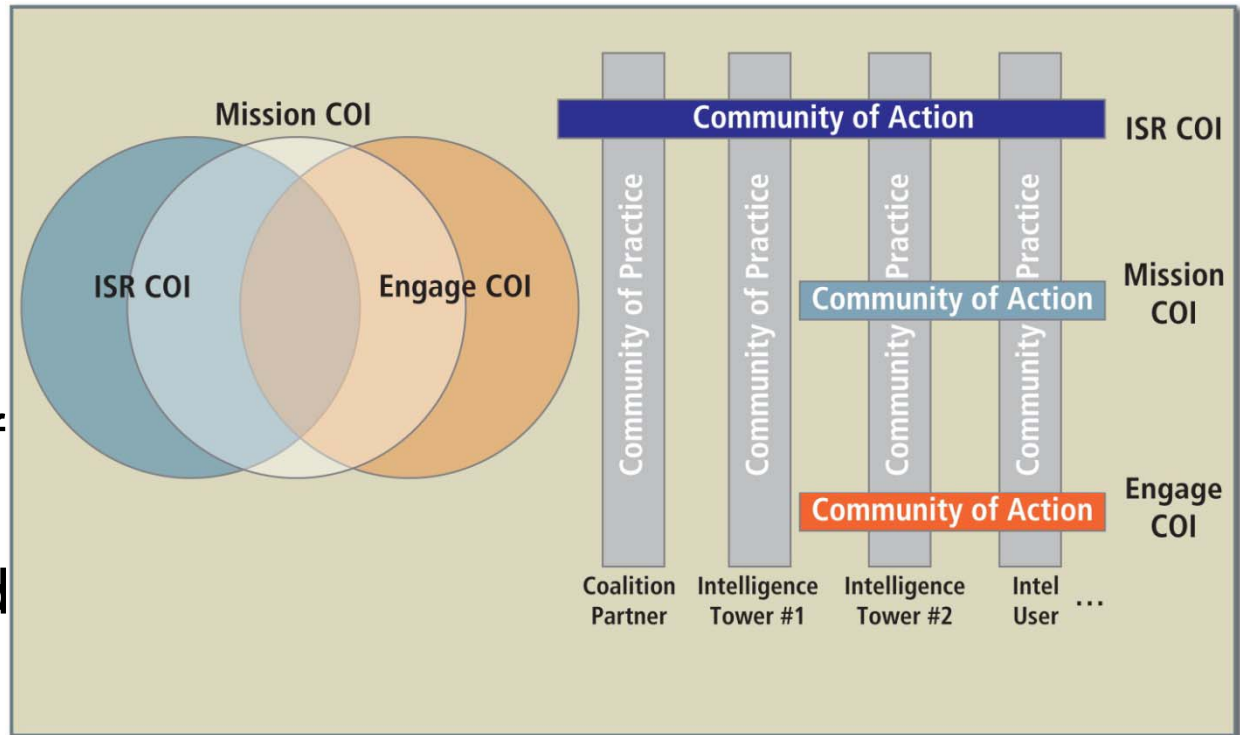
Consumers find services

Graphically Enabled Discovery

- Consumers and interests entered in COA registry

- Providers and services entered in COA registry

- Graphical display of COA registry (see Graphically enabled Messaging)



- COA users select (find) icons of interest (see Graphically Enabled Mediation)

Mission-focused registry

Standard Messaging

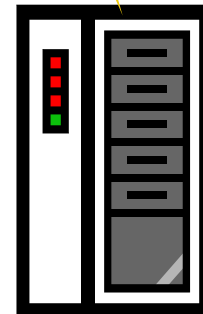
- Messaging responds to new publications
 - Creates new topic or channel
 - Sends new content from publishers to Content Delivery Service

Messaging Service



Post content
Post notice
Post alert

Create topic

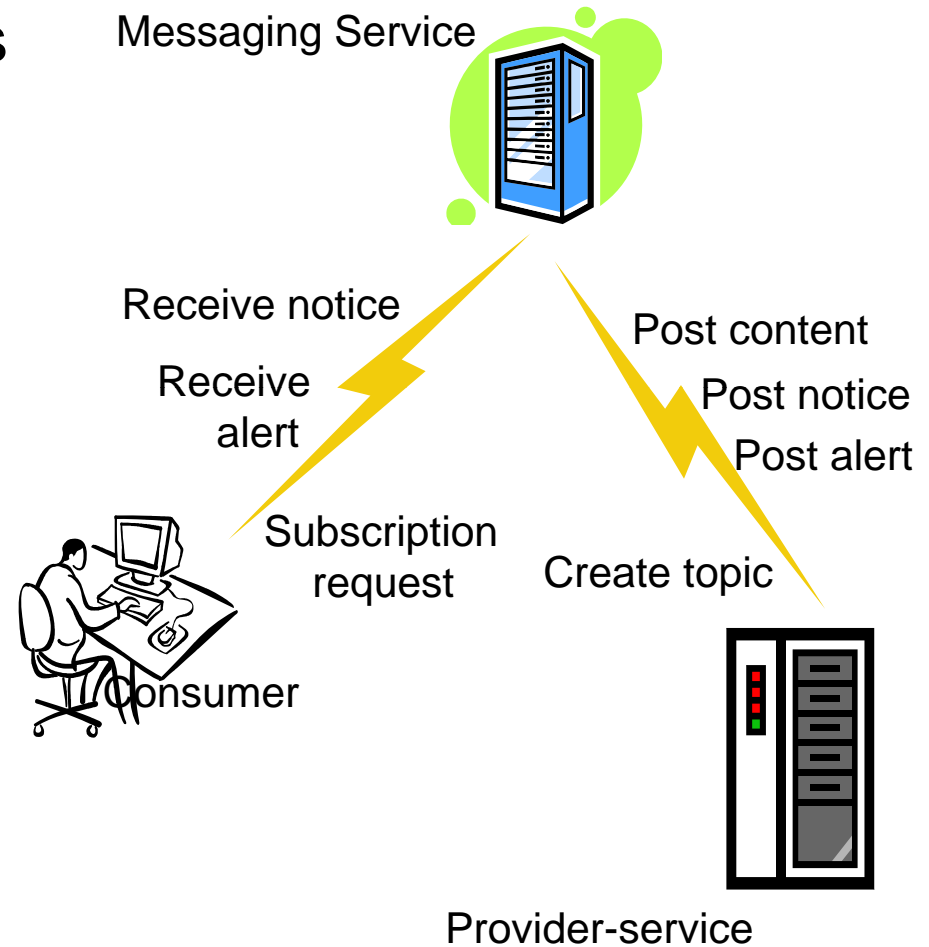


Provider-service

Messaging is in background

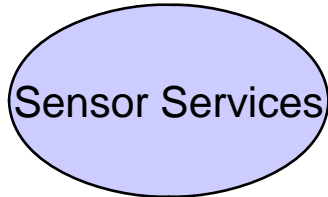
Standard Messaging

- Subscribers submit requests
 - Topic or channel
 - Interests or preferences for content
- Messaging responds to subscription requests
 - Alerts for topics or channels
 - Notifications for interests or preferences



Messaging is in background

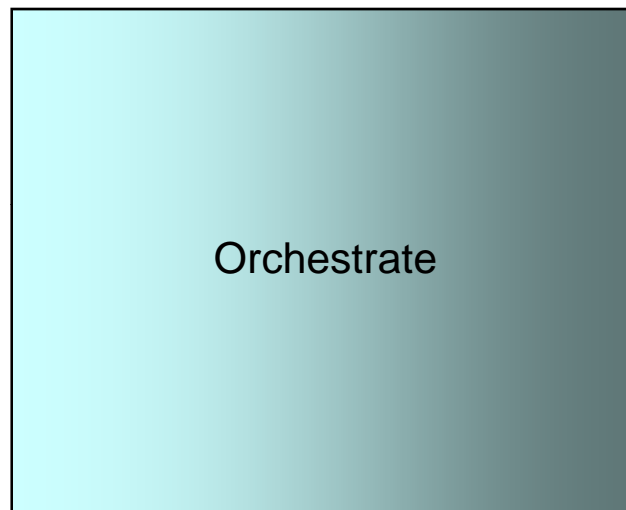
Graphically Enabled Messaging



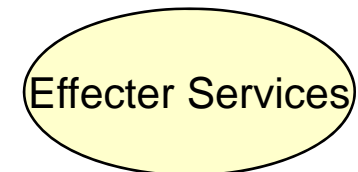
- Event service responds to new entries in COA registry



- Alert provided when display service displays icon for new service on all COA displays



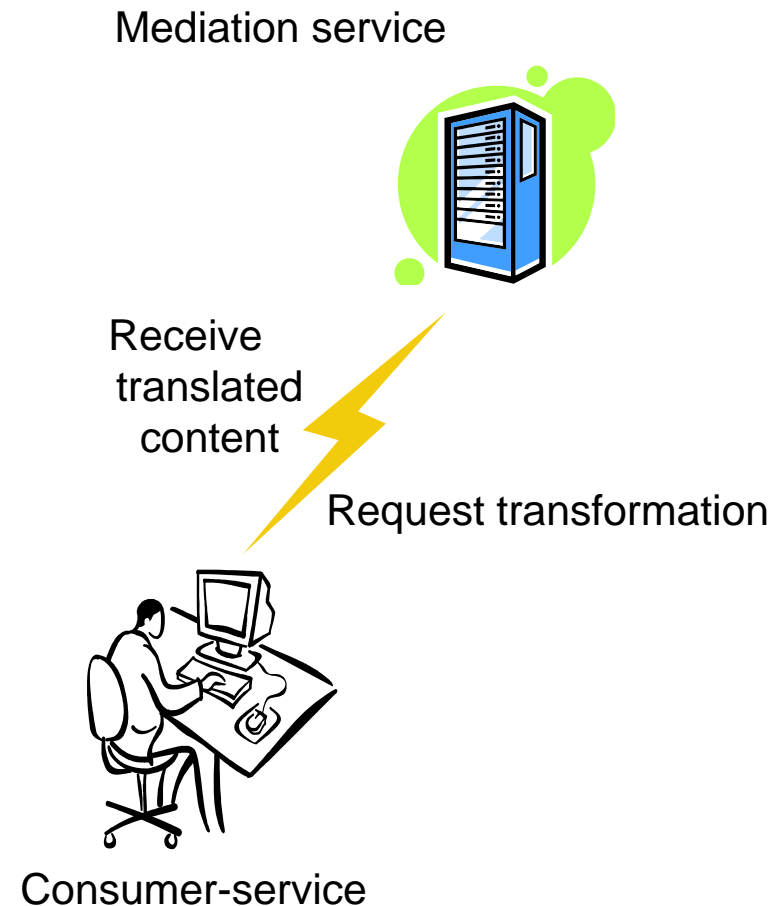
- Consumers implicitly subscribe to services when they register in COA registry



Messaging is in foreground

Standard Mediation – Transformation

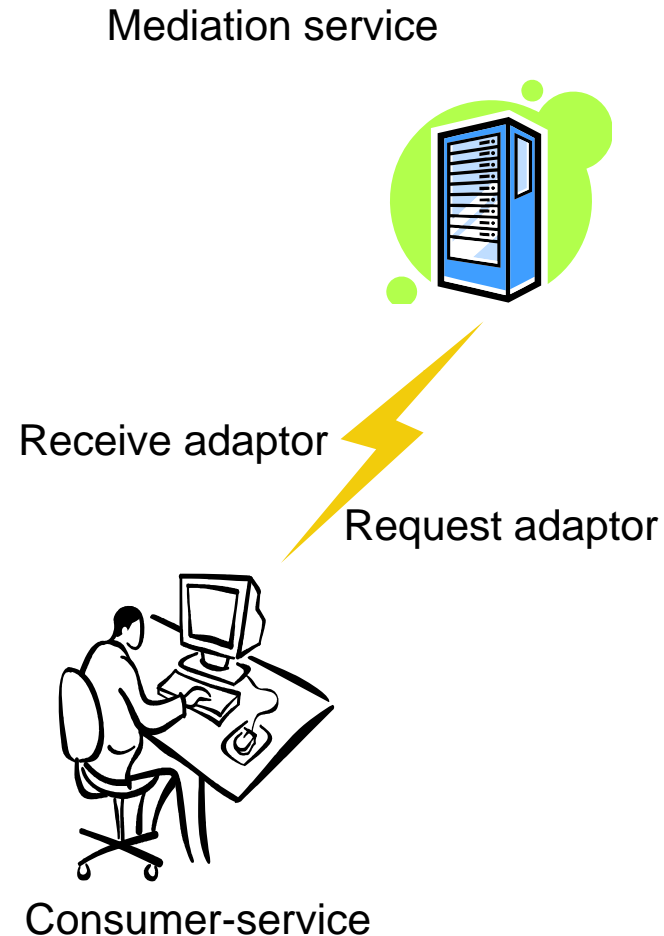
- Transformation
 - COA consumer requests format translation for content
 - Mediation service uses metadata discovery service to find relevant schemas
 - Mediation service translates content from one XML schema to another



Transformation explicitly requested

Standard Mediation

- Adaptation
 - COA consumer requests adaptor from mediation service
 - Mediation service uses metadata discovery service to find adaptor
 - Metadata discovery service returns adaptor to mediation service

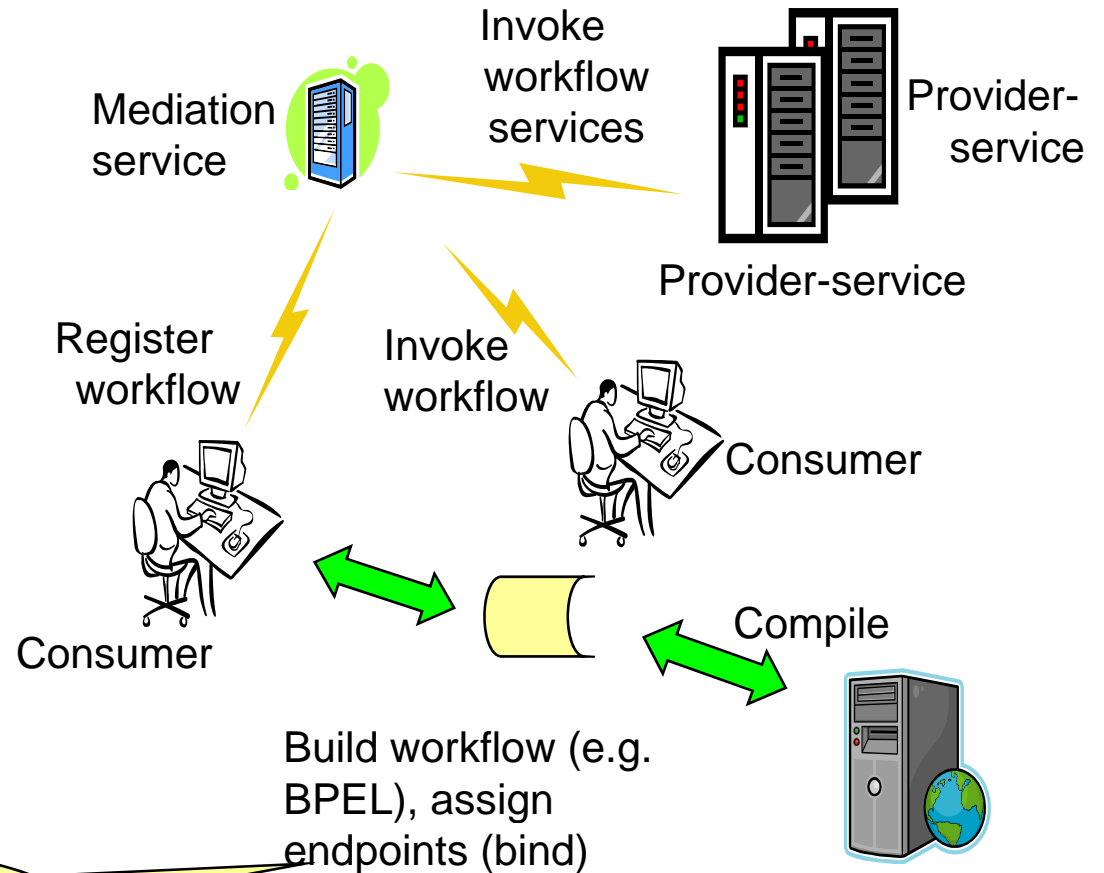


Adaptation explicitly requested

Standard Mediation

■ Orchestration

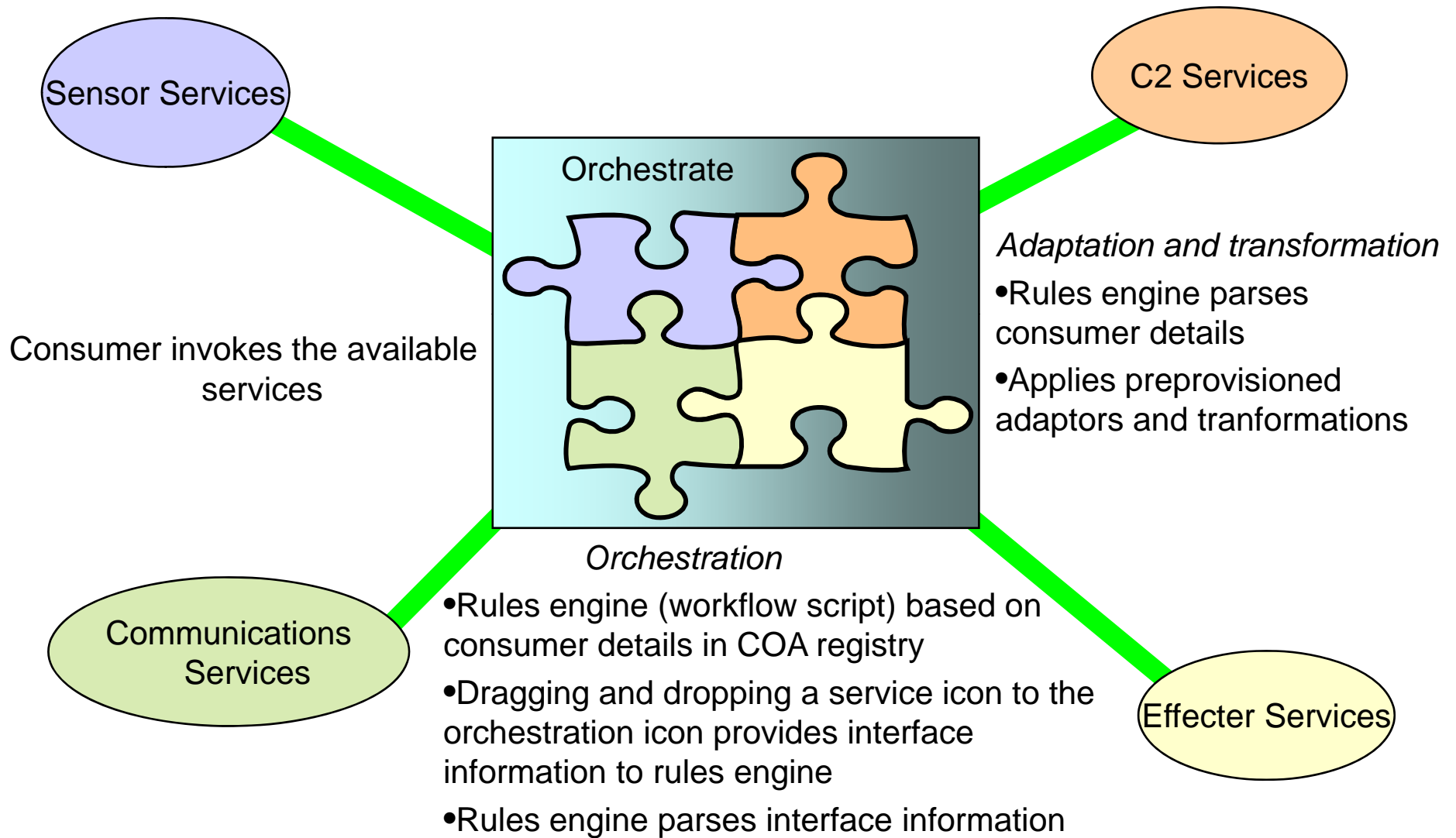
- COA consumer registers workflow script with mediation service
- COA consumer (same or different) invokes workflow script through mediation service
- Mediation service invokes operations from one or more providers



May require service discovery for endpoints

Workflow explicitly invoked

Graphically Enabled Mediation



Workflow implicitly invoked

Summary

- Four fundamental differences run across all three graphically enabled services, so there is some overlap in describing what's different
 - Graphically displayed registry
 - Limited registries
 - Consumers register, but don't subscribe explicitly
 - Registry-driven
- Simplifies and speeds up three foundation services at planning or execution time
- Domain rules for baseline SOA preserved

Biography

Wayne O'Brien is an Engineering Fellow in the Intelligence and Information Systems unit of Raytheon Company. He has worked for Raytheon for seventeen years, with a focus on software systems architecture for the past ten years. Beginning in 2006, he was the architecture SME or lead on several Enterprise Campaigns and is currently working as Technical Director on the Brunei National Modeling and Simulation Center capture.

Wayne received his Ph.D. in Information Technology and Engineering in 2006 from George Mason University. He is the inventor on one granted patent and the inventor on three Raytheon patent applications. Wayne's dissertation was published in book form in the United States and Europe in December of 2008. A related article was published in November of 2008 in the *Journal of Systems and Software*.

Acronyms

- CDD: Capability Development Document
- COA: Community of Action
- COI: Community of Interest
- COP: Community of Practice
- DDS: Data Distribution Service
- DISA: Defense Information Systems Agency
- DoD: Department of Defense
- DoDAF: DoD Architecture Framework
- ESM: Enterprise Service Management
- IA: Information Assurance
- MOM: Message Oriented Middelware
- NCES: Net-Centric Enterprise Services
- SOA: Service Oriented Architecture
- SOAF: SOA Foundation
- XML: eXtensible Markup Language

Backup

SOA Domain Rules

1. Access to a capability is physically or logically separated from the capability (OASIS Reference Model for Service Oriented Architecture 1.0, 8/2/2006 [OASIS RM], p. 9, lines 181-182; p. 10, lines 248-249)
2. Adaptation and extensibility are accomplished by accessing different capabilities rather than changing code or recomposing components (OASIS RM, p. 9, lines 178-179). I.e., consumer orchestrates a different set of services, rather than modifying services to meet changing needs.
3. Visibility (matching), interaction (using), and real-world effects (p.10, lines 263-265), using service descriptions and service interfaces (OASIS RM, p. 10, line 270) allow services to be consumed without regard to ownership.
4. Systems are composed for the consumer of a portfolio of services (consumed or provided) independently of ownership of the individual services (OASIS RM, p. 11, line 290). Moves ownership and implementation of system out of path for consuming its services, with emphasis on renting rather than owning. This allows the consumer to insert technology for the cost of orchestrating and incorporating a new set of services, without paying the full cost of developing and supporting new capabilities. Makes traditional boundaries artificial, e.g., physical, logical, ownership, temporal, and business process boundaries. Mission Capability Packages (MCPs) are examples of instantiating a portfolio of services, whether or not the portfolio must be expanded or contracted to support the MCP.
5. Integration of functionality no longer depends on tight integration of *system components, but instead is based on orchestrating functionality from services (OASIS RM, p. 11, line 289). Services are loosely coupled based on SLAs, which include service descriptions and interface definitions.
6. Eventual consumers of a service may not be addressed as a primary requirement (OASIS RM, p. 12, line 306), i.e., this describes the unanticipated user. This is an example of the provider side of loose coupling.
7. Eventual use of a service may not be addressed as a primary requirement (OASIS RM, p. 12, line 307)
8. Linkage between a service, with its interface, and its implementation may be dynamic, in contrast to function calls. That is, there is a dynamic rather than static relationship between service and implementation.
9. Discovery, based on an assumption that both consumers and providers are unknown to each other (OASIS RM, section 3.1), differs from non-SOA approaches, where consumers and providers are identified as part of the requirements (this helps account for the additional documentation needed for SOA – OASIS RM, p. 20, lines 557-558). This is amplified by the potential to change services, and for services to access different capabilities (lines 309-313), to perform the same real-world effect

SOA Domain Rules

10. Service levels are discoverable. There is no requirement by the consumer to know what the service level is in advance or that there be a prescribed service level. The consumer can make a determination of acceptability of the service level at time of consumption (OASIS RM, p. 24, lines 714-716).
11. Interactions are defined in terms of a marketplace of services encouraging the use of standards-based interfaces rather than proprietary and/or customized interfaces (OASIS RM, p. 11, lines 277-279, 294-296). Marketplace implies open to competition and technology infusion, rather than necessarily having multiple services with the same real-world effect available simultaneously.
12. Interoperability is required to realize the value inherent in individual components (OASIS RM, p. 12, lines 285-286).
13. There is a temporal aspect of SOA that distinguishes it from traditional approaches and parallels short term organizational arrangements (e.g., strategic partnerships and alliances, Communications of Interest, Cross Product Teams, or Integrated Product Teams). Facilitates rapid formation and dissolution.
14. The characteristics of SOA, especially as captured in rule 3, lead to rapid, continuous change and technology refresh without being hampered by large statically integrated solution sets that are difficult and expensive to alter. SOA does not enforce implementation sameness. Instead, SOA encourages interfaces based on open standards. Supports heterogeneous solutions, composed of parts, described in a standard way, interoperating through standards-based interfaces.
15. Providers must use a different development, deployment, and support model. Providers may build smaller chunks of capability, with greater likelihood of incomplete testing, deploy for wide accessibility, and support a more diverse and larger customer base. Support individual, heterogeneous chunks rather than monolithic whole. Full testing may occur with maturity after deployment. Certification may occur after development and deployment, related to de facto use rather than initial development, i.e., eventual users may need certification of the service for continued use. This reflects the rules that say that use is independent of ownership and may not be known initially to the provider. Providers may make prototype versions available with limited capability and reliability. SOA does not demand any particular methodology for development. Do we need “service” readiness levels, e.g., the four levels within Federated Development and Certification Environment?

SOA Domain Rules

16. *The characteristics of a marketplace in Rule 3 and premature deployment in Rule 15 may require external regulation for certain kinds of consumption, but SOA governance may be sufficient to assure proper quality of services through discovery policies, e.g., evaluating SLAs, consumer ratings. Places greater weight on ESM and having a consumer feedback loop for certain metrics, new requirements. This is an example of common benefits for consumers and providers.
17. *New business models for providers and consumers. The consumer's business model and that of the provider may be substantially different. This puts renewed importance on having a reference architecture. Must include guide book, best practices concerning how services are vetted before use, and SE practices.
18. Components assume minimal trust (OASIS RM, p. 12, lines 285-286) forcing explicit trust negotiation.
19. Enables sharing of data across the enterprise, where the data may be of different formats, types, and data models; heterogeneity is assumed. Sharing is enabled by metadata (standards based) and transformation services.
20. *Breaks down barriers to entry for new providers:
 - Open standards
 - Ownership independence
 - Open visibility and discoverable
 - No requirement to expose implementation (consumption is based on SLA; see rule 21)
 - Required interoperability
 - Lack of imposed methodology for development, implementation, and deployment

* Indicates primarily business considerations

SOA Domain Rules

21. *Services are provided and consumed based on published SLAs
 - Preconditions
 - Postconditions
 - Expectations
 - Quality attributes
 - Interface description requirements
 - Metrics
 - *Governance
 - Secure message delivery
22. *SOA driven by business level concepts, but may be constrained by technical considerations.
23. *SOA allows exposing legacy functionality in standards-based manner
 - Improved reuse.
 - Unanticipated users
 - Hides implementation behind business-oriented service interface
 - Reduced barriers to entry by providing a framework to make existing functionality available outside the stovepipe

* Indicates primarily business considerations