Technical Brief

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The Value of Using Intermediaries in a Service-Oriented Architecture (SOA)

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Introduction to Intermediaries

A service-oriented architecture (SOA) is an architectural pattern in computer software design in which application components provide services to consumers via a communications protocol using messages, typically over a network. The principles of service-orientation are independent of any vendor, product, or technology. Services are the means by which the needs of a consumer are brought together with the capabilities of a provider. These capabilities are provided to the consumer to produce some real-world effect (e.g., report an arrest).

Service-orientation is based on multiple principles that improve system interoperability and maintainability. These principles include reusability, loose coupling, abstraction, composability, autonomy, cohesiveness, and statelessness.[1] The discussion and value of these principles is beyond the scope of this document; however, using an intermediary is a key approach to achieving the benefits of these principles.

An *intermediary* is any service that receives a message and processes that message based on capabilities (policies) established by information sharing partners (consumers) that interface with the intermediary through their own local or edge services. The term "intermediary" indicates that these capabilities sit between other edge services and "mediate" the interaction by processing, managing, controlling, brokering, or facilitating the transmission of messages between them.

Although intermediaries are not a required component in the Global Reference Architecture (GRA),[2] there are significant benefits to using them. Intermediary services decouple service consumers from service providers, thereby allowing edge services to simply send and receive messages based on the agreed-upon policy response being enforced at the intermediary. The value of intermediaries increases as

[1] GRA Guidelines for Identifying and Designing Services, Version 1.1 – May 2011, Section 3.2. Service Design Principles

[2] GRA Execution Context Guidelines, Version 1.3 – April 2014, Section 5. Incremental Deployment of Common Services Infrastructure

the number of participating information sharing partners increases. The absence of an intermediary results in a point-to-point service architecture, which is counter to the intent of SOA and produces a brittle information environment.

Intermediaries decouple the senders (consumers) and recipients (providers) of messages. They centralize and share certain kinds of logic so that the logic can be maintained independent of the consumer and provider capabilities at the edges. Sharing logic via the intermediary also improves the likelihood of reuse, since it is easier to reuse functionality if it encapsulates a single task at a centralized location.

A single intermediary service could perform one or more capabilities, such as the following more common capabilities:

Orchestrations – Capabilities that coordinate interaction with multiple services.

Routers – Capabilities that receive a message, examine it based on some agreed-upon policy, and transmit it to one or more destinations based on the contents. In general, routers can be designed to operate on any of the information contained within the message; they may use information about the origin of the message, routing directive information contained within the message or the main content of the message itself.

Message Validators – Capabilities that examine a message to ensure that the content adheres to established business rules.

Transformers – Capabilities that receive a message and transform it into another format before transmitting it to another service provider.

Interceptors – Capabilities that receive a message and use the message content to trigger a secondary action. Generally, the interceptors pass the message unaltered to the next step in a process; however, an interceptor can also process and/or modify a message before passing. Most interceptors also capture information from the message for reporting or analytical purposes.

Information Flow Archetypes

Though different intermediary services will provide different "capabilities," the overall design of intermediary services generally falls into one of the following archetypal categories. Defining and following these archetypes assists in developing a consistent information sharing architecture that relies on intermediary services.

1. **Event-Driven Archetype.** Information exchange begins with the occurrence of a real-world business event that is either initiated through a triggering event (e.g., an arrest) or procedural task or activity (e.g., sentencing an offender). The composite (intermediary) response under this archetype represents the enterprise policy response or "handling" of this event, which generally involves orchestrating individual agency "component" responses. Essentially, the intermediary can implement any policy response to an event (through the capabilities listed above).

2. **Query-Response Archetype.** Information exchange begins with an individual's desire to know information about the state or history of something (including events that occurred [historical events] and any responses to those events). The composite (intermediary) response under this archetype represents the enterprise effort to gather the requested information from one or more component data sources and assemble the component responses into a single, enterprise response to the requestor.

3. **Request-Response Archetype.** Information exchange begins with a practitioner's request for procedural action (e.g., requesting a warrant) or for some change in the state of the world (e.g., updating status of compliance with an offender's terms of sentence). The composite (intermediary) response under this archetype, much like the composite response in the event-driven archetype, represents the enterprise response or handling of the request by the intermediary.

It is important to note that the notion of a "composite response" does not imply that multiple agencies (components) must be involved in every scenario, or information flow. It is entirely possible—and in fact, common—that composites will simply forward events, queries, or requests to a single agency for handling.

Connectors, Adapters, and Intermediaries

Connectors are components that implement the "consumer" side of a service interaction, typically by observing data changes or "triggers" in a consumer system and initiating a message transmission to an intermediary. The consumer system essentially "consumes" a service. The connector formulates a message from the service consumer environment in accordance with the service interface and sends the message to an intermediary service.

Adapters are components that implement the "provider" side of a service interaction, typically by receiving messages from the intermediary and interacting with the provider system. The provider system essentially "provides" the service. The adapter receives the message from the intermediary service and adapts the message to the service provider environment.

Intermediaries can be considered special adapters that mediate information exchanges between service consumers and service providers, performing such operations as transformations, routing, validation, and message aggregation. Intermediaries reside on an intermediary host or broker, which exists in a common space. The intermediary is a component (or set of components linked together) that implements a business process or flow between service consumers and service providers based on an established policy response. An intermediary is the mechanism by which the Global Reference Architecture[3] separates the integration logic (information flow) from the logic of line-of-business systems, which is a key feature of SOA.

The concepts of intermediaries, connectors, and adapters are used to ensure the loose coupling and separation of concerns for services. Without the intermediary, this would not be possible. The separation of integration logic from the specifics of interacting with each partner system also tends to produce reusable services.

Figure 1 illustrates the usual flow involving an intermediary service that decouples the consumer system from the provider system.

[3] https://it.ojp.gov/initiatives/gra

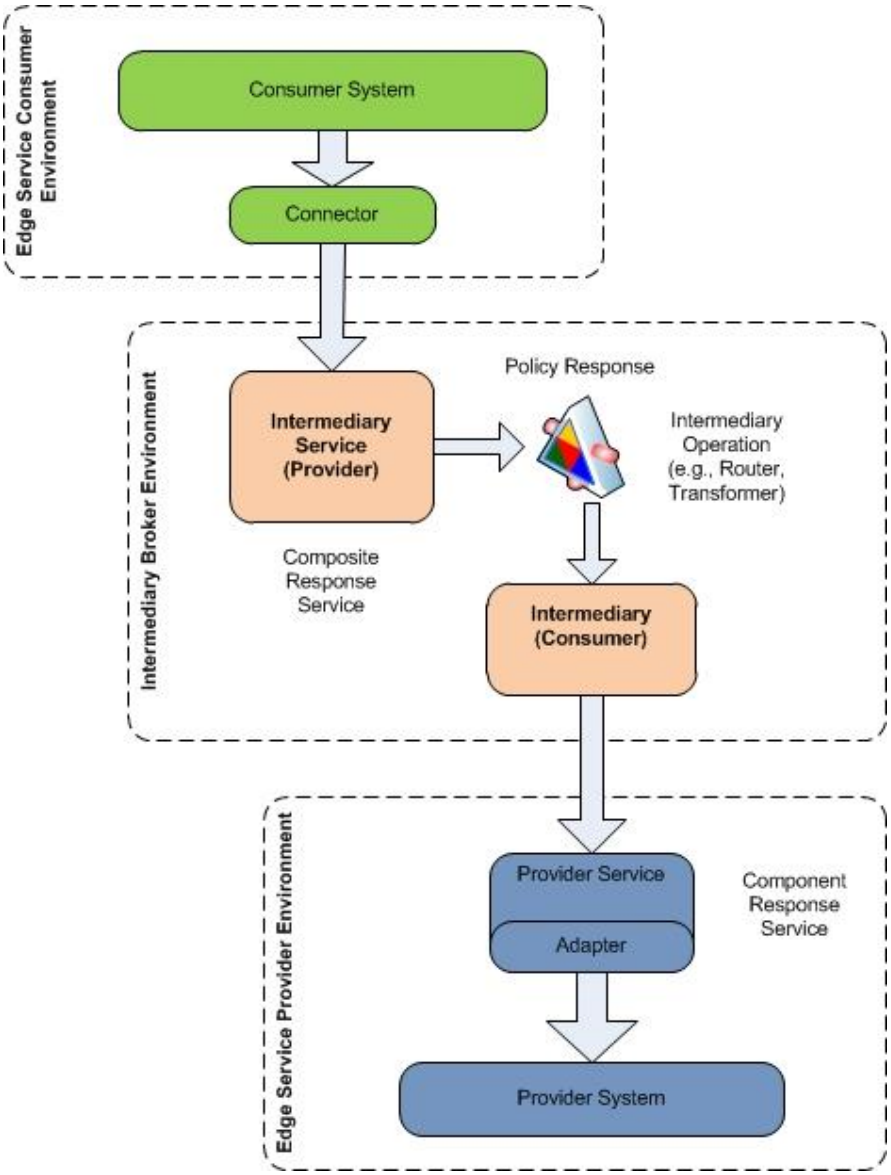

Figure 1

Avoiding Point-To-Point Exchanges

One of the most important features of the GRA is the separation of consumer systems from provider systems by creating an *intermediary* capability between systems. This is the defining characteristic of an SOA and is the key to minimizing the implementation dependencies between systems. An intermediary receives messages from a consumer system (service client) and subsequently, as a service consumer itself, interacts with the service provider(s).

A primary goal of using an intermediary is to avoid point-to-point information exchanges, which tend to be brittle, inflexible, and costly to maintain over time. As mentioned, the connector formulates information from the consumer system into a message and sends the message to the intermediary for business processing of the message (e.g., transformations, routing, validation, and message aggregation). A message emerges from the intermediary destined for a provider system that uses an adapter to formulate the message for the provider system. This approach eliminates the business processing burden

from the edge service consumer (connector) and edge service provider (adapter). Should the business processing logic (policy response) for the exchange require modification, or if new business logic is to be enacted, the intermediary assumes this responsibility, thus allowing the connector and adapter to simply send and receive the information required.

An Intermediary-based Service Modeling Framework

Typically, conducting business requires collaboration between autonomous organizations. With the collaboration, there is an "enterprise" or "common" aspect to conducting business in addition to the "autonomous" or "business-specific" aspect. Any framework that guides the implementation of information exchanges should foster and respect both autonomous and collaborative aspects, and ensure that they exist in harmony.

Accordingly, any information flow between business partners, through the implementation of services, should be decomposed into–

- an enterprise-provisioned (collaborative) component—called a "Composite Response Service"—that is implemented by an intermediary, and
- an agency-provisioned autonomous component—called a "Component Response Service"—that is implemented by an adapter within the provisioning business environment.

The *Composite Response Service* represents the "enterprise" or "common" policy response to the initial information exchange; the intermediary "brokers" or "facilitates" the contributions of the individual agencies' capabilities that make up the agreed-upon enterprise policy response. The *Component Response Service* represents the desired capability from the individual service provider at the edge (e.g., recording, filing, receiving a request or order, etc.). An intermediary-based service modeling framework accounts for both the common/collaborative and autonomous aspects of business processes and associated information exchanges. The intermediary accepts the responsibility of implementing the policy response through a composite response service and removes that burden from the component response services at the edge.

Practical Implementations

Intermediaries are used by the Open Justice Broker Consortium (OJBC) as a key component of its implementation architecture.[4] One current intermediary implementation in the OJBC has the capabilities to receive incident reports from multiple law enforcement agencies and send them to multiple destinations. By hosting a single service to report incident data in an intermediary, each law enforcement agency can submit data to the FBI as well as transform the report into a case referral that is sent to the prosecutor. Each agency need only support and manage one exchange rather than two, and more law enforcement agencies can take advantage of both capabilities by simply implementing one exchange with the intermediary service. Likewise, if additional reporting requirements (edge systems) are identified, only one new service interface needs to be established between the intermediary and the new end point.

In a point-to-point environment, where three law enforcement agencies need to report data to three other systems, a total of nine exchange interfaces must be managed and maintained. In an environment where an intermediary is used, only six exchange interfaces need to be managed and maintained. The disparity in the number of exchanges grows as more systems exchange data. The use of an intermediary significantly reduces to number and cost of maintaining interfaces, ensures that common policies are

[4] The Open Justice Broker Consortium is a nonprofit membership organization of government agencies and jurisdictions, dedicated to improving justice information sharing through the reuse of low-cost, standards-based integration software: http://www.ojbc.org

enforced for all exchanges, and eliminates the need of each partner to implement and manage the same capabilities in their local services. This greatly simplifies the overall information sharing environment as illustrated in Figure 2.

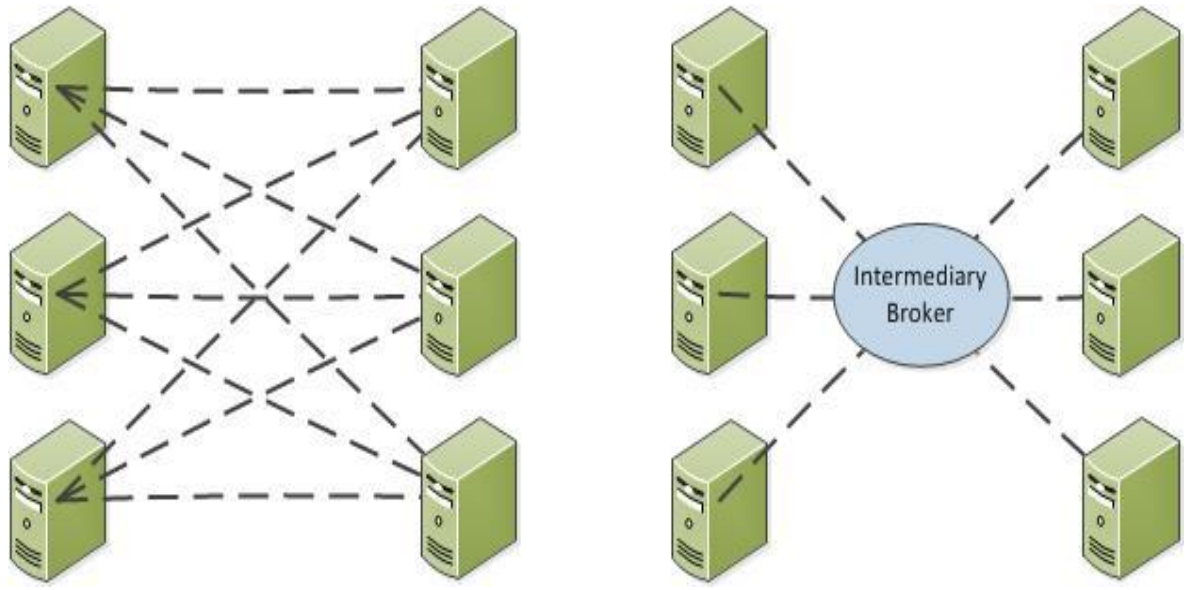

Figure 2

Summary

The use of intermediary services decouples service consumers from service providers, thereby allowing edge services to simply send and receive messages based on the agreed-upon policy response being enforced at the intermediary. This centralized policy response implementation allows for more agile management of polices, service consumers, and service providers.

The absence of an intermediary results in a point-to-point service architecture, which is counter to the intent of SOA and produces a brittle information environment. Intermediary services are a critical component of SOA that enables an agile (centralized) policy response, such as accommodating additional consumer and provider systems, as well as new or changing business requirements (e.g., routing, message transformation, message processing, logging, etc.). The use of intermediaries allows for better implementation and management of both the enterprise and autonomous aspects of information flows between business partners, and also positions the architecture for more agile growth in the future.

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