Nepal GEA SOA ESB Design Guidelines

Table of Contents

1. Executive Summary

1. Executive Summary

1.1 Purpose

The purpose of this document is to define the design guidelines applicable to project teams engaged in the design, development and implementation of synchronous and asynchronous services and mediate, aggregate and proxy them in the Enterprise Service Bus of the Service Delivery Gateway. The SOA Foundation is strategic SOA platform providing the tools, structure and processes for governing, managing and orchestrating web services.

There are effectively two main activities; service enablement and service integration. Development teams are responsible for the enablement (i.e. development/build) of services. The ESB team is responsible for the integration (i.e. connect, filter, transform, route etc). This Guideline defines how the SOA Foundation tools and processes will combine to provide integration and gateway management.

1.2 Scope

The scope of this document is the design and implementation for;

1. Service Integration in the Service Delivery Gateway.
2. Service consumers requiring to use the services of the Service Delivery Gateway
3. Service providers requiring to expose the services in the Service Delivery Gateway

Specifically it covers the following processes:

1. Design guidelines of the ESB, deployment topology and architectural artifacts;
2. Service design principles;
3. Service design patterns;
4. Guidelines on enabling services;
5. Guidelines on service contracts between service providers and service consumers;
6. Security framework on service invocations;
7. Guidelines of service signature alignment to master data structures;
8. Web services on the ESB

Excluded from the scope is:

1. Specific detailed design of software components and deployment of hardware components;
2. Performance Improvement of the Service Providing Applications and Service Consuming Applications;
3. The Throughput Improvement of the Network connecting the Service Providers and Consumers with the ESB.

The intended audience for this document is expected to be familiar with structured computer system development practices and with the key concepts for building web services and SOA.

1.3 Definitions

Definition	Description
AIM (Application Interaction Model)	Diagram showing interactions between applications.
BPEL (Business Process	XML-based language for the formal specification of business processes and business interaction protocols. BPEL extends the Web Services

Definition	Description
Execution Language)	interaction model and enables it to support business transactions.
EAI (Enterprise Application Integration)	The practice of integrating applications across an enterprise. This is typically an architecture led process where the interaction between the applications (modeled as business services) is defined and implemented via set of integration services managed through a Middleware foundation.
ESB (Enterprise Service Bus)	A software infrastructure solution that provides a set of tools and standards for governing, managing and orchestrating web services within the organization.
Managed Service or Managed Implementation	This is a virtualized representation of a raw service. A managed service has been registered within the ESB and contains functionality to support standard security, logging etc. All services requiring the use of another service should always use the managed service
Middleware	Software tools and techniques that are used as “plumbing” to link applications together. Eg. Oracle SOA suite, webMethods.
Raw Service or Raw Implementation	This is the actual implementation i.e. code, of a service. A raw service can be developed in any language that's supports WSDL such as Java, BPEL Orchestrations, .NET etc. A raw service has a physical end-point address.
SDS (System Design Specification)	Used for specifying system design.
Service	A service provides a set of well defined functions. Within the context of this document, all services are web services
SOAP (Simple Object Access Protocol)	SOAP is a standard for exchanging XML-based messages over a computer network, normally using HTTP. SOAP forms the foundation layer of the web services stack, providing a basic messaging framework that more abstract layers can build on.
SOP (Standard Operating Procedure)	Used for specifying operating procedures for systems and processes.
SRS (System Requirements Specification)	Used for specifying system requirements.
Web Service	Discrete self contained pieces of software functionality made available using internet technologies and compliant with the SOAP and WSDL standards
WSDL (Web Services Description Language)	An XML format for describing network services as a set of endpoints operating on messages containing either document-oriented or procedure-oriented information. The operations and messages are described abstractly, and then bound to a concrete network protocol and

Definition	Description
	message format to define an endpoint.

1.4 References

The following documents are referenced within this specification:

- Building Web Services with Java, Second Edition, by Steve Graham et al
- The Definitive Guide to SOA with BEA Aqualogic Service Bus by Jeff Davies
- SOA Governance by Todd Biske
- Web Service Contract Design and Versioning for SOA by Thomas Erl et al
- SOA Design Patterns by Thomas Erl
- Java Web Services Up and Running by Martin Kalin
- Enterprise Integration Patterns by Gregory Hohpe and Bobby Woolf
- Mule in Action by David Dossot and John D'Emic

2. Design Guidelines

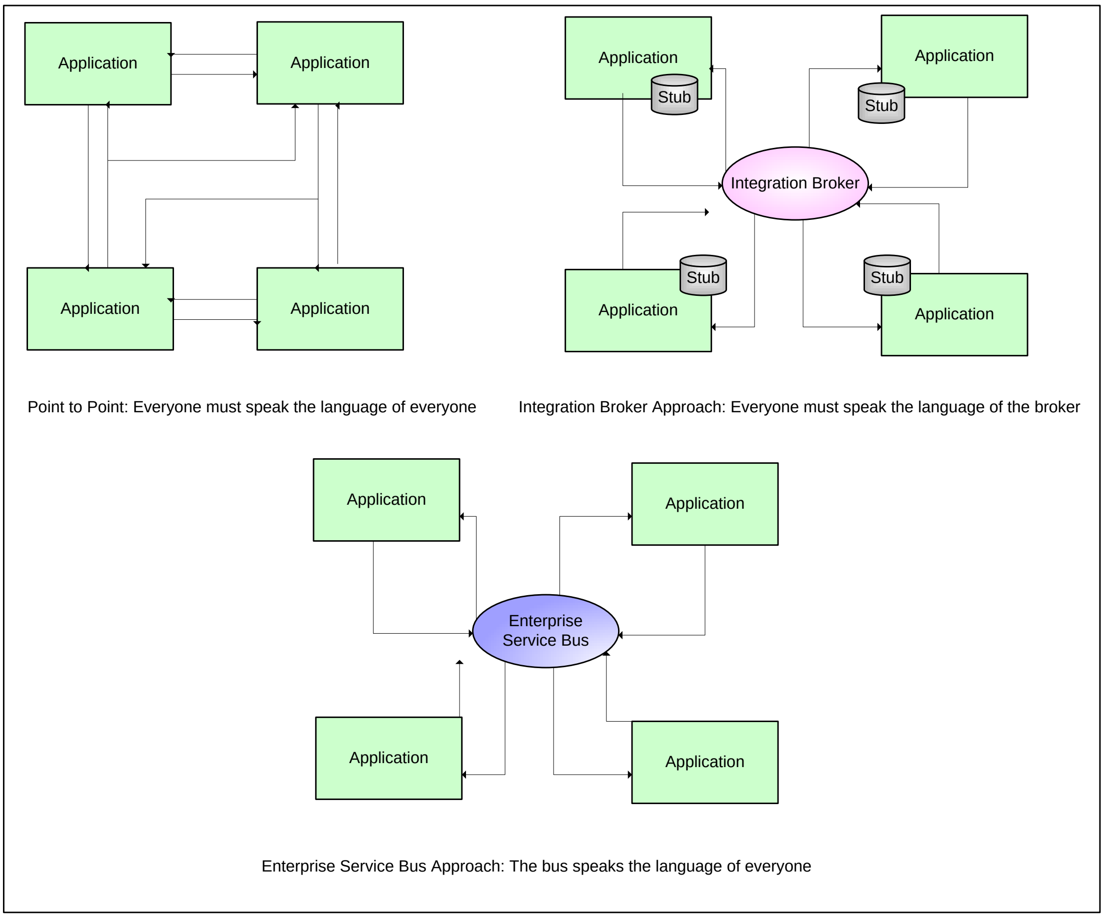
2. Design Guidelines

2.1 SOA implementation on Enterprise Service Bus

Application integration encompasses all the difficulties that heterogeneity creates in the world of software, leading to diversity in all the aspects of system communications and interrelations:

- Transport - applications can accept input from a variety of means, from the file system to the network.
- Data format - speaking the right protocol is only part of the solution, as applications can use almost any form of representation for the data they exchange.
- Invocation styles - synchronous, asynchronous, or batch call semantics entail very different integration strategies.
- Lifecycles - applications of different origins that serve varied purposes tend to have disparate development, maintenance, and operational lifecycles.

The normalization of the data model and service interface representations was a seminal event for the industry, as it began the search for platform-independent representation of all the characteristics of application communications. Web service technologies opened a lot of possibilities but also brought new challenges. One challenge is the proliferation of point-to-point communications across systems. This proliferation often leads to a spaghetti plate integration model, with many-to-many relationships between the different applications. Though the interoperability problem was solved, maintenance was complicated and no governance existed.



The design and implementation of Government of Nepal Service Delivery Gateway will be based upon the open source open standard ESB product Mule.

The Enterprise Service Bus would foster better practices by encouraging loosely coupled integration and at the same time discouraging many-to-many connectivity. Moreover, this platform wouldn't require any change from existing applications. It would be able to speak all languages and make dissembling systems talk with each other through its capacity to translate from one form of communication to another.

Acting like the bus at the core of computer architecture, this middleware would become the backbone of enterprise messaging, if not, according to some, the pillar of the service-oriented architecture (SOA) redesign that enterprises were going through. On top of solving the aforementioned integration issues, this bus would offer extra value-added services, like intelligent routing of messages between systems, centralized security enforcement, or quality of service measurement, as mentioned below:

Loose Coupling: One may have heard that web services provide one with loose coupling between systems. This is only partially true. But if one takes a look at any WSDL, one will see that service endpoints are written into the WSDL.

```
<service name="GetDrivingLicenseInformationService">
  <port binding="s1:GetDrivingLicenseInformationServiceSoapBinding"
          name="GetDrivingLicenseInformationPortSoapPort">
          <s2:address location="http://www.sdg.gov.ne:7001/esb/driving-license"/>
  </port>
</service>
```

By specifying a particular machine and port, one is tightly coupling this service to its physicl expression on a specific computer. So loose coupling is not achieved by WSDL or web services alone. A more robust solution is to provide some mediation layer between service clients and service producers. Such a mediation layer should also be capable of bridging transport and security technologies.

Location Transparency: Location transparency is a strategy to hide the physical locations of service endpoints from the service clients. This allows greater flexibility in managing the services as one can remove and add service endpoints as needed without fear of having to recompile the service clients.

Mediation: An ESB is an intermediary layer, residing between the service client and the service providers. This layer becomes the service provider to the service clients and has the ability to perform multiple operations: it can transform the data or the schema of the messages it sends and receives and it can intelligently route messages to various service endpoints, depending upon the content of the messages.

Schema Transformation: The web services published by the service bus might use a different schema from the schema of the business service it represents. This becomes a vital capability especially when used in conjunction with canonical taxonomy or when aggregating or orchestrating other web services. The ability to transform data from one schema to another is critical for the success of any ESB.

Service Aggregation: The service bus can act as a facade and makes a series of web service calls appear as a single service. Service orchestration is similar to service aggregation but includes some conditional logic that defines which of the lower level web services are called and the order in which they are invoked.

Load Balancing: Due to its position in the architecture, ESB is well suited to perform load balancing of service requests across multiple service endpoints.

Enforcing Security: The enterprise IT can enforce security in a centralized manner whenever possible in an ESB. This allows for a greater level of standardization and control of security issues. Security is best enforced through a policy driven framework and using security policies means that the creation and application of security standards happen outside the creation of individual web services.

Monitoring: ESB also provides the robust way to monitor its status in both proactive and reactive manners. The ability to proactively view the performance of the service bus allows Enterprise IT to help performance-tune the service bus for better performance and throughput. Tracking the performance over time can help IT plan for increasing the capacity of the service bus. Reactive business activity monitoring allows IT to define alerts for specific conditions.

2.2 Service Delivery Gateway Architecture

2.2.1 Objectives

The objectives of the Nepal Government Enterprise Architecture's Service Delivery Gateway are to cooperate, collaborate and integrate information across different Government Departments. To simplify the above task, the concept of Nepal Government Service Delivery Gateway has been materialized that will act as open source open standard Enterprise Service Bus and provide seamless interoperability and exchange of data and events across the Departments. The NGSDG shall

- Act as the Enterprise Service Bus for all the interactions between service consumers (the citizen and businesses) and various service providers (Government Departments) and even among Government Departments.
- Handle large number of transactions across the entire network; provide a common set of specifications and a single point access.
- Provide seamless interoperability and exchange of data and events across the departments.
- Provide data and format transformation if any along with routing and filtering of data.
- Facilitate real time and near real time synchronization and co-ordination of inter departmental working, tracking all transactions of the Nepal Government.

The basic functionalities planned through NGSDG are as follows:

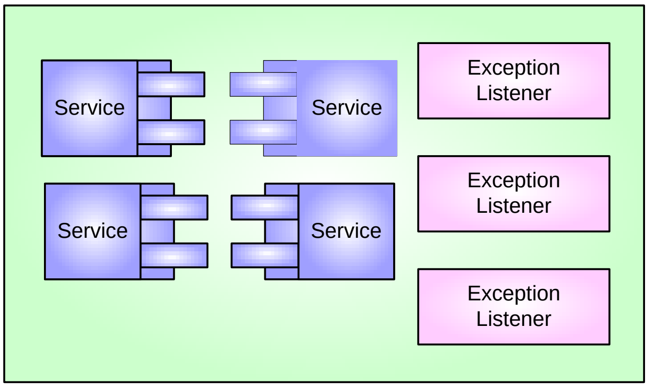
- Security and Audit - Results in better tracking (auditing) and security of each service invocation.
- Service enabling of Legacy Applications - With NGSDG, legacy applications can offer their services to various other consumers connected to the Enterprise Service Bus.
- Interoperability – The SDG Enterprise Service Bus as the middleware will facilitate easy inter-departmental data exchange.
- Seamless availability of information.
- Shared Services - In future, SDG Enterprise Service Bus has the capability to add additional functionality to support shared common services like Authentication, payment gateway interface, short messaging services, instant messaging services etc.
- Necessary connectors to interface with the applications developed at the Department level.

2.2.2 Artefacts

2.2.2.1 Model

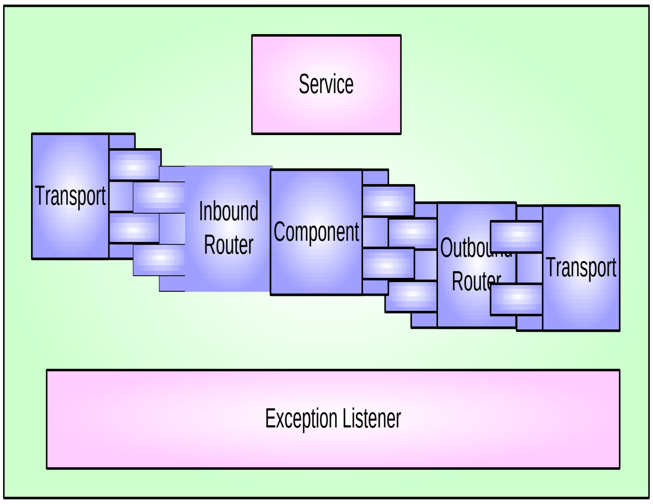
The first logical layer of the Mule instances in the Service Delivery Gateway is the model layer.

A Mule Model is the runtime environment into which the services of the Service Delivery Gateway are hosted. It defines the behaviour of Mule when processing requests handled by these services. The model provides services with supporting features, such as exception strategies. It also provides services with default values that simplify their configuration.



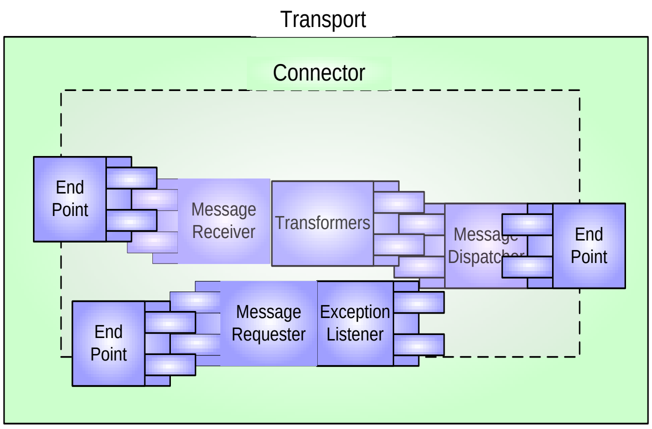
2.2.2.2 Service

A Mule service in the Service Delivery Gateway is composed of all the Mule entities involved in processing particular requests in predefined manners. To come to life, a service is defined by a specific configuration. This configuration determines the different elements, from the different layers of responsibility, which will be mobilized to process the requests that it'll be open to receive, depending on the type of input channel it uses, a service may or may not be publicly accessible outside of the ESB. For the time it gets handled by a service, a request is associated with a session object. As its name suggests, this object carries the entire necessary context for the processing of a message while it transits through the service.



2.2.2.3 Transports

The transport layer is in charge of receiving or sending messages. This is why it's involved with both inbound and outbound communications. A Mule transport provides all the ESB elements required for receiving, sending, and transforming messages for a particular protocol. A transport manifests itself in the configuration by the following elements: connectors, endpoints and transformers.



2.2.2.3.1 Connector

A connector is in charge of controlling the usage of a particular protocol. It's configured with parameters that are specific to this protocol and holds any state that can be shared with the underlying entities in charge of the actual communications. For example, a HTTP SOAP connector is configured with a Web Service, which is shared by the different entities in charge of the actual communication. These communicating entities will differ depending on whether the connector is used for listening/polling, reading from, or writing to a particular destination: they would respectively be message receivers, message requesters, and message dispatchers. Though a connector isn't part of a service, it contributes these communication parts to it. Consequently, a service is dependent on one or more connectors for actually receiving or sending messages.

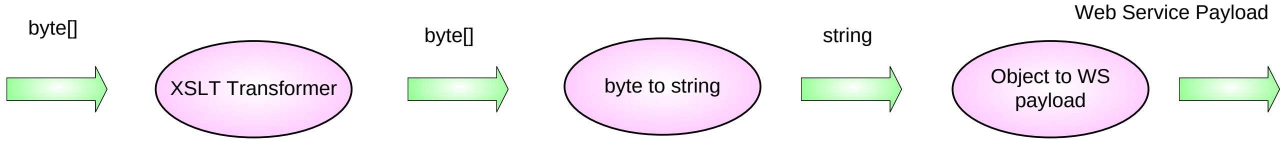
2.2.2.3.2 Endpoint

An endpoint represents the specific usage of a protocol, whether it's for listening/polling, reading from (requesting in Mule's terminology), or writing to a particular target destination. It hence controls what underlying entities will be used with the connector they depend on. The target destination itself is defined as a URI. Depending on the connector, the URI will bear a different meaning; for example, it can represent a URL or a JMS destination. Inbound and outbound endpoints exist in the context of a particular service and represent the expected entry and exit points for messages, respectively. These endpoints are defined in the inbound and outbound routers. It's also possible to define an inbound endpoint in a response router. In that case, the inbound endpoint acts as a response endpoint where asynchronous replies will be consolidated before the service returns its own response. Global endpoints can be considered abstract entities that get reified only when referenced in the context of a service: as such, they're a convenient way to share common configuration attributes.

2.2.2.3.3 Transformer

As its name suggests, a transformer takes care of translating the content of a message from one form to another. Mule ships with a wealth of general transformers that perform simple operations, such as byte-array-to-string-transformer, which builds a string out of an array of bytes using the relevant encoding. On top of that, each transport contributes its own set of specific transports, for example object-to-jmsmessage- transformer, which builds a javax.jms.Message out of any content. It's possible to chain transformers to cumulate their effects. Transformers can kick in at different stages while a message transits through a service. Essentially, inbound transformers come into play when a message enters a service, outbound transformers when it leaves, and response transformers when a message is returned to the initial caller of the service. Transformers are configured in different ways: globally or locally on endpoints by the user, and implicitly on connectors by the transport itself.

A transport also defines one message adapter. A message adapter is responsible for extracting all the information available in a particular request (data, meta information, attachments, and so on) and storing them in transport-agnostic fashion in a Mule message.

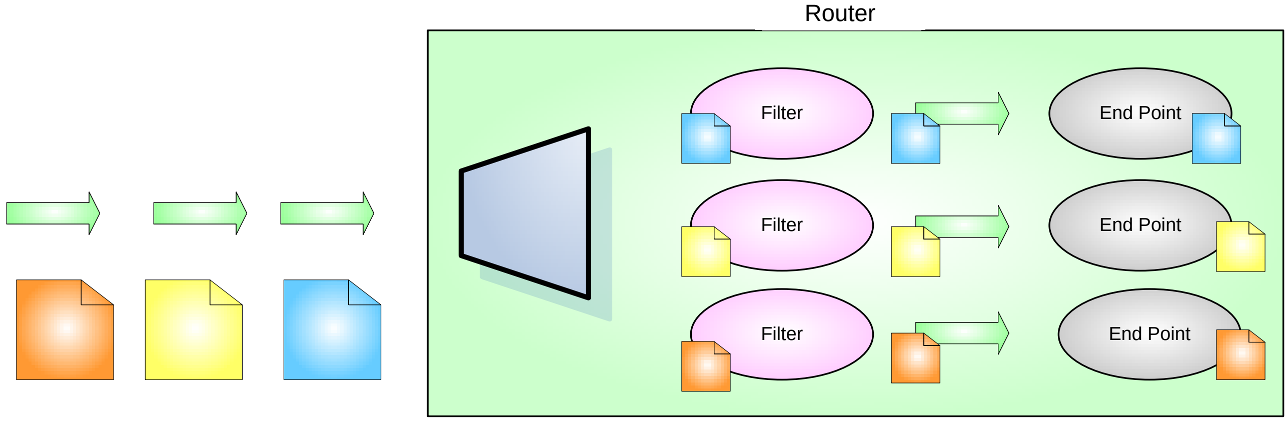


2.2.2.4Routers

Routers play a crucial role in controlling the trajectory a message will follow when it transits in Mule. They're the gatekeepers of the endpoints of a service. In fact, they act like railroad switches, taking care of keeping messages on the right succession of tracks so they can reach their intended destinations. Some of these routers play a simple role and don't pay much attention to the messages that transit through them. Others are more advanced: depending on certain characteristics of a message, they can decide to switch it to another track.

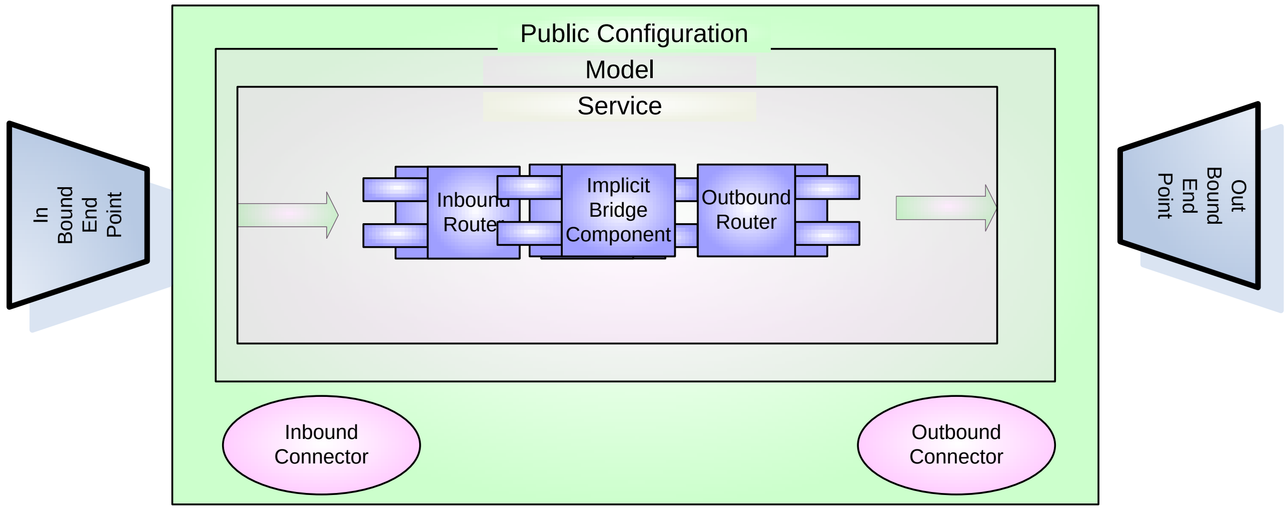
Certain routers go even further and can split, sort, or regroup messages based on certain conditions. These conditions are mainly enforced by special entities called filters.

Filters are a powerful complement to the routers. Filters provide the brains routers need to make smart decisions about what to do with messages in transit. They can base their filtering decisions on all the characteristics of a message and its properties. Some filters go as far as deeply analyzing the content of a message for a particular value on which their outcome will be based. The location of a router in a service determines its nature (inbound, outbound, or response) and the possible roles it could decide to play (pass-through, aggregator, and so on). Inbound routers are traversed before a message reaches a component, while outbound ones are reached after a message leaves a component. Response routers (aka async-reply routers) take care of consolidating asynchronous replies from one or more endpoint as a unique service response to the inbound request.



2.2.2.5Components

Components are the centrepiece of Mule's services. Each service is organized with a component at its core and the inbound and outbound routers around it. Components are used to implement a specific behaviour in a service. This behaviour can be as simple as logging messages or can go as far as invoking other services. Components can also have no behaviour at all; in that case they're pass-through and make the service act as a bridge between its inbound and outbound routers. In essence, a component receives, processes, and returns messages. It's an object from which one method will be invoked when a message reaches it.

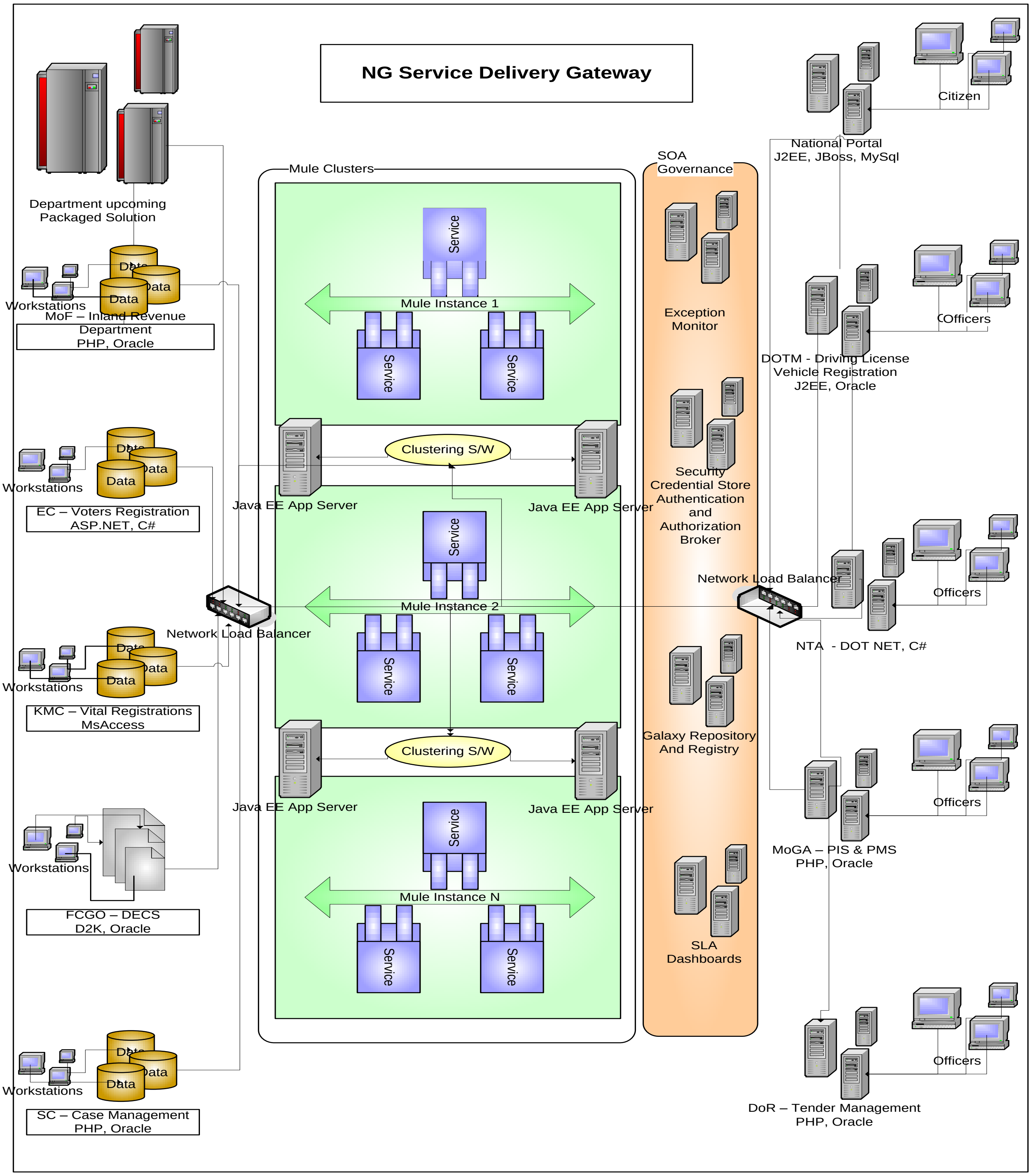


2.2.3 *Deployment View*

2.2.3.1 Topology

Nepal Government Enterprise Architecture‘s Service Delivery Gateway based on Mule is envisaged as a lightweight messaging framework and highly distributable object broker. Because of this dual nature of the ESB, its deployment topology is twofold: the instance level topology and the network level topology. The former is controlled by a set of configuration files and the latter is defined by the number of Mule instances deployed, their locations, and the transports they use.

In the following topology for Service Delivery Gateway, Mule services act as middlemen for the service consumer applications, taking care of invoking remote services for service provider applications. All the knowledge of the remote service is concentrated in a single place, the Mule Instance Clusters, which act as a proxy. This knowledge consists of not only connection details, but can also cover security configurations, specific data transformations, specific content based routing and filtering and service orchestrations.



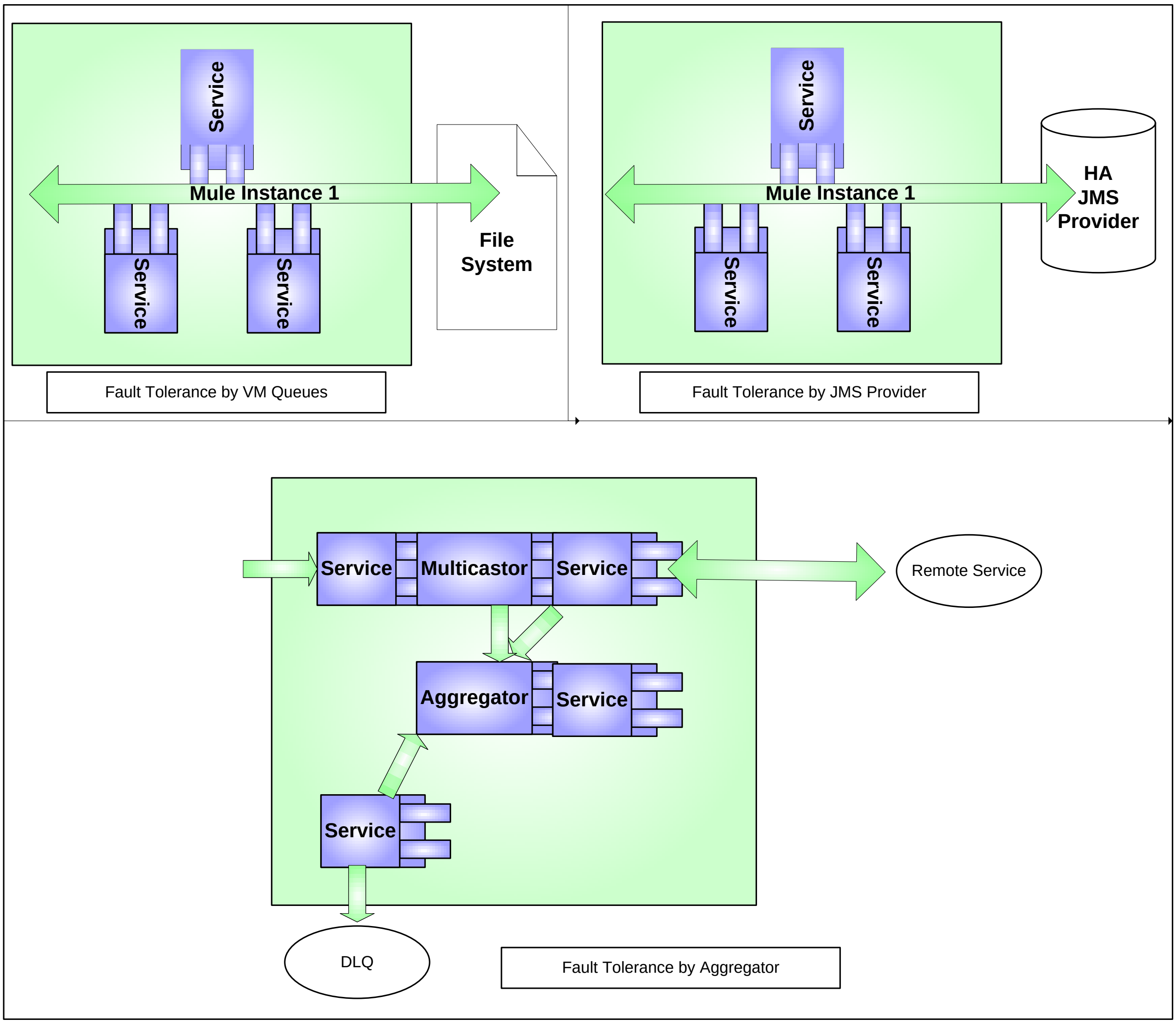
2.2.3.2 High Availability

High availability is generally attained with redundancy and indirection. Redundancy implies several Mule instances running at the same time. Indirection implies no direct calls between Service Provides, Service Consumers and the Mule instances. Using a Network Load Balancer in front of a pool of similar Mule instances is the prescription for High Availability.

With Network Load Balancer in place, one Mule instance can be taken down, for example for an upgrade, and the Producer and Consumer applications will still be able to communicate via an active instance. As the name suggests, using a load balancer would also allow to handle increases in load gracefully: it will always be possible to add a new Mule instance to the pool and have it handle the load.

2.2.3.3 Fault Tolerance

Depending upon the functionality, Mule can offer Fault Tolerance either via its persisted VM queues or an external highly available JMS provider. When persistence is activated for the VM transport, messages get stored on the file system when they move between different services of a Mule instance. In the other case, dedicated queues will be used for all inter-instance communication. Another way, by which Fault Tolerance can be achieved, is to store a little conversational state in an aggregator and wait for a response time from the invoked HTTP web service. If the response never comes, the aggregators will time out and the Service Delivery Gateway will be able to store the original invocation request, which was waiting in the aggregator, in a safe place.

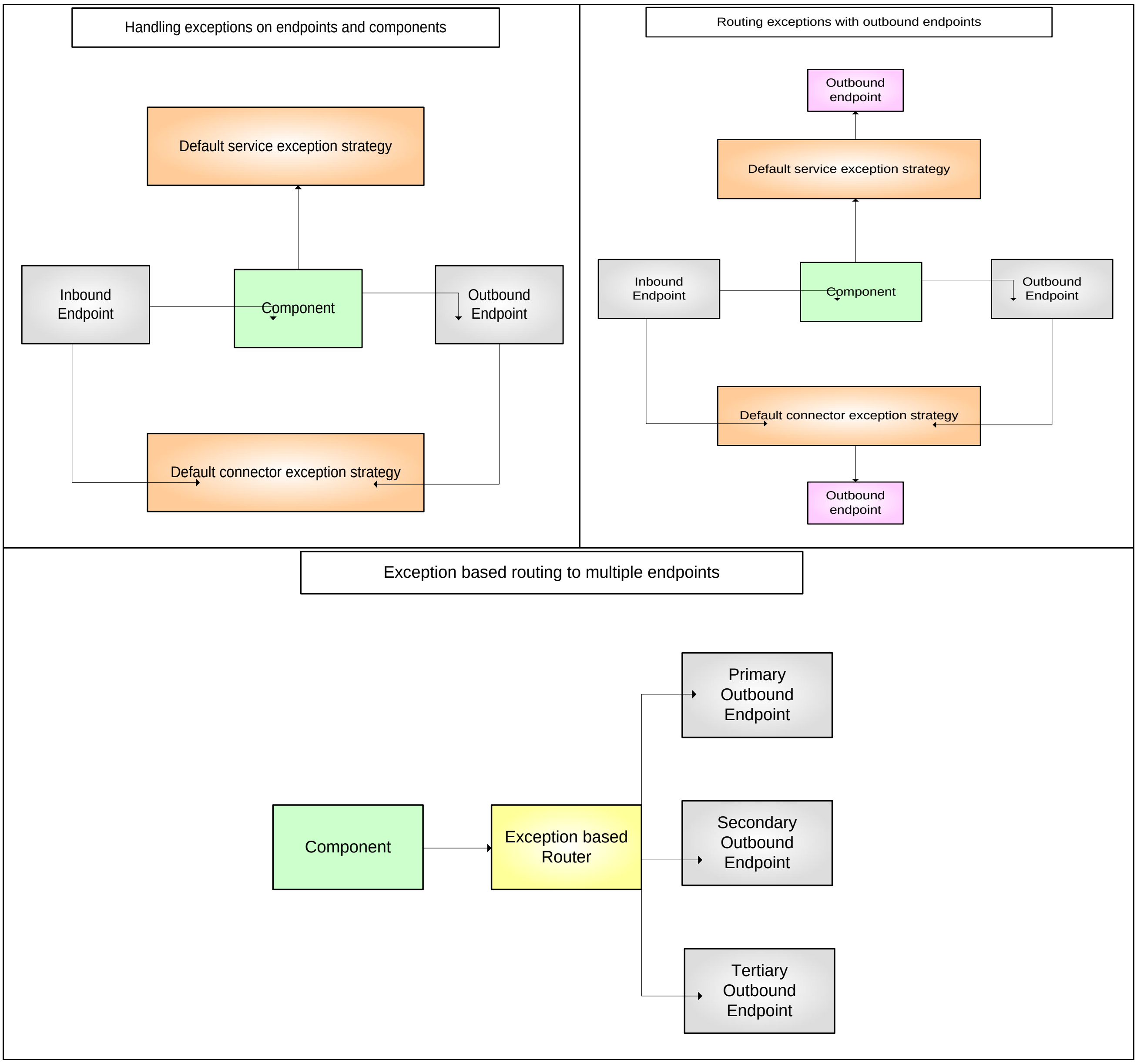


2.2.3.4 Exception Monitor

Mule uses exception strategies to handle failures in connectors and components. Exception strategies will be configured on a per-model basis and/or per service basis. The default exception strategy for connectors is responsible for handling transport related exceptions – such as errors on an HTTP/HTTPS endpoint, or a connection failure on a Database component. The default exception strategy for services handles exceptions that occur in components. Being able to define separate exception strategies for connectors and components will let Service Delivery Gateway handle each sort of error independently.

Service Delivery Gateway riding on Mule will allow to route exceptions by adding outbound endpoints to an exception strategy. This causes the exception strategy to send the exceptions through the endpoint as a message. The design guideline in the context of outbound routing is to provide multiple endpoints for a service to try in the event one of the endpoints is unavailable.

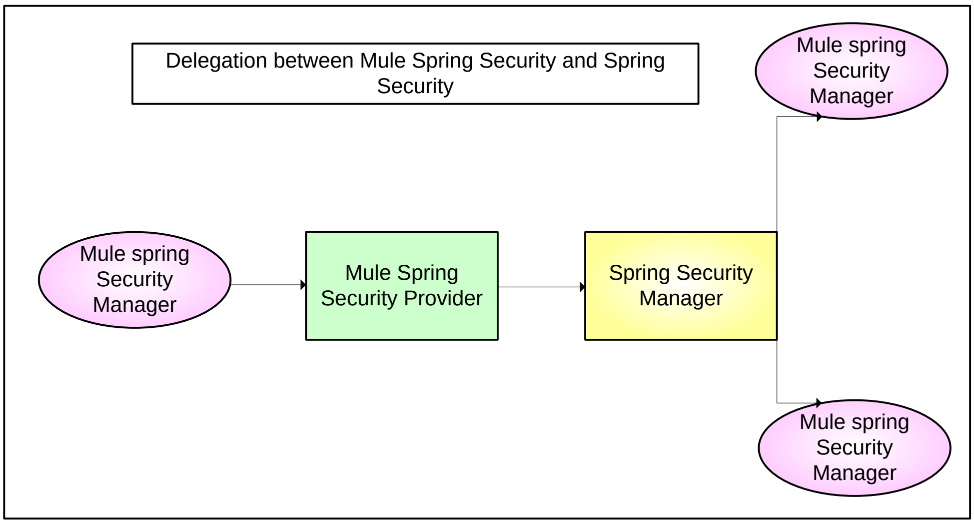
Service Delivery Gateway will use the Apache Commons Logging Framework to log the exceptions and errors with log4j utility as its default logging implementation. To deal with such text logs, Service Delivery Gateway's Exception Monitor will use Apache Chainsaw to graphically view and analyze the logs.



2.2.3.5 Security Framework

Mule Clusters running in the Service Delivery Gateway will offer Security functionalities for its components, endpoints, transformers and routers by Security Managers, which abstracts the details of the underlying security mechanism employed for the Nepal Government's Enterprise Architecture. These Security Managers will not only provide basic security like password and key based encryptions but also common backend authentication and authorization like Spring Security, JAAS, PGP etc against memory and LDAP databases.

Service Delivery Gateway will use Mule's Security Manager to broker authentication to the security provider and the backend security resource such as JDBC compliant database of user accounts and/or LDAP directory.



Service Delivery Gateway will use Security Filters to control access, authorization, and encryption of its inbound and outbound endpoints using Spring Security.

2.2.3.5.1 Securing an HTTP Endpoint

Service Delivery Gateway will use an inbound HTTP endpoint with the HTTP security filter. The HTTP Security Filter will attempt to authenticate every HTTP request it receives using HTTP basic authentication. Requests that do not contain a basic authentication header or whose header does not pass validation by the relevant Security Manager are not passed by the filter. Please note that Service Delivery Gateway can swap out the authentication mechanism from in-memory DAO to LDAP directory by simply changing the delegate reference inside the Security Manager. No changes need to be made in the configurations of the Security Filters.

2.2.3.5.2 Password based Payload Encryption

Mule configurations in the Service Delivery Gateway will set the password encryption strategy. The Encrypt Transformer will then be used to encrypt the outbound message payload before it is placed for consumption. When the message is received, it is decrypted by the Decrypt Transformer at the consumer end. Both the Encrypt Transformer and the Decrypt Transformer refer to the same Encryption Strategy set in the configurations.

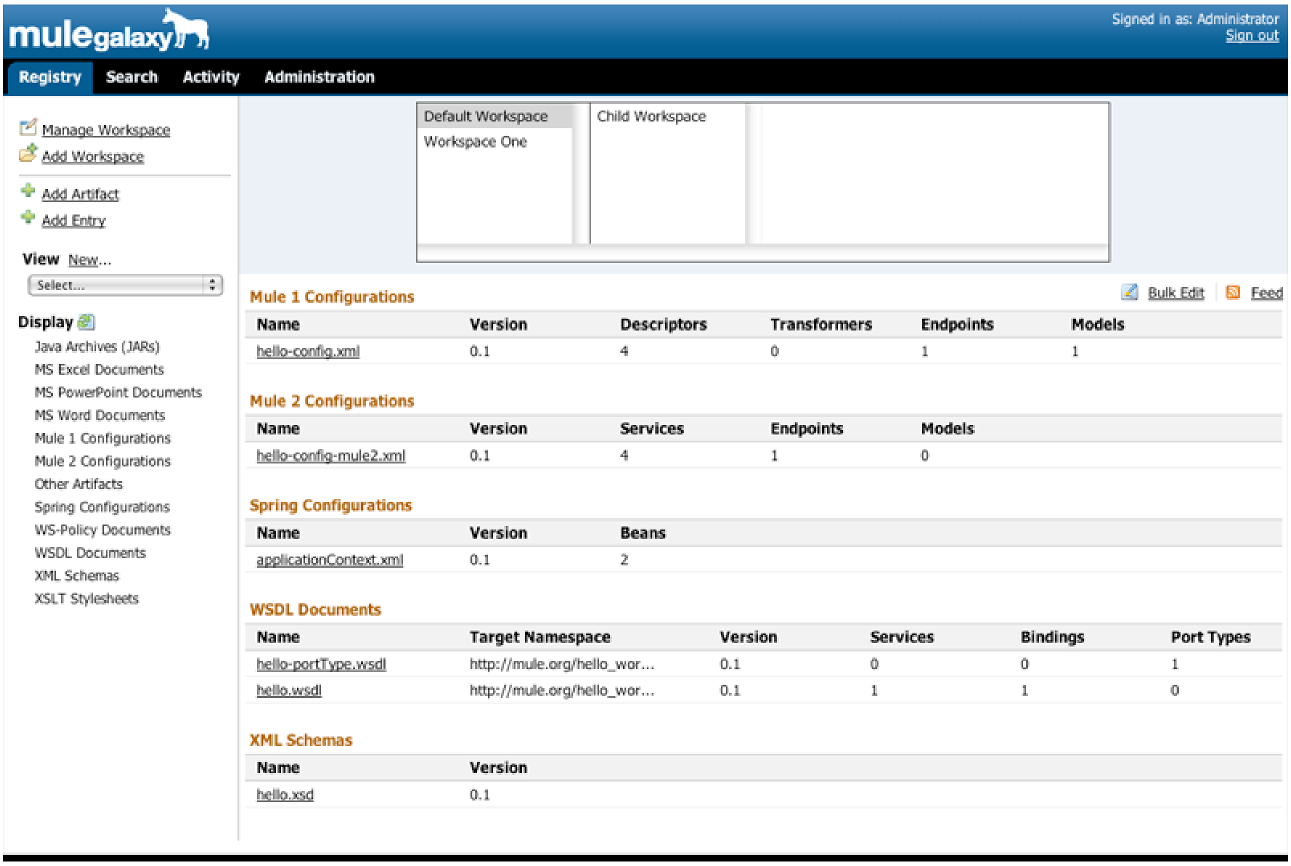
2.2.3.5.3 Public Key Encryption

Public key encryption uses key pairs instead of shared keys. When the Service Provider wants to send a message, it can encrypt the message using Service Delivery Gateway's public key. Service Delivery Gateway is then able to decrypt the message using its private key. The Gateway can then perform any logic or transformations on the payload and can again transmit using the Service Consumer's public key. Signing and verification can also be similarly done to guarantee the authenticity of the message.

PGP is a popular protocol for performing public key encryptions. Mule Clusters in the Service Delivery Gateway will use the Cryptix library's PGP support in the abstraction of Security Filters to perform decryption and signature verification of messages.

2.2.3.6Galaxy

Galaxy is a complete governance platform that will allow Service Delivery Gateway to fully manage the Mule Clusters deployed. Galaxy aids in the management of SOA by providing features such as lifecycle, dependency and artefact management, service discovery and reporting, and application deployment management.



2.2.3.6.1 Artefact Repository

Artifacts of the Service Delivery Gateway will be stored in Workspaces that are themselves organized as hierarchies. Artifacts will be versioned and they will support lifecycle phases that represent their maturity state. Galaxy will expose its content over the ATOM publishing protocol; it will also be possible to select artifacts by using the Galaxy Query Language. A number of artifact types will be maintained in the repository, including:

- Mule configurations
- Spring configurations
- XSLT stylesheets
- XML schemas
- WSDL documents
- WS-Policy documents

Artifacts progress through lifecycle phases inside Galaxy. This helps users and administrators make informed judgments about the state of the artifact and manage each stage of its lifecycle. For example, a QA team can look for artifacts inside the repository that are in the Developed phase, perform the necessary testing on them, and migrate them to the Tested phase. There is one default lifecycle in Galaxy. The phases occur in this order:

- Created
- Developed
- Tested
- Staged
- Deployed
- Retired

2.2.3.6.2 Registry

Galaxy will offer a full fledged registry service as it can deduce dependencies between configuration files including WSDL and XSD (s) used by Mule.

2.2.3.6.3 Governance Platform

Because it understands what it stores, Galaxy will enforce custom policies to ensure that diverse constraints are respected like enforcing the backward compatibility of all WSDL files. Galaxy also contains an integrated audit trail system that will allow Service Delivery Gateway to track all repository operations.

2.3 Service Design Principles

Service orientation represents a design approach comprised of eight specific design principles. Service contracts adhere to most but not all of these design principles.

2.3.1 Standardized Service Contract

The design principle of Standardized Service Contract states that the services within the same service inventory are in compliance with the same contract design standards.

Given the name, it is conclusive that this design principle is only about service contracts and the requirements for them to be consistently standardized within the boundary of a service inventory. This design principle essentially advocates “contract first” design for services.

2.3.2 Service Loose Coupling

The design principle of Service Loose Coupling states that the service contracts impose low consumer coupling requirements and are themselves decoupled from their surrounding environment.

This principle also relates to the service contract. Its design and how it is architecturally positioned within the service architecture are regulated with a strong emphasis on ensuring that only the right type of content makes its way into the contract in order to avoid the negative coupling types. Following sections enumerate common types of coupling – all are considered negative coupling types, except for the last.

2.3.2.1 Contract to Functional Coupling

Service contracts can become dependent on outside business processes, especially when they are coupled to logic that was designed directly in support of these processes. This can result in contract to functional coupling, whereby the contract expresses characteristics that are specifically related to the parent business logic.

2.3.2.2 Contract to Implementation Coupling

When details about a service's underlying implementation are embedded within a service contract, an extent of contract to implementation coupling is formed. This negative coupling type commonly results when service contracts are a native part of the service implementation or when they are auto-generated and derived from implementation resources such as legacy APIs, components and databases.

2.3.2.3 Contract to Logic Coupling

The extent to which a service contract is bound to the underlying service programming logic is referred to as contract to logic coupling. This is considered a negative type of service coupling because service consumer programs that bind to the service contract end up also inadvertently forming dependencies on the underlying service logic.

2.3.2.4 Contract to Technology Coupling

When the contract exposed by a service is bound to non standard communication technology, it forms an extent of contract to technology coupling. Although this coupling type could be applied to the dependencies associated with any proprietary technology, it is used exclusively for communication technology because that is what service contracts are generally concerned with.

2.3.2.5 Logic to Contract Coupling

Each of the previously mentioned forms of coupling are considered negative because they can shorten the lifespan of a Web Service Contract, thereby leading to increased governance burden as a result of having to manage service contract versions.

2.3.3 Service Abstraction

The design principle of Service Abstraction states that the service contracts contain only essential information and information about services is limited to what is published in service contracts.

By turning services into black boxes, the contracts are all that is officially available to consumer designers who want to use the services. While much of this principle is about the controlled hiding of information by service owners, it also advocates the stream lining of contract content to ensure that only essential content is made available.

2.3.4 Service Reusability

The design principle of Service Reusability states that services contain and express agnostic logic and can be positioned as reusable Enterprise Resources.

While this design principle is certainly focussed on ensuring that service logic is designed to be robust and generic, these qualities also carry over into contract design. When viewing the service as a product and its contract as a generic API to which potentially many consumer programs will need to interface, the requirement emerges to ensure that the services' functional context, the definition of the capabilities, and the level at which each of its design granularities are set are appropriate for it to be positioned as a reusable Enterprise resource.

2.3.5 Service Autonomy

The design principle of Service Autonomy states that the services exercise a high level of control over their underlying runtime execution environment.

2.3.6 Service Statelessness

The design principle of Service Statelessness states that the services minimize resource consumption by deferring the management of state information when necessary.

2.3.7 Service Discoverability

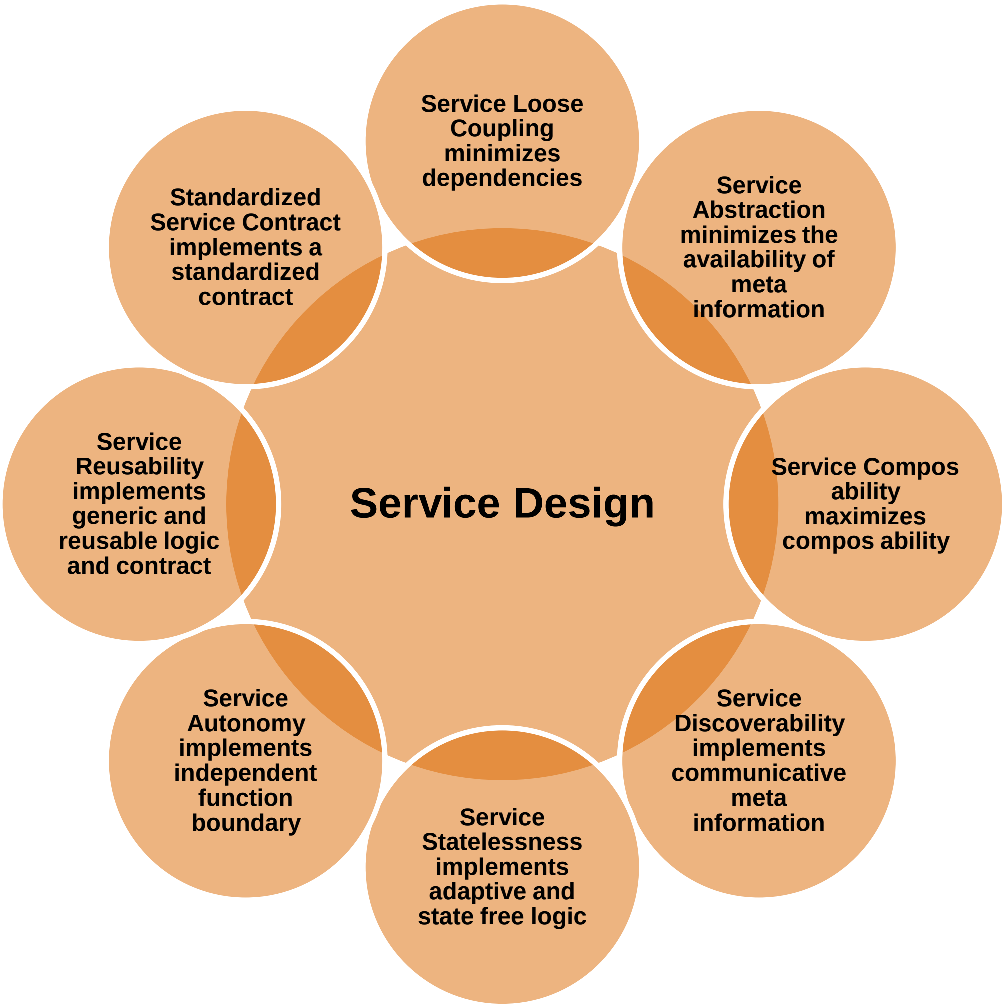
The design principle of Service Discoverability states that the services are supplemented with communicative Meta Data by which they can be effectively discovered and interpreted.

Because the service contracts usually represent all that is made available about a service, they are what this principle is primarily focussed on when attempting to make each service as discoverable and interpretable as possible by a range of project team members.

2.3.8 Service Compos ability

The design principle of Service Compos ability states that the services are effective composition participants, regardless of the size and complexity of the composition.

This regulatory design principle is very concerned with ensuring that service contracts are designed to represent and enable services to be effective composition participants. The contracts must therefore adhere to the requirements of the previously mentioned design principles and also take multiple and complex service composition requirements into account.



2.4 Service Design Patterns

Service Design Patterns provide a proven solution to a common problem in context, individually documented in a consistent format. As with design principles, the following design patterns can be applied to various measures.

2.4.1 Service Inventory Design Patterns

Service Inventory represents a collection on independently standardized and governed services. Design patterns associated with the design of the service inventory are provided below.

2.4.1.1 Foundational Inventory Patterns

Foundational Inventory Patterns provide the baseline design characteristics of the service inventory.

2.4.1.1.1 Enterprise Inventory

Enterprise Inventory addresses how services can be delivered to maximize re-composition.

Problem	• Delivering services independently • Different project teams • Inconsistent services and architecture implementations
Solution	• Services for multiple solutions can be designed for delivery within a standardized, enterprise wide inventory architecture where they can be repeatedly composed
Application	• The enterprise service inventory is modelled in advance • Enterprise wide standards are applied to services delivered by different project teams
Impacts	• Enterprise inventory blueprint • Organizational impacts
Principles	• Standardized Service Contracts • Service Abstraction • Service Composability
Architecture	• Enterprise • Inventory

2.4.1.1.2 Service Normalization

Service Normalization addresses how a service inventory can avoid redundant service logic.

Problem	• Risk of services being created with overlapping functional boundaries • Minimal wide spread reuse
Solution	• The service inventory needs to be designed with an emphasis on service boundary alignment
Application	• Functional service boundaries are modeled as a part of a formal analysis process and persist throughout inventory design and governance
Impacts	• Introduces extra up-front analysis • Introduces on-going governance effort
Principles	• Service Autonomy
Architecture	• Inventory • Service

2.4.1.1.3 Service layers

Service Layers address how the services in an inventory be organized based on functional commonality.

Problem	• Arbitrarily defining services by different project teams can lead to design inconsistency and functional redundancy across service boundary
Solution	• Structure in two or more service layers • Each layer is responsible for abstracting logic based on a common functional type
Application	• Service models are chosen • Form the basis for service layers establishing modeling and design standards
Impacts	• Accept common costs and impacts associated with design standards and upfront analyses
Principles	• Service Reusability • Service Composability
Architecture	• Inventory • Service

2.4.1.1.4 Canonical Schema

Canonical Schema addresses how services can be designed to avoid data model transformation.

Problem	• Services with disperate models for similar data impose transformation requirements • Increases design and development effort and performance overhead
Solution	• Data models for common information sets are standardized across service contracts within inventory boundary
Application	• Design standards are applied to schemas used by service contracts as part of formal design process
Impacts	• Sygnificant governance effort • Sygnificant cultural challenges
Principles	• Standardized Service Contract
Architecture	• Inventory • Service

2.4.1.2 Logical Inventory Layer Patterns

Logical Inventory Layer Patterns address how services within a service inventory can be grouped into logical layers.

2.4.1.2.1 Entity Abstraction

Entity Abstraction addresses how agnostic business logic can be separated, reused and governed independently.

Problem	• Process agnostic and process specific business logic are bundled into same service • Creation of redundant logic across multiple services
Solution	• An agnostic business service layer can be established, dedicated to services that base their functional context on existing business entities
Application	• Derive entity service contexts from business entity models • Establish a logical layer during the analysis phase
Impacts	• Extra modeling and design attention • Governance requirements
Principles	• Service Loose Coupling • Service Abstraction • Service Reusablity and Composability
Architecture	• Inventory • Composition • Service

2.4.1.2.2 Process Abstraction

Process Abstraction addresses how non-agnostic process logic can be separated and governed independently.

Problem	• Task centric logic and task agnostic logic are grouped together • Hinders governance of task speific logic and reuse of task agnostic logic
Solution	• Establish a dedicated parent business process service layer
Application	• Business process logic is typically filtered out after utility and entity services have been defined
Impacts	• Modeling and design considerations • Abstarcting parent business process logic establishes an inherent dependency on carrying out the logic
Principles	• Service Loose Coupling • Service Abstraction • Service Composability
Architecture	• Inventory • Composition • Service

2.4.1.3 Inventory Implementation Patterns

Inventory Implementation patterns address a variety of implementation design issues and options for service inventory.

2.4.1.3.1 Canonical Resources

Canonical Resources address how unnecessary infrastructure resource disparity can be avoided.

Problem	• Service implementations can unncessarily introduce disperate infrastructure resources, thereby bloating the enterprise and resulting in increased governance burden
Solution	• The supporting infrastructure and architecture can be equipped with common resources and extensions that can be repeatedly utilized by different services
Application	• Enterprise design standards are defined to formalize the required us of standardized architectural resources
Impacts	• If this pattern leads to too much dependency on shared infrastructure resources, it can decrease the autonomy and mobility of services
Principles	• Service Autonomy
Architecture	• Inventory • Enterprise

2.4.1.3.2 State Repository

State Repository addresses how service state data can be persisted for extended periods without consuming service runtime resources.

Problem	• Large amounts of state data cached to support the activity within a running service can consume too much memory, decreasing scalability
Solution	• State data can be temporarily written to and then later retrieved from a dedicated data repository
Application	• A shared or dedicated memory is made available as part of the inventory or service architecture
Impacts	• Additional read/write increases service design complexity • Negative effect on performance
Principles	• Service Statelessness
Architecture	• Inventory • Service

2.4.2 Service Design Patterns

Service Design Patterns specifically address the design of Web Services.

2.4.2.1 Foundational Service Patterns

Foundational Service Patterns establish fundamental service design characteristics via suggested application sequence.

2.4.2.1.1 Functional Decomposition

Functional Decomposition addresses how a large business problem can be solved without having to build a standalone body of solution logic.

Problem	• To solve a large complex business problem a corres- ponding amount of solution logic needs to be created resulting in self contained application with traditional governnance and reusability constraints
Solution	• Break down the larger problem into smaller related problems • Decompose solution logic into smaller related solution logic units
Application	• Depending on the nature of the large problem, a service oriented analysis process can be created to deconstruct it into smaller problems
Impacts	• The ownership of multiple smaller programs can result in increased design complexity and governance challenges
Principles	• n/a
Architecture	• Service

2.4.2.1.2 Service Encapsulation

Service Encapsulation addresses how solution logic can be made available as a resource of the enterprise.

Problem	• Solution logic designed for a single app environment is typically limited in its potential to interoperate with or be leveraged by other parts of the enterprise
Solution	• Solution logic can be encapsulated by a service so that it is positioned as enterprise resource capable of functioning beyond the boundary for which it is initially delivered
Application	• Solution Logic suitable for service encapsulation needs to be identified
Impacts	• Service encapsulated solution logic is subject to additional design and governance considerations
Principles	• n/a
Architecture	• Service

2.4.2.2Service Implementation Patterns

Service Implementation patterns provide design solutions for a range of service architecture specific issues

2.4.2.2.1 Service Façade

Service Façade addresses how a service can accommodate changes to its contract or implementation while allowing the core service logic to evolve independently.

Problem	• The coupling of teh core service logic to contracts and implementation resources can inhibit its evolution and negatively impact service consumers
Solution	• A service facade component is used to abstract a part of the service architecture with negative coupling potential
Application	•A separate facade component is incorporated into the service design
Impacts	• The addition of the facade component introduces design effort and performance overhead
Principles	• Standardized Service Contract • Service Loose Coupling
Architecture	• Service

2.4.2.2.2 Partial Validation

Partial Validation addresses how unnecessary data validation can be avoided.

Problem	• The generic capabilities provided by agnostic services sometimes result in contracts that impose unnecessary data and validation upon consumer programs
Solution	• A consumer program can be designed to only validate the relevant subset of the data and ignore the remainder
Application	• For web Services, X-Path can be used to filter out necessary data prior to validation
Impacts	• Extra design time effort • Runtime data filtering logic
Principles	• Standardized Service Contract • Service Loose Coupling
Architecture	• Composition

2.4.2.2.3 UI Mediator

UI Mediator addresses how a service oriented solution can provide a consistent interactive user experience.

Problem	• The consistency with which services respond to user requests originating from an user interface can fluctuate leading to a poor user experience
Solution	• Establish mediator between services layer and presentation logic
Application	• A utility mediator logic is positioned as the initial recipient of messages originating from UI. • This mediator responds in a timely and consistent manner
Impacts	• Additional layer of processing • Run time processing overhead
Principles	• Service Loose Coupling
Architecture	• Composition

2.4.2.3 Service Security Patterns

Service Security Patterns primarily shape the internal logic of services to equip them with security controls that encounter common threats.

2.4.2.3.1 Exception Shielding

Exception Shielding addresses how a service can prevent the disclosure of information about its internal implementation when an exception occurs.

Problem	• Unfiltered exception data output by a service may contain internal implementation details that can compromise the security of the services
Solution	• Potentially unsafe exception data is sanitized by replacing it with exception data that is safe by design
Application	• Design time review • Alter source code • Add dynamic sanitization routines
Impacts	• Tracking of errors become more difficult
Principles	• Service Abstraction
Architecture	• Service

2.4.2.3.2 Message Screening

Message Screening addresses how a service can be protected from malformed or malicious input.

Problem	• An attacker can transmit messages with malicious or malformed content to a service resulting in undesirable behaviour
Solution	• The service is equipped with special screening routines that assume all input data is harmful unless proven otherwise
Application	• When a service receives message, it makes a number of checks to screen message content for harmful data
Impacts	• Extra runtime processing for binary message content • May not be possible to check all possible harmful content
Principles	• Standardized Service Contract
Architecture	• Service

2.4.2.3.3 Trusted Subsystem

Trusted Subsystem addresses how a consumer can be prevented from circumventing a service and directly accessing its resources.

Problem	• A consumer that accesses backend resources of a service directly can compromise the integrity of the resources
Solution	• The service is designed to use its own credentials for authentication and authorization with backend resources on behalf of consumers
Application	• Depending upon the nature of the underlying resources, various design options and security technologies can be applied
Impacts	• If this type of service is compromised by attackers, it can be exploited to gain access to a wide range of downstream resources
Principles	• Service Loose Coupling
Architecture	• Service

2.4.2.4 Legacy Encapsulation Patterns

Legacy Encapsulation Patterns address how services can encapsulate and interact with legacy systems and resources.

2.4.2.4.1 Legacy Wrapper

Legacy Wrapper addresses how wrapper services with non standard contracts can be prevented from spreading indirect consumer to implementation coupling.

Problem	• Wrapper services required to encapsulate legacy logic are often forced to introduce non standard contract with high technology coupling requirements
Solution	• The non standard wrapper service can be replaced by standardized contract that extracts, encapsulates and eliminates legact technical details from the contract
Application	• A custom service contract and required service logic need to be developed to represent the proprietary legacy interface
Impacts	• Additional layer of processing • Associated performance overhead
Principles	• Standardized Service Contract • Service Loose Coupling • Service Abstraction
Architecture	• Service

2.4.2.4.2 Multi-channel Endpoint

Multichannel Endpoint addresses how legacy logic fragmented and duplicated for different delivery channels is centrally consolidated.

Problem	• Legacy systems custom built for specific delivery channels (desktop, kiosk, mobile) result in redundancy when multiple channels need to be supported, making them difficult to govern and federate
Solution	• An intermediary service is designed to encapsulate channel-specific legacy system and expose a single standardized contract for multi channel specific consumer
Application	• Significant processing and workflow logic to support multiple channels • Coordinate interaction with multi backend legacy systems
Impacts	• Infrastructure upgrades • Requires orchestration-capable middleware • Performance bottleneck
Principles	• Service Loose Coupling • Service Reusability
Architecture	• Service

2.4.2.4.3 File Gateway

File Gateway addresses how service logic can interact with legacy systems that can only share information by exchanging files.

Problem	• Data records in flat files produced by legacy systems need to be processed individually by service logic but legacy system is not capable of directly invoking services and conversely
Solution	• Intermediary two way file processing logic is positioned between the legacy system and the service
Application	• For inbound data, avail broker features for model and format transformations • For outbound data, intercept and package into new files for consumption by legacy system
Impacts	• Unsuitable when synchronous replies are required • Operation complexity and specialized administration skills
Principles	• Service Loose Coupling
Architecture	• Service

2.4.2.5 Service Governance Patterns

For Services already deployed and in use, Service Governance Patterns address common governance issues related post implementation changes.

2.4.2.5.1 Version Identification

Version Identification addresses how consumers can be made aware of service contract version information.

Problem	• When an already published service contract is changed, unaware consumers will not be able to leverage the change or may be negatively impacted
Solution	• Versioning information pertaining to compatible and incompatible changes can be expressed as a part of the contract, both for communicaton and enforcement purpose
Application	• With Web Service contracts, version numbers can be incorporated into namespace values and annotations
Impacts	• Version information expressed in proprietary vocabulary • To be understood by consumer designers in advance
Principles	• Standardized Service Contract
Architecture	• Service

2.4.2.5.2 Proxy Capability

Proxy capability addresses how a service subject to decomposition can continue to support consumers.

Problem	• If an established service needs to be decomposed into multiple services, its contract and its existing consumers can be impacted
Solution	• The original service contract is preserved • Underlying capability logic is separated • Establish capability definition into a proxy
Application	• Facade logic needs to be introduced • Relay requests and responses between the proxy and newly located capabilities
Impacts	• Measure of service de-normalization
Principles	• Service Loose Coupling
Architecture	• Service

2.4.3 Service Composition Design Patterns

Service Composition Design Patterns address service composition design and runtime interaction.

2.4.3.1 Service Messaging Patterns

Service Messaging Patterns address inter-service message exchange and processing.

2.4.3.1.1 Intermediate Routing

Intermediate Routing addresses how dynamic runtime factors affect the path of a message.

Problem	• Difficult to anticipate and design all possible runtime scenarios in advance, especially with asynchronous messaging based communication
Solution	• Merger paths can be dynamically determined through th euse of intermediary routing logic in the ESB
Application	• Various types of intermediary routing logic in the ESB can be incorporated to create message paths based on message content
Impacts	• Development effort • Design complexity
Principles	• Service Loose Coupling • Service Reusability • Service Composability
Architecture	• Composition

2.4.3.1.2 Event Driven Messaging

Event Driven Messaging addresses how service consumers can be automatically notified of runtime service events.

Problem	• Events that occur in the source subsystem may be of relevance to service consumers but without resorting to inefficient polling based interaction
Solution	• The consumer establishes itself as a subscriber of the service • The service in turn issues notifications of relevant events
Application	• Messaging framework in the ESB is implemented capable of supporting pub-sub MEP and associated event processing and tracking
Impacts	• Development effort • Design complexity
Principles	• Service Reusability • Service Loose Coupling
Architecture	• Inventory • Composition

2.4.3.2 Transformation Patterns

2.4.3.2.1 Data Model Transformation

Data Model Transformation addresses how services can interoperate when using different data models for the same type of data.

Problem	• Services may use incompatible schemas to represent the same data, hindering service interaction and composition
Solution	• Data transformation technology offered by the ESB can be incorporated to convert data between disperate schema structures
Application	• Mapping logic model needs to be introduced • Convert data compliant to one data model to comply to a different data model
Impacts	• Development effort • Design complexity • Runtime performance inhibiting recomposition potential
Principles	• Service Reusability • Service Composability
Architecture	• Inventory • Composition

2.4.3.2.2 Data Format Transformation

Data Format Transformation addresses how services can interact with programs that communicate with different data formats.

Problem	• A service may be incompatible with resources due to data format disparity. A service consumer that communicates using a format different from the target will be incompatible
Solution	• Intermediate data format transformation logic needs to be introduced in the ESB in order to dynamically translate one data format to another
Application	• Additional transofrmation logic in the ESB • Dedicated transformation service exposed in the ESB
Impacts	• Development effort • Design complexity • Runtime performance
Principles	• Service Loose Coupling • Standardized Service Contract
Architecture	• Inventory • Composition

2.5 Guidelines on Enabling Services for Applications

The applications in the IT landscape of Nepal Government departments can be widely classified into the following set of platforms: Web based J2EE applications, Microsoft ASP DOT NET applications, Web based PHP applications and two tier applications with a Microsoft Access database. In order to expose the Business Services provided by these applications in the Service Delivery gateway, all these applications needs to be Web Service enabled. By being Web Service enabled, all these Business Services can be invoked by any other in the wider scope of the IT landscape. More pertinently, any departmental application or Portal can avail these Web enabled Business Services via the Service Delivery Gateway. All other consumers will imagine the Service Delivery Gateway as the provider of all the required Business Services and the gateway in turn will proxy, mediate and aggregate these services provided by all other departmental applications.

2.5.1 Prerequisites

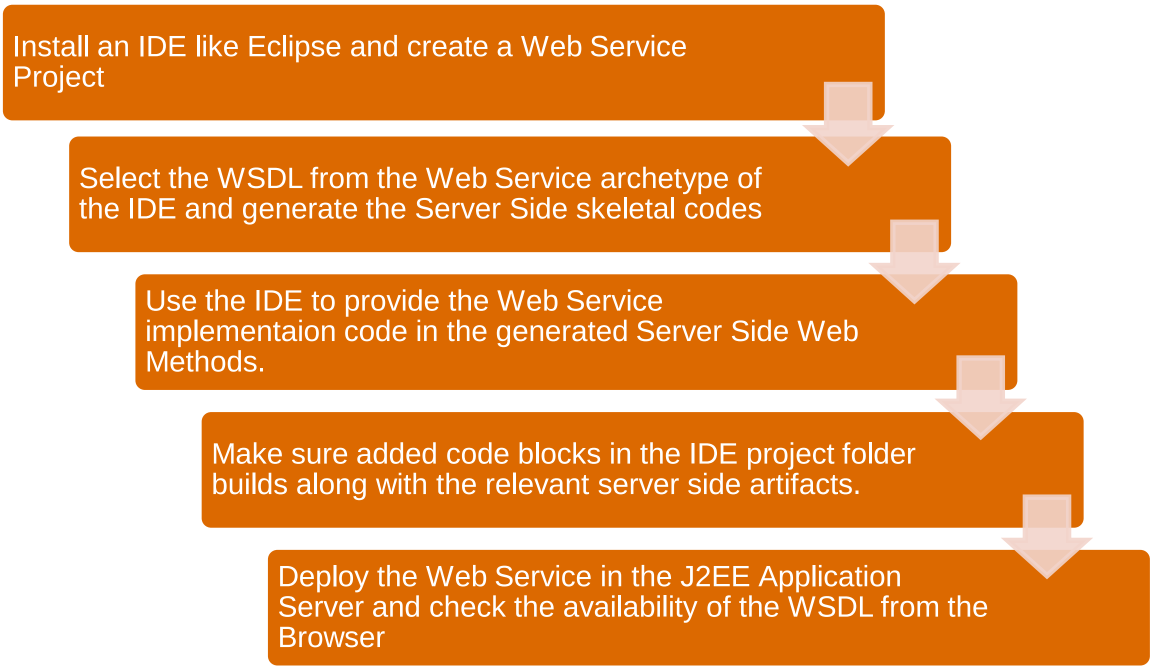
Following assumptions or prerequisites will seem to be relevant for the providers i.e. the applications in the departments providing the Business Services:

- The departmental application has LAN/WAN connectivity with the Service Delivery Gateway.
- The IT infrastructure hosting the Web Services of the departmental applications are robust enough to cater to the multitude of consumers across the Nepal Government's IT landscape.
- The Business Services hosted by the department applications abide by the schema, contracts, semantics and syntaxes specified by
- Reliability, performance, scalability, fault tolerance and high availability features have been addressed in the design and implementation of the departmental applications.
- In case of the two tier applications with the database like MS Access being primary custodian of the Business Services, the features of reliability, performance, scalability, fault tolerance and high availability features are provided by the database design and implementation.
- The Business Services provided by the departmental IT conform to the security provisions of the Nepal GEA Security specifications.
- The departmental IT participate in the Governance Strategies and Measures of the Service Delivery Gateway for maintaining the respective Business Services, adding newer versions, adding newer services, deprecating the older versions etc
- The hosts, ports and other connection information with respect to availability, monitoring, load balancing etc are made available to the Service Delivery Gateway Governance team

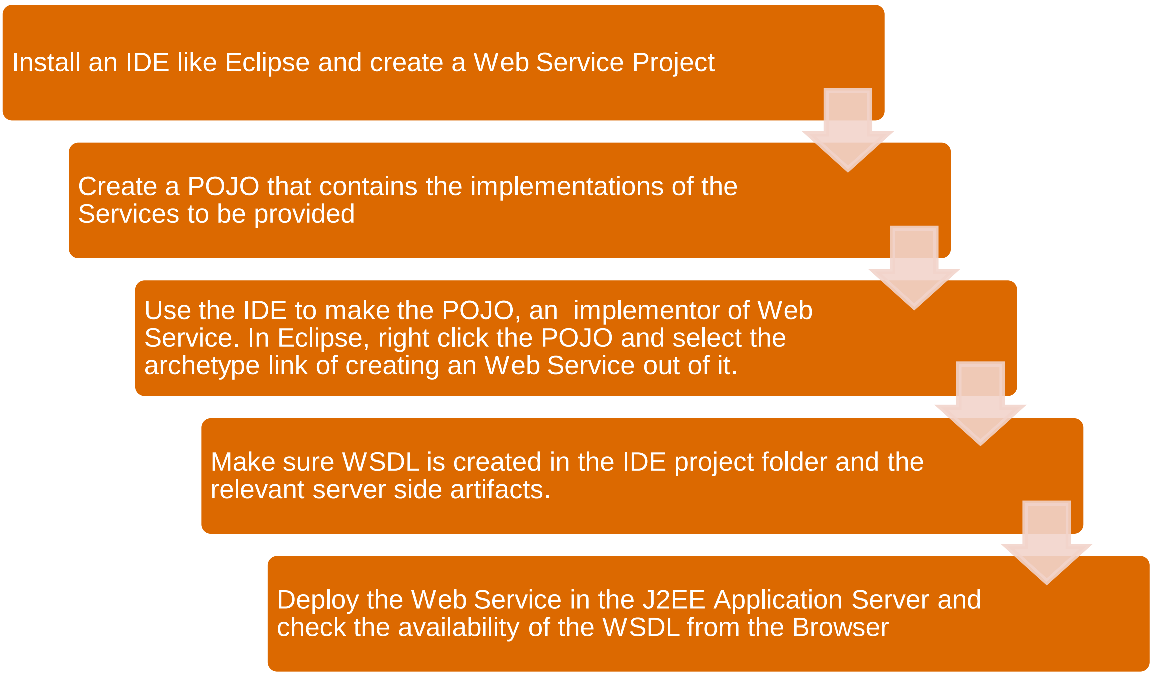
2.5.2 Web Based J2EE applications

There can be two approaches; one can take, in enabling the Business Services over the web. In the Contract first approach, start from the WDSL that has been prescribed by the Service Specifications team and the other is the Implementation first approach where the output WSDL is matched with that of the Service Specifications. Steps for the two approaches are enumerated below.

- Contract First: In this approach, the WSDL specified by the EA recommendations, serve as the starting point for generating the Web Services for the business functionalities.



- Implementation First: In this approach, the implementation for the business functionalities is done and then the API is exposed (built and deployed) as Web Services leading to the publication of the WSDL in conformance with that specified by the EA team.



2.5.3 Web based Microsoft DOT NET

The approach can be either Contract First or Implementation First as mentioned above. For the sake of simplicity only one is mentioned below. The business services provided by the application are exposed as Web

Services and deployed in the IIS, hosted by the departmental IT. Typically any DOT NET application will have a Business Logic layer which as a mediator between the ASPX layer and the ADO.NET layer. The business methods of this Business layer can be adapted to perform the Web Service features.

1. Create an ASP.NET Web Service Application using Visual Studio .The application has a file created in the name of default.asmx. You can rename the file accordingly.
2. This file will have the mapping information of the actual asmx.cs file which would have the methods that are to be exposed as web service.
3. In order to expose each method as Web Service the Class Methods inside the asmx.cs file need to have a declarative attribute statement [WebMethod] in front of it.
4. Build the application and start the IIS server to host the application.
5. You can now access the services from a browser by hitting the desired url.The web service deployment descriptor (wsdl) can be accessed by appending “?wsdl” to the url.

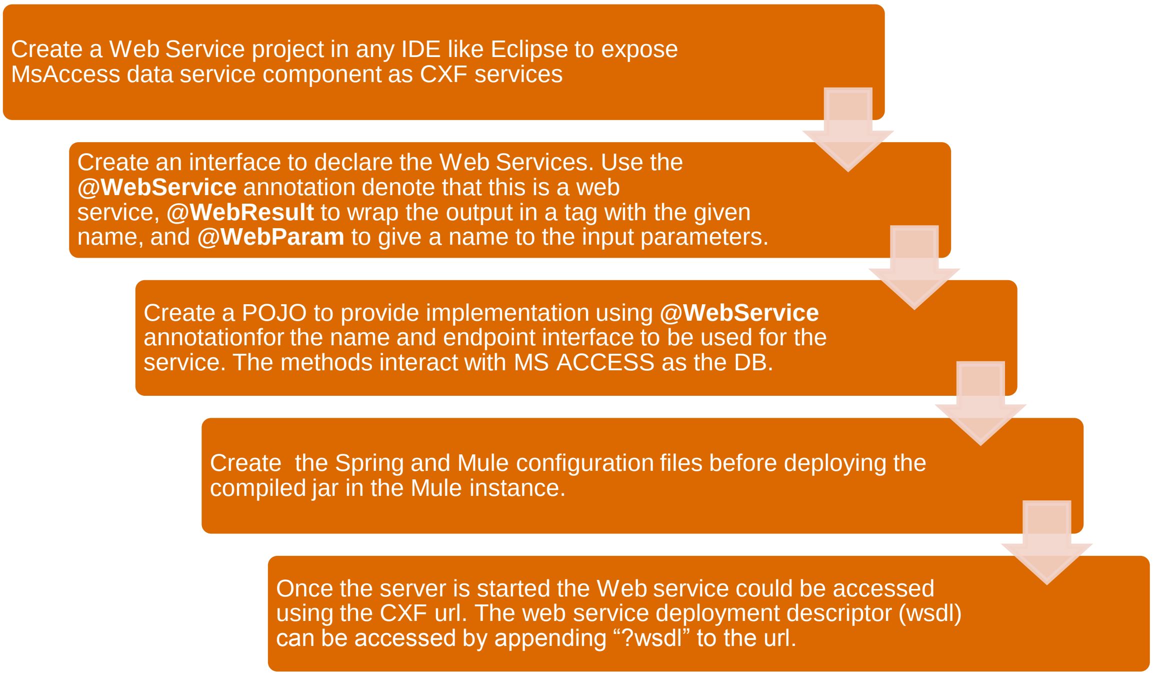
2.5.4 PHP Applications

The Nepal Government department providing business services in PHP platform will need to expose them as web services as mentioned below. It is recommended to move the version of the PHP platform to the latest version to avail the latest SOAP specifications and implementations for the latest WS-* recommendations.

1. Install the WAMP Server and download the SOAP extensions of the PHP. For example nusoap.php from the link http://www.nusphere.com/php_script/nusoap.htm
2. Create a new folder inside the “wamp\www” directory which will contain the php files for your application and place the “nusoap.php” inside the folder created.
3. Create you own php file which would contain the services to be exposed inside the same folder.
4. In the code, configure the WSDL, register the in/out parameters and the implentation of the method providing the service.
5. Start the WAMP Server and you can now access the services from a browser by hitting the desired url.The web service deployment descriptor (wsdl) can be accessed by appending “?wsdl” to the url.

2.5.5 Two Tier Architectures with MS Access backend

In the two tier architectural applications, which typically involve a database like MS Access as the persistent store, it is recommended for that departmental IT to expose the database in the LAN/WAN with relevant security credentials so that corresponding data services deployed in the Service Delivery Gateway can interact with the database. Neither web server nor 3-tier web application etc is required to be hosted by the departmental IT in this case. Relevant Web Services will need to be designed and authored by the Service Delivery Gateway team and deployed in the Mule environment. These web services will interact with the database over LAN/WAN using the security credentials specified by the Security Recommendations.



2.5.6 Indicative Mule Configuration

Mule will expose a web service that is running on a different server. The WSProxyService of Mule allows us to serve WSDLs locally while proxy-ing remote web services. Any request that comes in with a "?wsdl" attached to the HTTP URL will be redirected, and the specified WSDL will be served instead.

Requisite Namespace
<mule xmlns="http://www.mulesource.org/schema/mule/core/2.2"
xmlns:spring="http://www.springframework.org/schema/beans"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:http=http://www.mulesource.org/schema/mule/http/2.2

Requisite Namespace
< xsi:schemaLocation=" http://www.springframework.org/schema/beans http://www.springframework.org/schema/beans/spring-beans-2.5.xsd http://www.mulesource.org/schema/mule/http/2.2 http://www.mulesource.org/schema/mule/http/2.2/mule-http.xsd http://www.mulesource.org/schema/mule/core/2.2 http://www.mulesource.org/schema/mule/core/2.2/mule.xsd">

Configuration

```
<service name="ProxyLicenseService">
                <inbound>
                  <!-- WSDL URL: http://localhost:8888/stockquote.asmx?wsdl -->
                  <inbound-endpoint address="http://localhost:9999/proxyTelReg"
synchronous="true"/>
                </inbound>
                <outbound>
                  <chaining-router>
                    <outbound-endpoint
address="http://localhost:63821/LicenseService.asmx?wsdl" synchronous="true"/>
                  </chaining-router>
                </outbound>
              </service>
```

2.6 Guidelines on Service Contracts between Consumers and Producers

Service orientation places a great deal of emphasis on the design of service contracts between consumers and producers. The Standardized Service Contract Design principle requires that all contracts within a given service inventory conform to the same conventions so as to establish a truly federated endpoint layer.

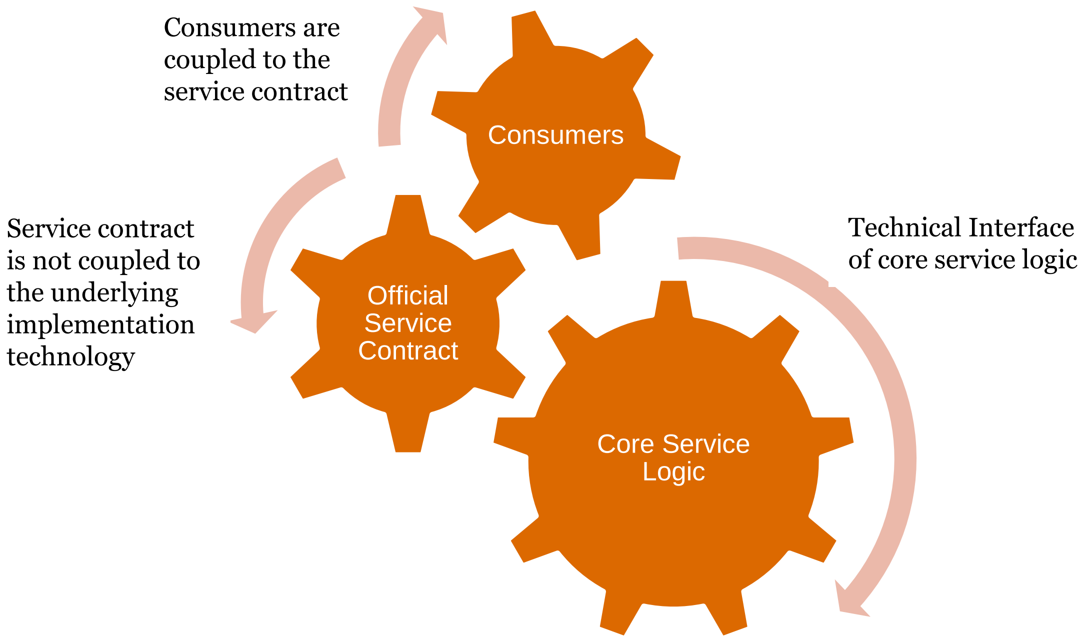
2.6.1 Decoupled Contract

The guideline of Decoupled Contract answers to the following question – how can a service express its capabilities independently of its implementation?

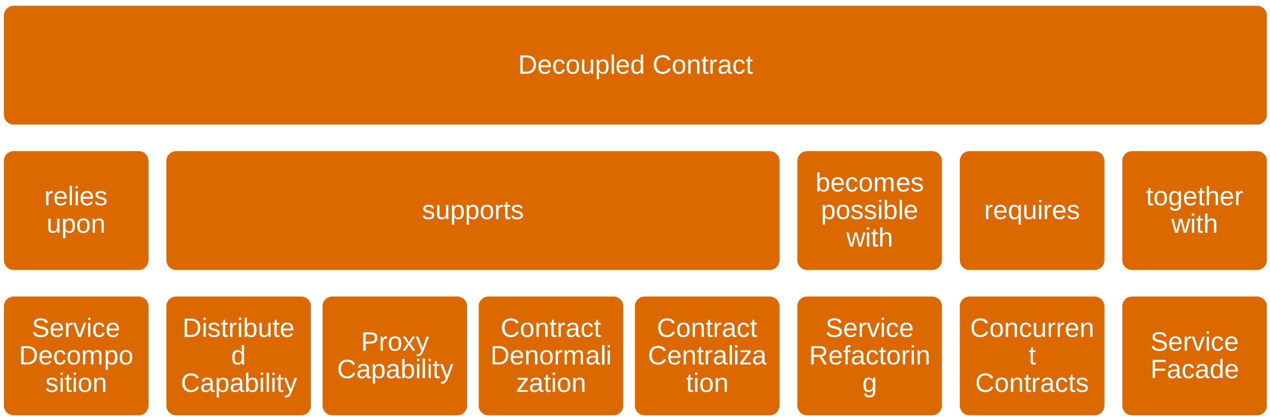
For a service to be positioned as an effective enterprise resource, it must be equipped with a technical contract that exists independently from its implementation yet still in alignment with other services.

The guideline is to make the service contract physically decoupled from its implementation.

A service's technical interface is physically separated and subject to relevant service orientation design principles.



Decoupled Contract establishes an important separation of logic, technology and technical interface that can be leveraged by many other design patterns.



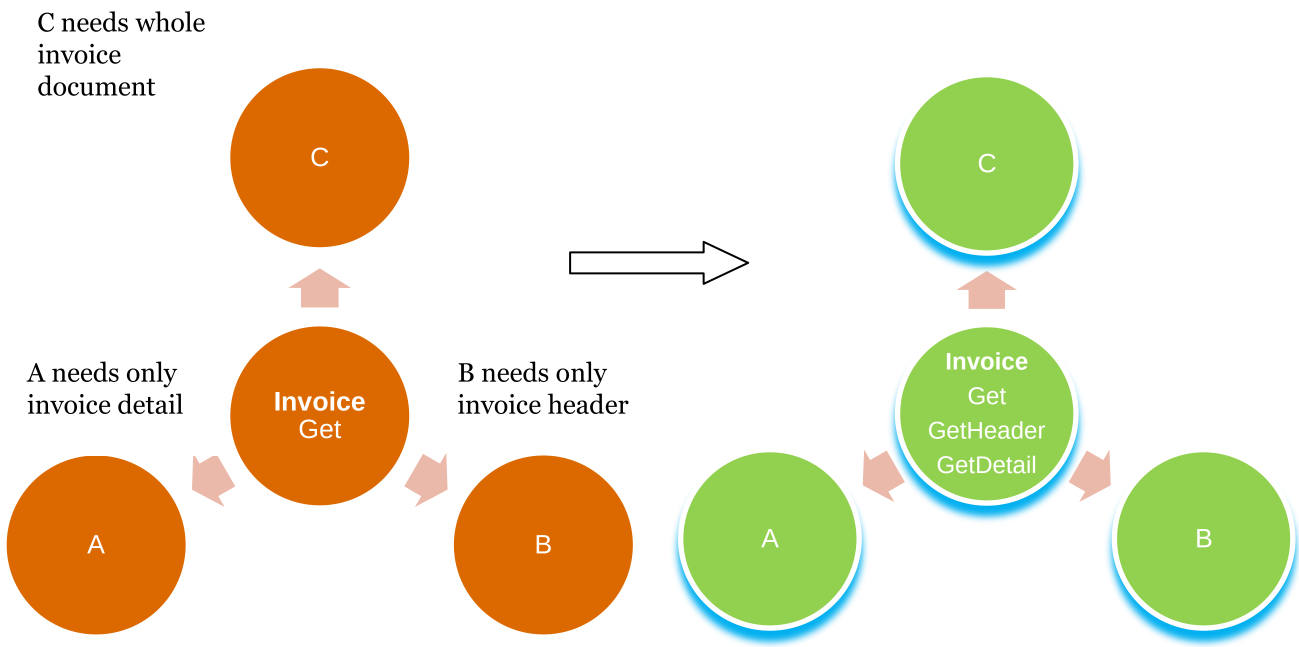
2.6.2 Contract De-normalization

The guideline of Contract De-normalization answers to the following question – how can a service contract facilitate consumer programs with differing data exchange requirements?

Services with strictly normalized contracts can impose unnecessary functional and performance demands on some consumer programs.

Service contracts can include a measured extent of de-normalization, allowing multiple capabilities to redundantly express core functions in different ways for different types of consumer programs.

The service contract is carefully extended with additional capabilities that provide functional variations of a primary capability.



Contract De-normalization allows for the extension of contracts with redundant capabilities and therefore relates mostly to patterns that can support this requirement.

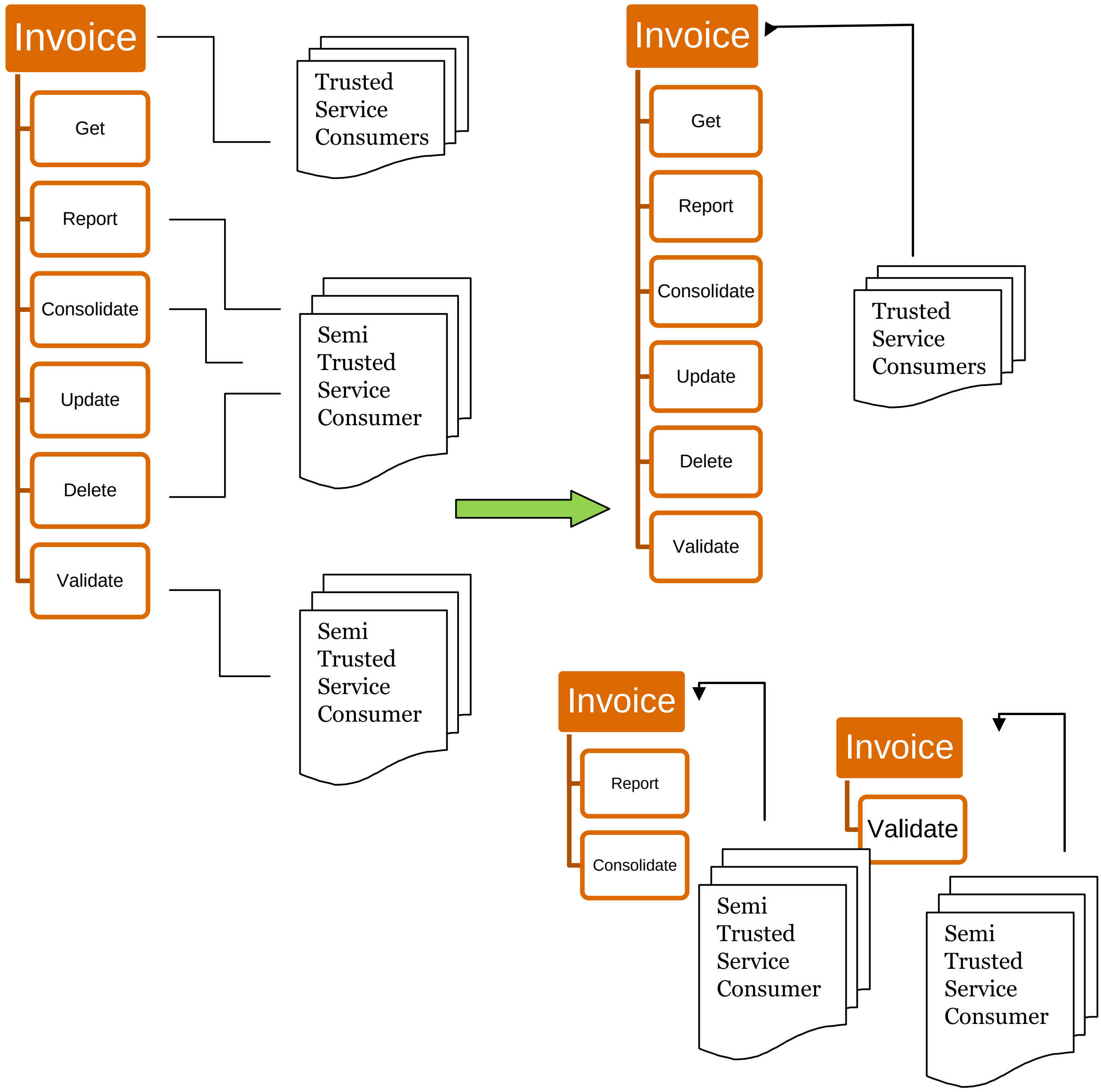
2.6.3 Concurrent Contracts

The guideline of Concurrent Contracts answers to the following question – how can a service facilitate multi-consumer coupling requirements and abstraction concerns at the same time?

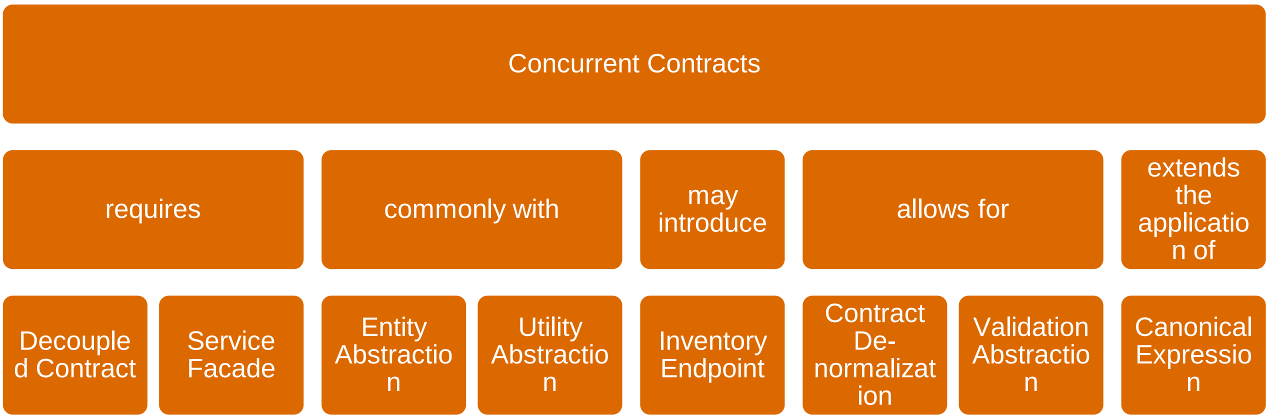
A service's contract may not be suitable for or applicable to all potential service consumers.

Multiple contracts can be created for a single service, each targeted at a specific type of consumer.

This guideline is ideally applicable together with Service Façade to support new contracts as required.



Concurrent Contracts relates to other contract related patterns that help support or are affected by the creation of multiple contracts for a single service.



2.6.4 Validation Abstraction

The guideline of Validation answers to the following question – how can service contracts be designed to more easily adapt to validation logic changes?

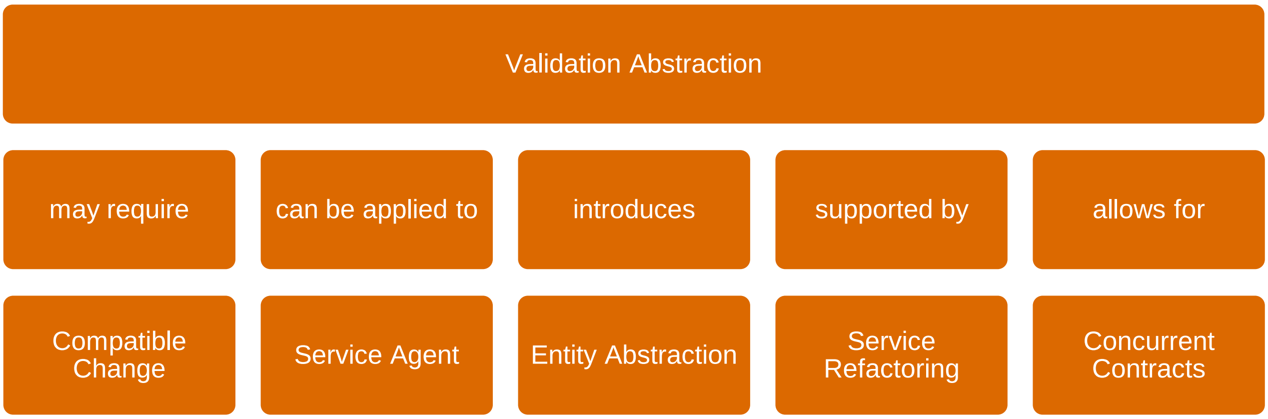
Service contracts that contain detailed validation constraints become more easily invalidated when the rules behind those constraints change.

Granular validation logic and rules can be abstracted away from the service contract, thereby decreasing constraint granularity and increasing the contract's potential longevity.

Abstracted validation logic and rules need to be moved to the underlying service logic, a different service, a service agent, or elsewhere. Examples of the types of Validation logic that the Validation Abstraction tends to target include:

- Detailed and granular validation constraints that express very specific conditions
- Constraints based upon precise value characteristics
- Constraints based on embedded enumeration value or code lists
- Policy expressions that define specific properties or behaviors derived from business rules

Validation Abstraction's goal of streamlining service contract can directly tie into the application of some patterns, while also meeting resistance from others.



2.7 Security Framework on Service Invocations

2.7.1 Data Confidentiality

The framework guideline of Data Confidentiality addresses how data within a message can be protected so that it is not disclosed to unintended recipients while in transit.

Within service compositions, data is often required to pass through one or more intermediaries. Point to point security protocols, such as those used frequently at the transport layer, may allow messages containing sensitive information to be intercepted and viewed by such intermediaries.

The message contents are encrypted independently from the transport as a part of the solution to the above problem. This ensures that only intended recipients can access the protected data.

A symmetric or asymmetric encryption and decryption algorithm, such as those specified in the XML encryption standard WS-Security is supplied at the message level.

This framework feature may add runtime performance overhead associated with the required encryption and decryption of message data. The management of keys can further add to the governance burden.

2.7.2 Data Origin Authentication

The framework feature of Data Origin Authentication addresses how a service can verify that a message originates from a known sender and the message has not been tampered while in transit.

The intermediary processing layers generally required by service composition can expose sensitive data when security is limited to point to point protocols, such as those used with Transport Layer Security.

As a part of the framework, the message is digitally signed so that the recipient services can verify that it originated from the expected consumer and that it has not been tampered with during transit.

A digital signature algorithm from within WS-Security standard, is applied to the message to provide "proof of origin", allowing sensitive message contents to be protected from tampering.

Message Authentication Code (MAC) is created by using a shared secret to sign and verify the message. MACs are generated by taking as input the checksum based on the message content and a shared secret. Each MAC can be verified only by a message recipient that has both the shared secret and the original message content that was used to create the MAC. MAC to be used in Web Services is the Hashed Message Authentication Code (HMAC), an algorithm that uses a shared secret and a hashing algorithm to create the signature that is then embedded in the message.

Asymmetric signatures can also be used, which are processed with two different keys. The private key is used for creating the signature and the public key for verifying it. For signing and encryption purposes, the framework proposes Public Key Infrastructure. Information that describes the consumer is bound to its public key through endorsement from a trusted party to form a certificate that allows message recipient to verify the private key in a received message signature to the public key in the sender's certificate.

The XML-Signature technology, which is a part of the WS-Security framework, is to be used to provide symmetric or asymmetric algorithms to SOAP message content.

Use of cryptographic techniques from the framework can add to the performance requirements and the choice of digital signing algorithm can affect the level of security actually achieved.

2.7.3 Direct Authentication

The framework feature of Direct Authentication addresses how a service can verify the credentials provided by a consumer.

Some of the capabilities offered by a service may be intended for specific groups of consumers or may involve the transmission of sensitive data. Attackers that access this data could use it to compromise the service.

Service capabilities require that consumers provide credentials that can be authenticated against the identity store of the enterprise. The service implementation is provided access to an identity store, allowing it to authenticate the consumer directly. The data stores required by this framework feature can be centralized or decentralized. The former model establishes a remote store that is shared by multiple services. A decentralized model enables some or all services to own their own individual identity stores.

2.7.4 Brokered Authentication

The guideline of Brokered Authentication addresses how a service can efficiently verify consumer credentials if the consumer and service do not trust each other or if the consumer requires access to multiple services.

The authentication broker with the centralized identity store assumes the responsibility for authenticating the consumer and issuing a token that the consumer can use to access the service. The authentication broker introduced into the inventory architecture carries out the intermediary authentication and issuance of temporary credentials using X.509 Certificates or Kerberos, SAML tokens.