Lecture 9 - Service Integration, Orchestration and Governance

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Integration

Plumbing different software applications/services/systems and forming new software solutions is known as 'Enterprise Integration'.

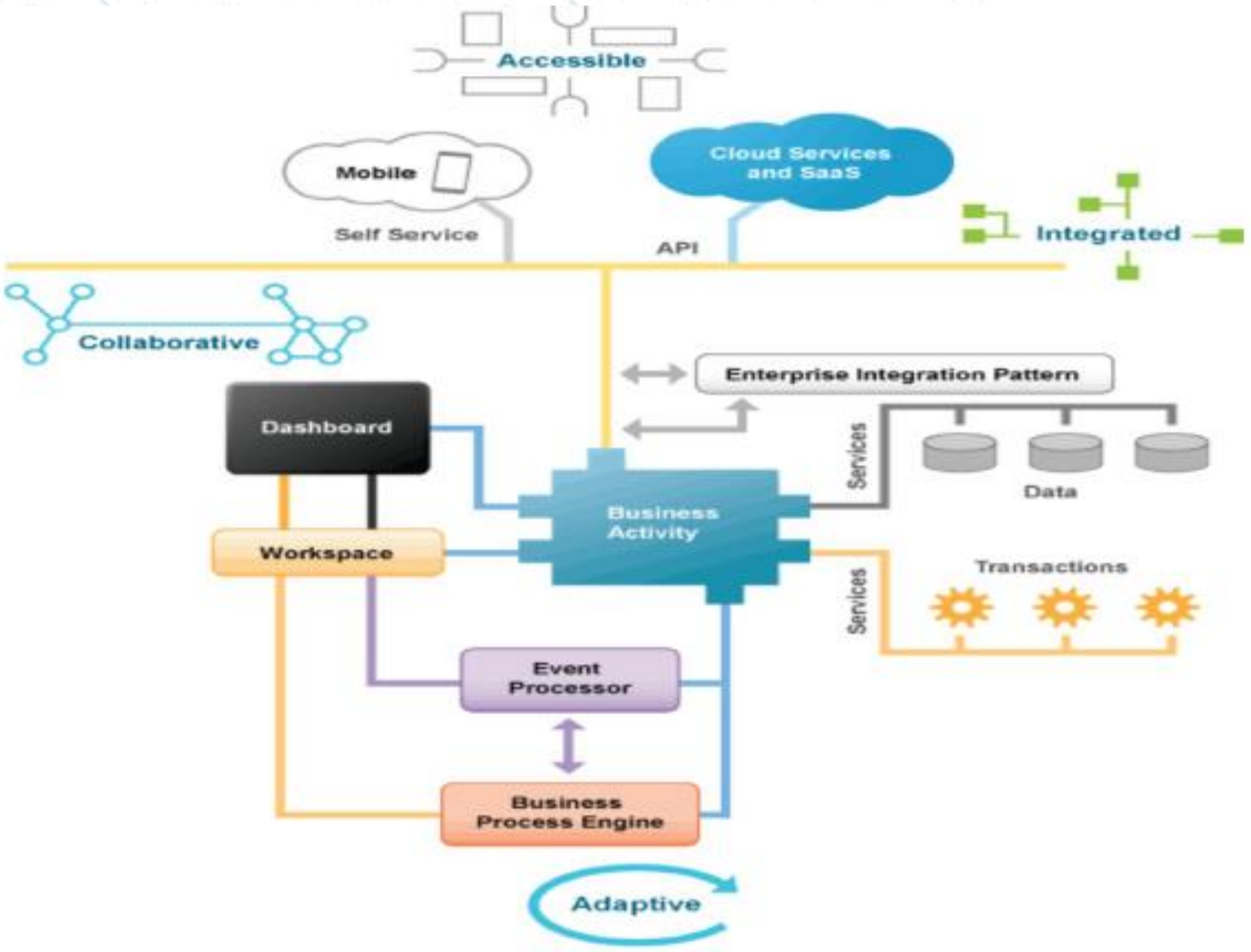
When SOA Integration is Used?

- Build new applications
- Expose a business function
- Reuse services to build new processes
- Business process automation
- Integrate data for analytics

Importance of Integration in SOA

- Enterprises heavily rely on the underlying software systems/services/applications.
- Disparate technologies and platforms
- No single solution or a vendor
- Diverse Business requirements

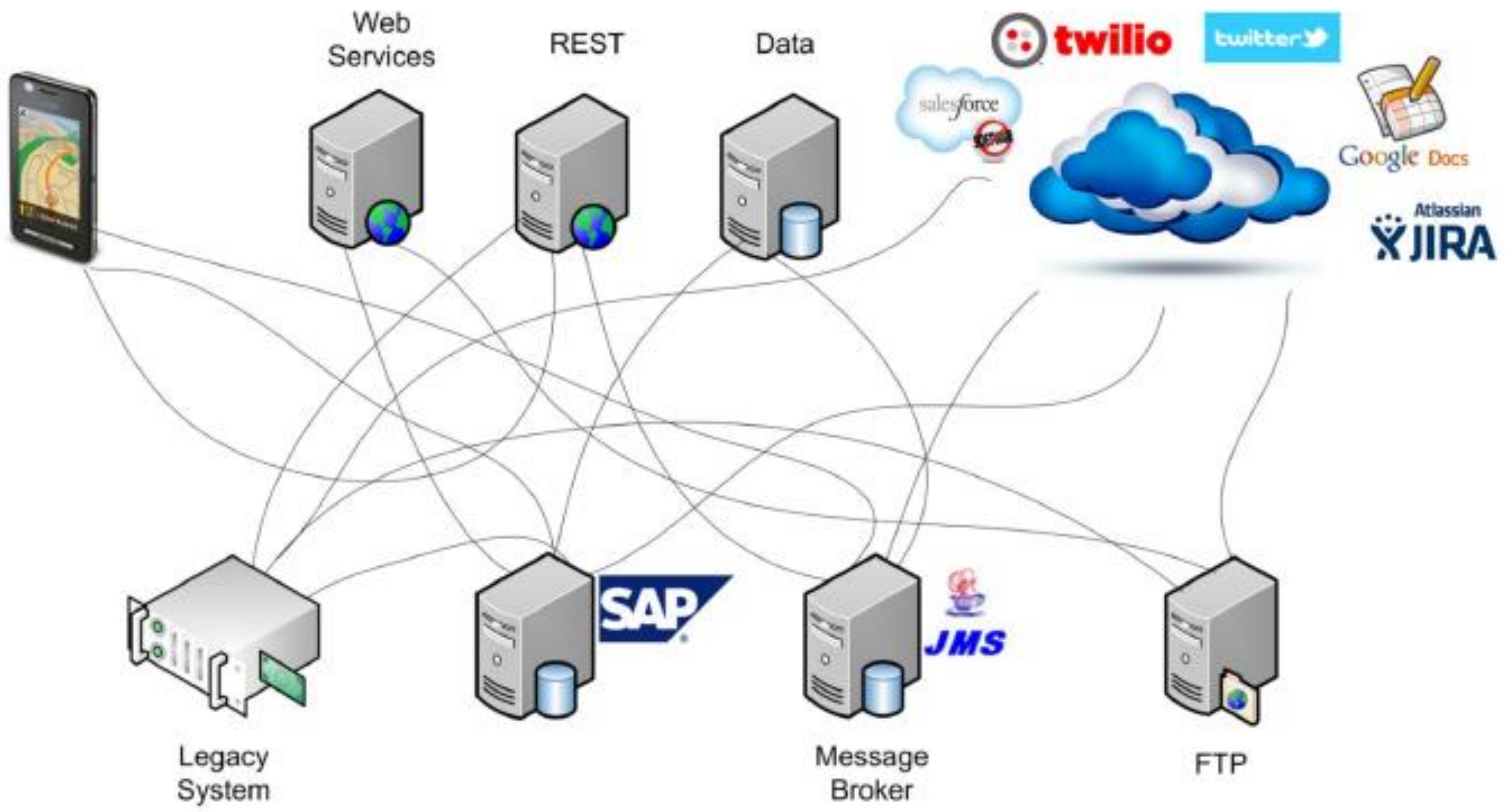
An Example


Accessible
Mobile
Self Service
Cloud Services and SaaS
API
Integrated
Collaborative
Enterprise Integration Pattern
Dashboard
Services
Data
Business Activity
Workspace
Transactions
Services
Event Processor
Business Process Engine
Adaptive

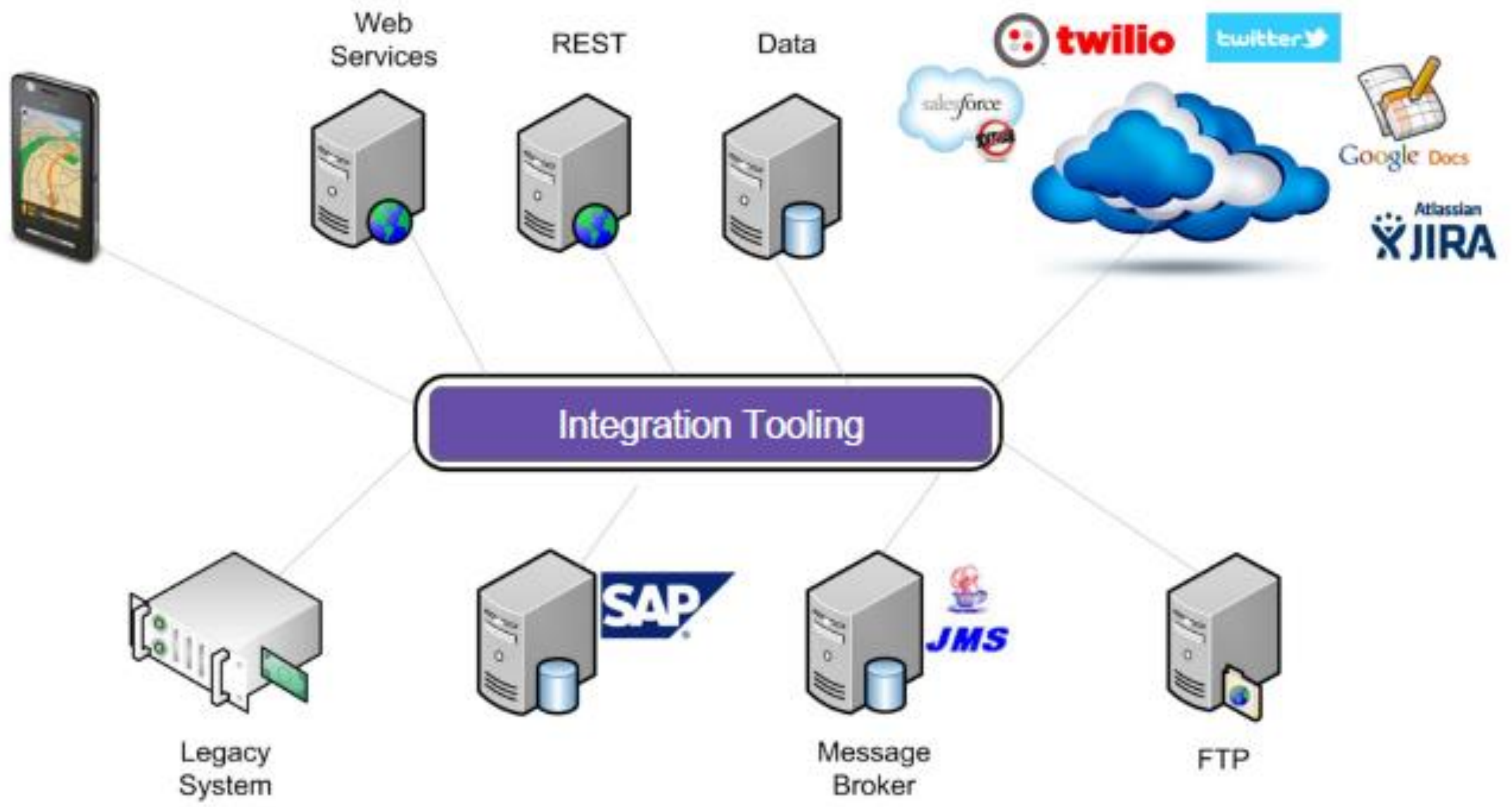
Challenges of Integration

- Heterogeneity: Disparate systems, protocols and standards
- Variety: Legacy systems, SOAP/REST services, Cloud APIs
- Disorganized: Spaghetti architecture, poorly managed
- Costly: Hardly scalable and maintainable
- Unquantifiable: Difficult to measure throughput & productivity

Unplanned Integration



Integration Tooling

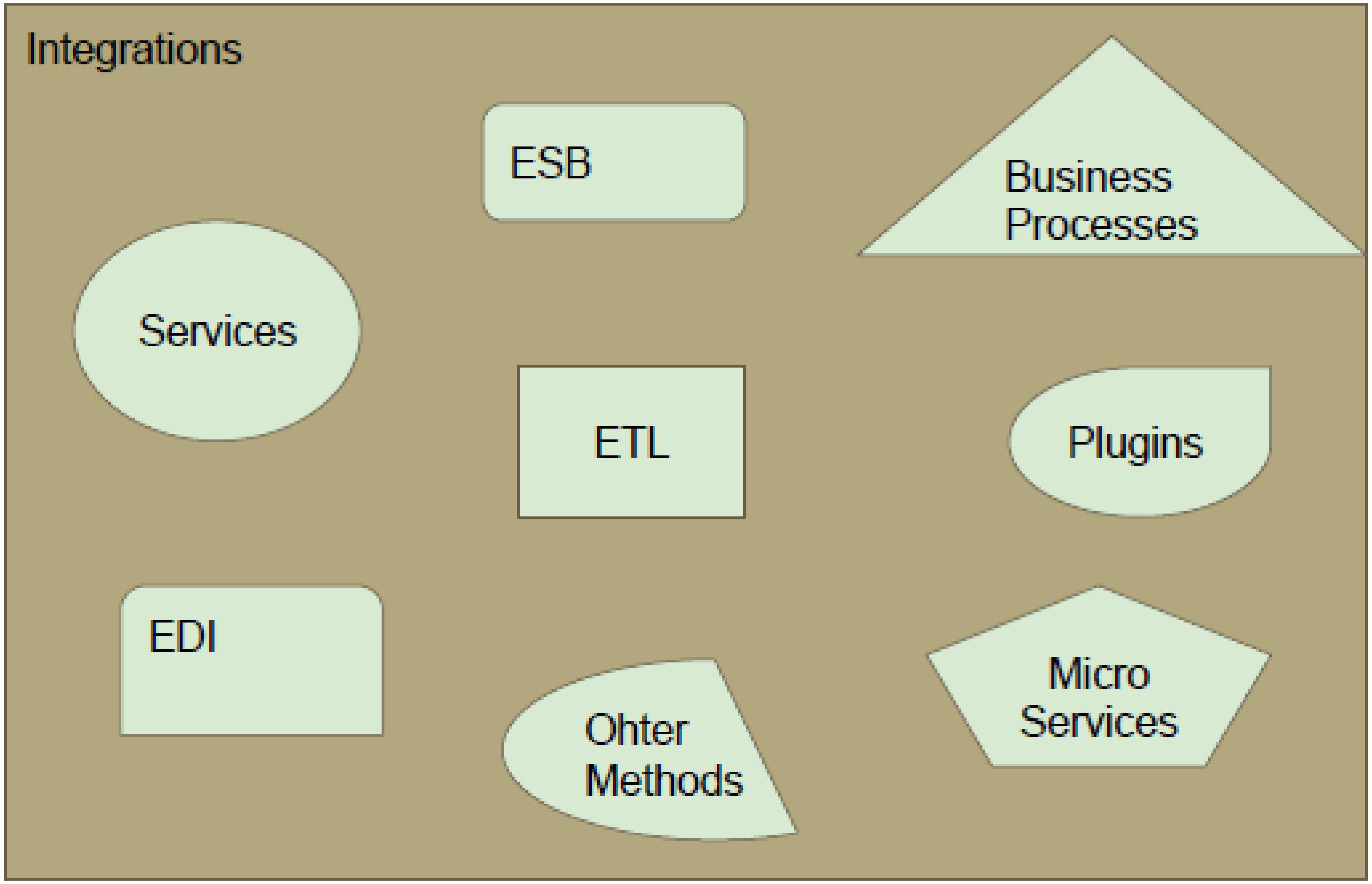


ESB

Implements a communication system between mutually interacting Software applications/services in a service-oriented architecture

- Routes
- Transforms
- Mediation

Integration Tooling - SOA and Non-SOA



ESB - Meets SOA Integration Challenges

- Transports: Support for web (HTTP), files (VFS), e-mail (POP, IMAP) and more..
- Formats/ Protocols: XML, JSON, CSV, EDI, SOAP, REST and more..
- Domain specific apps: Financial Services (FIX), Healthcare (HL7)..
- COTS: SAP, IBM WebSphere MQ, MSMQ and more..
- Cloud apps: Salesforce, Google Apps, Twitter, JIRA and more..
- Custom extensions: Handles proprietary/ non-standard integration cases

Hands On

Using an ESB for Integration

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Enterprise Integration Patterns

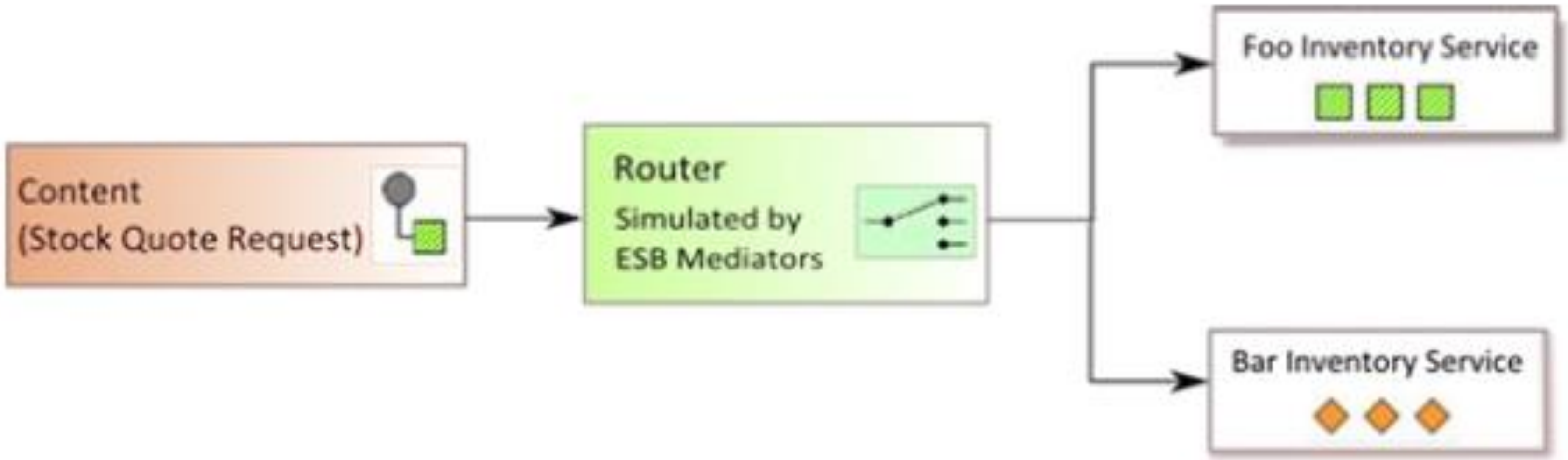
- A design Pattern - A pattern that keeps occurring
- Solution architects over the years found some patterns that kept recurring

http://www.enterpriseintegrationpatterns.com/books1.html

- Gregor Hope published a book - Enterprise Integration Patterns Designing, Building, and Deploying Messaging Solutions
- Contains 65 integration patterns

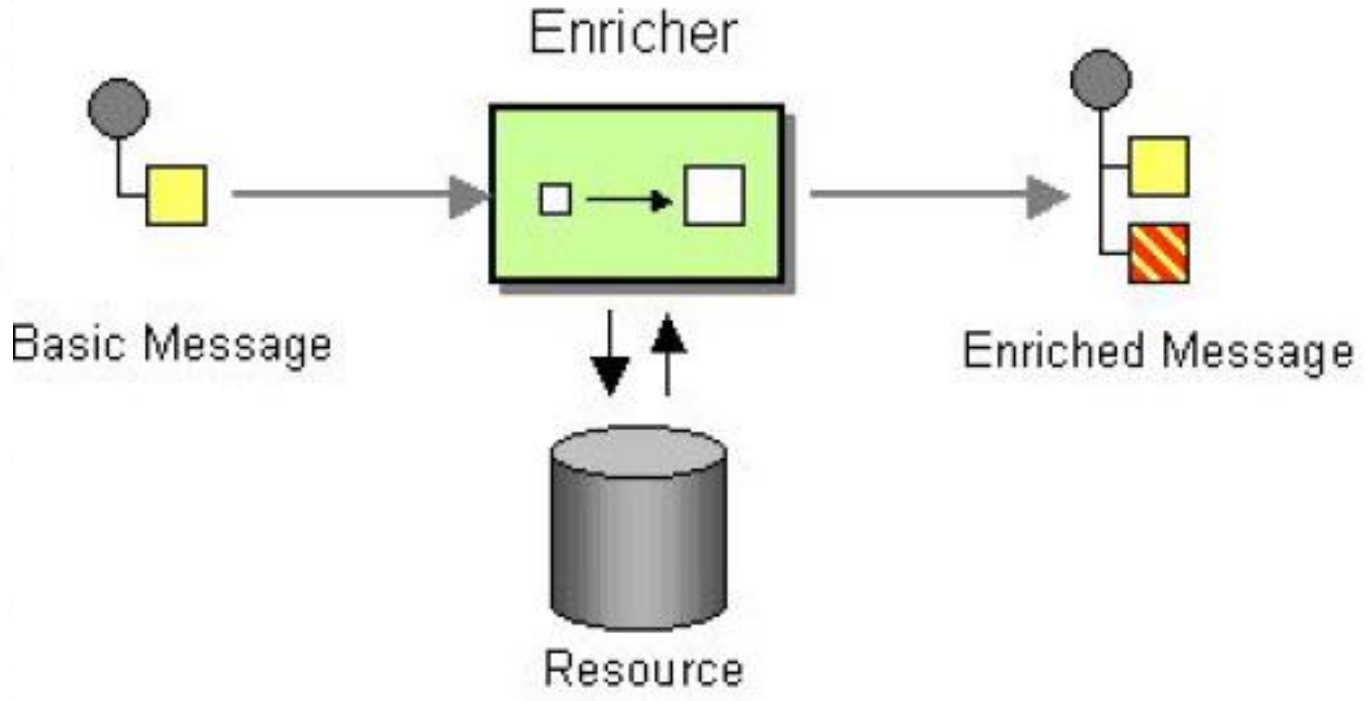
Enterprise Integration Patterns

Content Based Routing



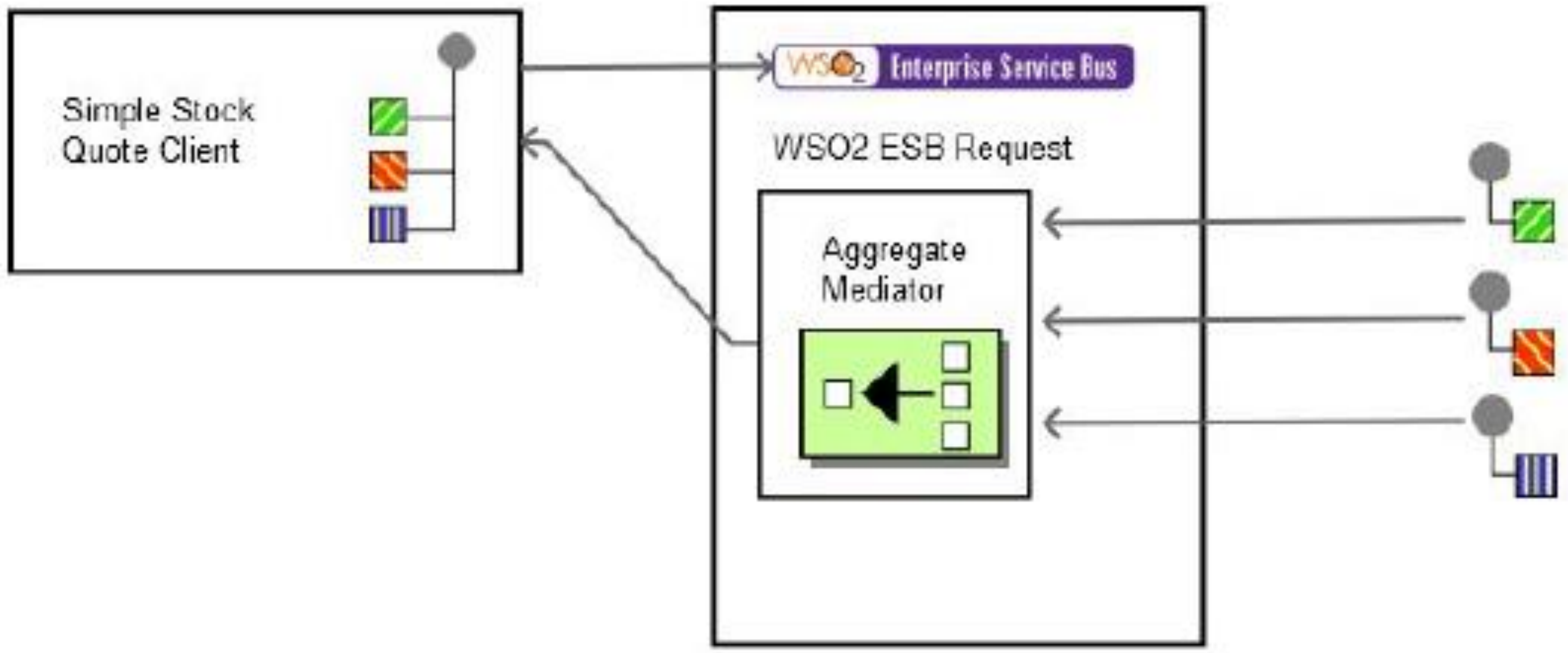
Enterprise Integration Patterns

Enricher



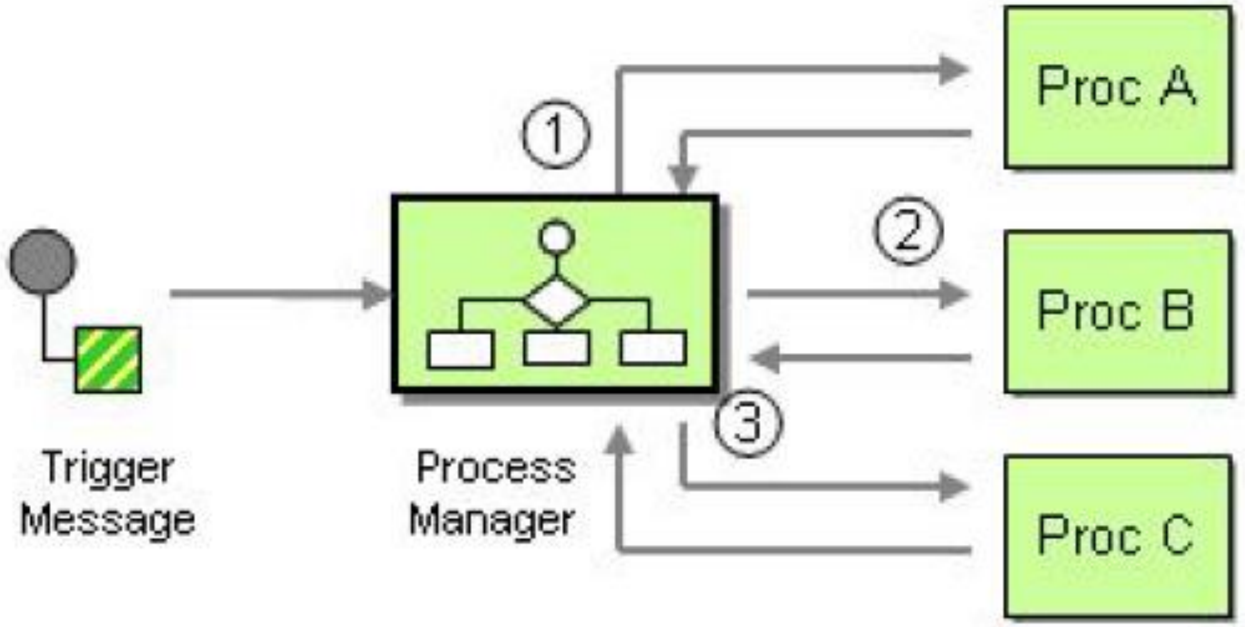
Enterprise Integration Patterns

Aggregator



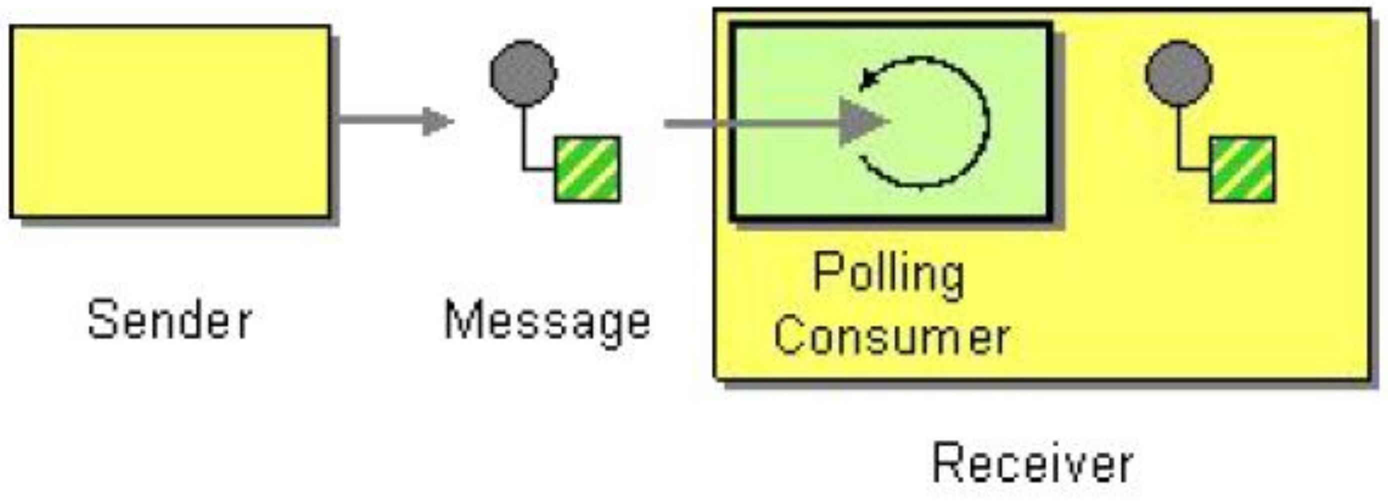
Enterprise Integration Patterns

Process Manager

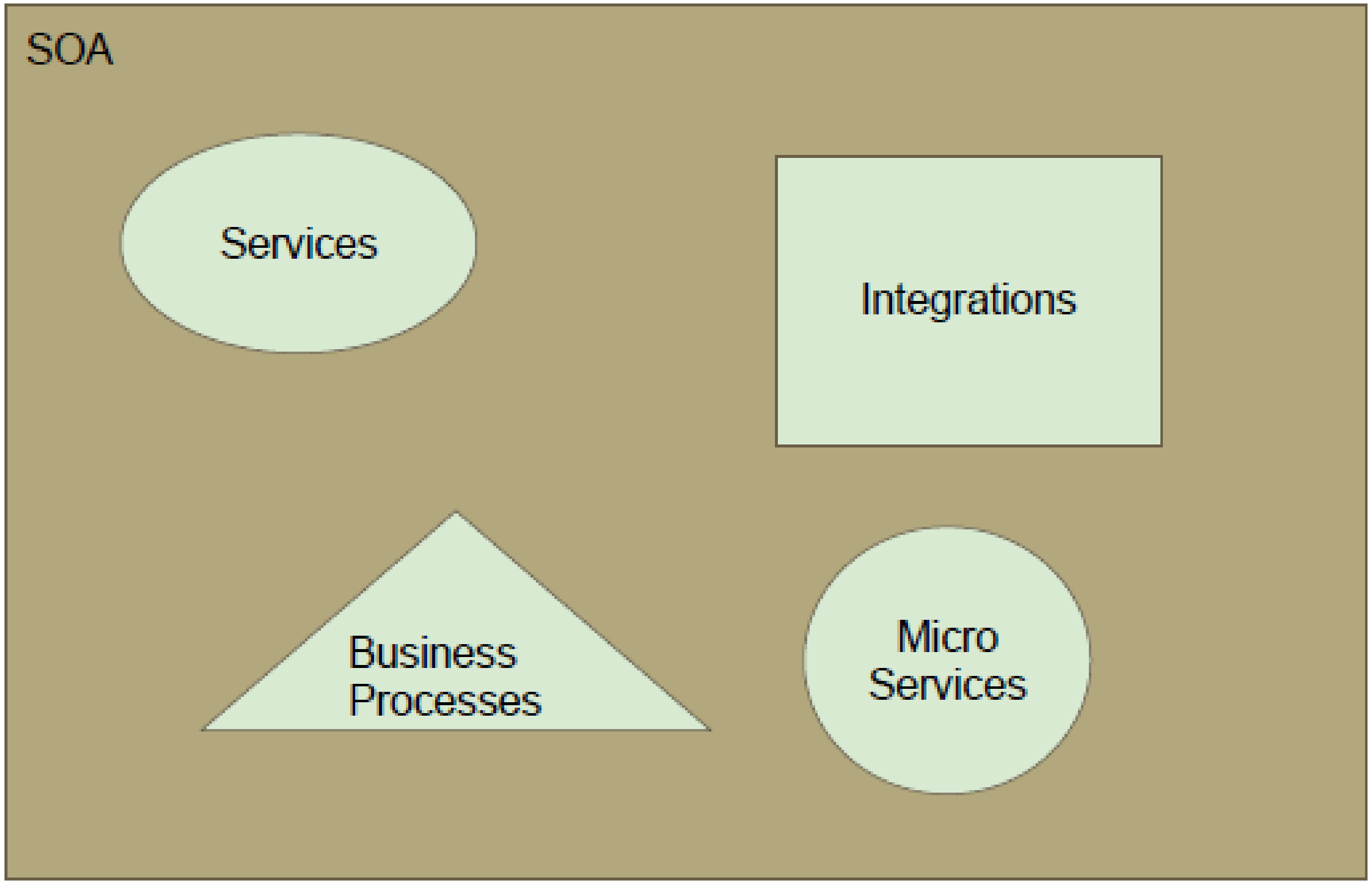


Enterprise Integration Patterns

Polling Consumer



SOA Space


SOA
Services
Integrations
Business Processes
Micro Services

Service Orchestration

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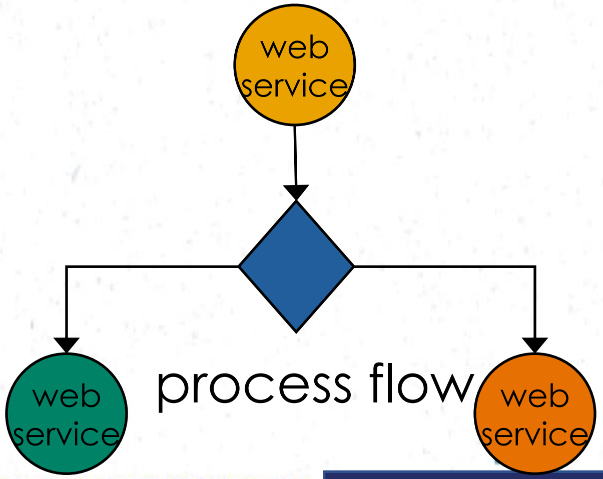
Service Orchestration

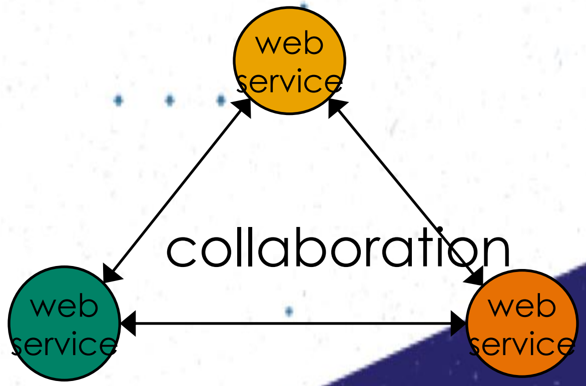
- Process Logic module is like a leader in an orchestration
- Services need to be linked and sequenced to form an application
  - This process is known as orchestration.
- Orchestration Models
  - Activity diagram
  - State charts
  - Petri Nets
  - Activity Hierarchy
  - Etc.

Orchestration vs. Choreography

- Orchestration
  - An executable business process describing a flow from the perspective and under control of a single endpoint

- Choreography
  - The observable public exchange of messages, rules of interaction and agreements between two or more business process endpoints





Service Choreography

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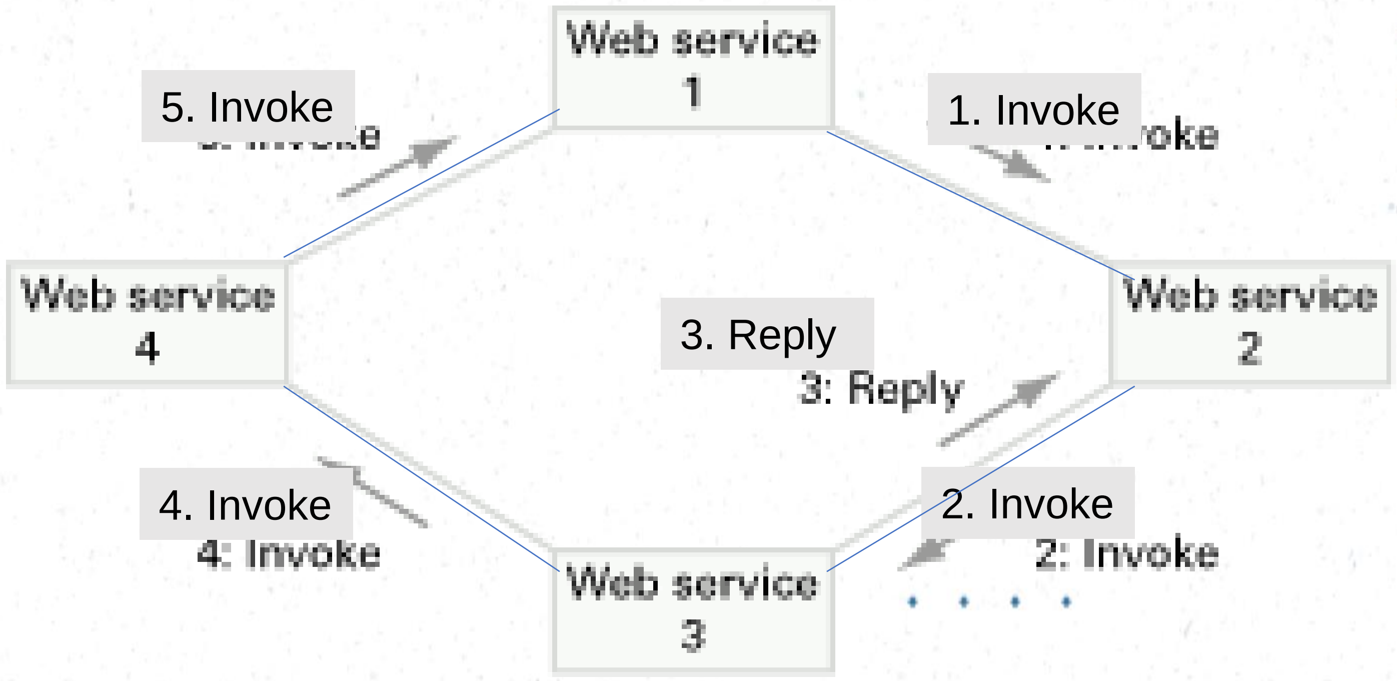
Choreography

- Does not rely on a central coordinator
- Each Web service involved in the choreography knows exactly when to execute its operations and with whom to interact
- Collaborative effort focusing on the exchange of messages in public business processes
- All participants in the choreography need to be aware of the business process, operations to execute, messages to exchange, and the timing of message exchanges.

Choreography



Orchestration versus Choreography

- From the perspective of composing Web services to execute business processes, orchestration is a more flexible paradigm and has the following advantages over choreography:
  - The coordination of component processes is centrally managed by a known coordinator.
  - Web services can be incorporated without their being aware that they are taking part in a larger business process.
  - Alternative scenarios can be put in place in case faults occur.

Orchestration versus Choreography

- BPEL supports two different ways of describing business processes that support orchestration and choreography:
  - **Executable processes** allow you to specify the exact details of business processes. They follow the orchestration paradigm and can be executed by an orchestration engine.
  - **Abstract business protocols** allow specification of the public message exchange between parties only. They do not include the internal details of process flows and are not executable. They follow the choreography paradigm.

Business Processes & BPEL

- A **business process** is a collection of interrelated tasks, which are designed to deliver a particular result
- A business process can be decomposed into several sub-processes, which have their own attributes, but are aligned with the goal of the overall process
- The analysis of business processes typically includes the mapping of processes and sub-processes down to an activity level

- BPEL: Business Process Execution Language

BPEL

- Basically a tool to create programs using flow diagrams, whose building blocks are individual services
- Really meant for business analysts, not programmers
  - Facilitates orchestration without knowing how to code
  - Programmers would do it in a 'proper' programming language
- WSBPEL is a BPEL implementation for Web Services
  - BPEL could apply to other SOA approaches

BPEL

- BPEL is an XML-based language.
- It is an open standard – not proprietary
- BPEL scope includes:
  - Sequencing of process activities, especially Web Service interactions
  - Correlation of messages and process instances
  - Recovery behavior in case of failures and exceptional conditions
  - Bilateral Web Service based relationships between process roles

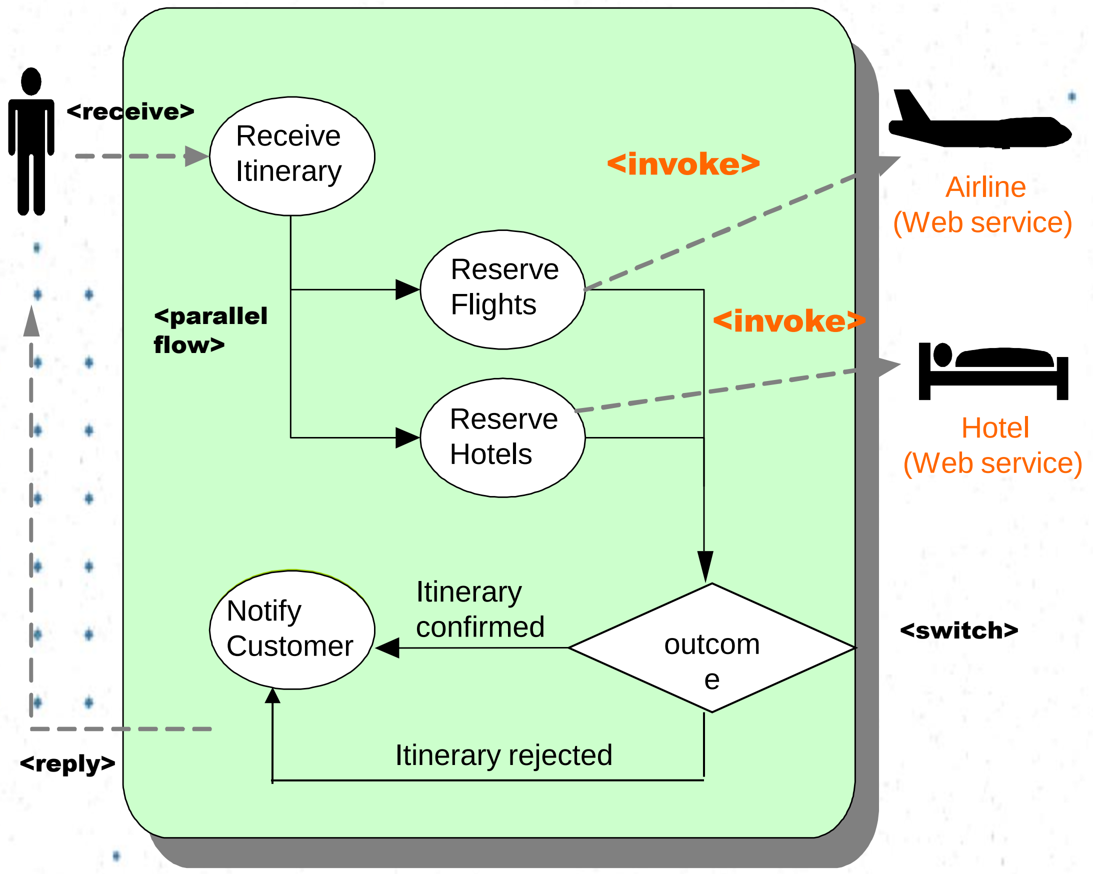
BPEL Activity

- A BPEL process consists of steps. Each step is called an activity.
- BPEL supports primitive and structural activities.
- Primitive activities represent basic constructs and are used for common tasks, such as those listed below:
  - Invoking Web services, using **<invoke>**
  - Waiting for the request, using **<receive>**
  - Manipulating data variables, using **<assign>**
  - Indicating faults and exceptions, using **<throw>**, etc.

BPEL Activity

- We can then combine these activities into more complex algorithms that specify the steps of a business process.
- To combine primitive activities, BPEL supports several structure activities.
- The most important are:
  - Sequence (**<sequence>**) for defining a set of activities that will be invoked in an ordered sequence
  - Flow (**<flow>**) for defining a set of activities that will be invoked in parallel
  - Case-switch construct (**<switch>**) for implementing branches
  - While (**<while>**) for defining loops, etc.

BPEL-Example



- <receive> and <reply> activities receive messages from and give feedback to customers
- <invoke> activities are used to trigger internal and/or external web services
- <parallel flow> activity allows tasks to be executed concurrently.
- <switch> activity allows conditional behaviours in business process.

A BPEL Process

```
<process name="purchaseOrderProcess"
        targetNamespace="..."
        xmlns="..."
        xmlns:lns="...">
...
  <sequence>
    <receive partnerLink="purchasing"
          portType="lns:purchaseOrderPT"
          operation="sendPurchaseOrder"
          variable="PO">
    </receive>
    <flow>
      <links>
        <link name="ship-to-invoice"/>
        <link name="ship-to-scheduling"/>
      </links>
      <sequence>
        <assign>
          <copy>
            <from variable="PO" part="customerInfo"/>
            <to variable="shippingRequest"
               part="customerInfo"/>
          </copy>
        </assign>
        <invoke  partnerLink="shipping"
              portType="lns:shippingPT"
              operation="requestShipping"
              inputVariable="shippingRequest"
              outputVariable="shippingInfo">
          <source linkName="ship-to-invoice"/>
        </invoke>
        <receive partnerLink="shipping"
              portType="lns:shippingCallbackPT"
              operation="sendSchedule"
              variable="shippingSchedule">
          <source linkName="ship-to-scheduling"/>
        </receive>
      </sequence>
      <sequence>
        <invoke  partnerLink="invoicing"
              portType="lns:computePricePT"
              operation="initiatePriceCalculation"
              inputVariable="PO">
        </invoke>
        <invoke  partnerLink="invoicing"
              portType="lns:computePricePT"
              operation="sendShippingPrice"
              inputVariable="shippingInfo">
          <target linkName="ship-to-invoice"/>
        </invoke>
        <receive partnerLink="invoicing"
              portType="lns:invoiceCallbackPT"
              operation="sendInvoice"
              variable="Invoice"/>
      </sequence>
      <sequence>
        <invoke  partnerLink="scheduling"
              portType="lns:schedulingPT"
              operation="requestProductionScheduling"
              inputVariable="PO">
        </invoke>
        <invoke  partnerLink="scheduling"
              portType="lns:schedulingPT"
              operation="sendShippingSchedule"
              inputVariable="shippingSchedule">
          <target linkName="ship-to-scheduling"/>
        </invoke>
      </sequence>
    </flow>
    <reply partnerLink="purchasing"
         portType="lns:purchaseOrderPT"
         operation="sendPurchaseOrder"
         variable="Invoice"/>
  </sequence>
</process>
```

Structured Activities

```
<process name="purchaseOrderProcess"
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      <links>
        <link name="ship-to-invoice"/>
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      </links>
      <sequence>
        <assign>
          <copy>
            <from variable="PO" part="customerInfo"/>
            <to variable="shippingRequest"
                part="customerInfo"/>
          </copy>
        </assign>
        <invoke  partnerLink="shipping"
                 portType="lns:shippingPT"
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                 inputVariable="shippingRequest"
                 outputVariable="shippingInfo">
          <source linkName="ship-to-invoice"/>
        </invoke>
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                 portType="lns:shippingCallbackPT"
                 operation="sendSchedule"
                 variable="shippingSchedule">
          <source linkName="ship-to-scheduling"/>
        </receive>
      </sequence>
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                 operation="sendShippingSchedule"
                 inputVariable="shippingSchedule">
          <target linkName="ship-to-scheduling"/>
        </invoke>
      </sequence>
    </flow>
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           portType="lns:purchaseOrderPT"
           operation="sendPurchaseOrder"
           variable="Invoice"/>
  </sequence>
</process>
```

Primitive Activities

```
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      xmlns:lns="...">
...
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        </invoke>
      </sequence>
    </flow>
    <reply partnerLink="purchasing"
         portType="lns:purchaseOrderPT"
         operation="sendPurchaseOrder"
         variable="Invoice"/>
  </sequence>
</process>
```

Data Flow

```
<process name="purchaseOrderProcess"
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      xmlns="..."
      xmlns:lns="...">
...
  <sequence>
    <receive partnerLink="purchasing"
          portType="lns:purchaseOrderPT"
          operation="sendPurchaseOrder"
          variable="PO">
    </receive>
    <flow>
      <links>
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      </links>
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        </assign>
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</process>
```

Partner Links

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      xmlns:lns="...">
...
  <sequence>
    <receive partnerLink="purchasing"
          portType="lns:purchaseOrderPT"
          operation="sendPurchaseOrder"
          variable="PO">
    </receive>
    <flow>
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</process>
```

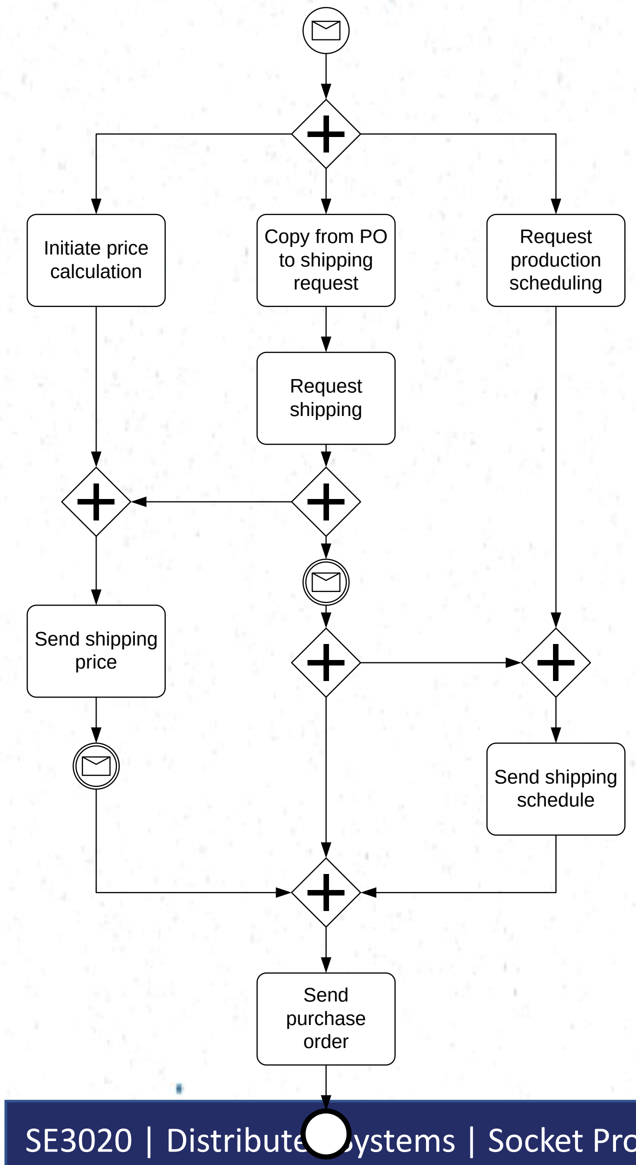
BPMN (Business Process Markup and Notation)

The primary goal of **BPMN** is to provide a notation that is readily understandable by all business users

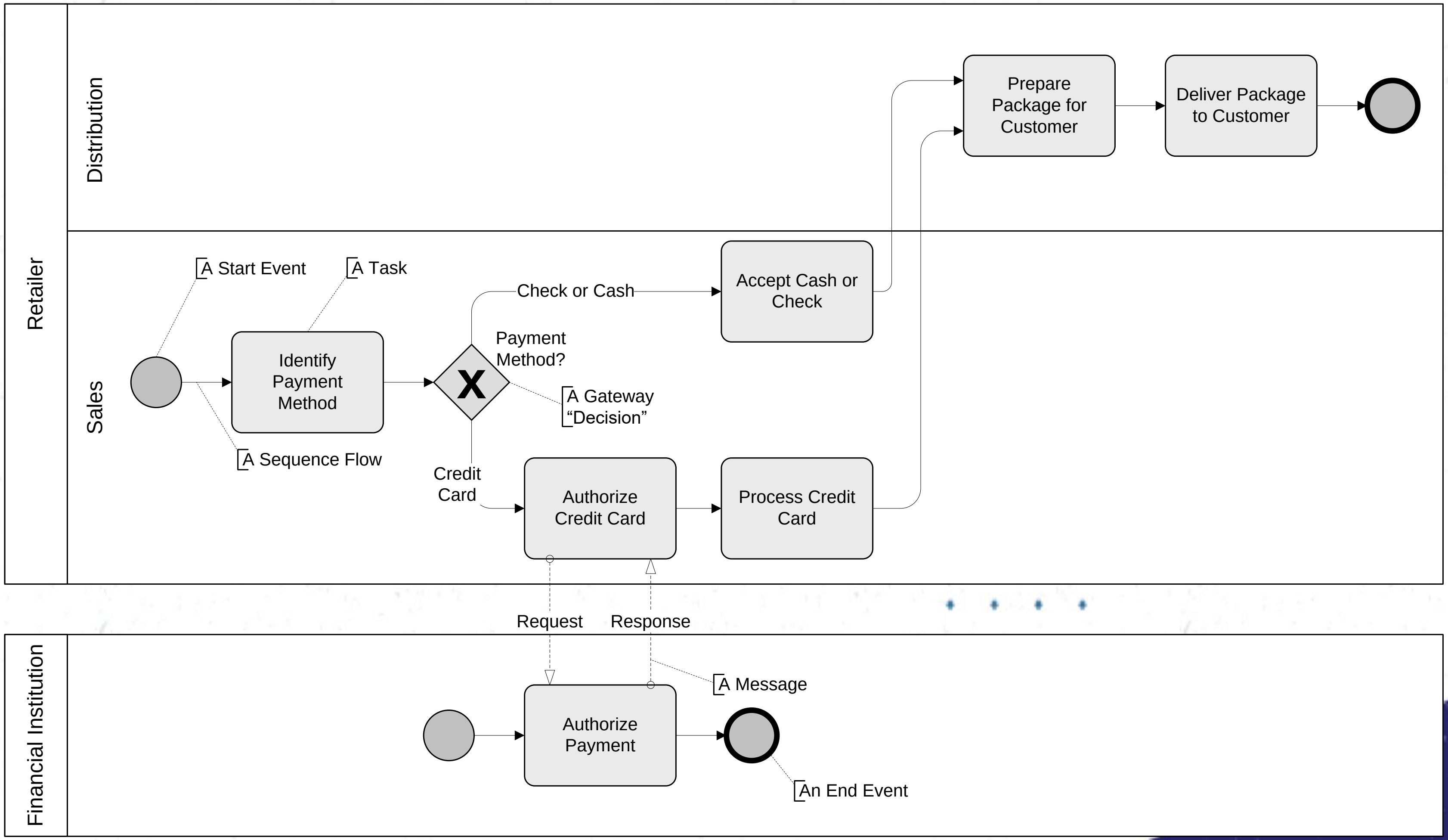
BPMN creates a **standardized bridge** for the gap between the business process design and process implementation.

Another goal, but no less important, is to ensure that XML languages designed for the execution of business processes, such as **BPEL4WS** (Business Process Execution Language for Web Services), can be visualized with a business-oriented notation.

The BPEL Process in BPMN


Initiate price calculation
Copy from PO to shipping request
Request production scheduling
Request shipping
Send shipping price
Send shipping schedule
Send purchase order

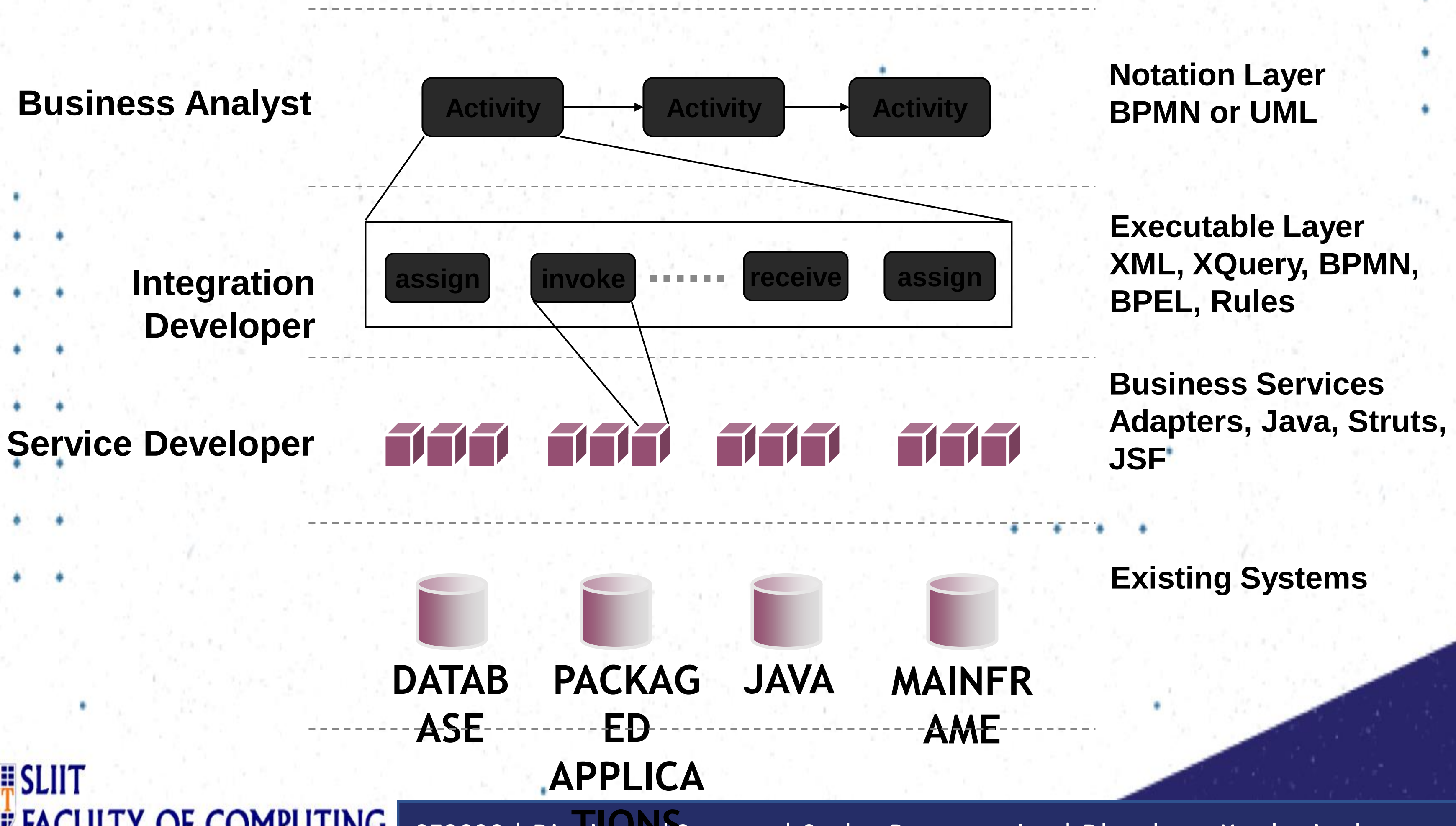
BPMN explained



BPMN Vs BPEL

- BPMN is richer than BPEL
- Transformation from BPEL to BPMN less a problem
- From BPMN to BPEL
  - Loss of information
  - Loss of design considerations
- Potential Solutions
  - Restriction to a subset of BPMN
  - Extension of BPEL

The Top Down Perspective



Securing Web Services

Security Fundamentals

- Authentication
- Authorization
- Integrity
- Confidentiality
- Availability
- Non-Repudiation

Security a Web Service

- WS-Security (SOAP services only)
- SSL with HTTP BasicAuth/HTTP Digest Auth
- SSL with Username Token (OAuth)
- SSL with IDToken (OpenID)

WS Security

- WS Security 1.0 on 2004 and 1.1 on 2006
- Based on
  - PKI
  - X509 Certificates
  - XML Security - XML Encryption and Signature
- Related Standards
  - WS Secure Conversation
  - WS Trust

WS Security

- Username Token
- Message level encryption
- Message level signature
- Message level encryption and signature

WS Security Sepcification Family

- A comprehensive specification
- Provides message level security
- Industry is no longer using it

TLS for HTTP → HTTPS

- TLS - Transport Layer Security
  - Version 1, 1.1, 1.2 and 1.3
- Predecessor of TLS is SSL
- Adds an additional encryption layer over HTTP
- Transport layer provides
  - Transport level confidentiality
  - Transport level integrity

HTTP BasicAuth

- HTTP Header with Username & Password
  - Authorization : Basic <Base64 encoded Username:Password>
- Base64 is not encryption. What is it?
  - Difference between
    - Encoding
    - Encryption
    - Hashing

Hands-on

Create a BasicAuth Header

Demo

HTTP Basic Auth Sample

TLS with BasicAuth

- Provides Authenticity
- Possible to do Authorization
- Transport layer confidentiality and integrity

Http Digest Auth

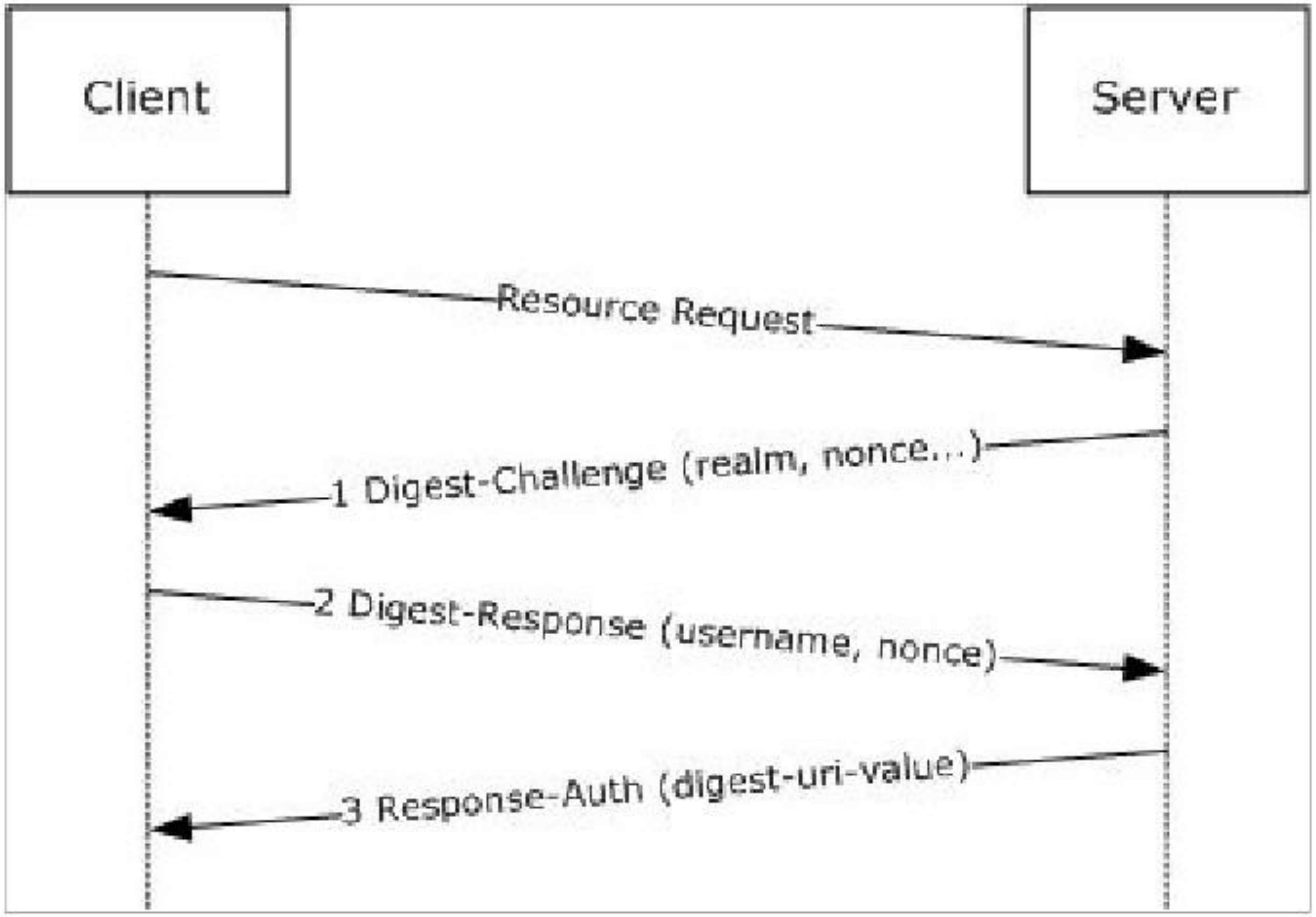
More on Hashing

- Irreversible. Result is called digest.
  - d = hash(m1)
- Deterministic
- Small change → Drastic result in the digest
- Second image resistance. Given d=hash(m1), it is hard to find m2 such that d=hash(m2)
- Collision resistance
  - hash(m1) = hash(m2)

Cryptographic Nonce

- A number tht is used only once
- Random Number
- Adding a Nonce to a message before hashing makes the Digest attacks hard

HTTP DigestAuth


Client
Server
Resource Request
1 Digest-Challenge (realm, nonce...)
2 Digest-Response (username, nonce)
3 Response-Auth (digest-uri-value)

Http DigestAuth

- *STEP 1* : a client sends a request to a server
- *STEP 2* : the server responds with a special code (called a **nonce** i.e. **n**umber used only **once**), another string representing the ‘realm’ and asks the client to authenticate
- *STEP 3* : the client responds with the hashed value of this nonce and the username, password and realm
- *STEP 4* : the server responds with the requested information if the client hash matches their own hash of the nonce, username, password and realm, or an error if not

TLS with HTTP DigestAuth

- Secure than BasicAuth
- Provides Authenticity
- Possible to do Authorization
- Transport layer confidentiality and integrity

OAuth for Security REST Services

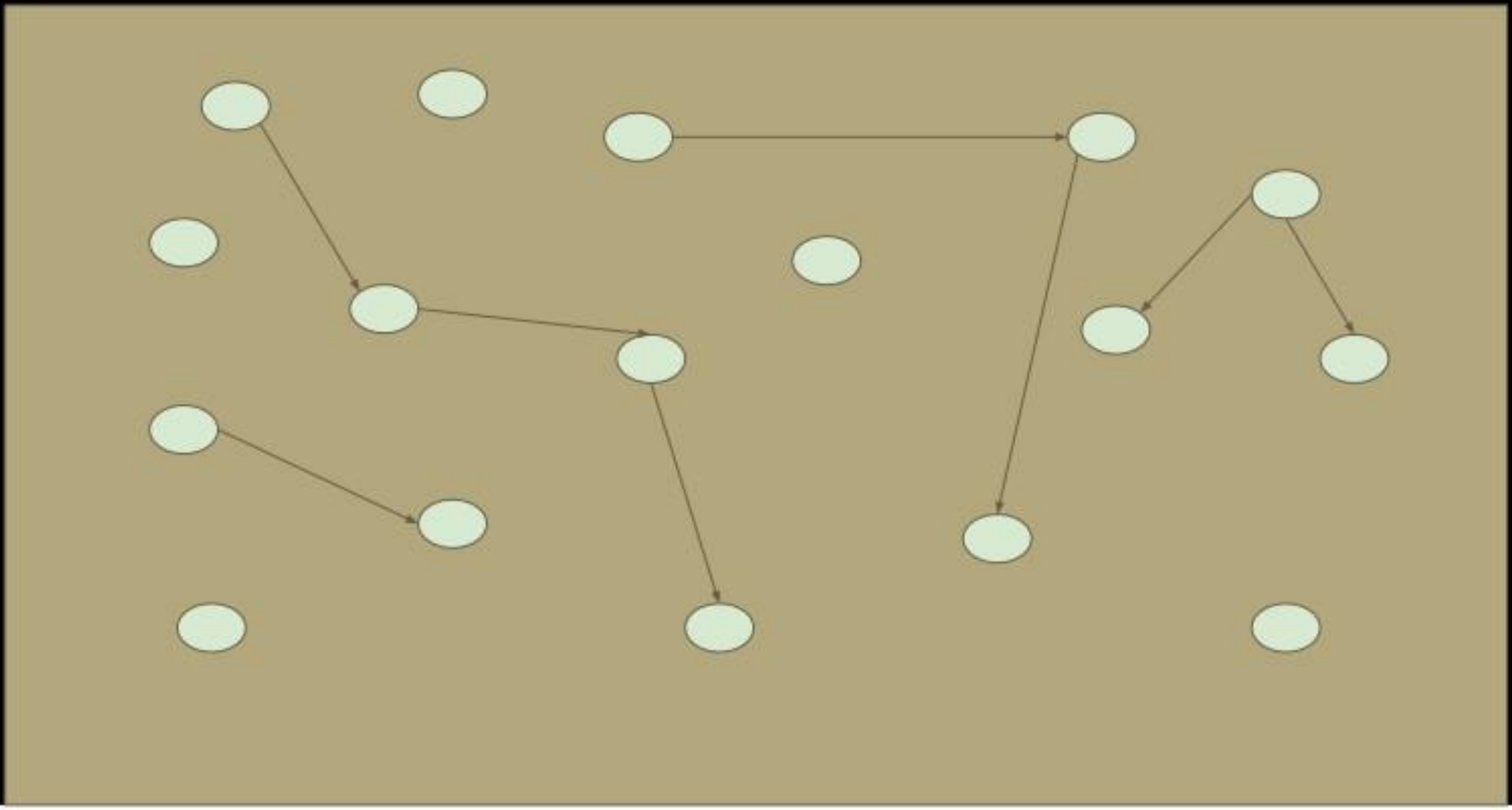
- OAuth1.0 & 2.0
  - Open standard for Authorization
- OAuth 2.0 Framework and Bearer Token Usage RFC published on 2012
- OAuth2.0 - Most commonly used standard for security REST Services
  - Facebook Graph API, Google APIs
- Different implementations: e.g. WSO2 Identity Server,

SOA Governance

SOA Governance

- The "course of action" taken to ensure that an effective decision- making process is in place
- A set of processes, responsibilities and tools, which reinforces good behavior and help avoid bad behaviors
- Ensure defined processes and responsibilities are followed through the implementation of proper measurement technique
- It's all about control!

SOA



Why SOA Governance

- Essential part in making SOA successful
    - Need to reuse services
    - Need to make developing application, automated processes easy
    - Need to manage services

Why SOA Governance

How to promote reuse services

- List services and their descriptions
- Show the technical/business owners of a service
- Analyze inter relationship of service
- Validate the service - Check technical and business rules

Why SOA Governance

Manage Services

- Version the services
- Provide security policies at runtime
- Provide secure access to services
- Track the QoS
- Maintain lifecycle management

When is Governance Required?

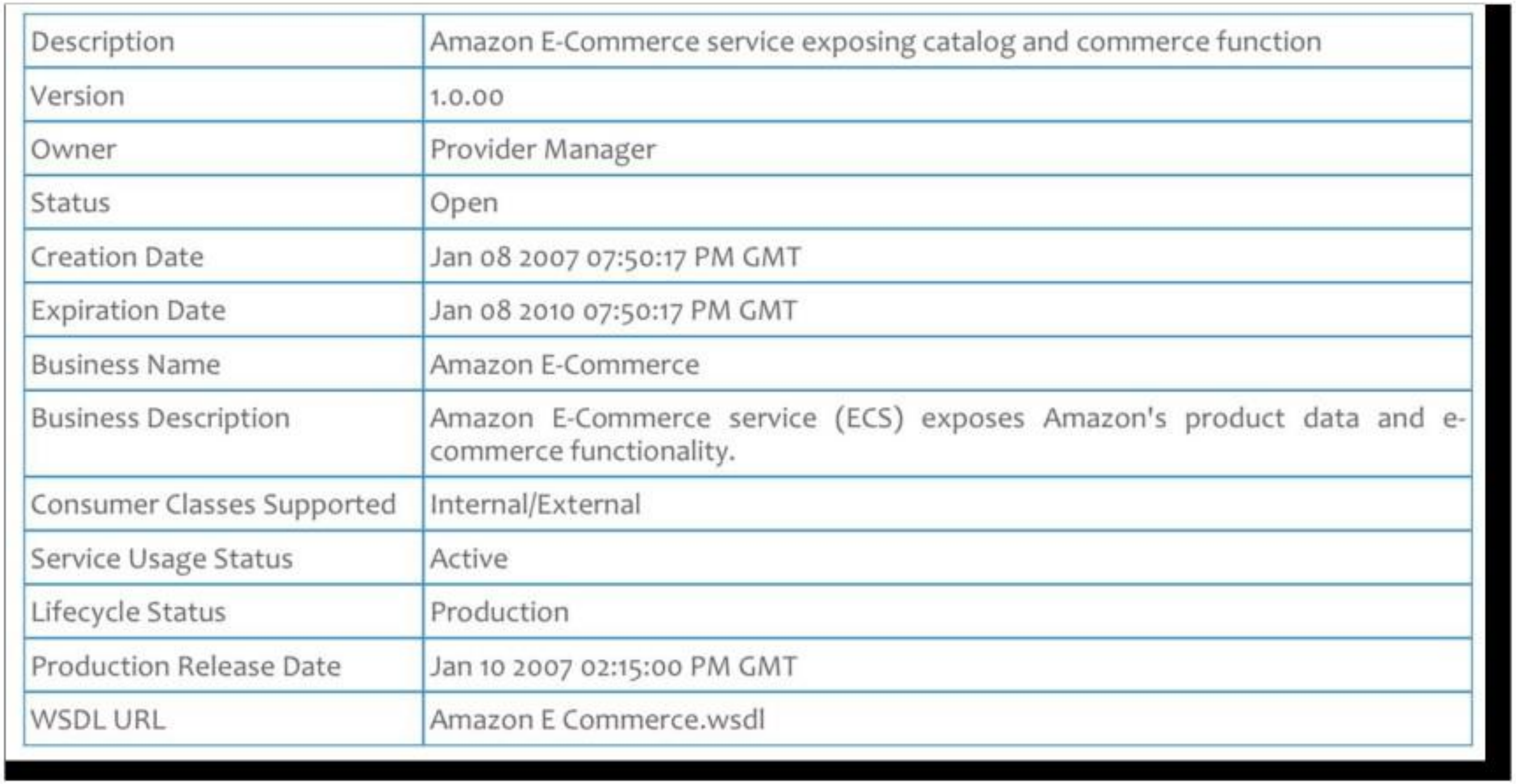
- Architecture Governance
- Design-time Governance
- Run-time Governance
- Organizational Governance

How to implement SOA Governance

Service Registry is the central piece of SOA governance

- Service Catalog
- Service Description
- Service Consumption
- Service inter-dependencies
- Service Discovery
- Service Lifecycle
- Service Policies

Service Description

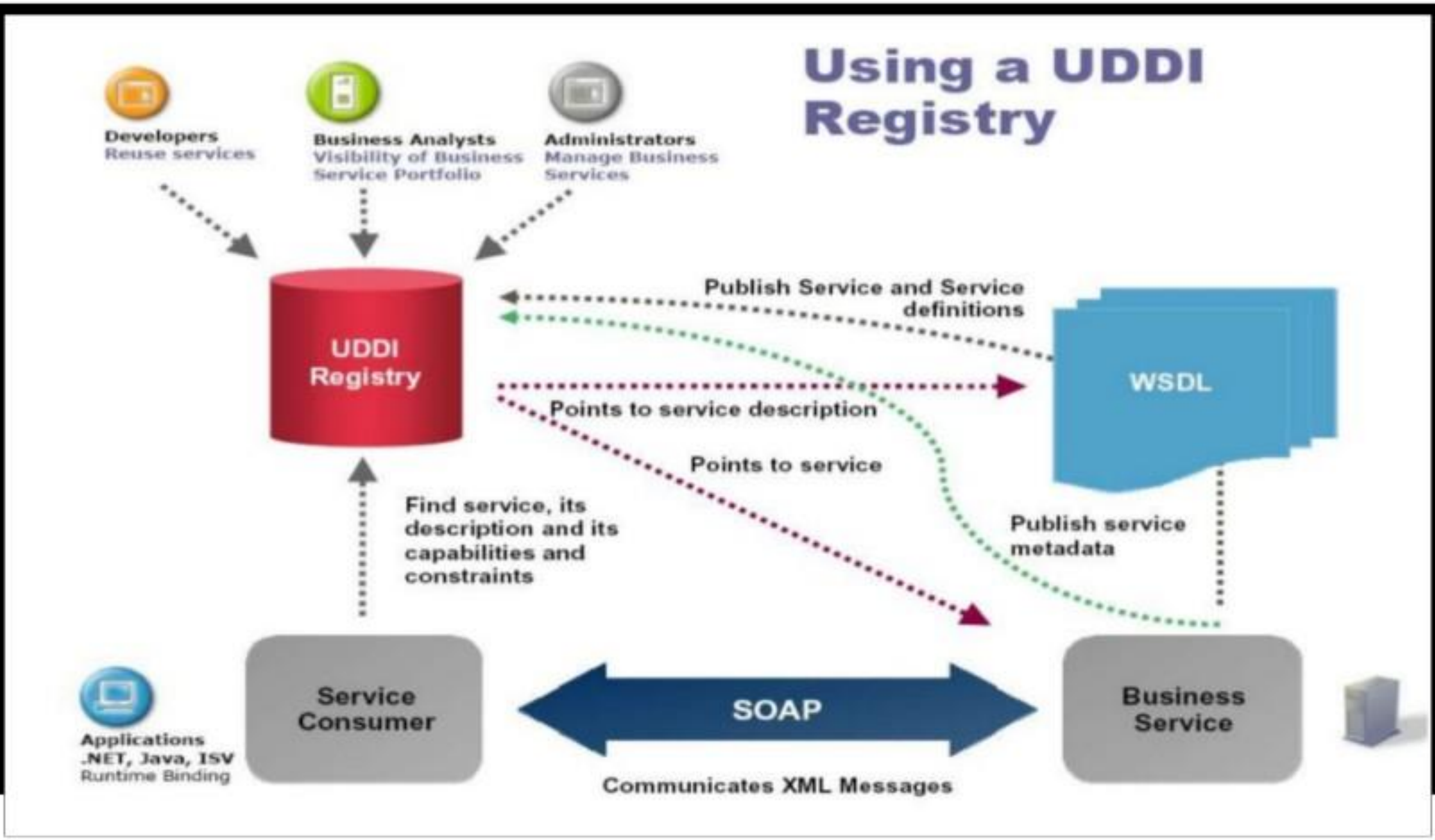


Description	Amazon E-Commerce service exposing catalog and commerce function
Version	1.0.00
Owner	Provider Manager
Status	Open
Creation Date	Jan 08 2007 07:50:17 PM GMT
Expiration Date	Jan 08 2010 07:50:17 PM GMT
Business Name	Amazon E-Commerce
Business Description	Amazon E-Commerce service (ECS) exposes Amazon's product data and e-commerce functionality.
Consumer Classes Supported	Internal/External
Service Usage Status	Active
Lifecycle Status	Production
Production Release Date	Jan 10 2007 02:15:00 PM GMT
WSDL URL	Amazon E Commerce.wsdl

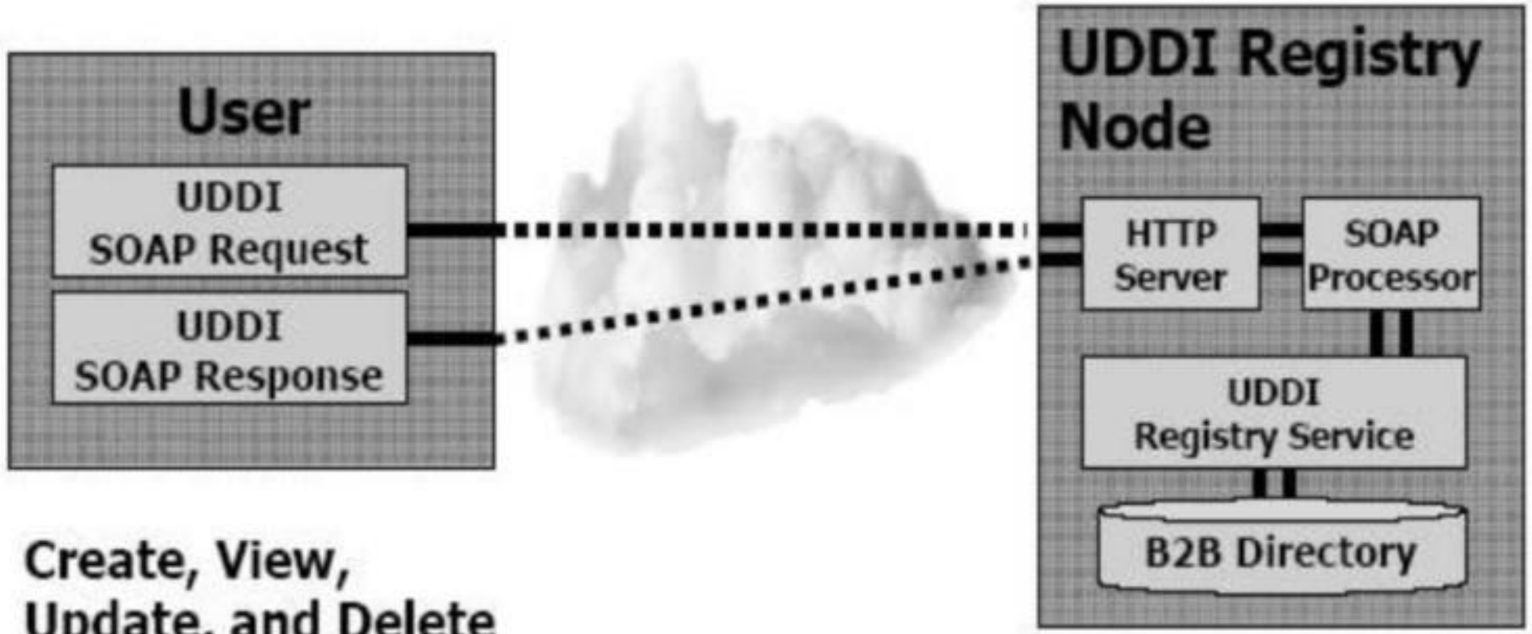
UDDI

- A registry standard - Universal Description, Discovery and Integration
- SOAP 1.1 based standard since 2000
  - Describing services
  - Publishing services
  - Discovering services
- Four components
  - Registry
  - Data, meta-data
  - UDDI specification
  - API for publishing, managing and discovering services

UDDI


Using a UDDI Registry
Developers
Reuse services
Business Analysts
Visibility of Business Service Portfolio
Administrators
Manage Business Services
UDDI Registry
Publish Service and Service definitions
WSDL
Points to service description
Points to service
Find service, its description and its capabilities and constraints
Publish service metadata
Applications
.NET, Java, ISV
Runtime Binding
Service Consumer
SOAP
Business Service
Communicates XML Messages

UDDI



Create, View, Update, and Delete registrations

Implementation-neutral

UDDI - Low Adoption Rate

- Tightly coupled to SOAP/WSDL
- No homogeneous standard in different business
- Look up services at runtime by clients

  - not a common usecase
- Original spec didn’t have human friendly formats
- Hard to use (long document required)
  (Governance Interoperability Framework)

Current Registry Implementations

- Infravio
- TIBCO Active Matrix
- BEA
- Oracle
- Sun
- Systinet
- WSO2

Modern Governance Products

- Human friendly service catalog
- Has REST interface - No standard
- Can publish services in different formats
- Integrates with developer tooling
- Innovation enabler, not a restrictor
- Notifications to watchers, workflows
- Lifecycle management

Summary

- Orchestration/Choreography to manage the business process
- Service integration to connect services
- Enterprise Service Bus
- Securing web services
  - WS-Security
  - HTTP + BasicAuth/HTTP+ DigestAuth
  - OAuth/OpenID
- SOA Governance