Service Oriented Architercture and Web Services

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Outline

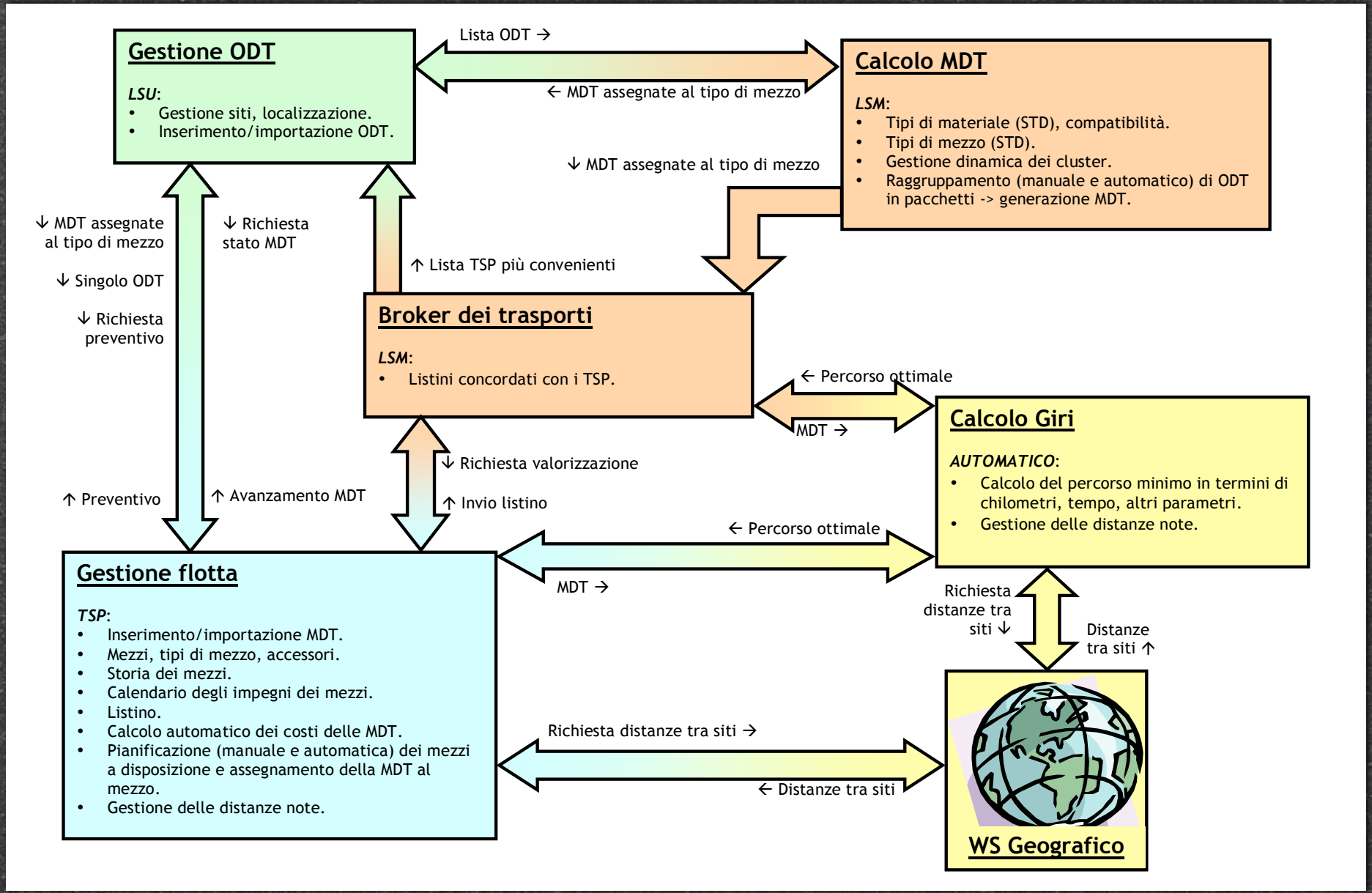
- SOA
  - Fundamental SOA
  - SOA Service
  - Service orientation principles
- Web Services SOA oriented
  - Proposal & framework
  - Logical components of automation logic
  - Service-orientation and the enterprise
    - Layers of Abstraction
  - Service role
  - Service description (WSDL)
    - WSDL: which style?
  - Messaging framework (SOAP)
- Message exchange patterns
- SOA Platform

SOA introduction

- SOA is Service Oriented Architecture
- Web Services and SOA are related but are independent ...
- SOA is a new paradigm regard object orientation...
- why we need new paradigm?
- --> follow the example

SOA introduction

- Which domain? which style?



Fundamental SOA

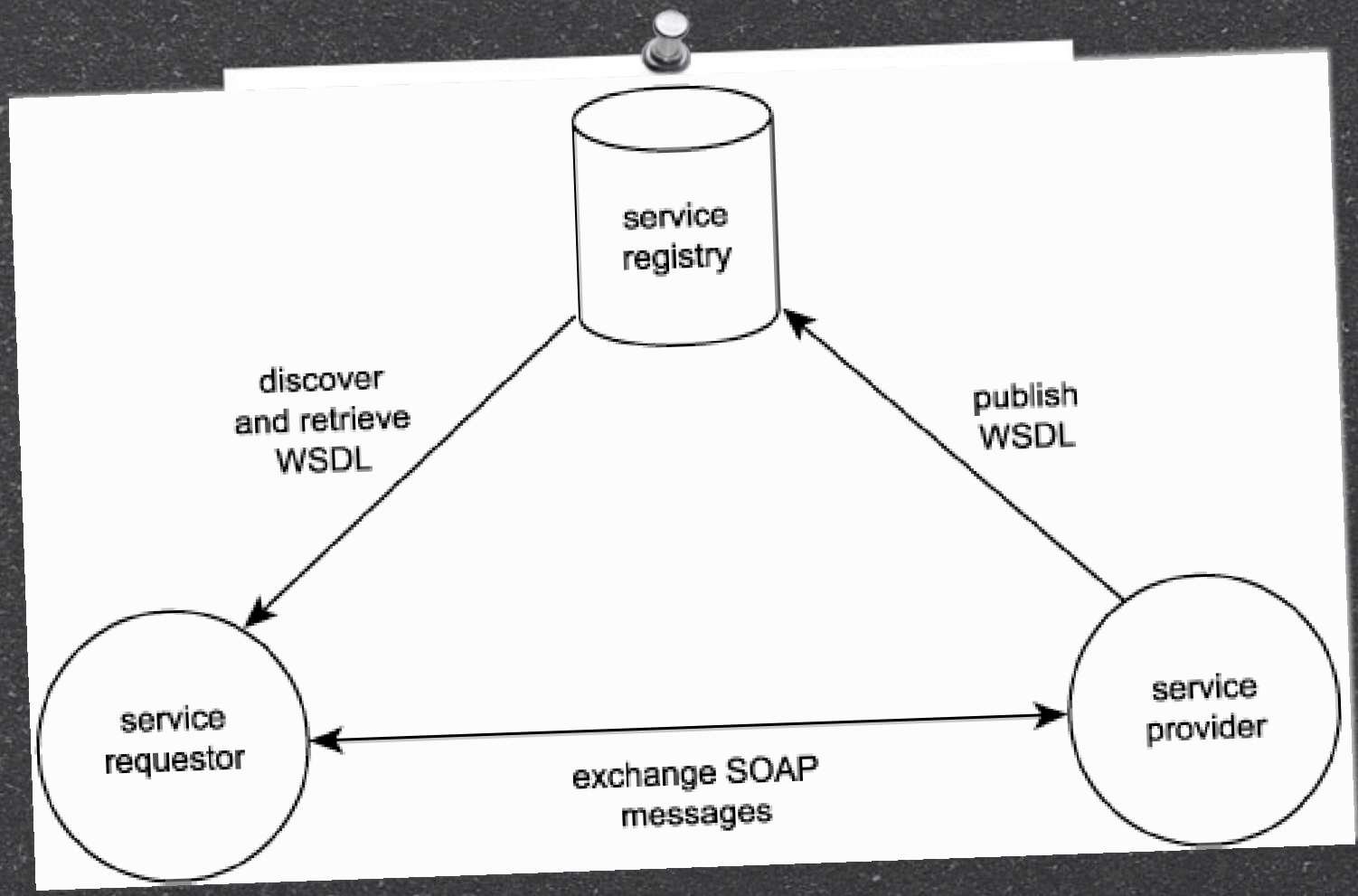
"Because the term 'service-oriented' has existed for some time, it has been used in different contexts and for different purposes. One constant through its existence has been that it represents a distinct approach for separating concerns. What this means is that logic required to solve a large problem can be better constructed, carried out, and managed if it is decomposed into a collection of smaller, related pieces. Each of these pieces addresses a concern or a specific part of the problem. [...] What distinguishes the service-oriented approach to separating concerns is the manner in which it achieves separation."

From: Service-Oriented Architecture Concept, Technology, and Design - Thomas Erl

Fundamental SOA

- Service-oriented architecture
  - a model in which business logic is decomposed into smaller, distinct units of logic
  - collectively this units comprise a large piece of business logic (individually can be distributed)
- BUT We want to
  - self-governing individual services -> independence between services
  - MUST ensure that they adhere to certain baseline conventions

An early incarnation of SOA



SOA Service

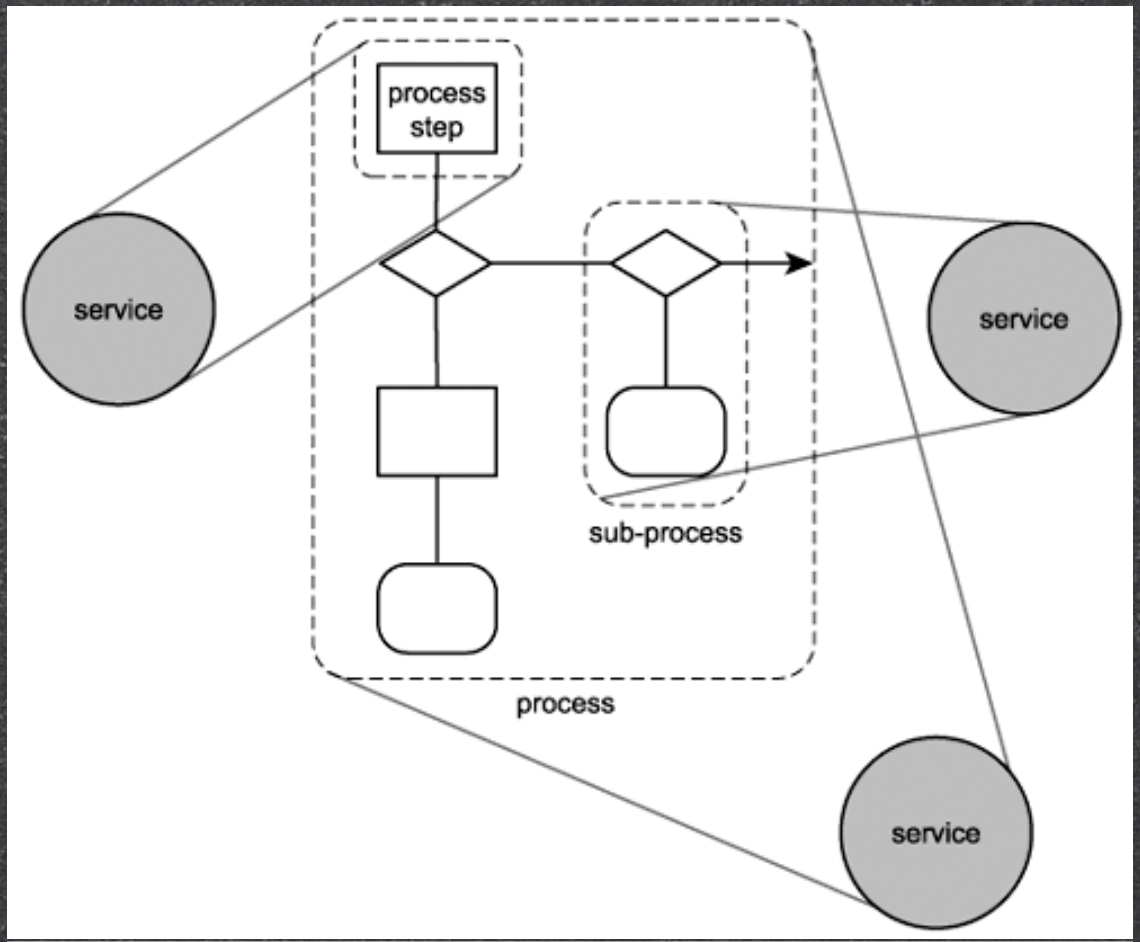
Service as a unit of logic within a context

- service has a description
- services relate using messages
  - we need messaging framework
  - message as “independent units of communication”

SOA KEYs: Service, Description and Message

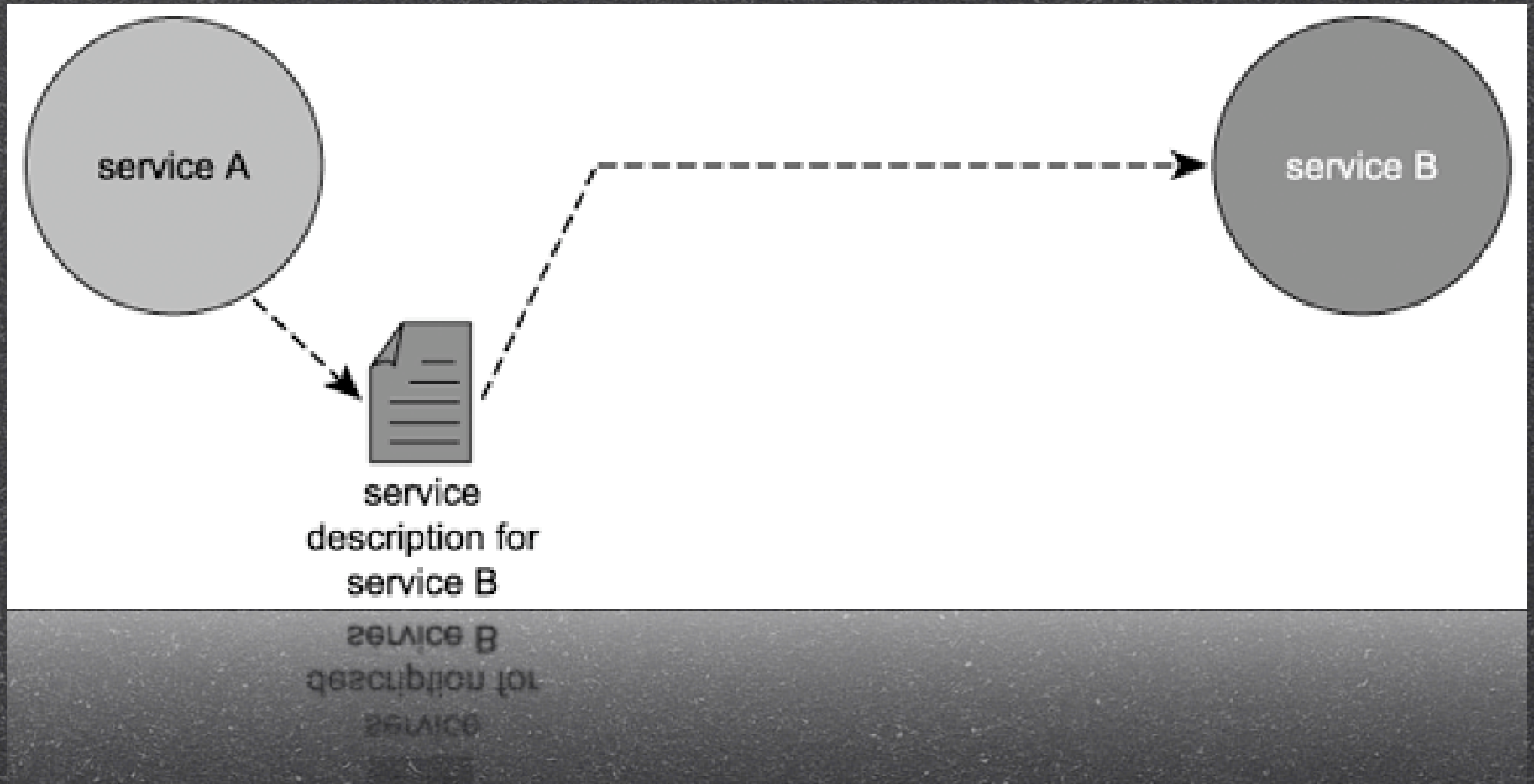
How service encapsulate logic

To retain their independence, services encapsulate logic within a distinct context. This context can be specific to a business task, a business entity, or some other logical grouping.



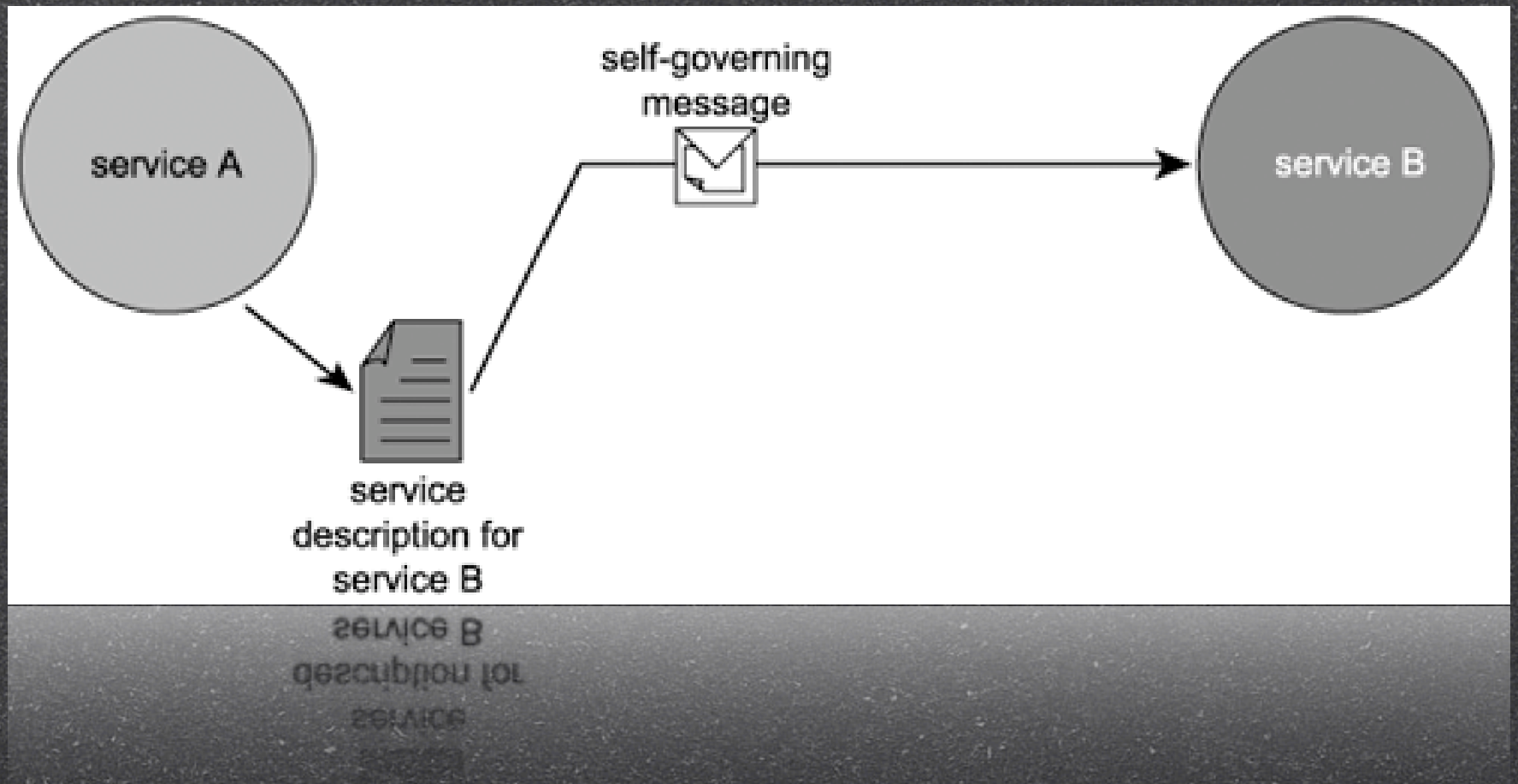
How services relate

The relationship between services is based on an understanding that for services to interact, they must be aware of each other. This awareness is achieved through the use of service descriptions.



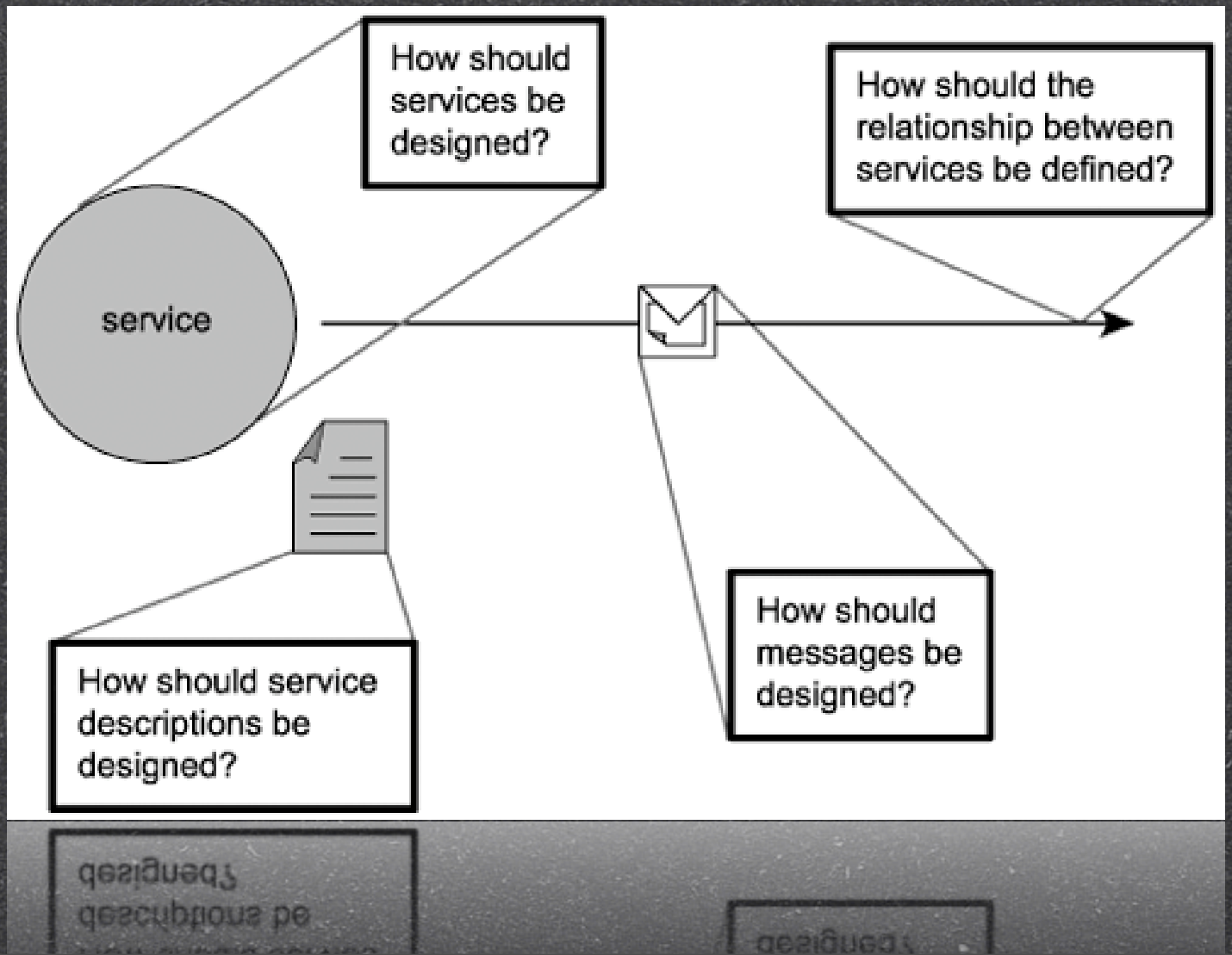
How services communicate

After a service sends a message on its way, it loses control of what happens to the message thereafter. That is why we require messages to exist as "independent units of communication." This means that messages, like services, should be autonomous.



How services are designed

When a solution is comprised of units of service-oriented processing logic, it becomes what we refer to as a service-oriented solution.



Service orientation principles

- Common principle/1:
  - Services are reusable
    Regardless of whether immediate reuse opportunities exist, services are designed to support potential reuse.
  - Services share a formal contract *
    For services to interact, they need not share anything but a formal contract that describes each service and defines the terms of information exchange.
  - Services are loosely coupled *
    Services must be designed to interact without the need for tight, cross-service dependencies.
  - Services abstract underlying logic *
    The only part of a service that is visible to the outside world is what is exposed via the service contract. Underlying logic, beyond what is expressed in the descriptions that comprise the contract, is invisible and irrelevant to service requestors.

Service orientation principles

- Common principle/2:
  - Services are composable

    Services may compose other services. This allows logic to be represented at different levels of granularity and promotes reusability and the creation of abstraction layers (ESB principle...)
  - Services are autonomous *

    The logic governed by a service resides within an explicit boundary. The service has control within this boundary and is not dependent on other services for it to execute its governance.
  - Services are stateless

    Services should not be required to manage state information, as that can impede their ability to remain loosely coupled. Services should be designed to maximize statelessness even if that means deferring state management elsewhere.
  - Services are discoverable

    Services should allow their descriptions to be discovered and understood by humans and service requestors that may be able to make use of their logic.

Web services

(the proposal of)

- “Web Services provide a standard means of interoperating between different software application on a variety of platforms and frameworks”
- ... Web Services Architecture W3C working group
- they focus on Interoperability!

What is a Web service?

- “WS is a software system designed to support interoperable machine-to-machine interaction over a network [..] using SOAP messages”
- “WS is an abstract notion that must be implemented by a concrete agent [..] the agent is the concrete piece of software that send and receive messages”

Web services framework

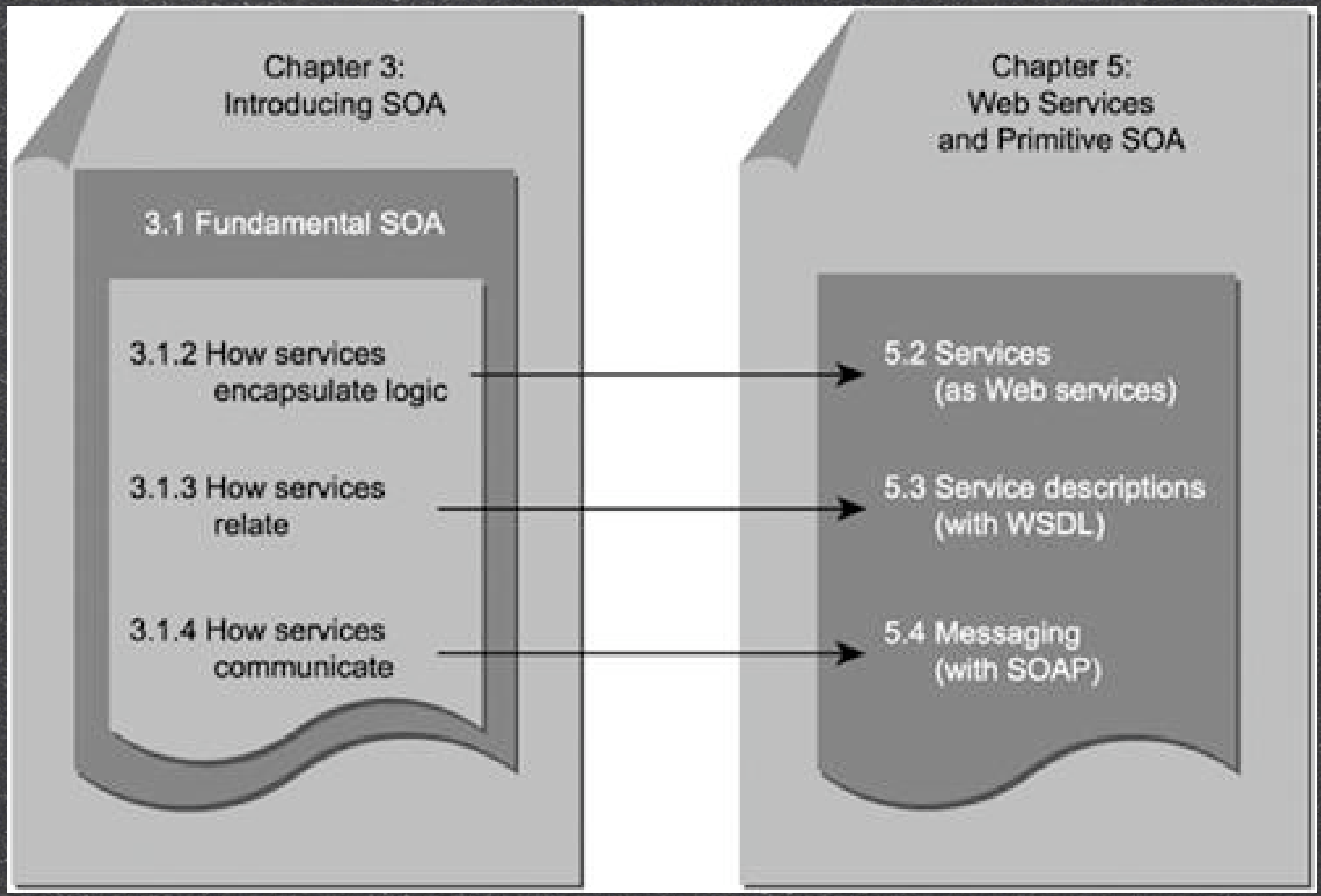
- Web services framework is flexible and adaptable -> large in scope
- Characterized by/1:
  - an abstract (vendor-neutral) existence defined by standards organizations and implemented by (proprietary) technology platforms
  - core building block that include Web services, service descriptions and messages
  - a communications agreement centered around service descriptions based on WSDL

Web services framework

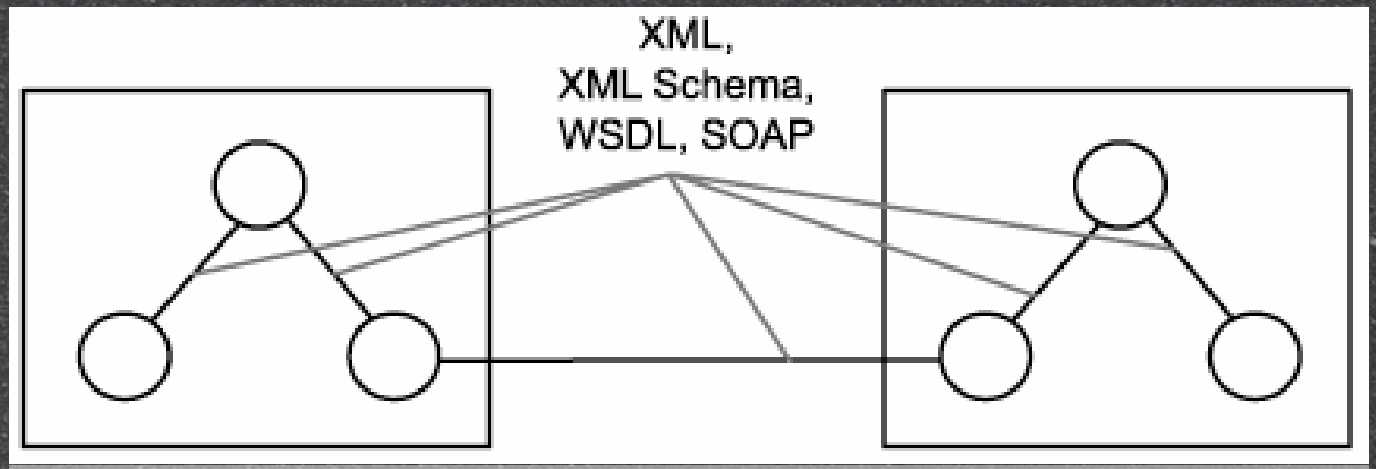
- Characterized by/2:
  - a messaging framework comprised of SOAP technology and concepts
  - a service description registration and discovery architecture sometimes realized through UDDI
  - architecture that support message pattern
  - WS-* specifications

Web services framework

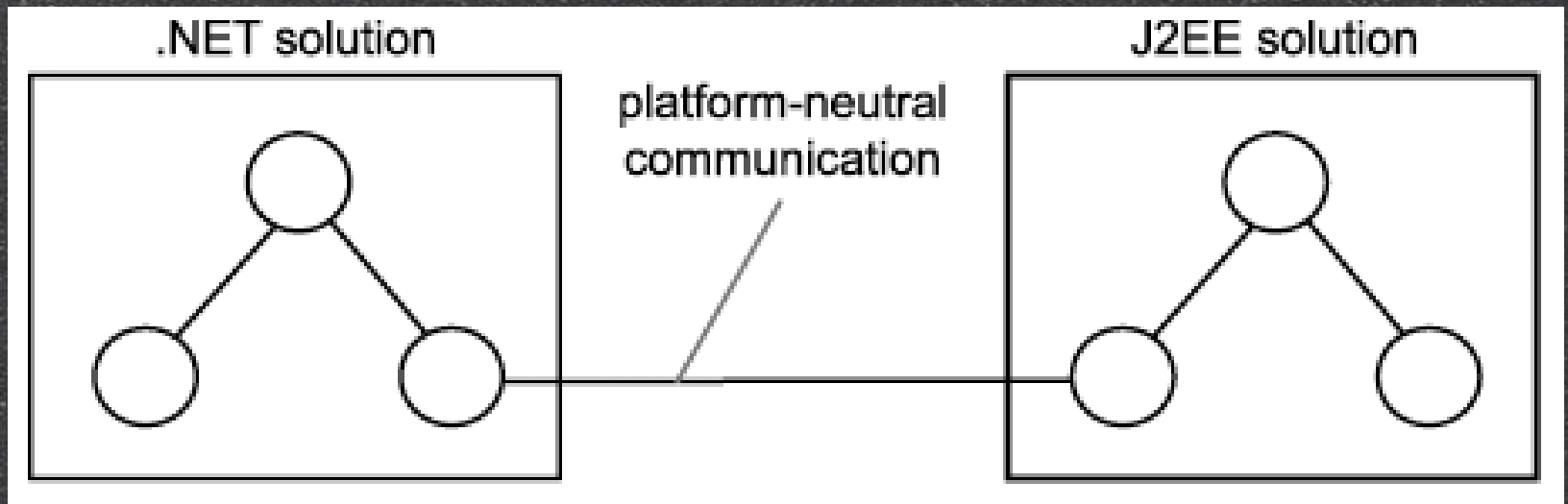
Web services framework



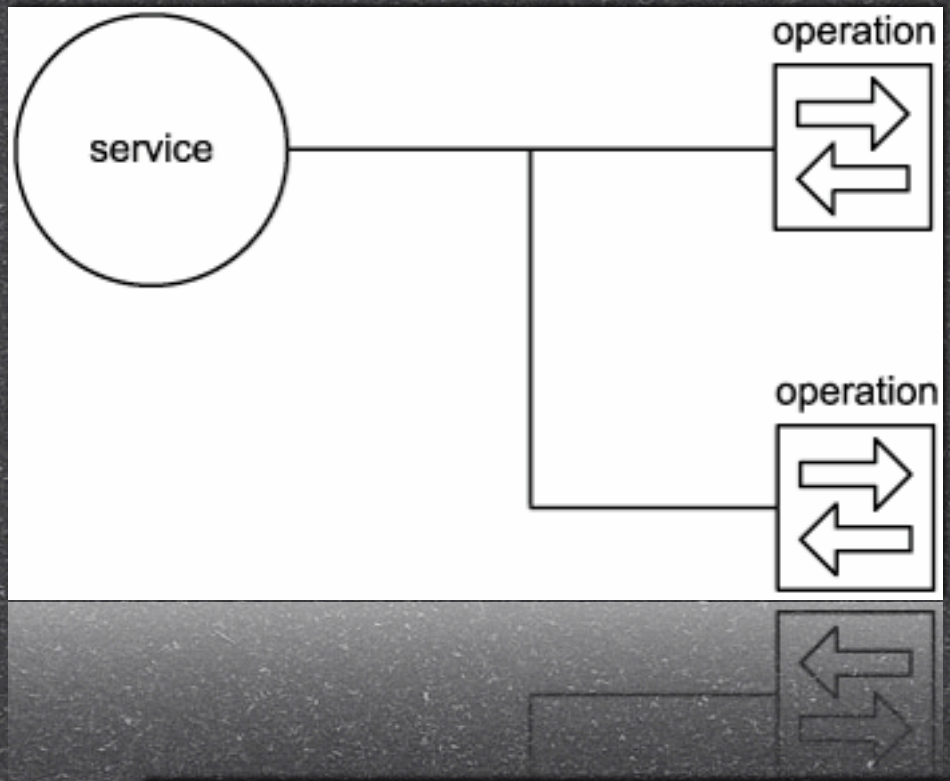
- based on open standard

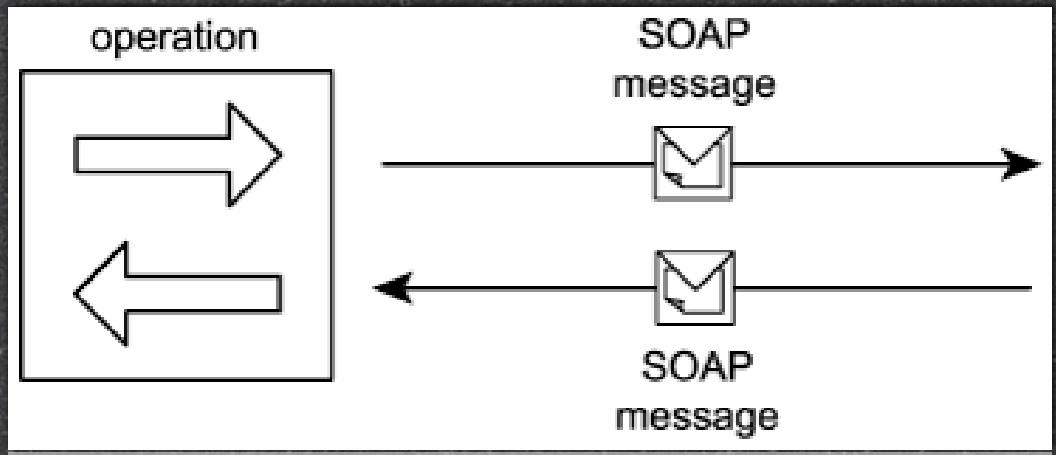


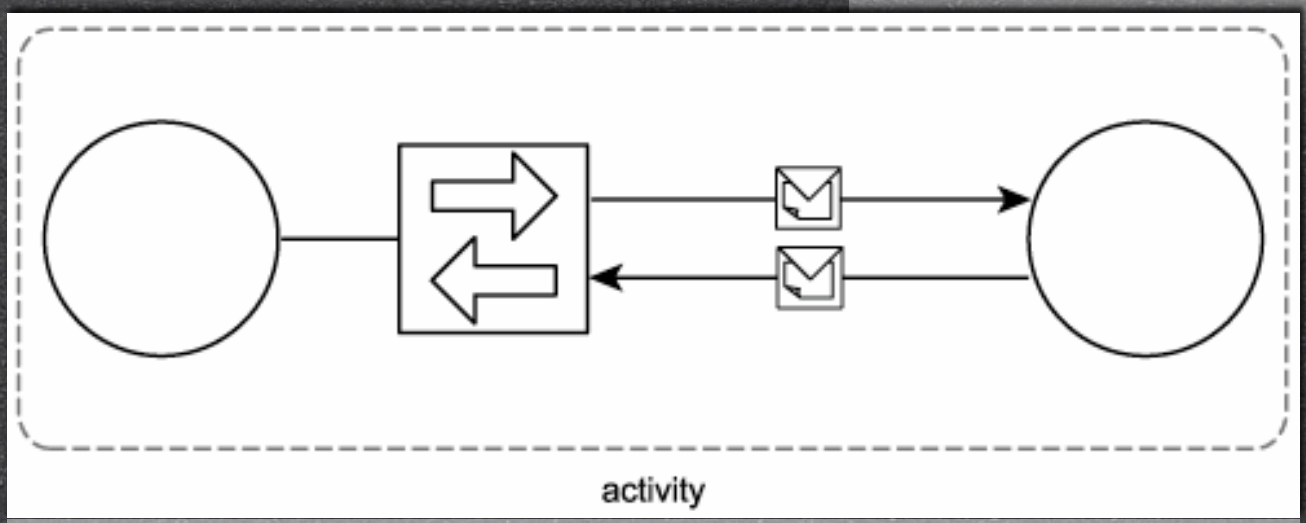
- support vendor diversity



Logical components of the WS framework







Logical components of automation logic

Fundamental parts of the WS framework

- SOAP messages
- Web service operations
- Web services
- activities (typically used to represent the temporary interaction of a group of Web services)

Service oriented perspective

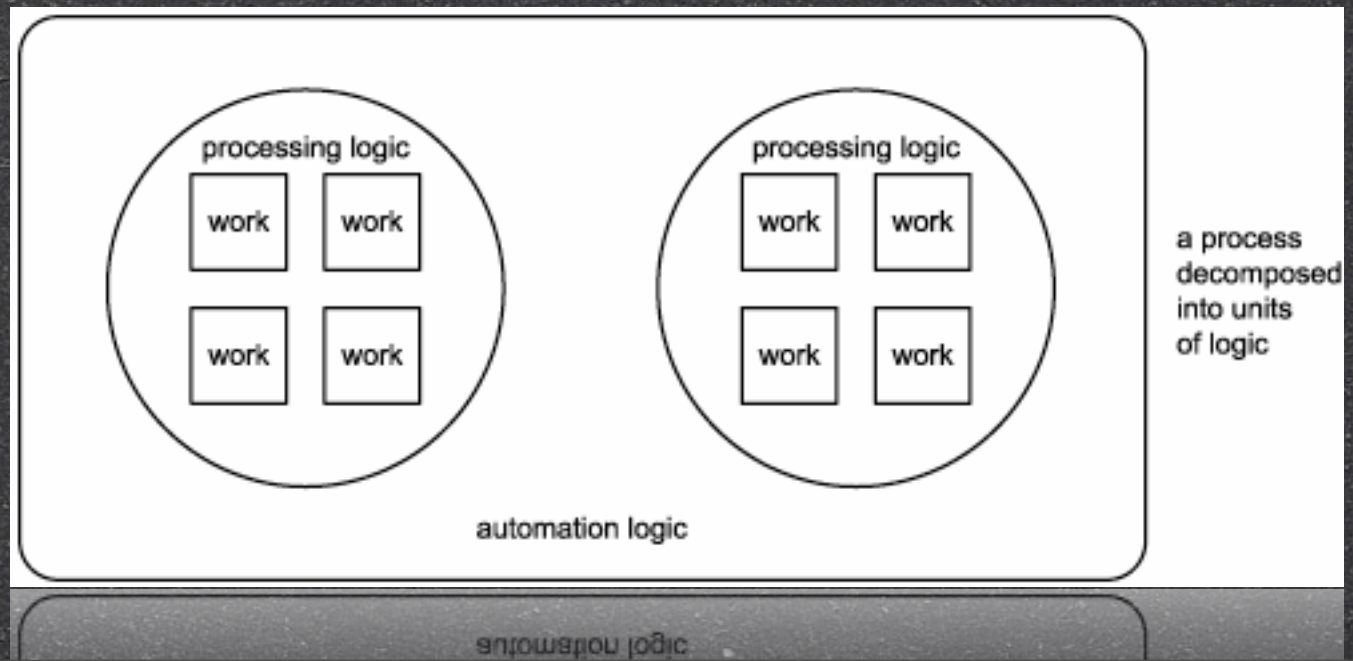
- messages
- operations
- services
- processes (static definition of interaction logic)

Logical components of automation logic

Automation logic is comprised of four parts

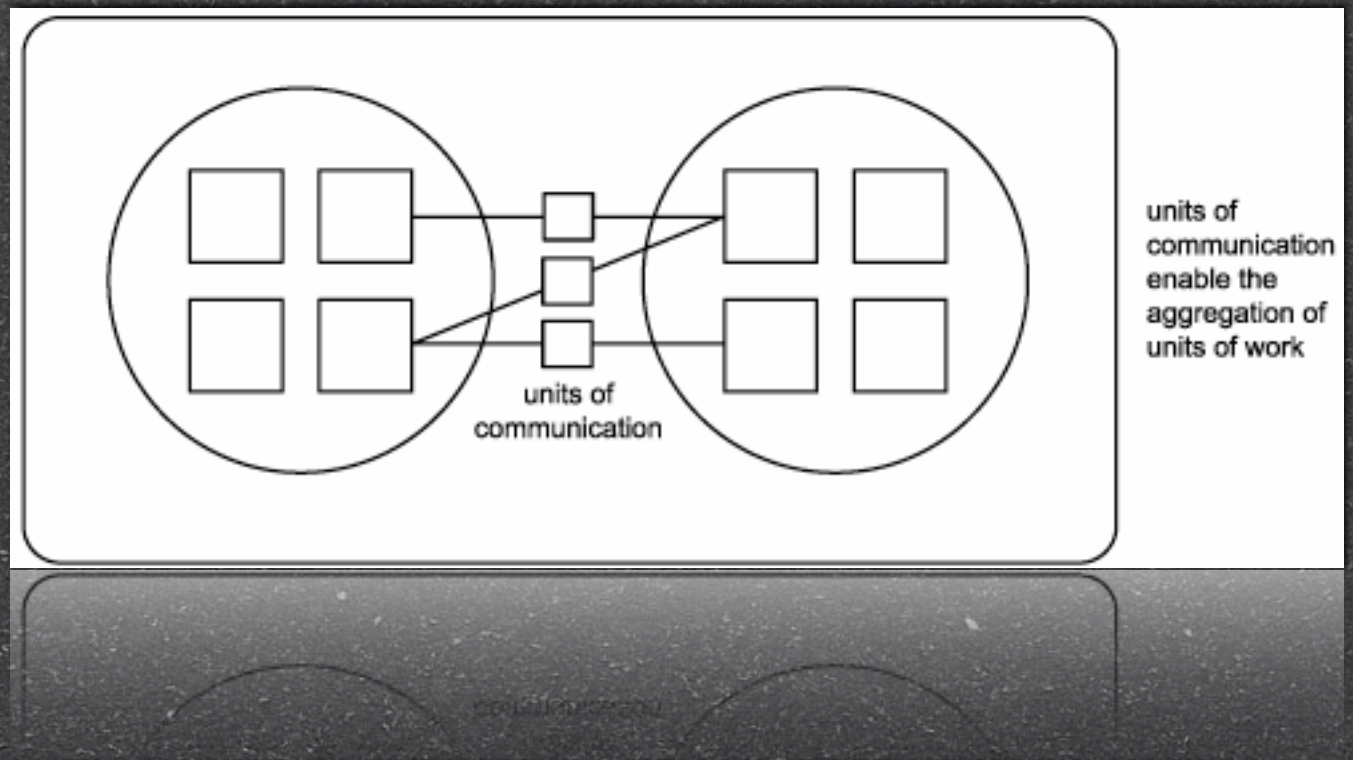
- messages = units of communication
- operations = units of work
- services = units of processing logic (collections of units of work)
- processes = units of automation logic (coordinated aggregation of units of work)

A primitive view of how SOA modularizes automation logic into units.

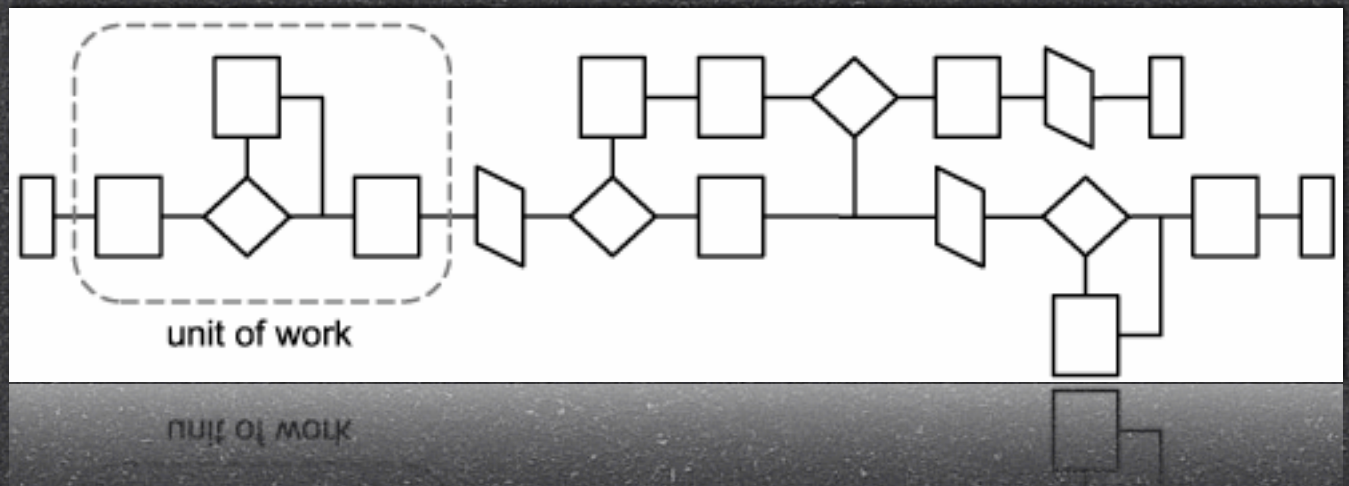


Logical components of automation logic

A primitive view of how units of communication enable interaction between units of logic.

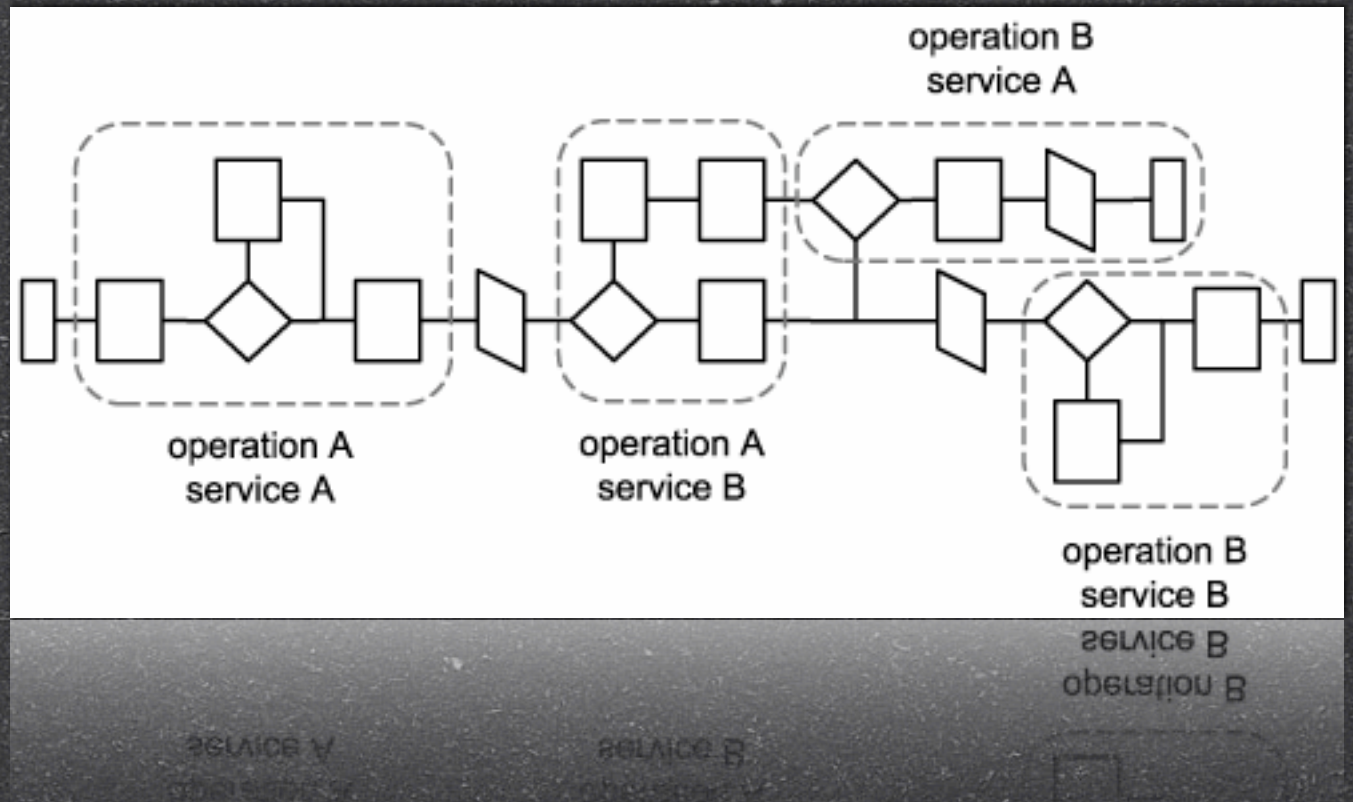


The scope of an operation within a process



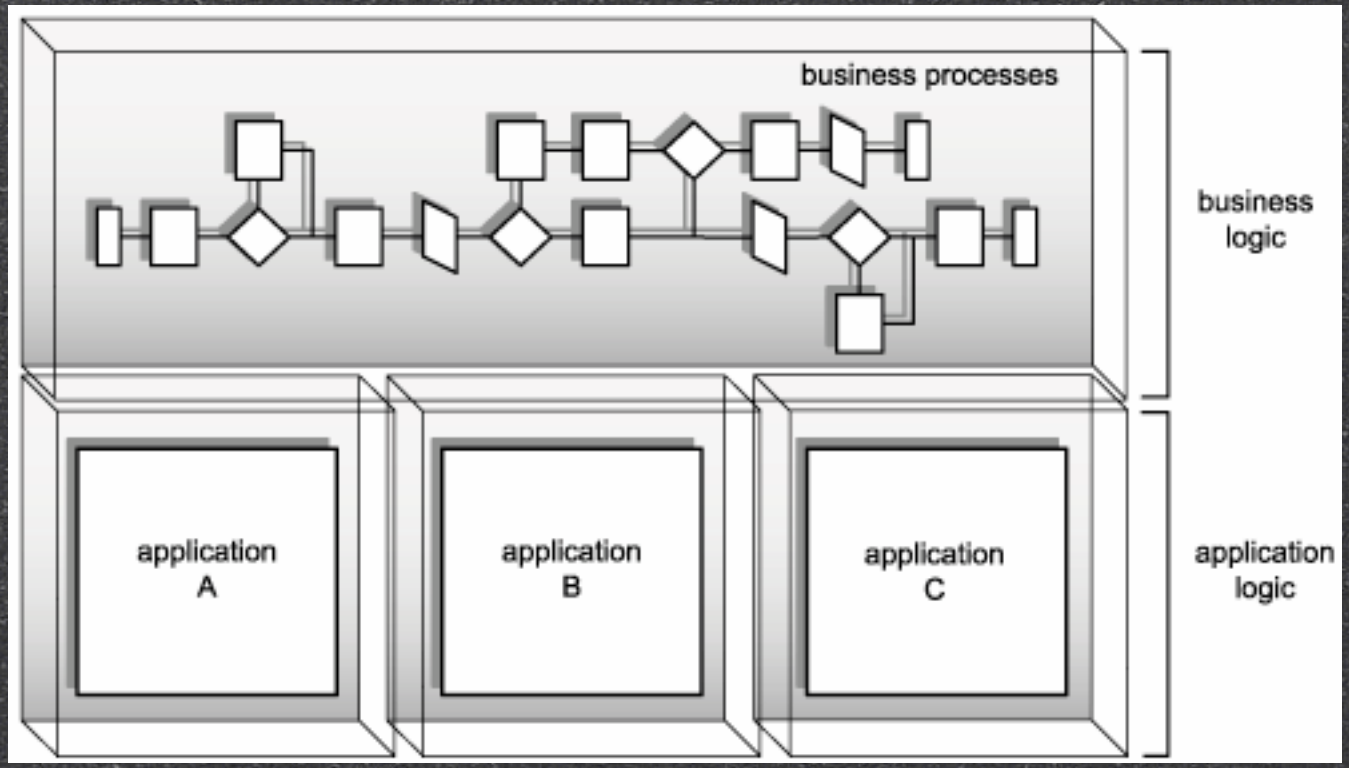
Logical components of automation logic

Operations belonging to different services representing various parts of process logic



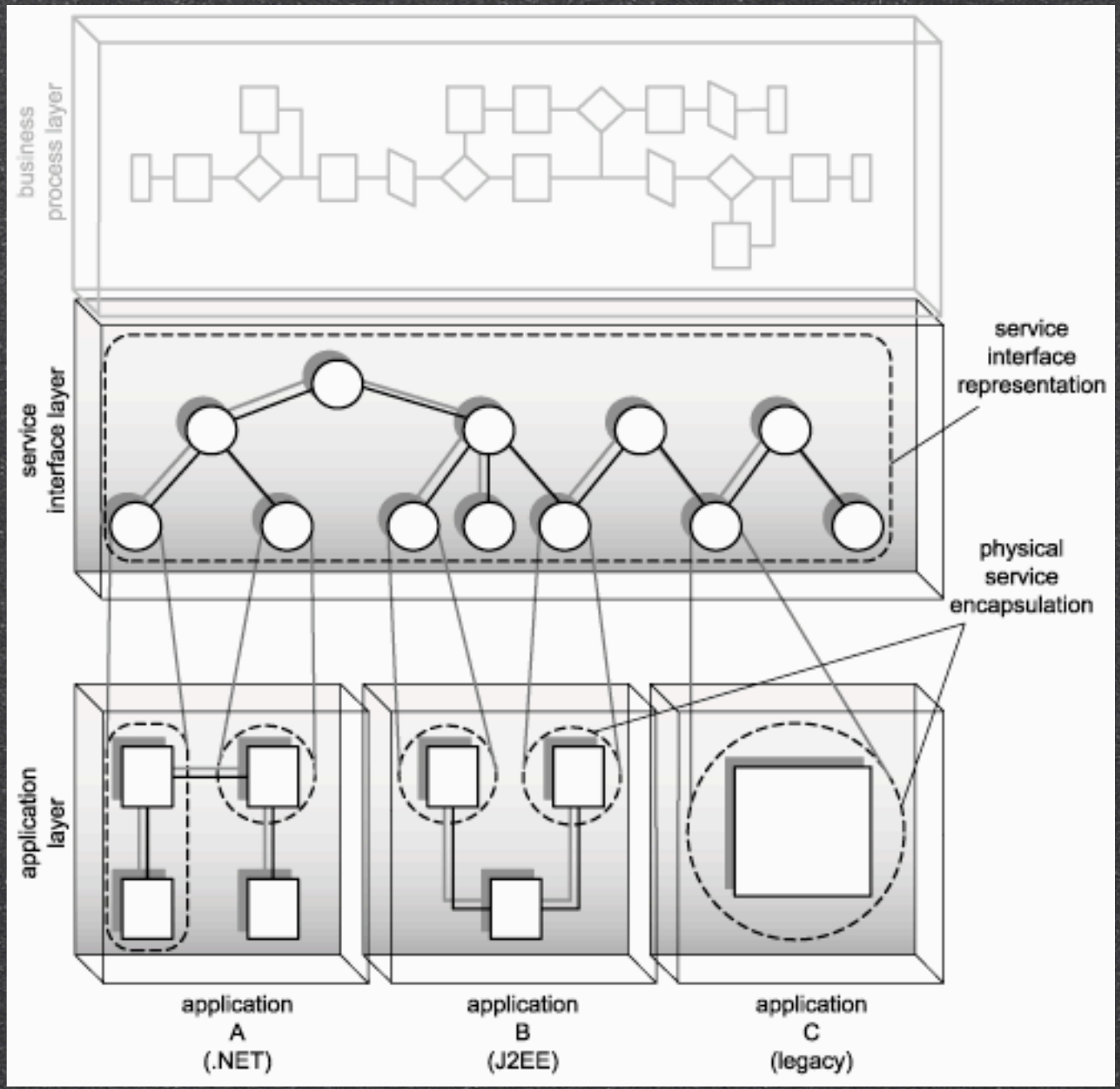
Service-orientation and the enterprise

- Business logic is a documented implementation of the business requirements that originate from an enterprise's business areas.
- Application logic is an automated implementation of business logic organized into various technology solutions.



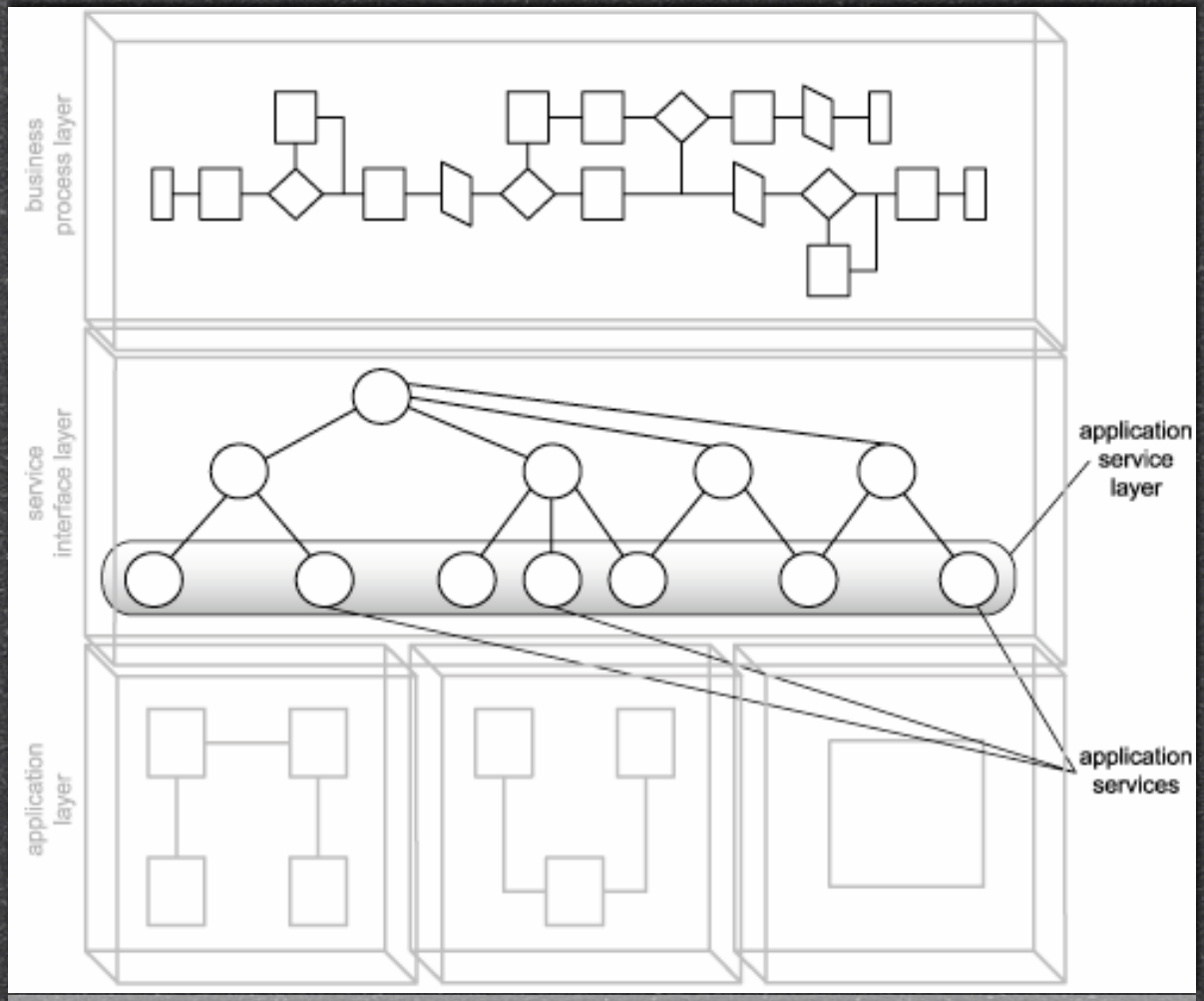
Service-orientation and the enterprise

- Individual services, represented as service interfaces within the service interface layer, represent application logic originating from different platforms.

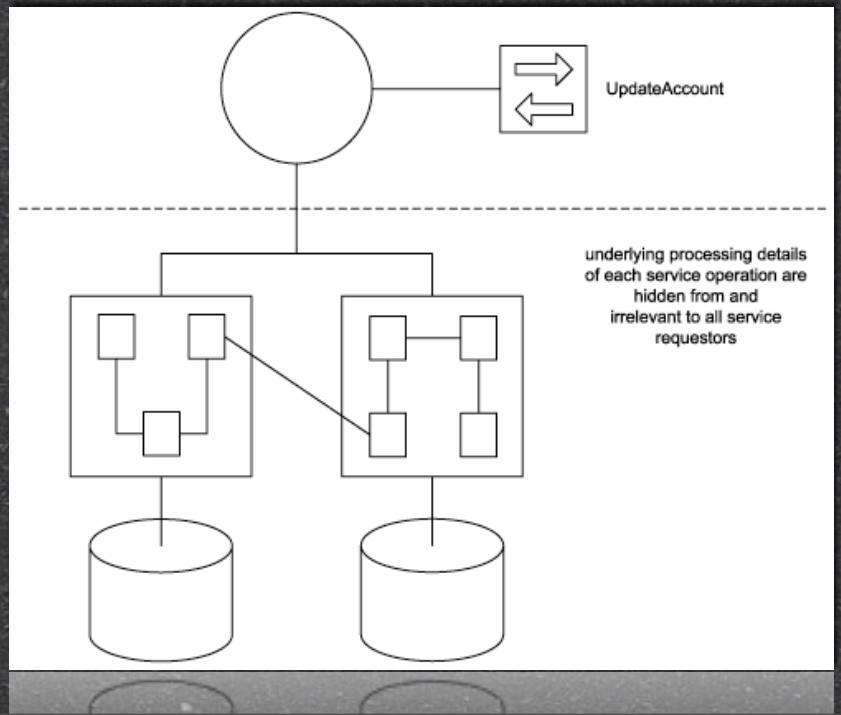


Layers of Abstraction

- Leveraging the concept of composition, we can build specialized layers of services (towards Enterprise Service Bus principles)
- Each layer can abstract a specific aspect of our solution, addressing one of the issues we identified



The application service layer exists to express technology-specific functionality

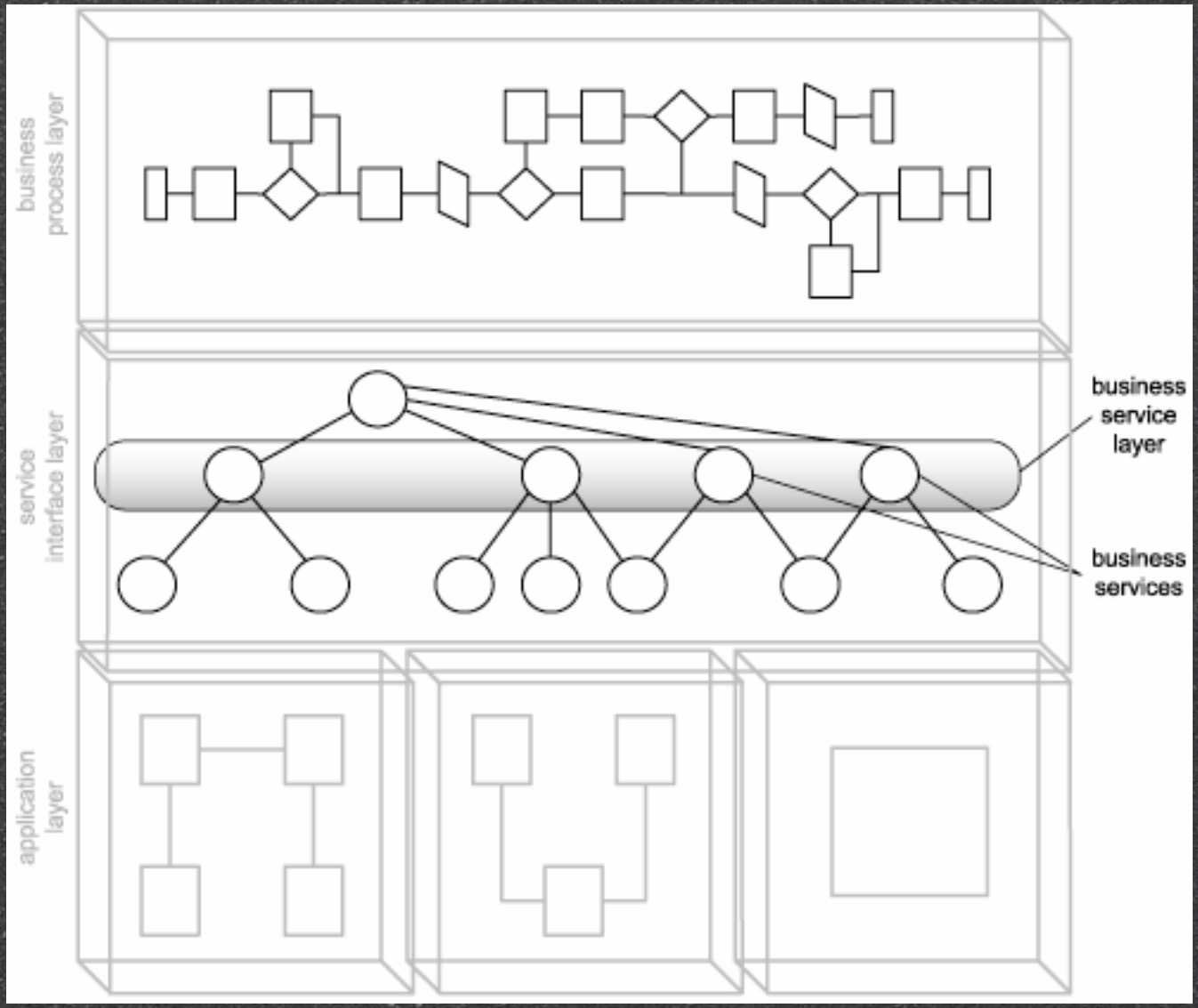


Logical components of automation logic

The business service layer is comprised of business services, a direct implementation of the business service model.

eg:

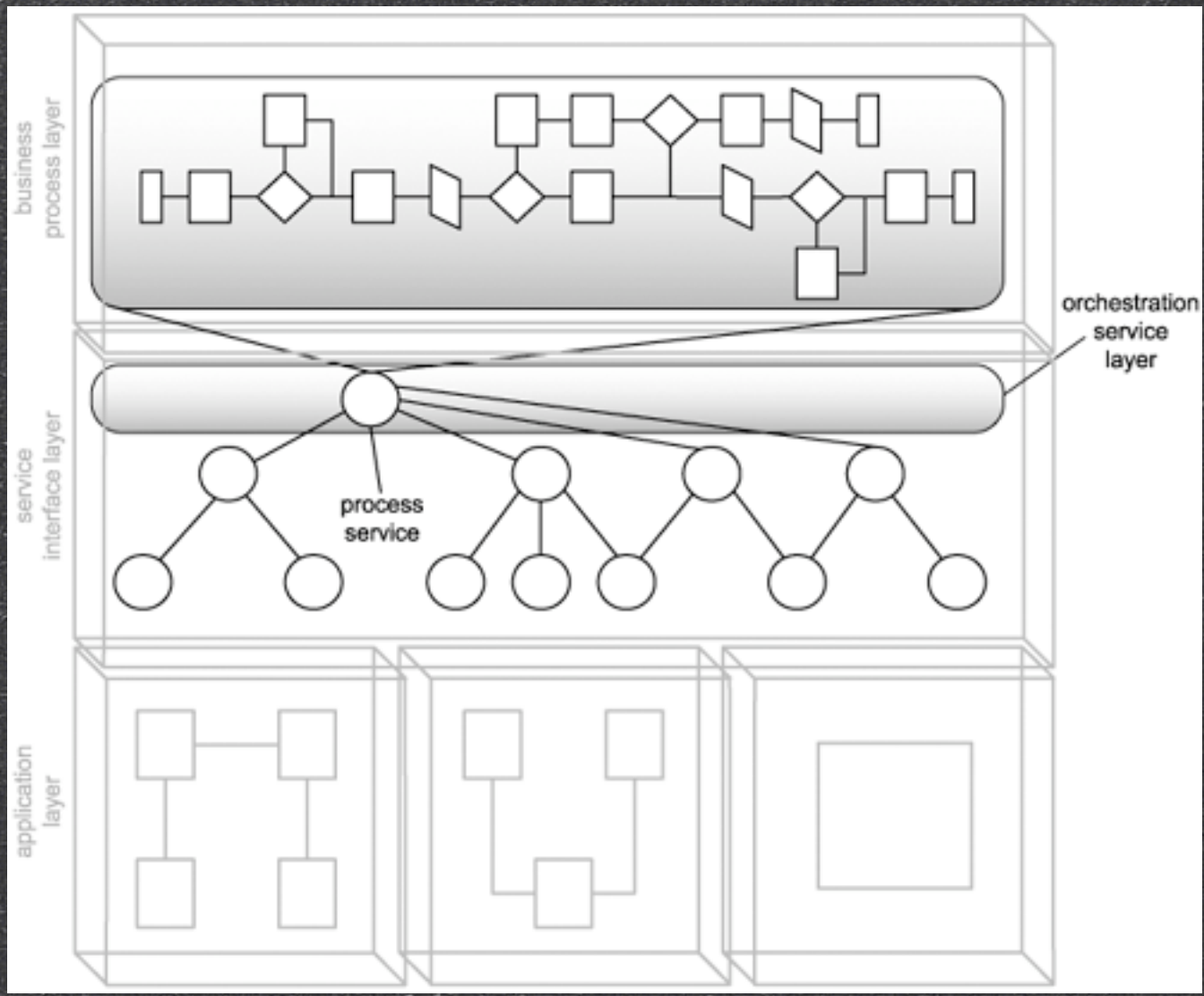
- Purchase Order Service
- Billing Service



Logical components of automation logic

The orchestration service layer introduces a level of abstraction that alleviates the need for other services to manage interaction details required to ensure that service operations are executed in a specific sequence.

Orchestration languages (such as WS-BPEL) realize workflow management, bringing the business process into the service layer.

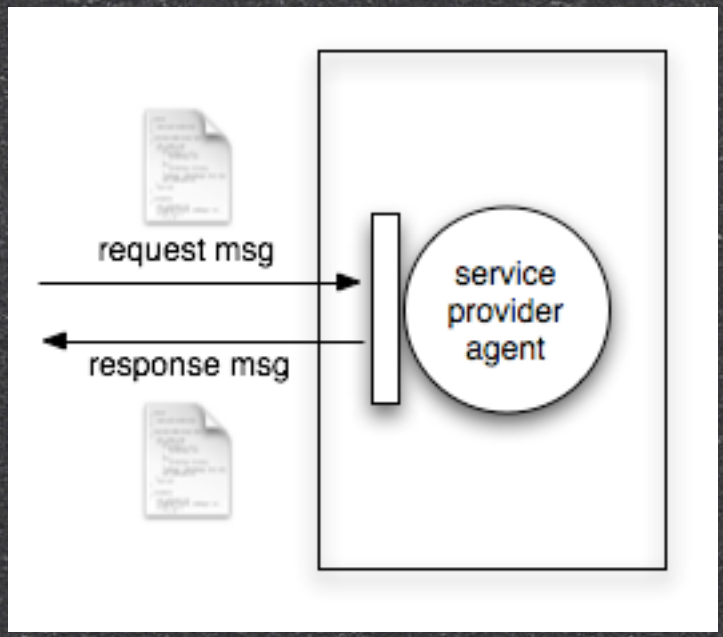


Service role

- Service role (runtime classification)
  - depending on its processing responsibility in a given scenario (initiator - relayer - recipient of a message)

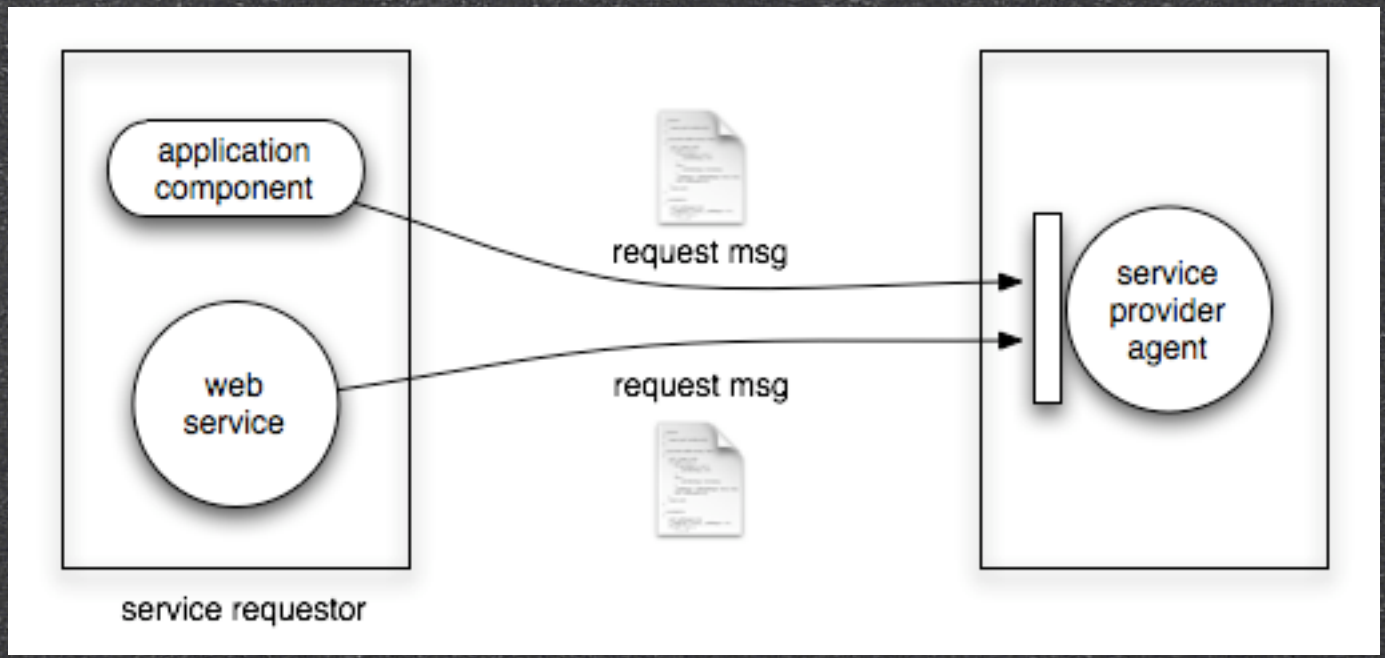
Service role

- Service provider role
  - is invoked via an external source
  - publish a service description (WSDL)



Service role

- Service requester role
  - invoke a service provider by sending msg
  - search the most suitable service provider studying available service descriptions



Service role

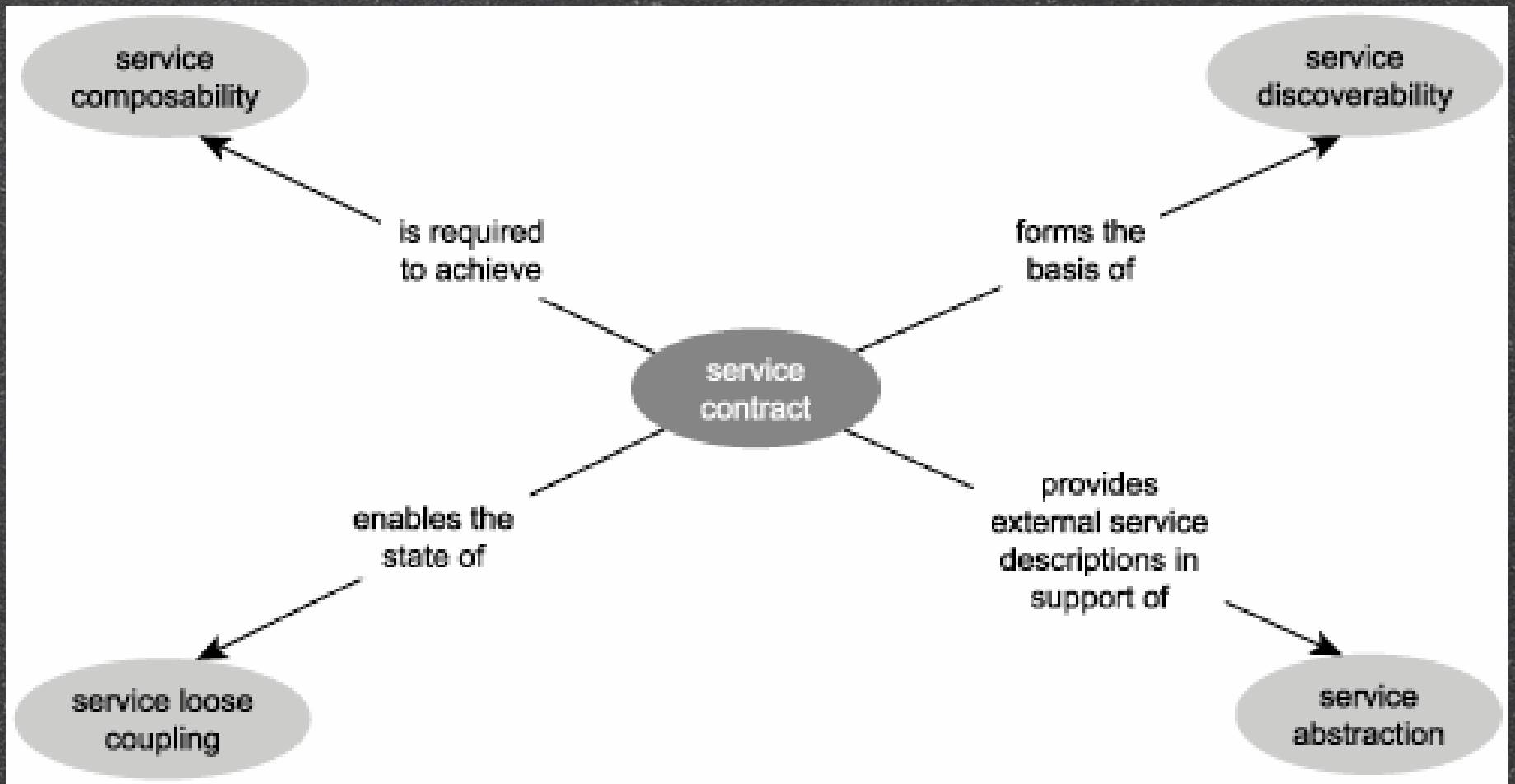
- Service intermediator role
  - forwarding to destination
  - passive: without altering content
  - active: process and alter message content, typically will lock for a particular SOAP header
  - e.g.: policy rule, load balancing, ...
- Service composition
  - Orchestration & choreography

Service Description

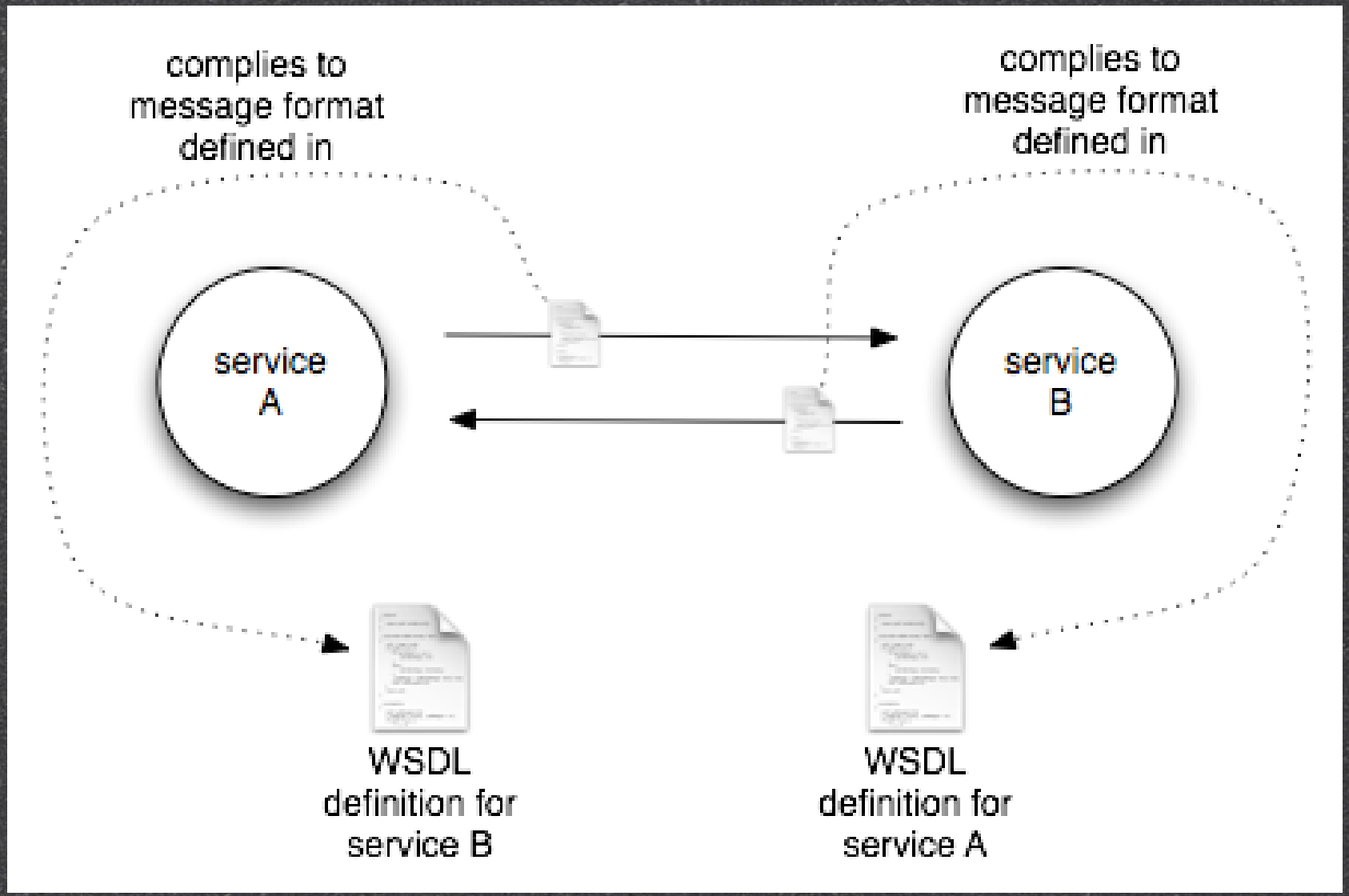
- Service Description as “contract” that can be used to build and validate messages
  - what kind of operation can I invoke on service X? - requester role
  - what kind of operation/request can I accept? - provider role
- WSDL Web Service Description Language

Service Description

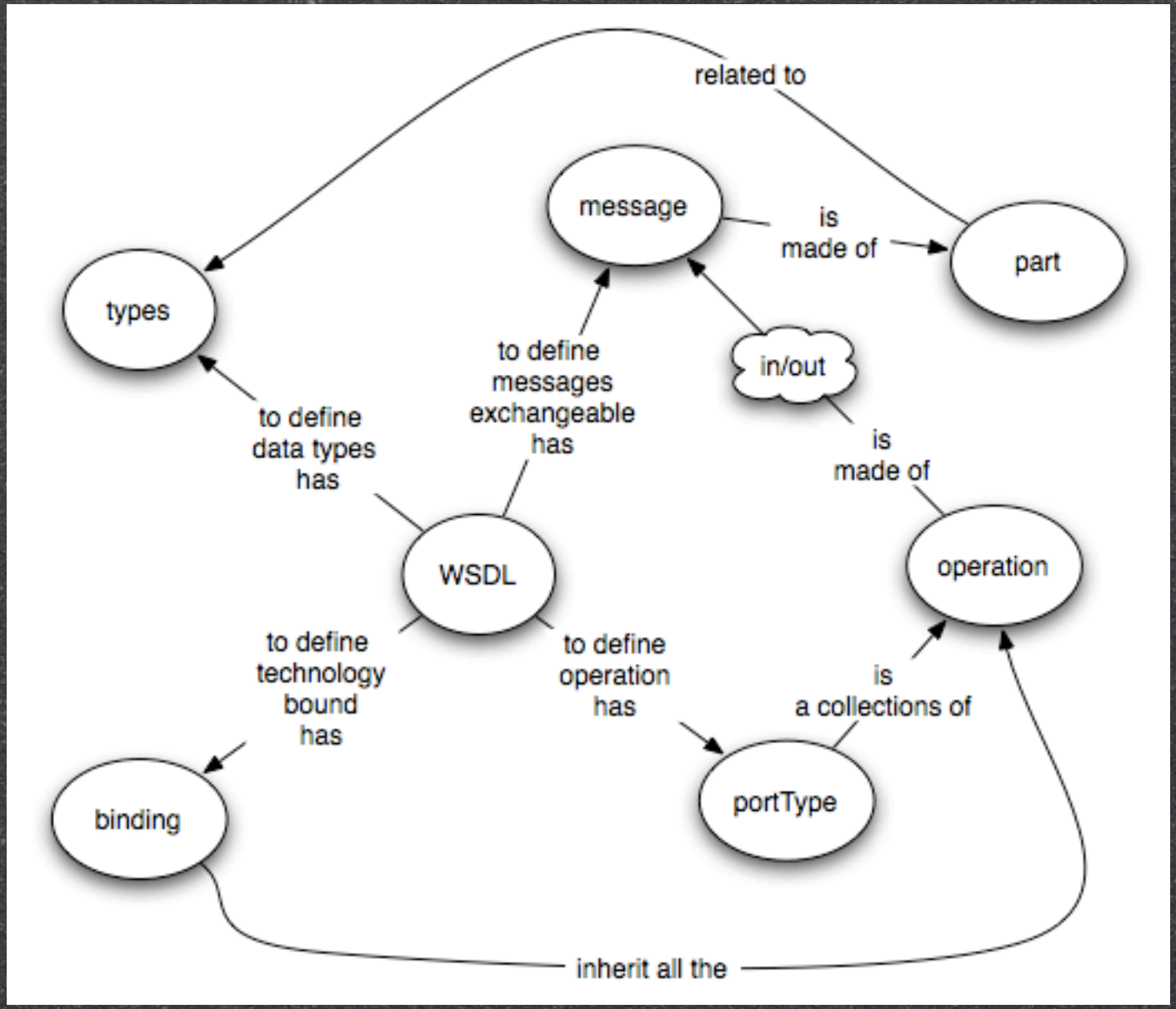
Metadata that defines the only information made available to service requestors.



Service Description



Service Description

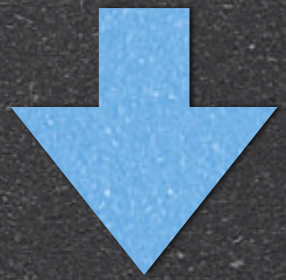


Service Description

- WSDL - Web Server Description Language
  - Abstract description
    - interface characteristic without technology reference
  - Concrete description
    - connection to some real, implemented technology

WSDL

- Abstract Description - high level view of the service
  - definition - root element declaring namespace
  - types - where XML Schema is placed, to simple data to complex business document
  - example -> echo and ping operations



WSDL

- Abstract Description
  - messages designed to receive or transmit

```
<wsdl:message name="echoRequestMessage">
    <wsdl:part name="part1" element="ns1:echoRequest"/>
</wsdl:message>

<wsdl:message name="echoResponseMessage">
    <wsdl:part name="part1" element="ns1:echoResponse"/>
</wsdl:message>

<wsdl:message name="pingRequestMessage">
    <wsdl:part name="part1" element="ns1:pingRequest"/>
</wsdl:message>
```

WSDL

```
<wsdl:types>
   <xs:schema targetNamespace="http://org.apache.axis2/xsd"
            elementFormDefault ="unqualified"
attributeFormDefault="unqualified">

          <xs:element name="pingRequest">
              <xs:complexType>
                   <xs:sequence>
                        <xs:element type="xs:anyType" name="element"/>
                   </xs:sequence>
              </xs:complexType>
          </xs:element>

          <xs:element name="echoRequest">
              <xs:complexType>
                   <xs:sequence>
                        <xs:element type="xs:anyType" name="element"/>
                    </xs:sequence>
              </xs:complexType>
          </xs:element>
```

WSDL

- Abstract Description - high level view of the service
  - portType (collection of) -> operation

```
<wsdl:portType name="MyServicePort">
    <wsdl:operation name="echo">
        <wsdl:input message="tns:echoRequestMessage"/>
        <wsdl:output message="tns:echoResponseMessage"/>
    </wsdl:operation>
    <wsdl:operation name="ping">
        <wsdl:input message="tns:pingRequestMessage"/>
    </wsdl:operation>
</wsdl:portType>
```

  - operation is not (only) a method mapping

WSDL

- Concrete Description
  - binding -> concrete binding to SOAP

```
<wsdl:binding name="MyServiceBinding" type="tns:MyServicePort">
    <soap:binding transport="http://schemas.xmlsoap.org/soap/http"
    style="document"/>
    <wsdl:operation name="echo">
        <soap:operation soapAction="echo" />
        <wsdl:input>
            <soap:body use="literal" namespace="http://www.org.apache.axis2"/>
        </wsdl:input>
        <wsdl:output>
            <soap:body use="literal" namespace="http://www.org.apache.axis2"/>
        </wsdl:output>
    </wsdl:operation>
</wsdl:binding>
```

WSDL

- Concrete Description
  - service -> physical address at which access service
  - port -> location information

```
<wsdl:service name="MyService">

    <wsdl:port name="MyServicePortType0"
                                binding="tns:MyServiceBinding">

            <soap:address location="http://localhost:8080/MyService"/>

    </wsdl:port>
</wsdl:service>
```

WSDL Semantic (pills)

- ...and what about semantic
  - how a service behaves under certain conditions
  - how service will respond to specific conditions
  - what specific tasks the service is most suited for
- OWL - OWLS (think about)
  - no standardized solution yet

Which style of WSDL should I use?

- In relation to WSDL binding to SOAP
  - RPC/encoded
  - RPC/literal
  - Document/encoded
  - Document/literal
- Following the example
  - myMethod operation with parameters (integer x, float y)

Which style of WSDL should I use?

- RPC/encoded - `void myMethod(int x, float y)`

WDSL

```
<message name="myMethodRequest">
   <part name="x" type="xsd:int"/>
   <part name="y" type="xsd:float"/>
</message>


<portType name="PT">
   <operation name="myMethod">
      <input message="myMethodRequest"/>
   </operation>
</portType>

<binding .../>
```

SOAP

```
<soap:envelope>
   <soap:body>
      <myMethod>
         <x xsi:type="xsd:int">5</x>
         <y xsi:type="xsd:float">5.0</y>
      </myMethod>
   </soap:body>
</soap:envelope>
```

overhead

op. name

not WS-I compliant

Which style of WSDL should I use?

- RPC/literal - `void myMethod(int x, float y)`

WDSL

```
<message name="myMethodRequest">
   <part name="x" type="xsd:int"/>
   <part name="y" type="xsd:float"/>
</message>


<portType name="PT">
   <operation name="myMethod">
      <input message="myMethodRequest"/>
   </operation>
</portType>

<binding .../>
```

SOAP

```
<soap:envelope>
   <soap:body>
      <myMethod>
         <x >5</x>
         <y >5.0</y>
      </myMethod>
   </soap:body>
</soap:envelope>
```

op. name

WS-I compliant

Which style of WSDL should I use?

- Document/literal

WDSL

XML-Schema

```
<types>
   <schema>
      <element name="xElement" type="xsd:int"/>
      <element name="yElement" type="xsd:float"/>
   </schema>
</types>

<message name="myMethodRequest">
   <part name="x" element="xElement"/>
   <part name="y" element="yElement"/>
</message>
```

SOAP

op name?

```
<soap:envelope>
   <soap:body>
      <xElement>5</xElement>
      <yElement>5.0</yElement>
   </soap:body>
</soap:envelope>
```

not WS-I compliant

Which style of WSDL should I use?

- Document/literal wrapped

WDSL

XML-Schema

```
<types>
   <schema>
      <element name="myMethod">
         <complexType>
            <sequence>
               <element name="x" type="xsd:int"/>
               <element name="y" type="xsd:float"/>
            </sequence>
         </complexType>
      </element>
   </schema>
</types>

<message name="myMethodRequest">
   <part name="parameters" element="myMethod"/>
</message>
```

SOAP

```
<soap:envelope>
   <soap:body>
      <myMethod>
         <x>5</x>
         <y>5.0</y>
      </myMethod>
   </soap:body>
</soap:envelope>
```

SOAP action

WS-I compliant

WSDL binding SOAP

- Concrete Description
  - binding -> concrete binding to SOAP

```
<wsdl:binding name="MyServiceBinding" type="tns:MyServicePort">
    <soap:binding transport="http://schemas.xmlsoap.org/soap/http"
    style="document"/>
    <wsdl:operation name="echo">
        <soap:operation soapAction="echo" />
        <wsdl:input>
            <soap:body use="literal" namespace="http://www.org.apache.axis2"/>
        </wsdl:input>
        <wsdl:output>
            <soap:body use="literal" namespace="http://www.org.apache.axis2"/>
        </wsdl:output>
    </wsdl:operation>
</wsdl:binding>
```

SOAP

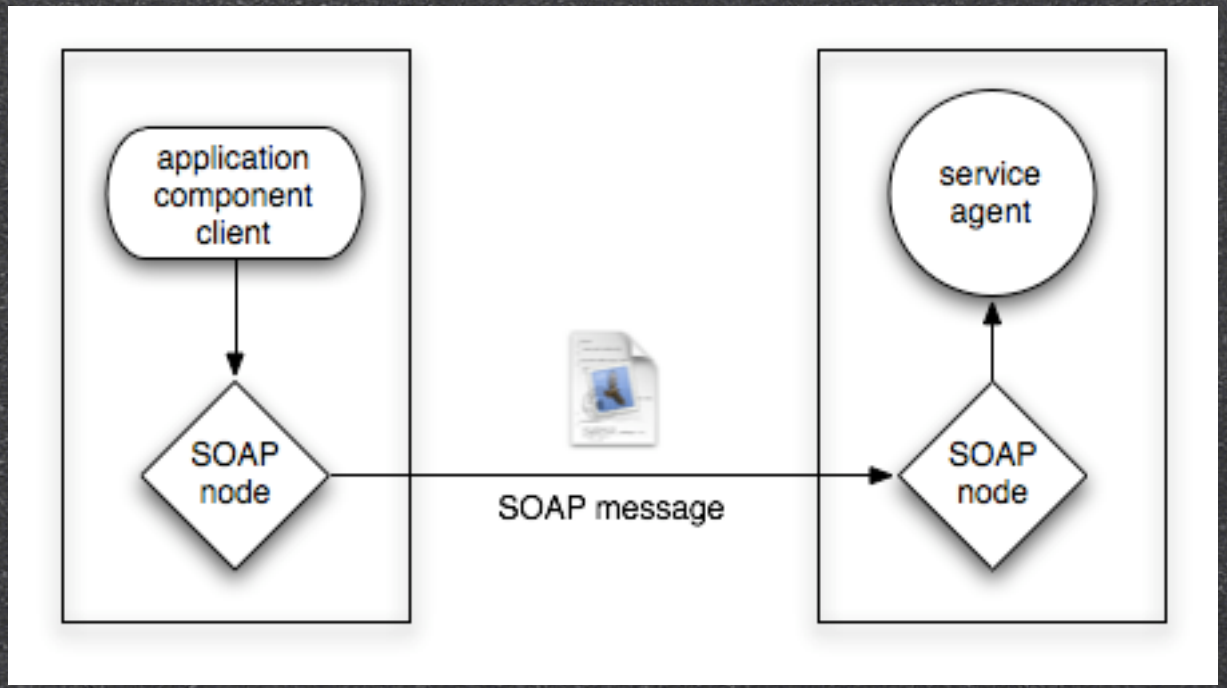
- Messaging Framework Specification
- Simple Object Access Protocol
  - originally designed to replace proprietary RPC protocols -> serialization of object
  - now the purpose is to define a standard message format !!!
  - extremely flexible and extensible
- The RPC-Style messages runs contrary to the SOA principle.

SOAP

- Each message packaged in ENVELOPE
  - Header - area dedicated to hosting meta information --> WS-*
  - Body - XML formatted data, is the message payload
- Message have high level of independence --> robustness and extensibility
- Fundamental in a loosely coupled env.

SOAP

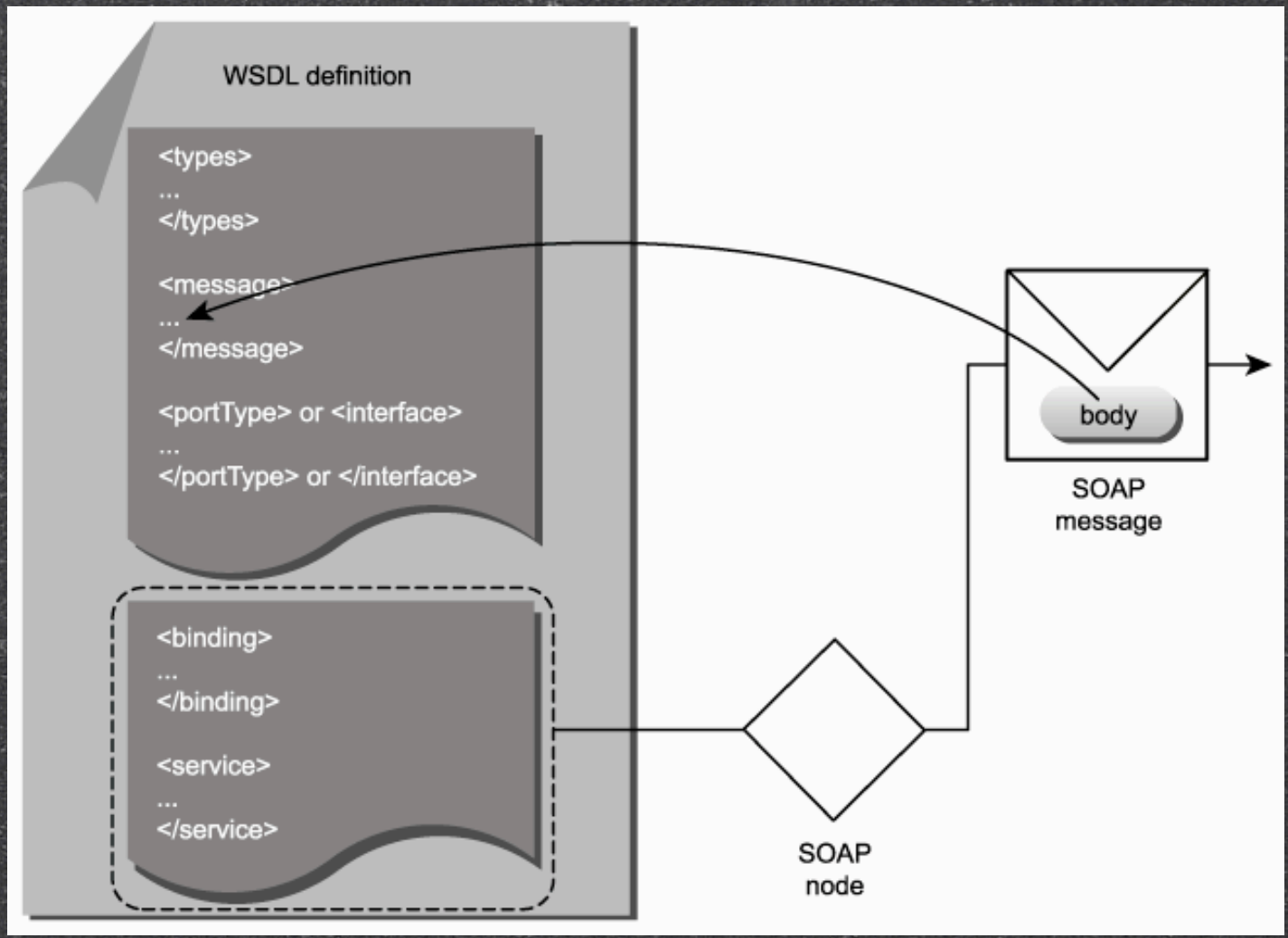
- The SOAP Nodes
  - sender
  - receiver
  - intermediary
  - initial
  - ultimate



- Remember the model!!

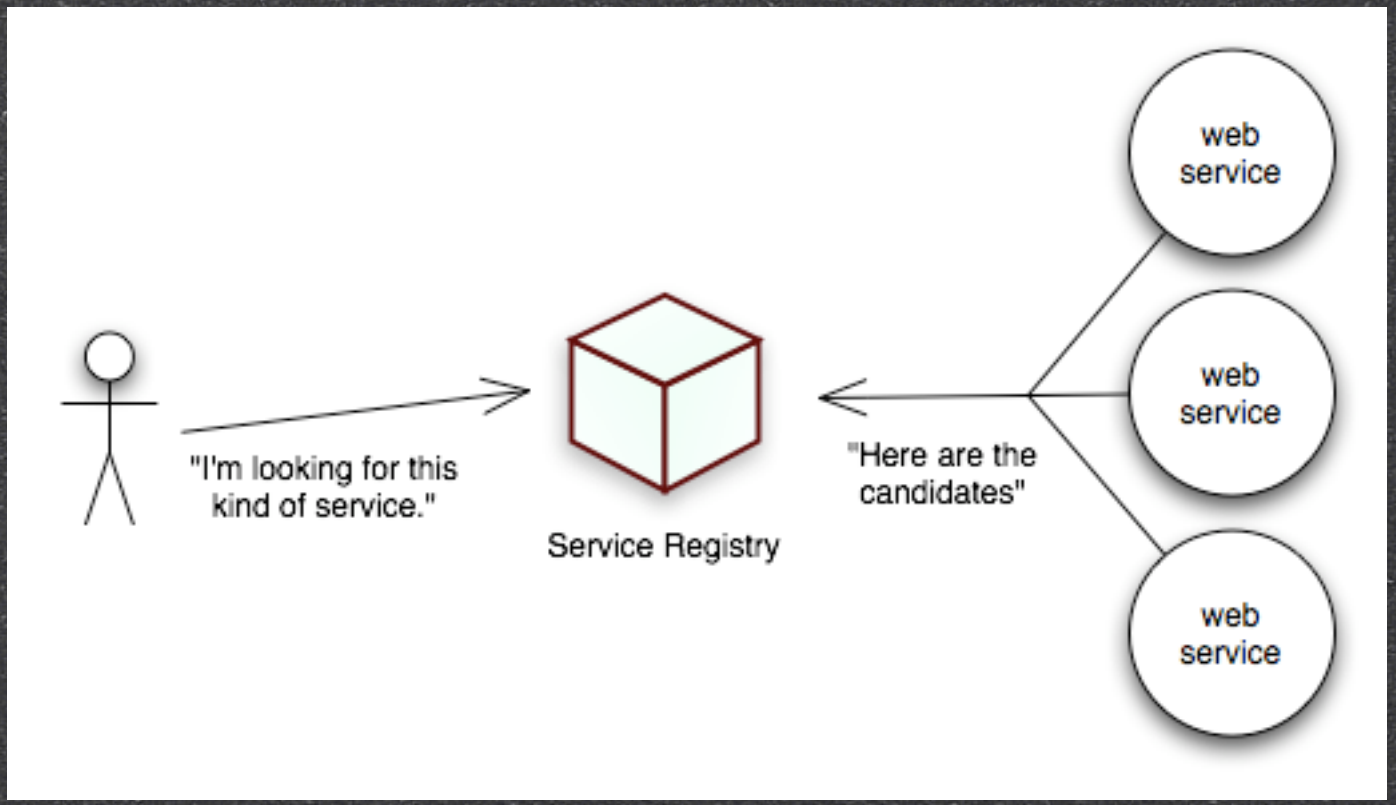
SOAP & WSDL

- Processing of SOAP message using concrete definition



UDDI (pills)

- Service description advertisement and discovery
  - UDDI V2.0 specifications approved as an OASIS Standard



- Not yet commonly implemented

MEPs
message exchange patterns

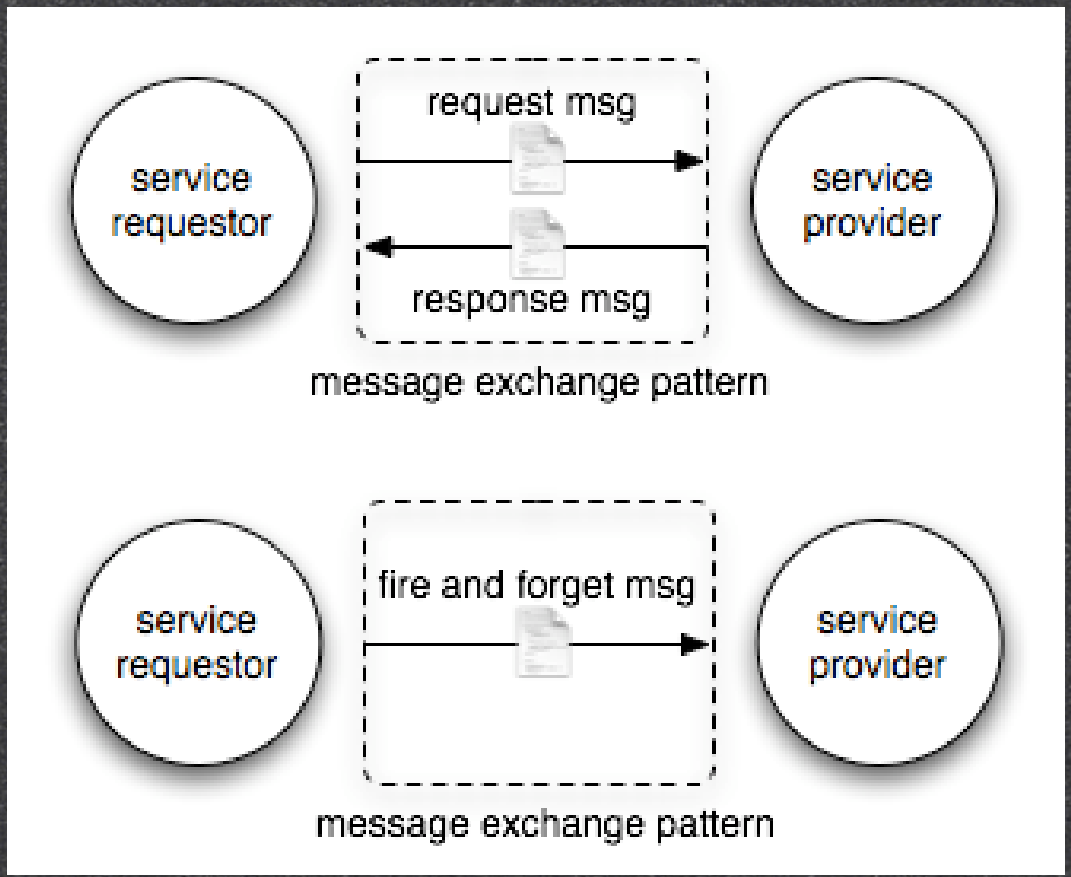
- Interaction between services
  - as result of engineering interaction
- A group of already mapped out sequence for the exchange of messages
- Simple MEPs as building block for Complex MEPs

MEPs
message exchange patterns

- Primitive MEPs
  - request-response
    - correlation concept
    - define synchronous communication
  - fire and forget
    - single destination - multicast - broadcast

MEPs
message exchange patterns

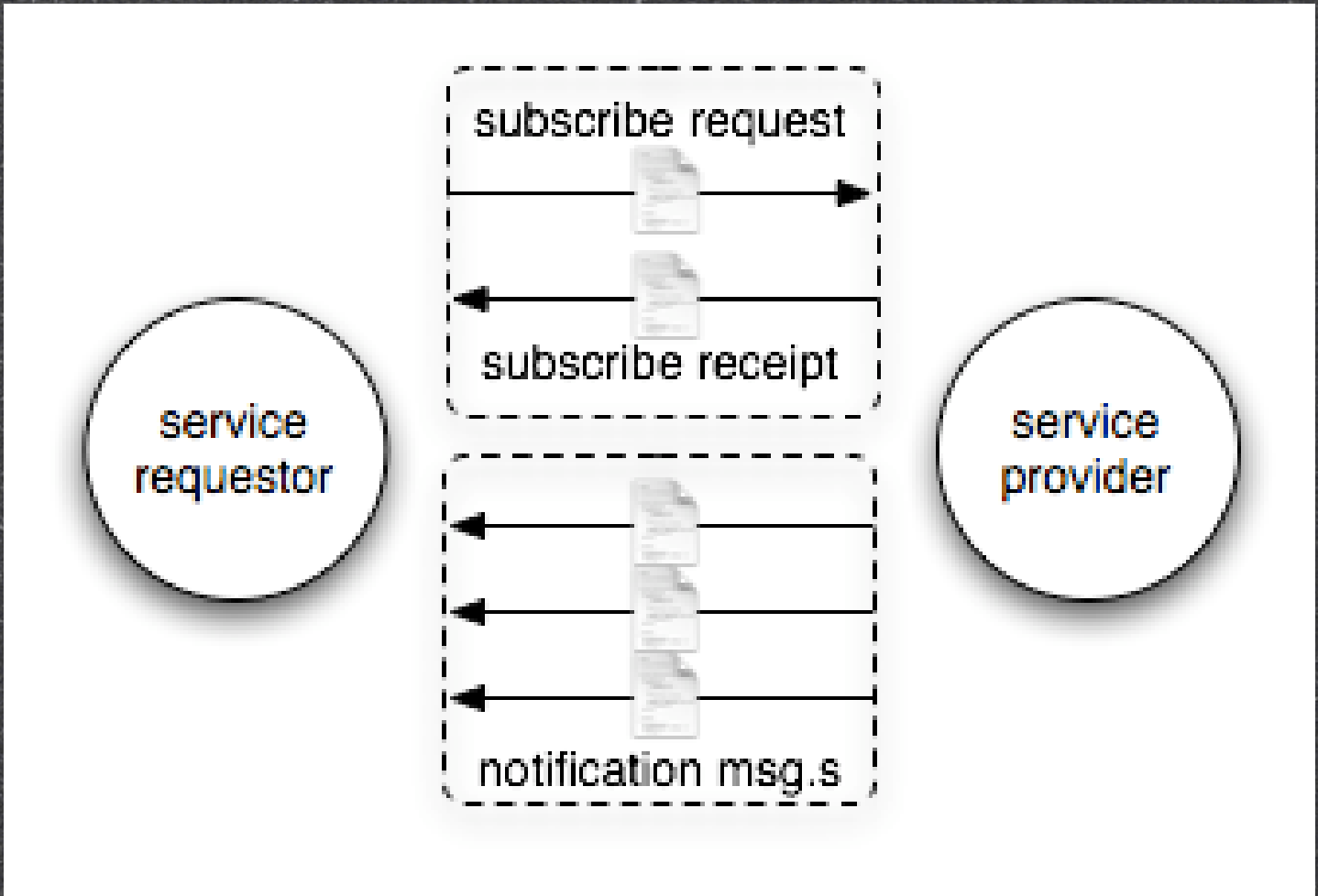
- Primitive MEPs



MEPs

message exchange patterns

- Complex MEPs --> e.g.: publish-and-subscribe



MEPs

message exchange patterns

- Blocking or not blocking? Technical issue
  - only for request-response pattern
  - in a dual transport like Http is a client matter -> but Long Time Transaction?
  - two separate transport connection for request and response is a client and service matter --> WS-*
  - WS-Addressing (later)

MEPs And WSDL

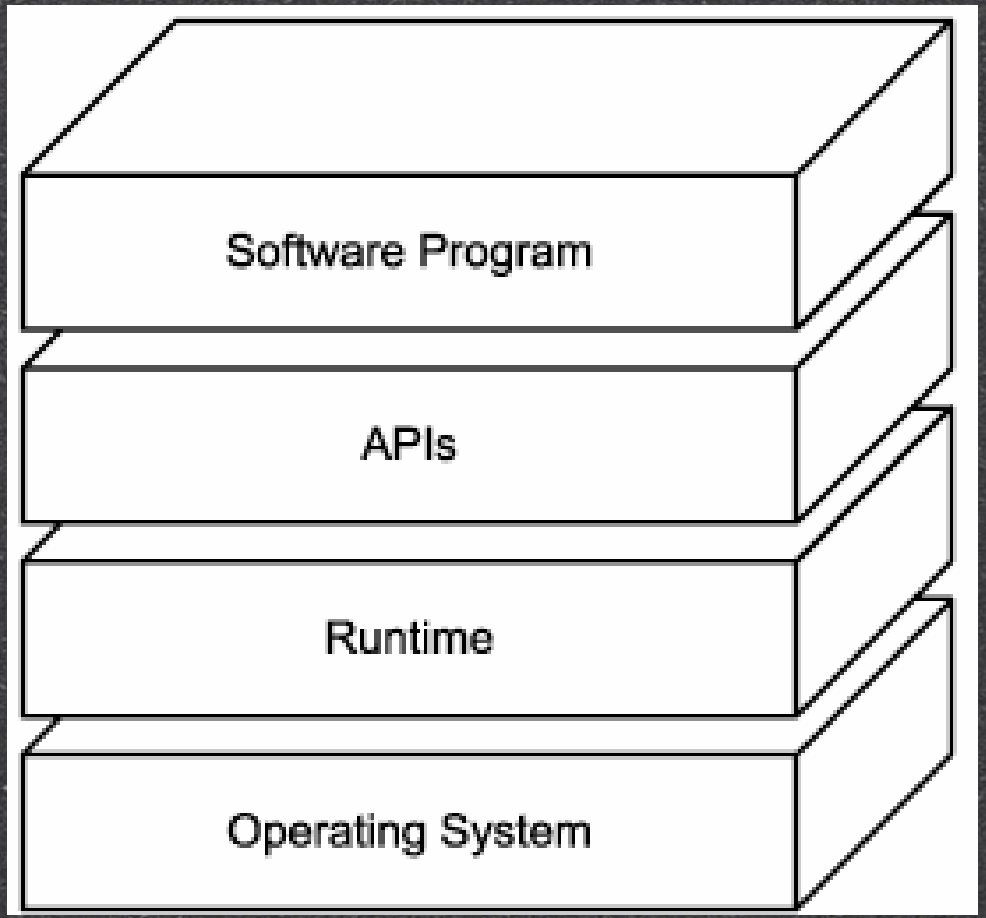
- In WSDL 1.1 terms
  - Request-Response -> WS-I ok
  - Solicit-Response -> WS-I ok
  - One-way operation -> WS-I ko
  - Notification Operation -> WS-I ko
- WS-I delivers practical guidance, best practices and resources for developing interoperable Web services solutions. http://www.ws-i.org/

MEPs And WSDL

- In WSDL 2.0 terms
  - In-out pattern = Request-Response
  - out-in pattern = Solicit-Response
  - In-only pattern = One-way operation
  - Out-only pattern = Notification Operation
  - Robust in-only -> fault message from receiver are allowed
  - In-optional-out pattern -> the response is optional

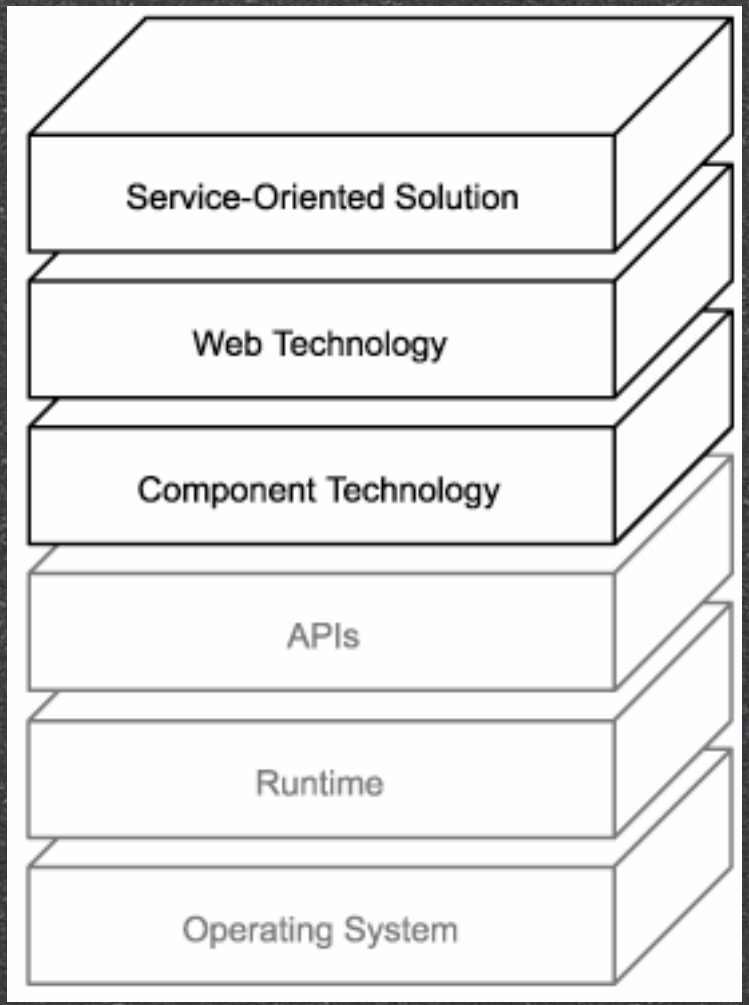
SOA Platform

- Basic platform building block

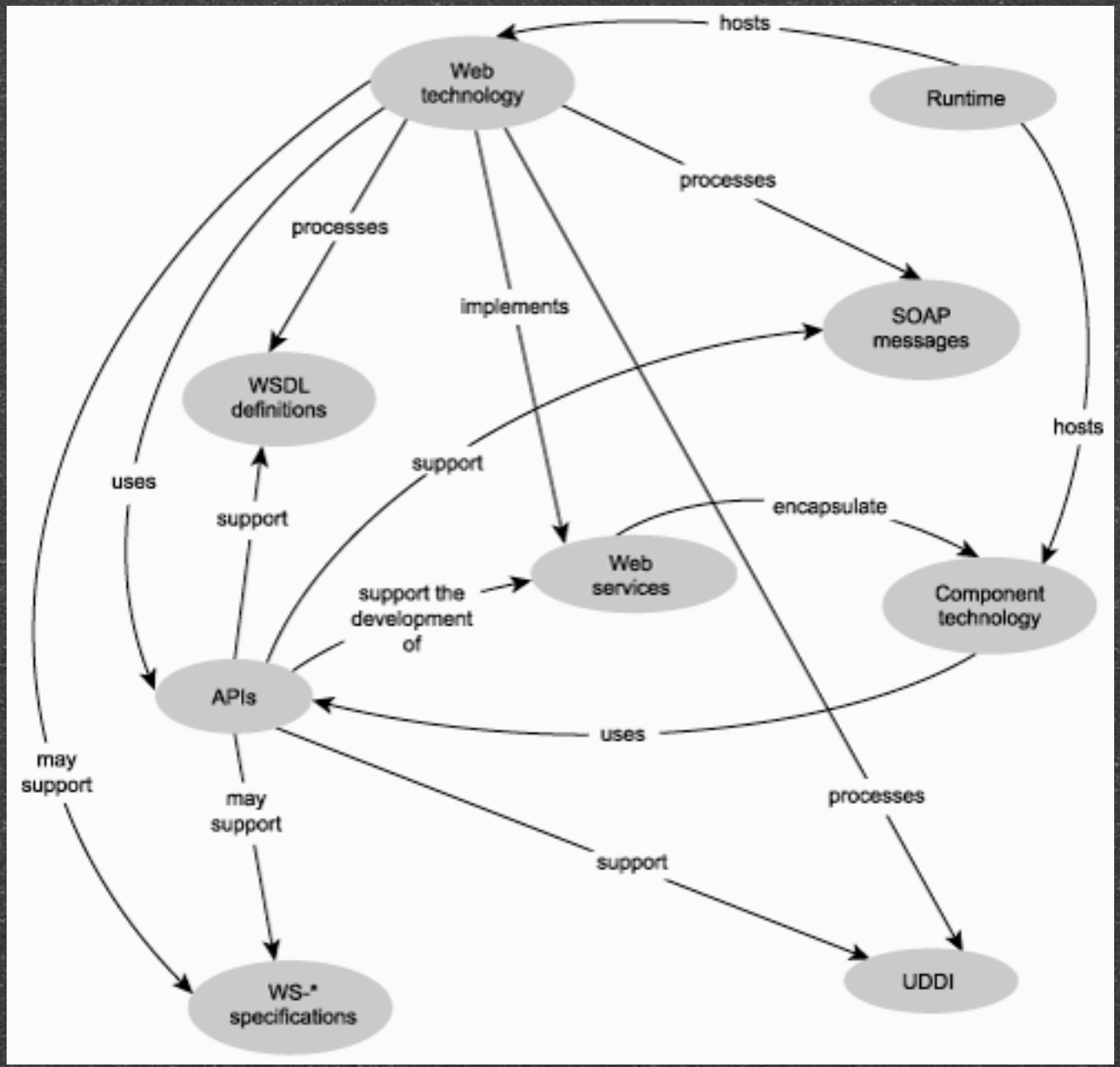


SOA Platform

- Common SOA platform layer



SOA Platform



Service Processing task

- Service provider are expected to
  - supply a public interface (WSDL)
  - receive a SOAP message from requester
  - processing the header block within SOAP m.
  - validate and parse payload of SOAP m.
  - transform payload in a different format
  - encapsulate business processing logic

Service Processing task

- Service provider are expected to
  - assemble SOAP message containing the response to the original request SOAP
    - WS-Addressing and correlation
  - transform the contents of the message back into the form expected by the requestor
  - transmit the response SOAP

Service Processing task

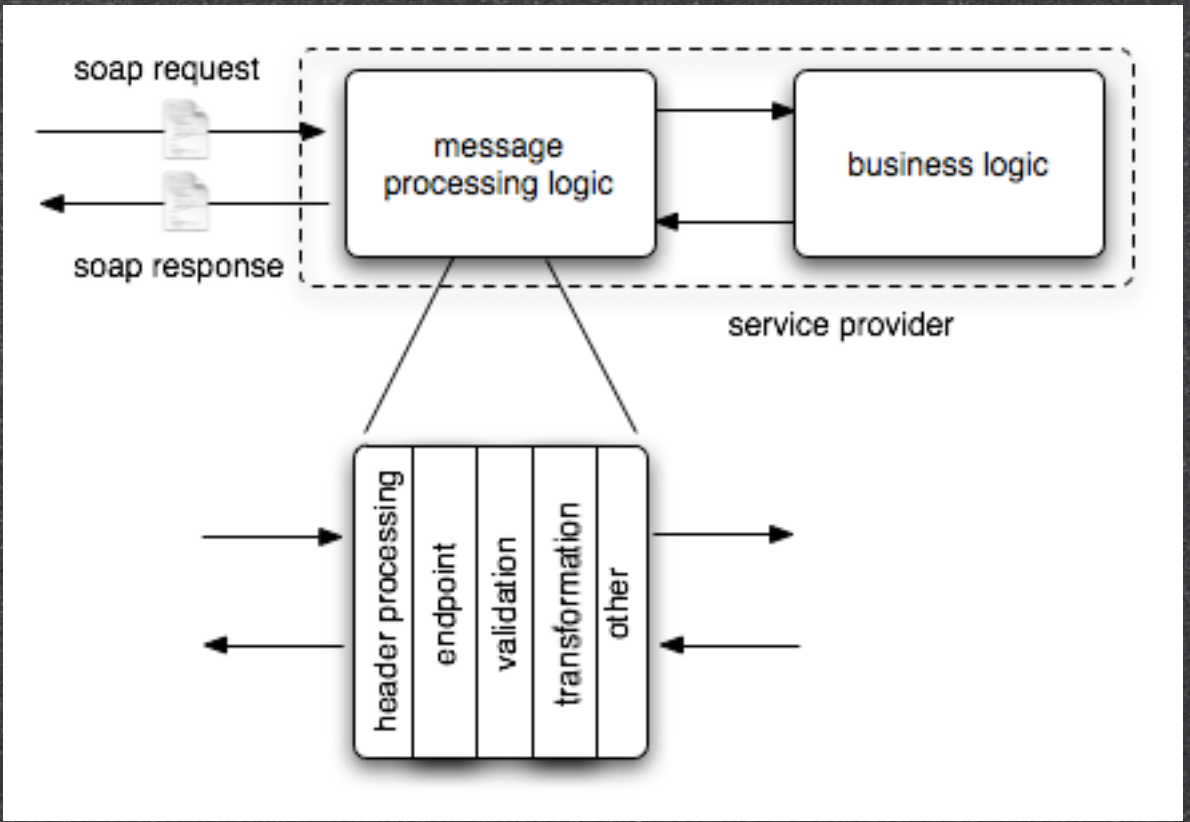
- Service requester are expected to
  - contain business processing logic that calls a service provider
  - interpret a service provider’s WSDL definition
  - assemble a SOAP request in compliance with service provider WSDL definition
  - trasmitt SOAP request message to service provider

Service Processing task

- Service requester are expected to
  - receive a SOAP response message
  - validate and parse the SOAP response
  - transform payload in a different format
  - process SOAP header block

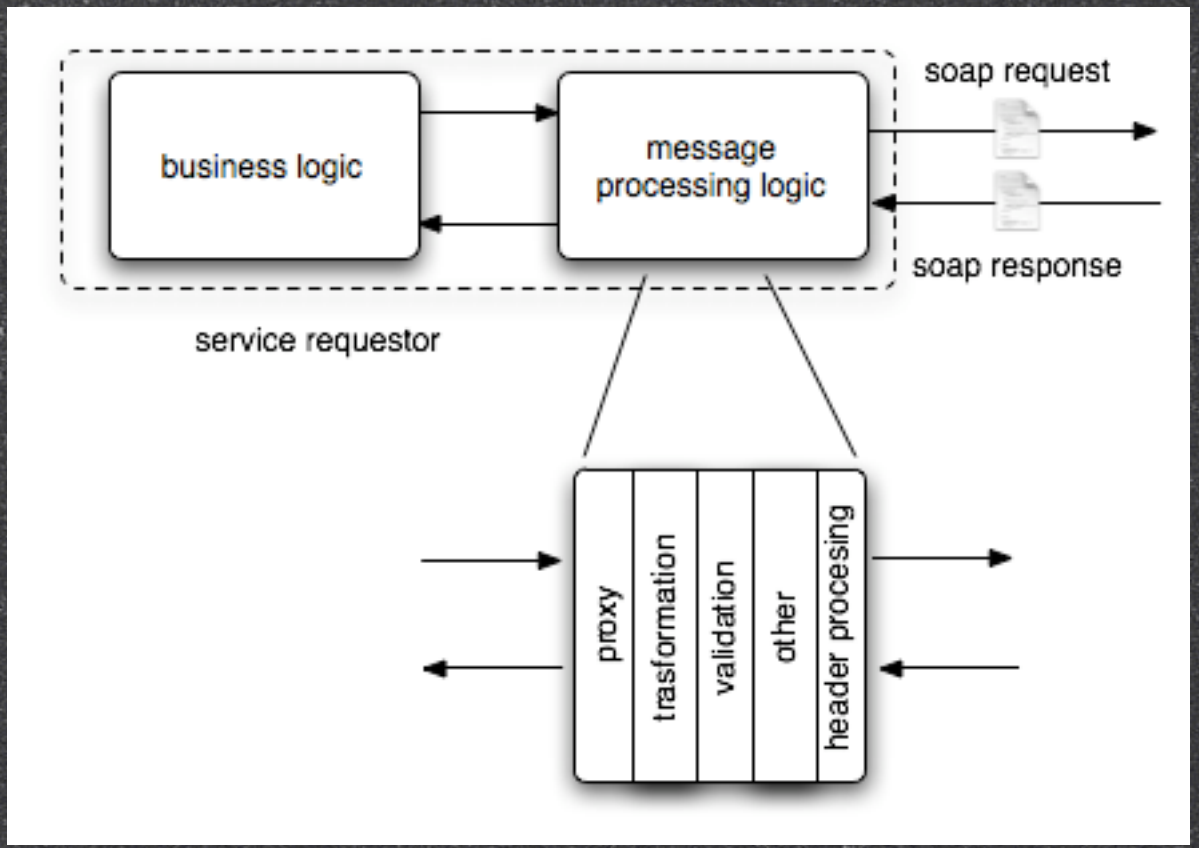
Service Processing task

- Service provider

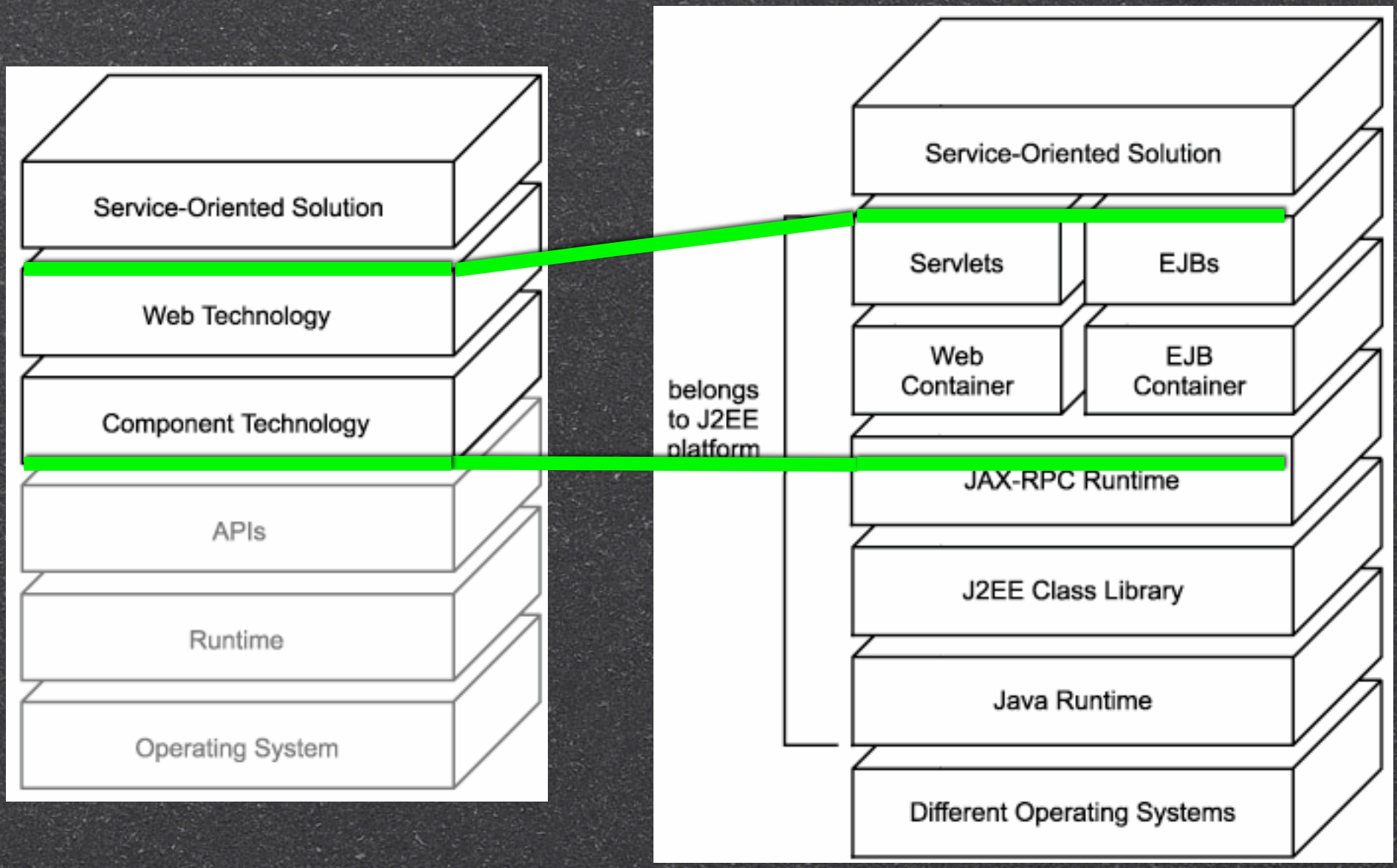


Service Processing task

- Service requester

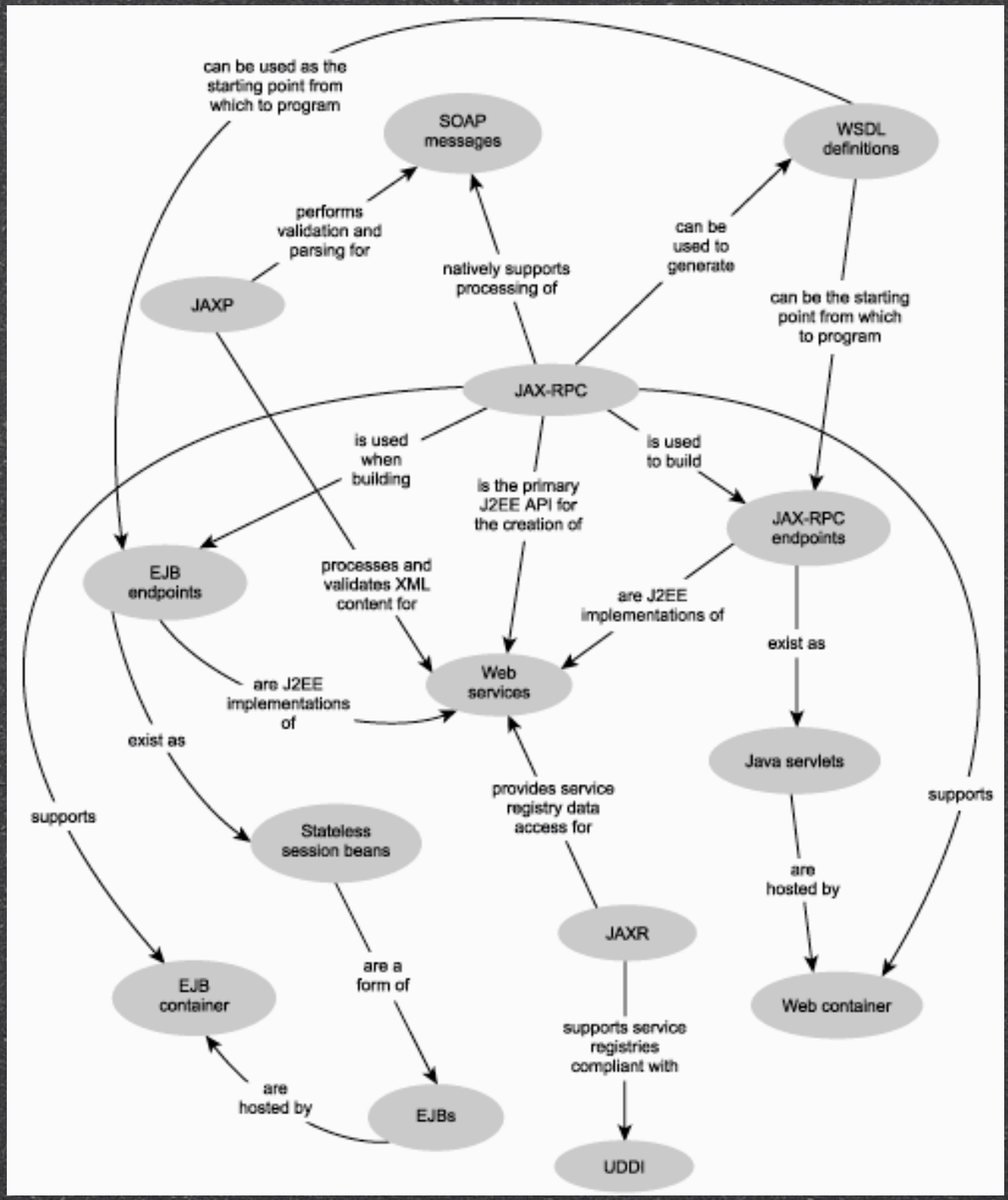


SOA support in J2EE

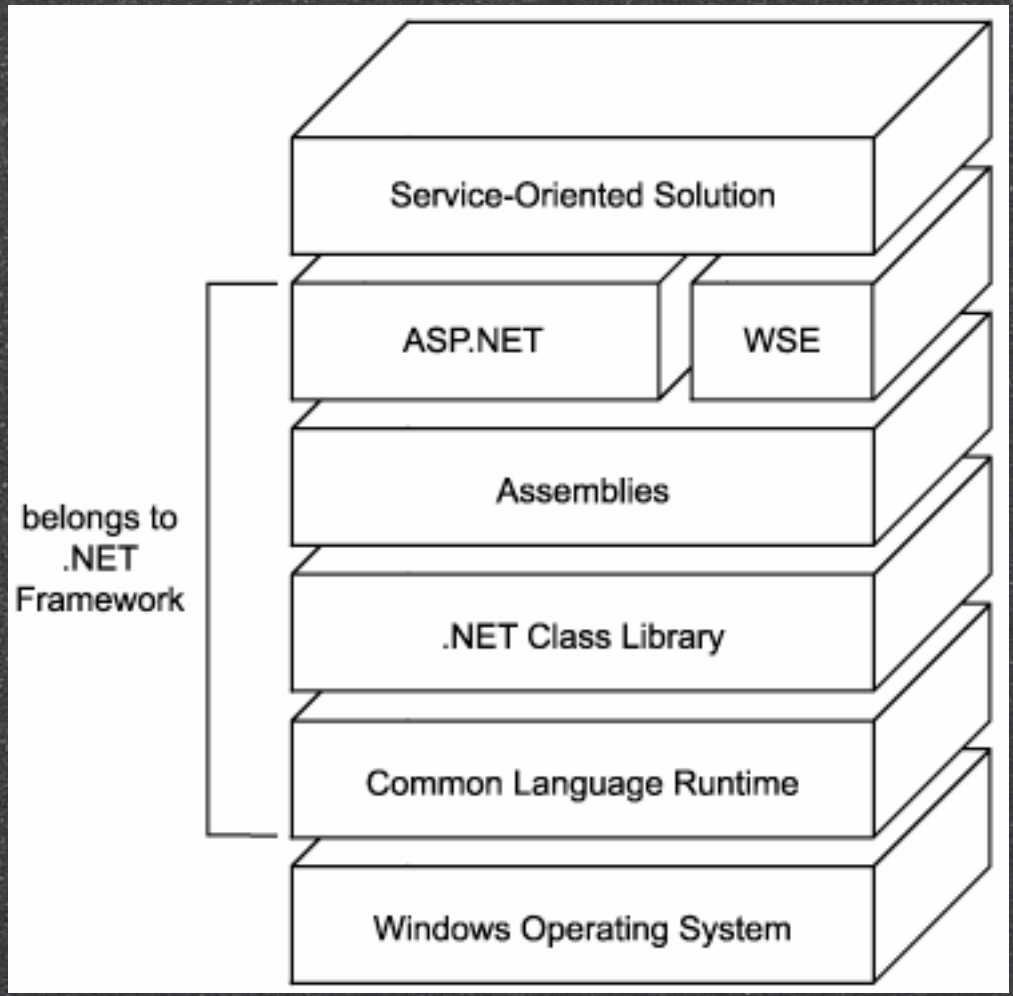


SOA support in J2EE

- **Java API for XML Processing (JAXP)** This API is used to process XML document content using a number of available parsers. Both Document Object Model (DOM) and Simple API for XML (SAX) compliant models are supported, as well as the ability to transform and validate XML documents using XSLT stylesheets and XSD schemas.
- **Java API for XML-based RPC (JAX-RPC)** The most established and popular SOAP processing API, supporting both RPC-literal and document-literal request-response exchanges and one-way transmissions. Example packages that support this API include:
- **Java API for XML Registries (JAXR)** An API that offers a standard interface for accessing business and service registries. Originally developed for ebXML directories, JAXR now includes support for UDDI.
- **Java API for XML Messaging (JAXM)** An asynchronous, document-style SOAP messaging API that can be used for one-way and broadcast message transmissions (but can still facilitate synchronous exchanges as well).
- **SOAP with Attachments API for Java (SAAJ)** Provides an API specifically for managing SOAP messages requiring attachments. The SAAJ API is an implementation of the SOAP with Attachments (SwA) specification.
- **Java Architecture for XML Binding API (JAXB)** This API provides a means of generating Java classes from XSD schemas and further abstracting XML-level development.
- **Java Message Service API (JMS)** A Java-centric messaging protocol used for traditional messaging middleware solutions and providing reliable delivery features not found in typical HTTP communication.


can be used as the starting point from which to program
SOAP messages
WSDL definitions
performs validation and parsing for
natively supports processing of
can be used to generate
JAXP
can be the starting point from which to program
JAX-RPC
is used when building
is the primary J2EE API for the creation of
is used to build
JAX-RPC endpoints
EJB endpoints
processes and validates XML content for
are J2EE implementations of
exist as
are J2EE implementations of
Web services
exist as
Java servlets
provides service registry data access for
supports
supports
Stateless session beans
are hosted by
JAXR
are a form of
EJB container
Web container
supports service registries compliant with
are hosted by
EJBs
UDDI

SOA Platform



Bibliography

- Web Service Architecture W3C working group: http://www.w3.org/TR/ws-arch
- Service-Oriented Architecture Concept, Technology, and Design - Thomas Erl - Prentice Hall PTR
- Enterprise Service Bus - David A. Chappell - O'REILLY
- Some article from: http://www-128.ibm.com/developerworks/webservices