SOA, Services, Workflows & Components

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Content

- SOA
- Web Services
- Dataflow/Workflow
  - BEPL
- Services & Components
  - SCA
  - STCM

SOA

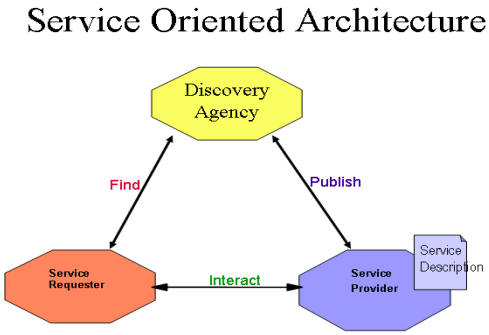
Service Orientated Architecture

SOA – Service Orientated Architecture

- “This term is increasingly used to refer to an architectural style of building reliable distributed systems that deliver functionality as services, with the additional emphasis on **loose coupling** between interacting services.”

  OGSA Glossary

Publish, Find and Bind Triangle



Characteristics of SOA – WS-Architecture

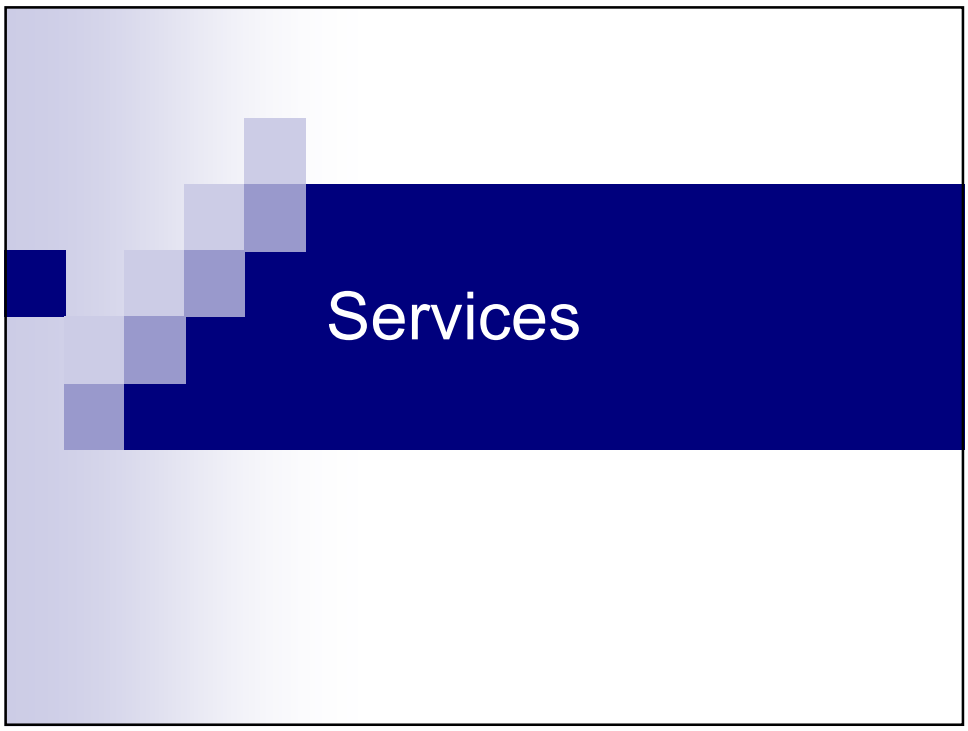
- **Logical view:** The service is an abstracted, *logical* view of actual programs, databases, business processes, etc. , defined in terms of what it does, typically carrying out a business-level operation.
- **Message orientation:** The service is formally defined in terms of the messages exchanged between provider add requester agents, and not the properties of the agents themselves.
- **Description orientation:** A service is described by machine-processable meta data.

Characteristics of SOA – WS-Architecture

- **Granularity:** Services tend to use a small number of operations with relatively large and complex messages.
- **Network orientation:** Services tend to be orientated toward use over a network.
- **Platform neutral:** Messages are sent in a platform-neutral, standardized format delivered through the interfaces, XML is the most obvious format that meets this constraint.

SOA References

- **WSG** – Web Service Grids, http://www.nesc.ac.uk/technical_papers/UKeS-2004-05.pdf
- **W3C WSA** – Web Service Architecture, http://www.w3.org/TR/2004/NOTE-ws-arch-20040211/
- **OGSA Glossary** - https://forge.gridforum.org/projects/ogsa-wg
- For discussions on SOA see:
  - http://savas.parastatidis.name/
  - http://jim.webber.name/
  - WS-GAF mailing list



Why Web Services

- Execute everywhere
  - Multi-platform
  - Multi-languages
- From everywhere
- Through everything
  - In particular, through firewalls

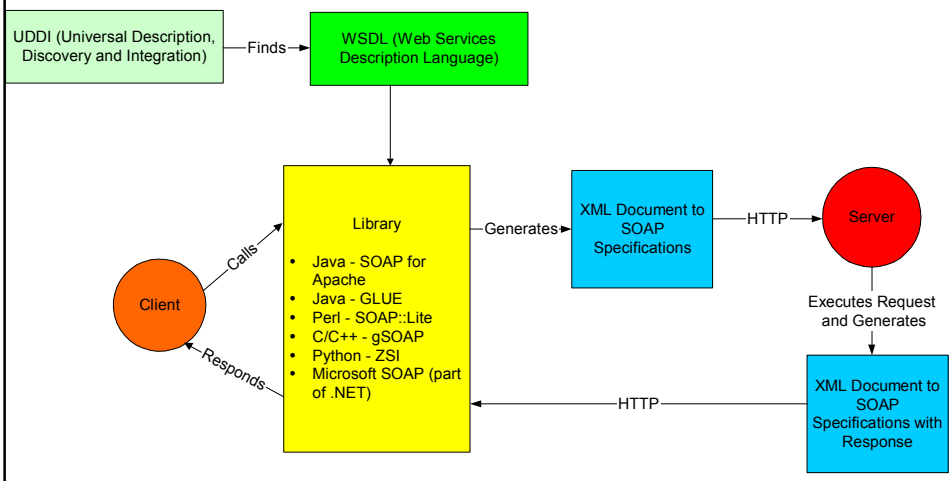
What is needed?

- To execute on a platform
  - Description language
    - Interfaces
    - Data types
  - Mappings to/from programming languages
- To execute remotely
  - A service of naming or discovery
  - A communication protocol

Web Services: Elements

- WSDL
  - Web Services Description Language
- SOAP
  - Simple Object Acess Protocol
- XML
  - eXtended Markup Language
- UDDI
  - Universal Description, Discovery and Integration

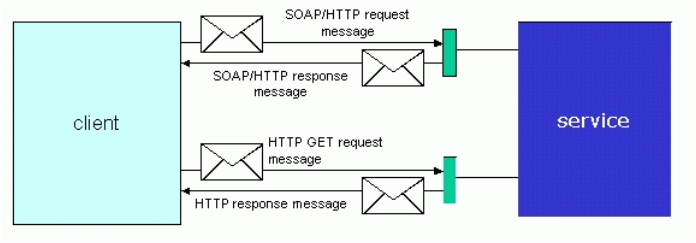
Web Services: Architecture



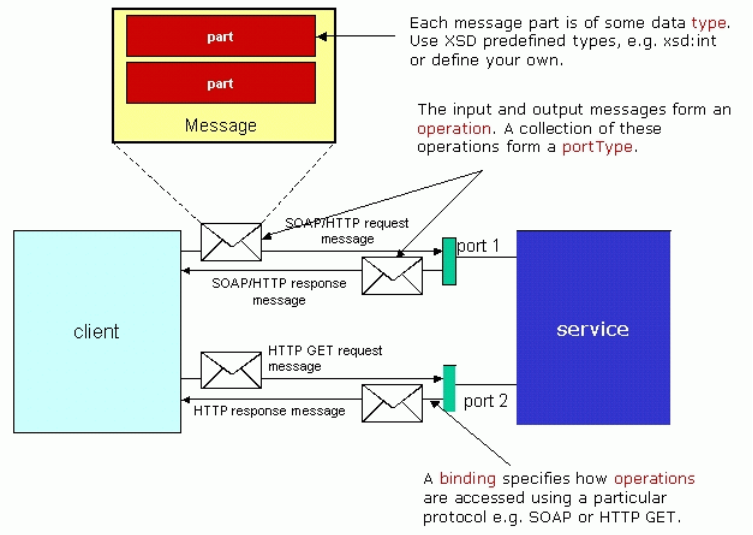
SOAP [Simple Object Access Protocol]

- Provides
  - RPC
  - User Defined Data Types
  - Localization (English, Chinese, etc.)
- Uses widely adopts standards
  - HTTP
  - XML
- Multi-platform (contrary to DCOM)
- Multi-language (contrary to Java RMI)
- Independent of the protocol (~contrary to CORBA)

SOAP


client
SOAP/HTTP request message
SOAP/HTTP response message
HTTP GET request message
HTTP response message
service

SOAP


part
part
Message
Each message part is of some data type. Use XSD predefined types, e.g. xsd:int or define your own.
The input and output messages form an operation. A collection of these operations form a portType.
SOAP/HTTP request message
SOAP/HTTP response message
port 1
client
service
HTTP GET request message
HTTP response message
port 2
A binding specifies how operations are accessed using a particular protocol e.g. SOAP or HTTP GET.

WSDL

- Specifications (09/2000)
  - Ariba, IBM, Microsoft
  - TR W3C v1.1 (25/03/2001)
- Goals
  - *WSDL is an XML format for describing network services as a set of endpoints operating on messages containing either document-oriented or procedure-oriented information.*
- XML grammar (schema XML)
  - Modular (import of other documents WSDL and XSD)
- Non targeting human beings
  - There are generator of WSDL from programming languages

Elements of a WSDL definition

<types>
- Embeds the type definition using a type system (such as XSD).

<message>
- Describes the names and the types of the set of fields to transmit
  - Parameters of an invocation, answer, ...

<porttype>
- Describes a set of operations. Each operation has zero or one message as input, zero or several message(s) as outputs, or faults

<binding>
- Specifies a link between a <porttype> and a concrete protocol (SOAP1.1, HTTP1.1, MIME, &). A <porttype> can have several bindings!

<port>
- Specifies an endpoint as the combination of a <binding> and a network address.

<service>
- A collection of endpoints.

An example of WSDL

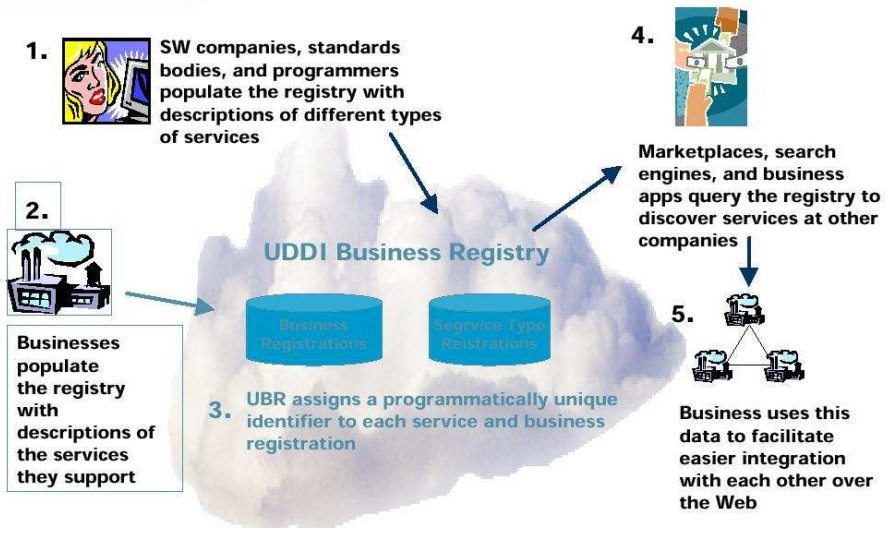
```
<?xml version="1.0"?>

    <wsdl:definitions name="EndorsementSearch"
      targetNamespace="http://namespaces.snowboard-info.com"
      xmlns:es="http://www.snowboard-info.com/EndorsementSearch.wsdl"
      xmlns:esxsd="http://schemas.snowboard-info.com/EndorsementSearch.xsd"
      xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
      xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/">

      <wsdl:types>
        <xsd:schema targetNamespace="http://namespaces.snowboard-info.com"
          xmlns:xsd="http://www.w3.org/1999/XMLSchema">

          <xsd:element name="GetEndorsingBoarder">
             <xsd:complexType>
               <xsd:sequence>
                 <xsd:element name="manufacturer" type="string"/>
                 <xsd:element name="model" type="string"/>
               </xsd:sequence>
             </xsd:complexType>
          </xsd:element>

          <xsd:element name="GetEndorsingBoarderResponse">
          ...
        </xsd:schema>
      </wsdl:types>

      <wsdl:message name="GetEndorsingBoarderRequest">
        <wsdl:part name="body" element="esxsd:GetEndorsingBoarder"/>
      </wsdl:message>

      <wsdl:message name="GetEndorsingBoarderResponse">
        <wsdl:part name="body" element="esxsd:GetEndorsingBoarderResponse"/>
      </wsdl:message>

      <wsdl:portType name="GetEndorsingBoarderPortType">

        <wsdl:operation name="GetEndorsingBoarder">
          <wsdl:input message="es:GetEndorsingBoarderRequest"/>
          <wsdl:output message="es:GetEndorsingBoarderResponse"/>
          <wsdl:fault message="es:GetEndorsingBoarderFault"/>
        </wsdl:operation>
      </wsdl:portType>

    ...

     </wsdl:definitions>
```

Censured

UDDI: Registry of Web Services

- Specification (09/2000)
  - Ariba, IBM, Microsoft +260 other companies
  - OASIS standard (04/2003)
- Goals
  - Worldwide registry of companies/services.
  - Several indexed entries: name, company ID, description of product, of services, remotely accessible software services (endpoints)
  - Indexation of proprietary catalogues (ebXML, RosettaNet, Ariba, Commerce One, etc.)
- XML grammar (schema XML)
  - Submission/Request based on SOAP et WSDL

UDDI: What's inside?



UDDI: Information Organization

- Businesses register public information about themselves
- Standards bodies, Programmers, Businesses register information about their Service Types

White Pages

Yellow Pages

Green Pages

Service Type Registrations

UDDI: White pages

- Business Name
- Text Description
  - list of multi-language text strings
- Contact info
  - names, phone numbers, fax numbers, web sites...
- Known Identifiers
  - list of identifiers that a business may be known by - DUNS, Thomas, other

UDDI: Yellow Pages

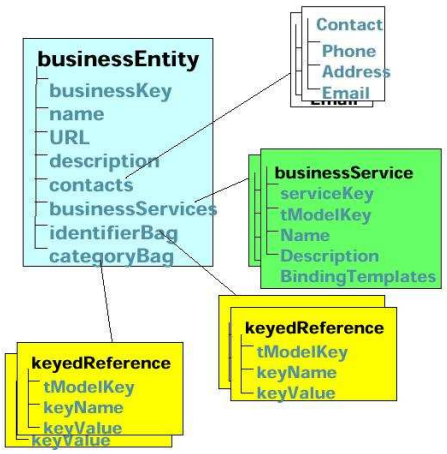
- Business categories
  - 3 standard taxonomies in V1
    - Industry: NAICS (Industry codes - US Govt.)
    - Product/Services: UN/SPSC (ECMA)
    - Location: Geographical taxonomy
      - Implemented as name-value pairs to allow any valid taxonomy identifier to be attached to the business white page

UDDI: Green Pages

- New set of information businesses use to describe how to do e-commerce with them
  - Nested model
    - Business processes
    - Service descriptions
    - Binding information
  - Programming/platform/implementation agnostic
  - Services can also be categorized

UDDI

- XML document
- Created by end-user company (or on their behalf)
- Can have multiple service listings
- Can have multiple taxonomy listings



Bibliography

- Web Services
  - Distributed Applications with XML-RPC, SOAP, UDDI & WSDL, Ethan Cerami, February 2002 O'Reilly
- WSDL
  - W3C specification
  - http://www.w3.org/TR/wsdl
- UDDI
  - http://www.uddi.org
  - Java and SOAP, Robert Englander, May 2002 O'Reilly

Workflows

Service Composition

- *Composite Service*
  - a service implemented by combining other web services
- *Service composition*
  - the process of developing a composite web service
- **Composition as a way to master Complexity**

Orchestration models

- Goals
  - Specifying the order of service invocations depending on conditions
- Need for abstraction models and languages
  - activity diagrams
  - statecharts
  - petri-nets
  - pi-calculus
  - activity hierarchies
  - rule-based orchestration approaches
  - gamma-calculus

Service Selection

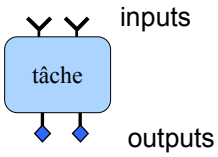
- During execution, a composition engine has to target messages to specific services, which are defined in the composition schema (typically in the form of a port type)
- The question is how to select and bind the services:
  - Static binding
  - Dynamic binding by reference
  - Dynamic binding by lookup
  - Dynamic operation selection

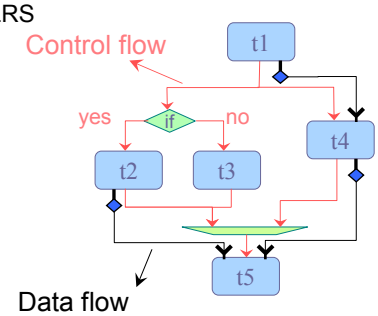
Dependencies between Coordination and Composition

- *Composition protocols*
  - private documents that define the internal implementation of a Web service.
- *Coordination protocols*
  - public documents focusing on external interactions of a Web service.
- Coordination Protocols and Composition Schemas
- Conversation Controllers and Composition Engines

Workflow based models

- Bibliography
  - **http://www.gridworkflow.org/snips/gridworkflow/**
  - Askalon-AGWL (Abstract Grid Wrokflow Language) - Innsbruck, Austria
  - Triana - Cardiff, UK
  - GriCoL (Grid Concurrent Language) - HLRS Stuttgart, Germany
  - Kepler - SEEK, SDM, GEON, …
- Generic models
  - Task
  - Ports
    - Input/output data
  - Assembly
    - Control/data flows

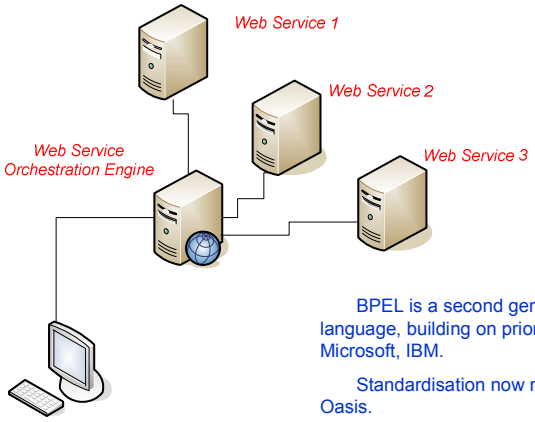




BPEL

BPEL for Web Services

Combining Atomic Web Services into a Composite Web Service



BPEL is a second generation language, building on prior work by Microsoft, IBM.

Standardisation now managed by Oasis.

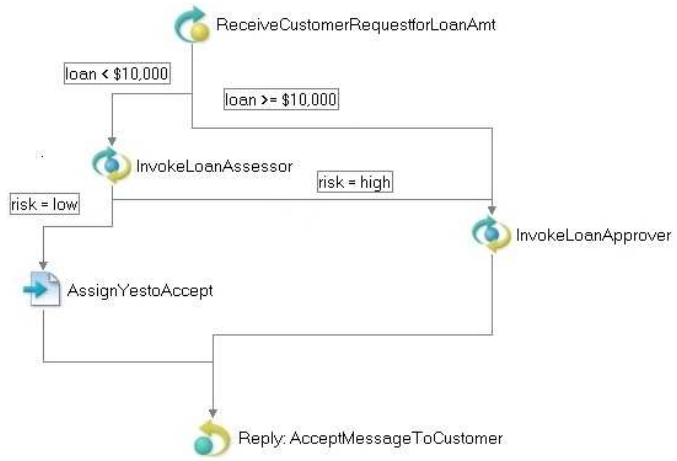
BPEL: Construct Overview

- Process declaration

```
<process>
   <partners/>
   <receive/>
   <invoke/>
   <invoke/>
   <invoke/>
   <reply/>
</process>
```

- Business logic
  - <sequence/>
  - <flow/>
  - <link/>
  - <switch/>
  - <throw/>
  - <scope/>
  - <while/>
  - <pick/>
  - <copy/>
  - <assign/>

Loan Processing Orchestration



SCA

Service Component Architecture

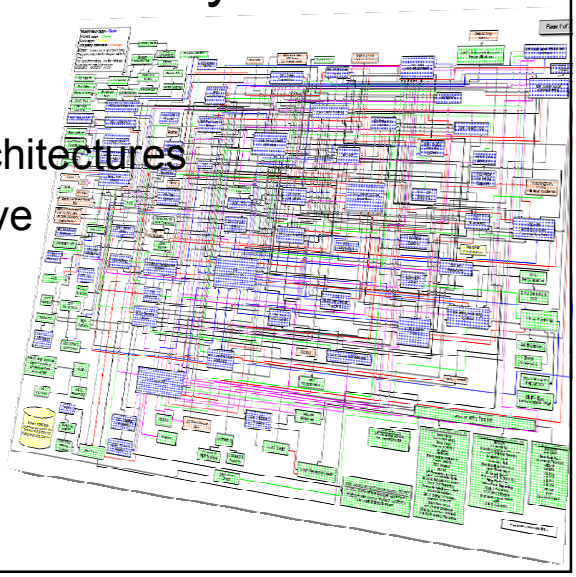
- A vendor-, technology-, language-neutral model for the creation of business systems using SOA by the composition and deployment of new and existing service components

Business Drivers

- Flexible businesses require flexible IT
  - Globalization demands greater flexibility
  - Global supply chain integration
  - Business processes
    - Daily changes vs. yearly changes
  - Growth through flexibility is at the top of the CEO agenda
  - Reusable assets can cut costs by up to 20%
  - Crucial for flexibility and becoming an On Demand Business

What We have Today

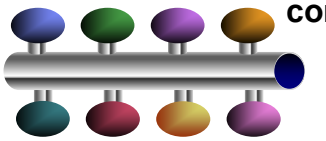
- Complexity
- Rigid, brittle architectures
- Inability to evolve



What we want to get to

- Well-defined interfaces with business-level semantics
- Standardized communication protocols
- Flexible recombination of services to enhance software flexibility

Service-Oriented Architecture is one of the key technologies to enable flexibility and reduce complexity



Service-oriented Architecture

- SOA derives its technical strategy and vision from the basic concept of a *service*:
  - "A service is an abstraction that encapsulates a software function."
  - "*Developers* build services, use services and develop solutions that aggregate services."
  - "*Composition* of services into integrated *solutions* is a key activity"

SOA Core Elements

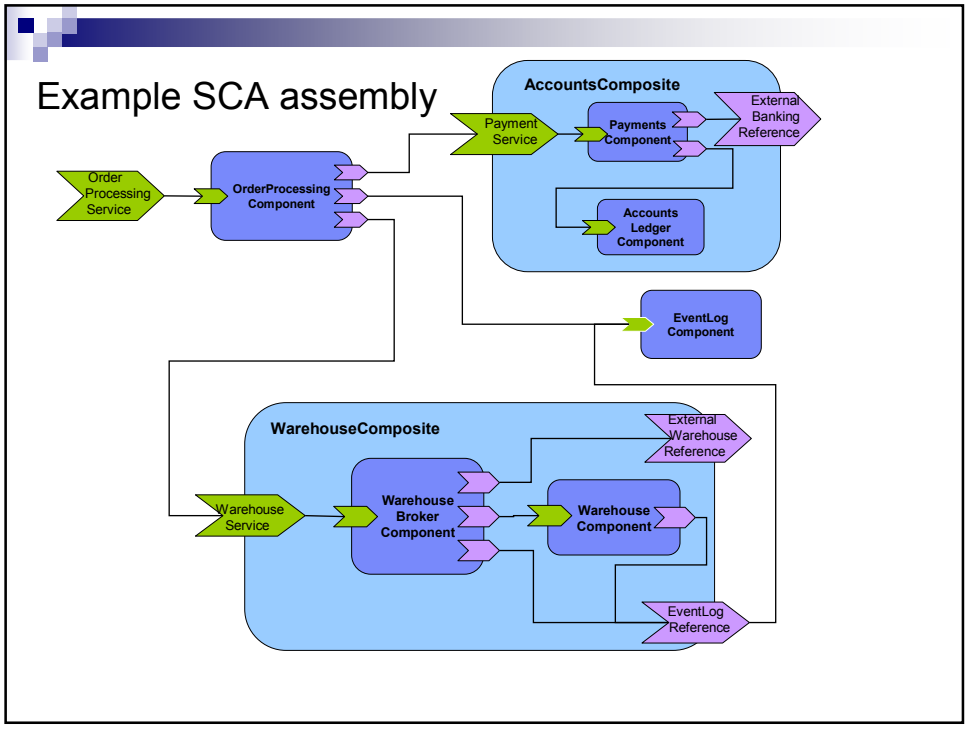
- **Service Assembly**
  - technology- and language- independent representation of the composition of services into business solutions
- **Service Component**
  - technology- and language-independent representation of a service which can be composed with other services

SCA: Simplified Programming Model for SOA

- What is SCA:
  - Model for assembly of service components into business solutions
  - Simplified ***component programming model*** for implementation of services:
    - Business services implemented in any of a variety of technologies
      - e.g. EJBs, Java POJOs, BPEL process, COBOL, C++, PHP …
- Key Benefits of SCA:
  - ***Loose Coupling***: Components integrate with other components without needing to know how other components are implemented
    - **Loose coupling - KEY requirement for SOA**
  - ***Flexibility***: Components can easily be replaced by other components
    - **Flexibility - KEY requirement for SOA**
  - ***Services*** can be *easily* invoked either synchronously or asynchronously
  - ***Composition*** of solutions: clearly described
    - **Composition of services - KEY requirement for SOA**
  - ***Productivity***: Easier to integrate components to form composite application
- SCA simplifies development experience for **all** developers, integrators and application deployers

SCA: What is it NOT

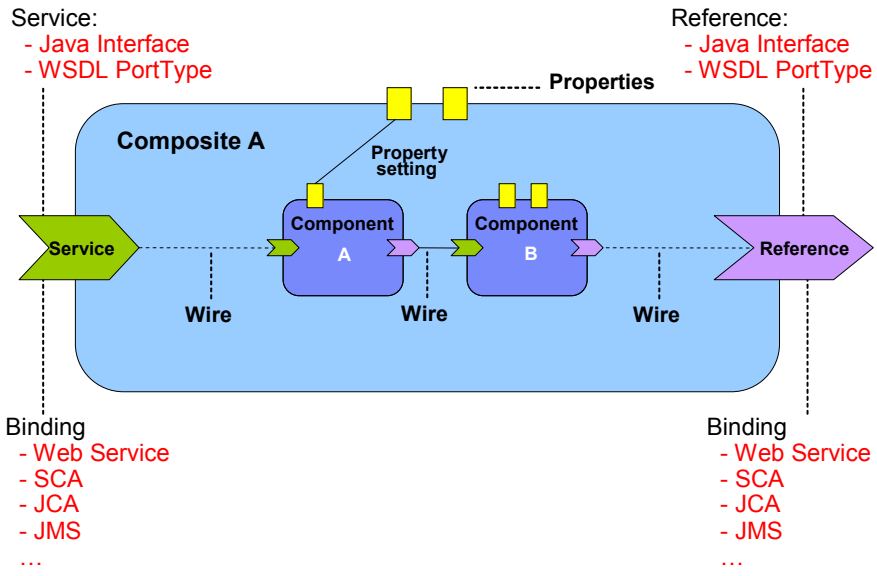
- Does not model individual ***workflows***
  - use BPEL or other workflow languages
- Is not ***Web services***
  - SCA can use / may use Web services, but can also build solutions with no Web services content
- Is not tied to a specific runtime environment
  - distributed, heterogeneous, large, small
- Does not force use of specific programming languages and technologies
  - aims to encompass many languages, technologies



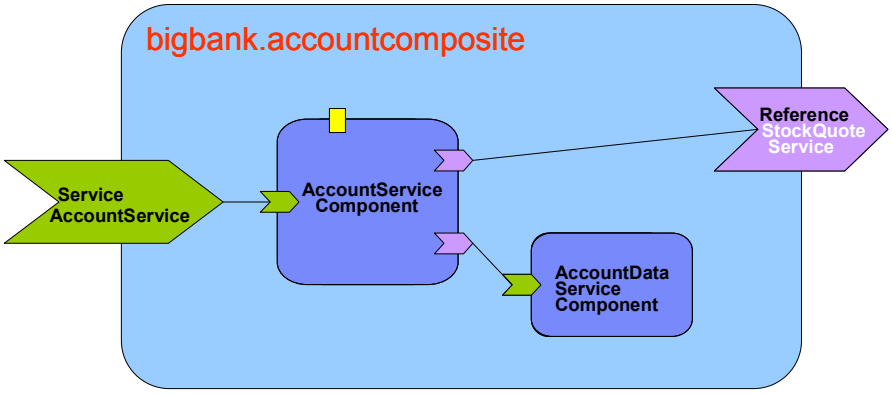
Assembly Model Concepts

- Component
- Implementation
- Composite
- Service
- Reference
- Wire
- ComponentType
- ConstrainingType
- Domain
- Contribution

SCA Composite Component



Example



SCA Interaction Model

- ***Synchronous*** & ***Asynchronous*** service relationships
- ***Conversational*** services
  - stateful service interactions
- Asynchronous support
  - "non-blocking" invocation
  - asynchronous client to synchronous service
  - callbacks

Policies Framework and Infrastructure Capabilities

- ***Infrastructure*** has many configurable capabilities
  - Security: Authentication and Authorization
  - Security: Privacy, Encryption, Non-Repudiation
  - Transactions, Reliable messaging, etc.
  - Complex sets of configurations across multiple domains of concern
- SCA abstracts out complexity with a ***declarative model***
  - no implementation code impact
  - simplify usage via declarative policy intents
  - simple to apply, modify
  - complex details held in PolicySets

Java Common Annotations

- Java Annotations for generating corresponding componentType
- Common across all Java-related specifications
- Implementation annotations
  - @Service
  - @Reference
  - @Property
  - @Scope @Init @Destroy @EagerInit
  - @ConversationID @ConversationAttributes
  - @ComponentName
  - @Constructor
- Interface annotations
  - @AllowsPassByReference
  - @Callback
  - @Remotable
  - @Conversational
  - @Oneway

Java Annotation Example

```
package services.account;
...
public class AccountServiceImpl implements AccountService {
    @Property
    private String currency = "USD";

    @Reference
    private AccountDataService accountDataService;

    @Reference
    private StockQuoteService stockQuoteService;

    ...

    public AccountReport getAccountReport(String customerID) {
        ...
    }

    ...
}
```

Java Common APIs

- Common across all Java-related specifications
- APIs for:
  - Component context
  - Request context
  - Callable reference
  - Service reference
  - Conversation
  - Exceptions

BPEL Component Implementation

- SCA and BPEL are complementary
  - BPEL provides business orchestration view of the component
  - SCA provides a compositional view of interconnection among service components
- Supports WS-BPEL 1.1 and 2.0
- Requires WSDL interfaces
- SCA service = partnerLink with a single role belonging to the BPEL process
- SCA reference = partnerLink with a single role belonging to a partner
- When partnerLink defines two role, directionality defines whether it is a service or a reference
- SCA extensions
  - Attribute “sca:property” on a variable declaration defines a property
  - Element “sca:multiReference” on a variable declaration defines a multivalued reference

STCM

Spatio-Temporal
Component Model

Workflow models vs. Component models

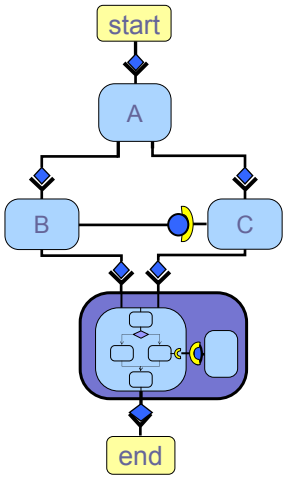
	assembly	simplicity	Code coupling	Resources usage
Workflow models	+	+	-	+
Component models	+	+	+	-

Limitation of existing approaches

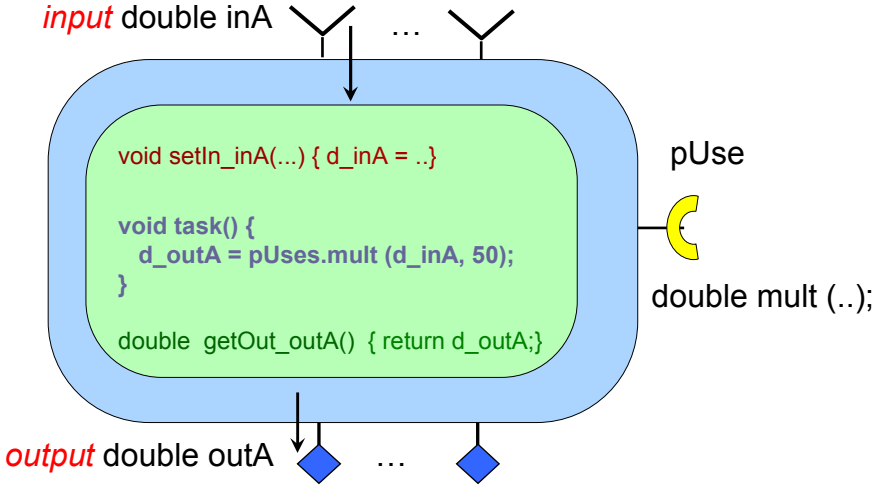
- Software component models
  - Adding meta-data about component's behavior (exp: ICENI)
  - Objective: compute an optimal placement of components
  - Require code knowledge
  - Complicate application design
- Workflow models
  - Encapsulate spatial composition within tasks implementations
  - Objective: offer a level of composition for coupled codes
  - Limits the hierarchy to two levels
  - Limits re-usability
- Limitations because of
  - spatial and temporal compositions are not at the same level

Principle of STCM

- Combination of component and workflow models
  - Spatial and temporal dimensions at the same level of assemblies
- Component-task
  - Input and output ports (temporal)
  - Spatial ports
  - Task
- Assembly model
  - Adaptation of a workflow language

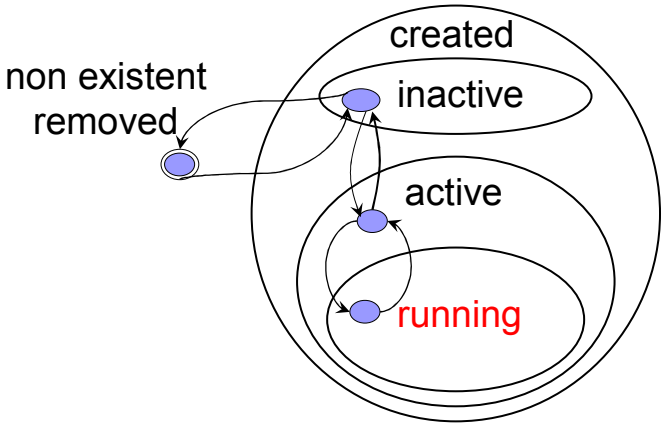


Temporal ports & task



Life cycle

- States of a component instance at execution



Temporal ADL: Primitive Component *à la Fractal*

```
<component name="name" (extends="parentType")?>

   <clientPort name="…" type="itfName" (set="…")? />*
   <serverPort name="…" type="itfName" (set="…")? />*
   <attribute  name="name" type="attributeType"/>*

   <dataIn     name="…" type="dataType" (set="…")? />*
   <dataOut    name="…" type="dataType" (set="…")? />*

   <impl type="exe|dll|.." signature="sign" />

  <controllerDesc desc="desc"/>?
</component>
```

Temporal ADL of Composite based on AGWL (1/2)

```
<component name="name" (extends="parentType")?>
   <dataIn     name="…" type="dataType" (set="…")? />*
   <dataOut    name="…" type="dataType" (set="…")? />*
   <body>
       component*

       <instance name="i1" compRef="C1" />
       <instance name="i2" compRef="C2" />

       <setPort client="i2.p2" server="i1.p1" />
       <setPort in="i2.d2"     out="i1.d1" />

       instruction?
  </body>
  <controllerDesc desc="desc"/>?
</component>
```

Temporal ADL of Composite based on AGWL (2/2)

Sequence

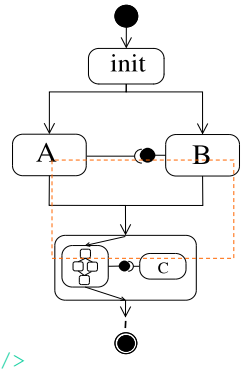
```
<sequence name="name">
 <dataIn name="name" type="..."
         (set=..)?/>*
 <dataOut name="name" type="..."/>*
 <clientPort name="name" type="..."
             (set=..)?/>*
 <serverPort name="name"
             type="..."/>*
 <!-- other spatial ports -->
 <instruction1>
 ...
 <instructionN>
</sequence>
```

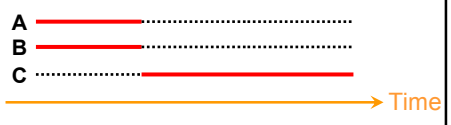
Condition

```
<if name="name">
 <!-- like in sequence-->
 <condition>
    boolean expression
 </condition>
 <then>
    <instruction1>
 </then>
 <else>
    <instruction2>
</else>
</if>
```

Example

```
<component name ="example">
 ...
 <parallel name="ParallelCtrl">
  <section>
   <component name="B">
    <dataIn name="inB" ... set="init.out1"/>
    <serverPort name="pB" type="Foo"/>
   </component>
  </section>
  <section>
   <component name="A">
    <dataIn name="inA" ... set="init.out2"/>
    <clientPort name="pA" type="Foo" set="B.pB"/>
   </component>
  </section>
 </parallel>
 ...
 </component>
```





Summary

- Combination of component and workflow models
  - Component-task
  - Temporal ports
  - Assembly model “à la workflow”
- STCM
  - Extension of GCM (CoreGrid)
    - Temporal ports and task
  - Adaptation of AGWL (Abstract Grid Workflow Language)
    - Component and spatial composition