



Web Services **WSC** WORLD WIDE WEB

- A software application identified by a URI, whose interfaces and bindings are capable of being defined, described, and discovered as XML artifacts.
- A Web service supports direct interactions with other software agents using XML-based messages exchanged via Internet-based protocols (W3C)
- Utilize the WWW infrastructure
- Example: <http://etech.kaist.ac.kr:8080/search.html> Google

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SOA, SOC, SODA

Everything is a service!

Service: A procedure, method, or object with a stable, published interface that can be invoked by clients

```

    graph TD
      SR[Service Registry] --> DS[Discover service UDDI, WSDL]
      SR --> RS[Register service UDDI, WSDL]
      SR --> IS[Invoke service SOAP, WSDL]
      subgraph Interaction
        SReq[Service Requester] --> IS
        SProv[Service Provider] --> IS
      end
  
```

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Research Background

- Web services as an emerging platform for automating end-to-end e-business transactions
- Conversation: the sequences of operations that could occur between a client and a service as part of the invocation of a Web service
- Coordination protocol: the specification of the set of correct and accepted conversations
- Composition: Implementation of web services whose business logic involves the invocation of operations offered by other web services

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Supporting standards

- Coordination: CS-WS, WSCL, WS-Coordination, WS-Transaction, CPP/CPA
- Composition: BPML, WSCI, BPEL, BPSS

MSC Web Services Technologies

- Choreography Language (WG, Jan, 2003)
- Service Description (WSDL 1.2)
- Messaging Framework (SOAP 1.2)

Coordination vs. Composition

- Coordination protocols: **External**
 - Are **public** documents, and meant to be advertised in WS registries
 - Support **design-time discovery** and **run-time binding**
 - **Impose requirements** on how the composition is to take place
- Composition: **Internal**
 - The specification of a composite service is done by a company and is kept **private**
 - **Whether a service is basic or composite** is irrelevant from the client's perspective
 - **Determines the conversations** that a composite service is able to execute

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WSCL

- **Web Services Conversation Language**
- A submission by HP in 2002
 - W3C Note: <http://www.w3.org/TR/wscl10/>
- Allows defining the **business level conversations** by specifying the XML documents exchanged and the sequencing of those documents
- The conversation (i.e., business protocol) proceeds from **one interaction to another** according to the legally defined **transitions**
- WSCL conversation definitions are themselves **XML documents** and can therefore be interpreted by Web services infrastructures and development tools

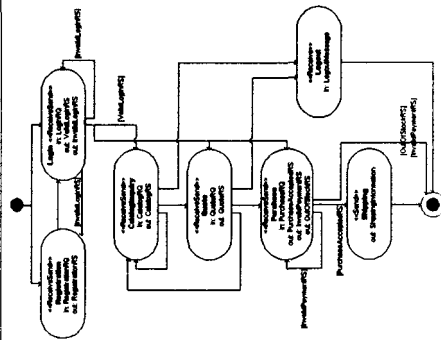
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WSCL: graphical definition example



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An example of WSCL instance

(Source: IEEE Computer, May 2002)

```

<ConversationInteractions>
  <Interaction StepType="ReceiveSend" Id="ProcessPO">
    <InboundXMLDocuments>
      <hrefScheme="PO.xml"/>
    </InboundXMLDocuments>
    <OutboundXMLDocuments>
      <hrefScheme="Shipment.xml"/>
    </OutboundXMLDocuments>
  </Interaction>
  <Interaction StepType="Receive" Id="ProcessPayment"> ..... </Interaction>
</ConversationInteractions>
<ConversationTransitions>
  <Transition>
    <SourceInteraction href="#ProcessPO"/>
    <DestinationInteraction href="#ProcessPayment"/>
    <TriggeringDocument href="#Shipment"/>
  </Transition>
</ConversationTransitions>

```

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BPEL (WSBPEL, BPEL4WS)

- Business Process Execution Language
- A standard for web services composition to define a business process
- Can define the external behavior of a service (through an abstract process) as well as the internal implementation (through an executable process)
- BPEL specifications are XML documents
- History
 - Initially proposed in July 2002 by BEA, Microsoft, and IBM
 - WSBPEL TC: http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=wsbpeel
 - Version 1.1 released in May 2003: <http://www.106.ibm.com/developerworks/webservices/library/ws-bpel/>
 - Now being revised for Version 1.2

Engines

- Collaxa, OpenStorm, IBM, Oracle, WebMethods, ...

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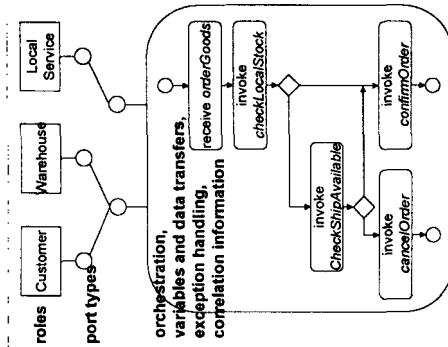
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BPEL can specify

- The different roles that take part in the message exchanges with the process
- The port types that must be supported by the different roles and by the process itself
- The orchestration and the other different aspects that are part of a process definition
- Correlation information, defining how messages can be routed to the correct composition instances



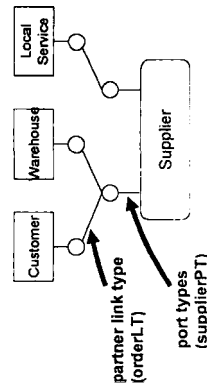
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BPEL

- Partner link type identifies a pair of roles that exchange messages during process execution
- the WSDL port types that the services playing these roles are required to implement



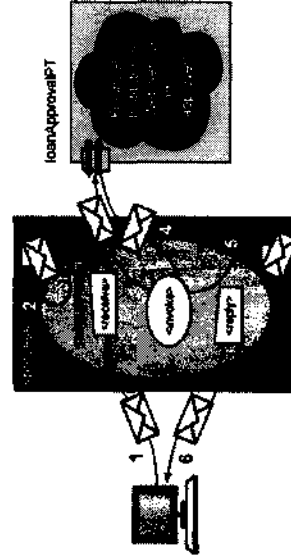
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BPEL4WS Example

(Source: IBM developerWorks)



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BPEL4WS Example: LoanApproval.bpel

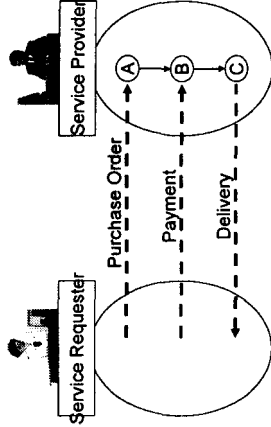
```

<receive name="start" type="http://www.w3.org/2003/05/soap-envelope:Message" />
<reply name="reply" type="http://www.w3.org/2003/05/soap-envelope:Message" />
<sequence />
<invoke name="approve" type="http://www.w3.org/2003/05/soap-envelope:Message" />
</sequence>
</reply>
</receive>

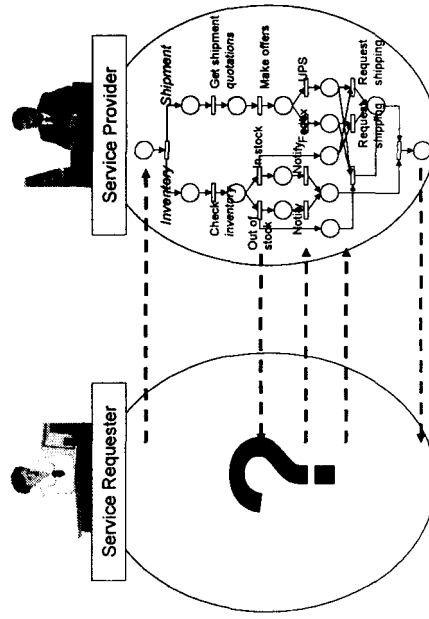
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Interoperation between business processes

- The basic web services infrastructure supports interactions where the client invokes a **single operation** on a Web service
- When the interaction involves **coordinated sequences of operations**, additional abstractions and tools are needed to ensure the correctness and consistency



Interoperation: Harder case



Problem definition

- In order to seamlessly interact with the business process exposed as a web service, it is still the responsibility of the service requester to compose its flow logic by **figuring out how it can interact with the given service**
- Composition of the flow logic of the service requester** that drives the execution of the various components of a publicly available business process remains **unautomated**
- The problem is **trivial** if the target business process requires a **single step interaction** such as RPC and asynchronous messaging

Key ideas

- Co-BP (Co-Business Processes)
 - The partner BP that seamlessly interacts with a target BP by following the conversation specification defined in the target BP
- A Co-BP will undergo the various interleavings of the messages from each independently running sub-process of the target BP
 - Extract the untimed conversation from the external interfaces of a BP
 - Every well-defined conversation must be finite
 - Automatically composed from the target BP specification such as BPEL

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Propositions

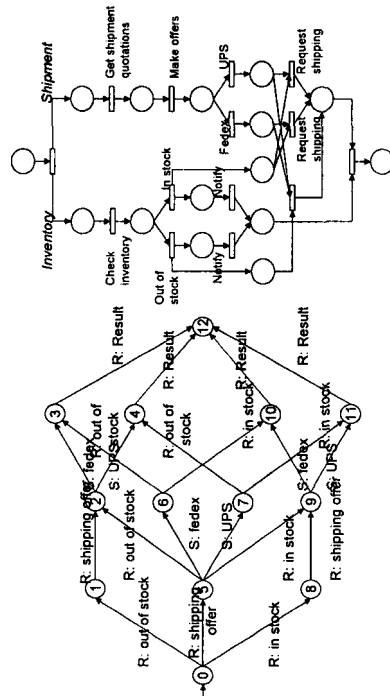
- Three cases
 - Sequential BP (FSA expressible)
 - Sequential/Parallel BP (Petri net expressible)
 - General (well-defined) BP (but with FSA expressible state space)
- Let C be a finite conversation specification for a business process. Then, the conversation specification of the Co-BP, C^∞ , can be computed by inverting the directions of all messages defined in C
- Let F be a flow logic specification for a well-defined BP. Then, the conversation specification of the Co-BP, F^∞ , can be computed by (i) generating the reachability graph of the external interfaces of F , denoted by F_r , and (ii) then inverting the directions of all messages defined in F_r

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Behavior of the CoWS



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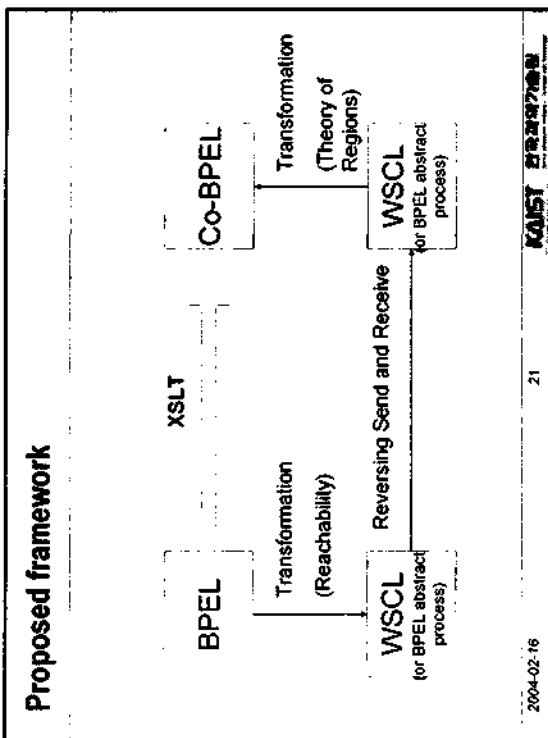
Notes on XSLT

- eXtensible Stylesheet Language Transformations
- XSLT specification is an XML document
- A language for transforming XML documents into other XML documents
- Originally designed for use as part of XSL, which is a stylesheets language for XML
- A Turing-complete functional programming language
- W3C recommendation (v 1.0): <http://www.w3.org/TR/xslt>

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- ### Discussion
- A framework for automatic composition of Co-BP that can interact with its target BP
 - 1) XSLT for transformation from BPEL to WSCL
 - 2) XSLT for transformation from WSCL to BPEL
 - 3) XSLT for transformation between BPEL and BPEL
 - Expected to not only facilitate the web services-enabled dynamic composition, but also increase the user acceptance of recently emerged proposals for web service composition
 - Enhancing the processing power
 - Beyond the expressiveness of Petri net for (2) and (3)
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- ### Implications to ebXML community
- Automatic generation of Co-BPSS
 - Automatic generation of BPSS choreography from more abstract business process specifications
 - Automatic generation of CPP/CPA from more abstract business process specifications
 - Transformation between business process instances defined by different specifications
 - BPSS, BPEL, BPML, XPDL
 - Transformation between conversation instances defined by different specifications
 - BPEL abstract process, BPSS choreography, WSCL, WSCI
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 PARTIAL BPEL/BPML/CPA/CPA
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