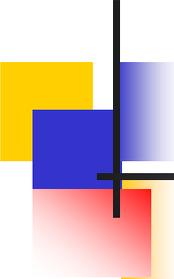


Model Driven Dynamic Composition of Web Services Flow for Business Process Integration

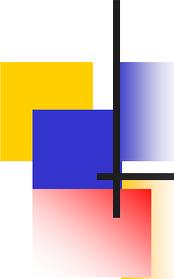
Liang-Jie Zhang, Jen-Yao Chung
IBM T. J. Watson Research Center

April, 2003



Agenda

- Introduction
- Adaptive Web Services Composition Framework
 - Major Components
- Research prototype
 - Web based composition portal
 - Eclipse composition toolkit
- Summary

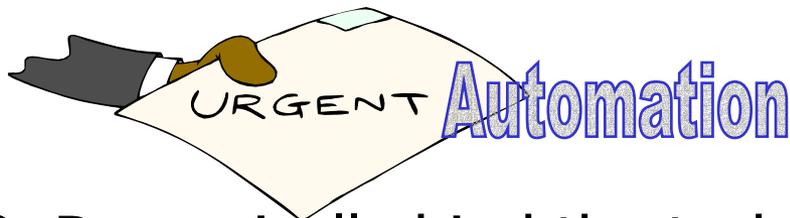


Why Need Dynamic Web Service Composition?

- A business process includes many "stateful," long-running interactions involving two or more parties. **Creating business processes on demand is important for meeting changing customer requirements.**
 - Companies offering new business processes composed by Web Services is a direct and effective way in which an organization can control costs, improve profits, and enhance overall responsiveness to changing market dynamics. (outsourcing)
- Selection and composition of services in a drag-and-drop manner is **time-consuming manual labor**. Dynamically composing the flow of Web services via discovery and selection instead of manual coding is imperative for developers.

Vision

1. Automatically generate business process flow skeleton

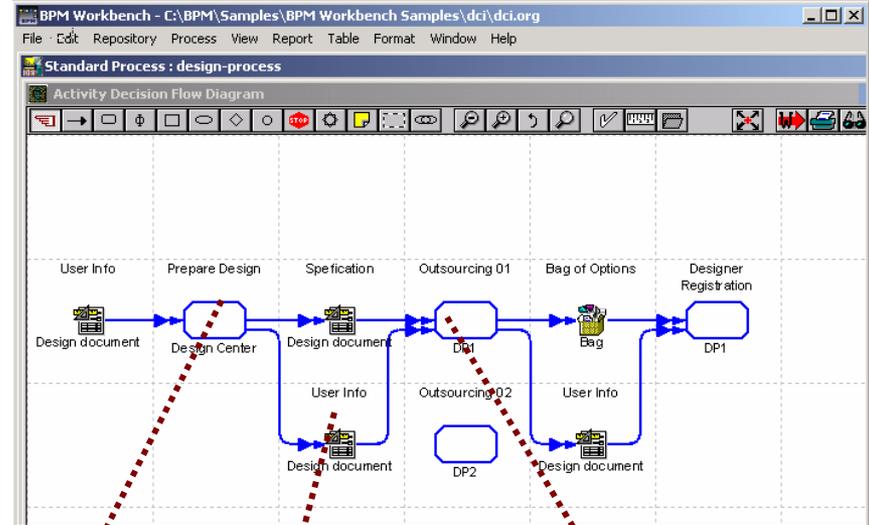


2. Dynamically bind the tasks to specific Web services provided by multiple service providers

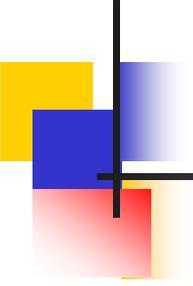
Web Services 1

Web Services 2

Web Services N



3. Adaptively tune the constructed business process flow on a business process engine.



Business Process Flow Languages

- BPEL4WS: Business Process Execution for Web Services
 - IBM, BEA, Microsoft
 - Convergence of WSFL and XLANG
- WSCI: Web Service Choreography Interface (message-flow oriented interface)
 - [BEA Systems](#), [Intalio](#), [SAP AG](#), and [Sun Microsystems](#)

Problems to be solved

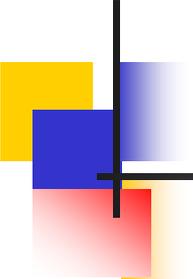
- Lack **uniformed representation** to capture customers' requirements, preferences, QoS, Web Services features, event-action mappings as well as the relationships among Web Services
- Lack an **automation mechanism** to generate search script to dynamically find appropriate Web Services for performing a specific task from UDDI registries with thousands or tons of Web Services records



Problems to be solved (cont.)

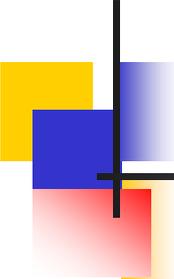
- Lack **effective service selection mechanism** to automatically construct an optimal business process using available Web Services
- Lack **efficient tooling** to support dynamic adaptation of Web Services flow to different modeling languages





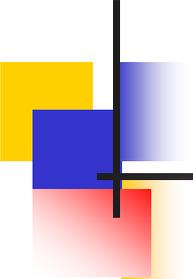
Agenda

- Introduction
- Adaptive Web Services Composition Framework
 - Major Components
- Research prototype
 - Web based composition portal
 - Eclipse composition toolkit
- Summary



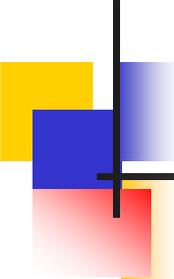
Web Services Composition for Business Process Integration

- A business process consists of multiple Web services which maybe provided by different service providers
- A framework should enable dynamic composition of Web services flow based on customer requirements (Business Process On Demand)
- Web Services Outsourcing Manager (WSOM) is an example dynamic composition framework



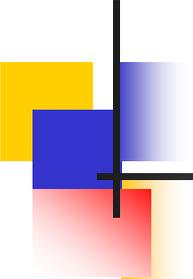
Adaptive Web Services Flow Composition Framework

- Major Components:
 - Requirement annotation document to describe the customer's requirement, preferences, QoS and relationships
 - Generating Search Script based on the requirement annotation document for Leveraging advanced Web Services discovery engine: **First level service selection**



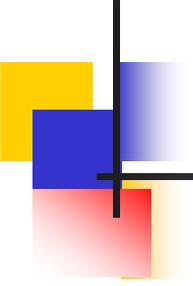
Adaptive Web Services Flow Composition Framework (cont.)

- Using optimization algorithm for service selection (aka. service matchmaking) to configure the optimal Web services flow to satisfy customer requirements (e.g. lowest cost, shortest time): **Second level service selection**
- Final Output: WSFL or other Web Services business process languages (BPEL4WS)



Features of the Composition Framework

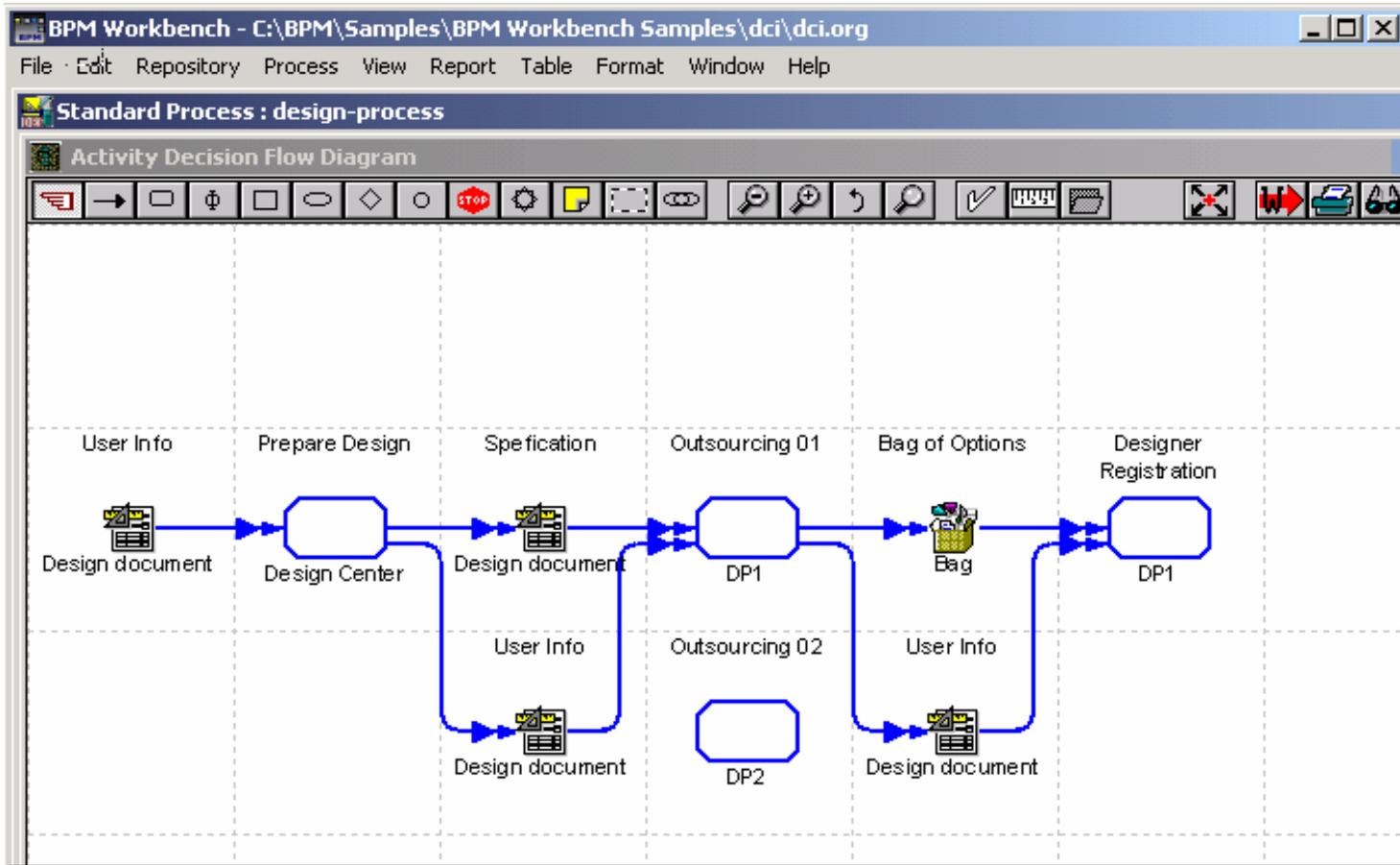
- Fully automate the end-to-end composition of business processes by using existing Web services.
- Bridge the gap between the informal, subjective customer requirements and the objective, machine-readable flow language, such as BPEL4WS, WSFL, and XLANG.
- Automate the generation of scripts for searching for Web services; and it automates the process of selecting Web services by using a "pluggable" optimization framework.
- Monitor and tune the composed business process so that it adapts to the new requirements at run time.



Agenda

- Introduction
- Adaptive Web Services Composition Framework
 - Major Components
- Research prototype
 - Web based composition portal
 - Eclipse composition toolkit
- Summary

Business Process Template Creation



GUI based tool (e.g. HoloSofx Workbench) could be used to create a workflow template.

Internal Representation of a Flow Template

```

Name="Invitation" OID="design-processDesign
Outsourcing02Invitation" Stereotype="" Arguments=""
  <Transition />
</Transitions>
<Actions />
</Activity>
- <Activity ClassType="Activity" Documentation="" Name="Prepare
Design" OID="design-processPrepare Design" Stereotype=""
stateModel="design-processSM" swimlane="Engineer"
SubStateModel="">
- <Transitions>
- <Transition ClassType="Transition" Documentation="" Name=""
OID="design-processPrepare DesignDesign
OutsourcingPrepare DesignTr" Stereotype=""
Client="design-processDesign Outsourcing01"
ClientType="Activity" stateModel="design-processSM"
Supplier="design-processPrepare Design">
<Action ClassType="null" />
<Event ClassType="Event" Documentation=""
Name="Specification" OID="design-processPrepare
DesignSpecification" Stereotype="" Arguments=""
Condition="" />
</Transition>
</Transitions>
<Actions />
</Activity>
- <Activity ClassType="Activity" Documentation="" Name="Design
Outsourcing01" OID="design-processDesign Outsourcing01"
Stereotype="" stateModel="design-processSM"
  
```

BPM XML

```

<process name="purchaseOrderProcess" targetNamespace="http://acme.com/ws-
bp/purchase" xmlns="http://schemas.xmlsoap.org/ws/2002/07/business-
process/" xmlns:ins="http://manufacturing.org/wsd/purchase">
- <partners>
<partner name="customer" serviceLinkType="ins:purchaseLT"
myRole="purchaseService" />
<partner name="invoiceProvider" serviceLinkType="ins:invoiceLT"
myRole="invoiceRequester" partnerRole="invoiceService" />
<partner name="shippingProvider" serviceLinkType="ins:shippingLT"
myRole="shippingRequester" partnerRole="shippingService" />
<partner name="schedulingProvider" serviceLinkType="ins:schedulingLT"
partnerRole="schedulingService" />
</partners>
+ <containers>
+ <faultHandlers>
- <sequences>
<receive partner="customer" portType="ins:purchaseOrderPT"
operation="sendPurchaseOrder" container="PO" />
- <flow>
- <links>
<link name="ship-to-invoice" />
<link name="ship-to-scheduling" />
</links>
- <sequence>
- <assign>
+ <copy>
</assign>
- <invoke partner="shippingProvider" portType="ins:shippingPT"
operation="requestShipping" inputContainer="shippingRequester"
  
```

UML XML

```

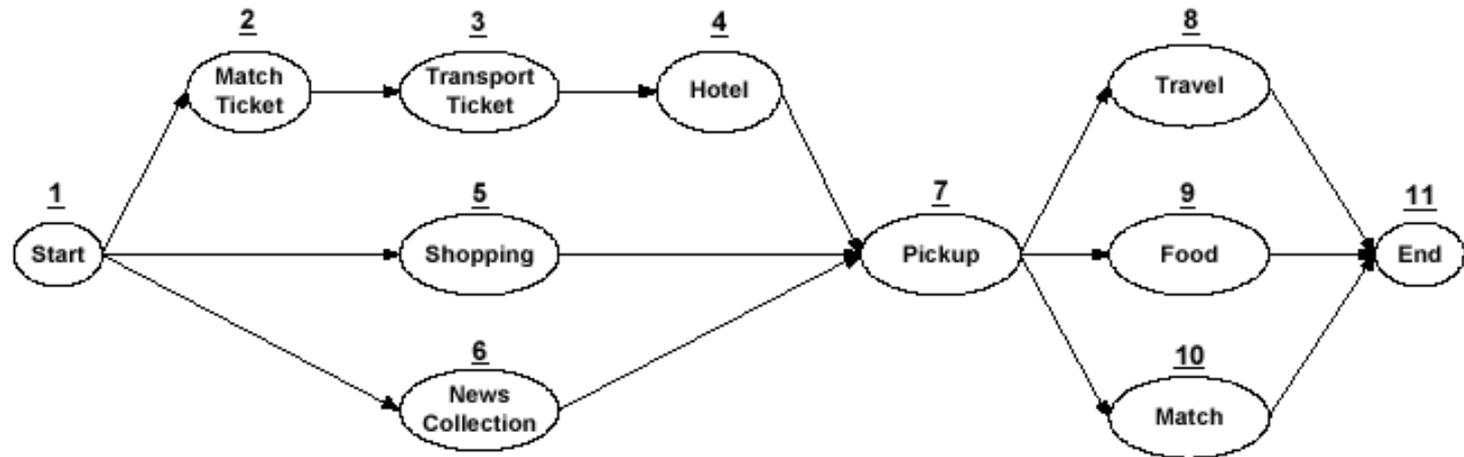
- <WFBPR>
- <RepositoryData>
+ <OrganizationData>
- <ProcessData>
- <Tasks>
- <Task>
<TaskName Name="Designer Registration" />
<OrganizationUnitName Name="DP1" />
<RoleName Name="Assembler" />
</Task>
- <Task>
<TaskName Name="Prepare Design" />
- <TaskNotes>
<Notes />
</TaskNotes>
<OrganizationUnitName Name="Design Center" />
<RoleName Name="Engineer" />
</Task>
- <Task>
<TaskName Name="Design Outsourcing" />
<OrganizationUnitName Name="DP1" />
<RoleName Name="Warehouse clerk" />
</Task>
- <Task>
<TaskName Name="Service Provider Discovery" />
<OrganizationUnitName Name="DCI" />
</Task>
</Tasks>
  
```

BPEL4WS XML

Enhanced Capability

Current Capability

Example: Travel Planning Process Skeleton



The model contains the following nine activities:

1. Start
2. Purchase a game ticket (Match Ticket)
3. Purchase transportation ticket (Transport Ticket)
4. Book a hotel room (Hotel)
5. Shop for the trip (Shop)
6. Collect news about the game (News Collection)
7. Reserve a pickup service (Pickup)
8. Make a sightseeing plan (Travel)
9. Make a restaurant reservation (Food)
10. Watch the game (Match)
11. End

Generate Requirement Annotation Document

- Two major parts in Requirement Annotation Document
 - Flow rules
 - Parallel services
 - Sequential services
 - Customer requirements
 - Preferences (e.g. QoS)
 - Business rules
 - Relationship links
 - Event-action mappings



Example: WSOM Web Portal - Screens

alphaWorks: Web Service Outsourcing Manager - Microsoft Internet Explorer

File Edit View Favorites Tools Help Links » Back Forward Stop Home Search Favorites History

Address http://localhost:8080/wsom/index.htm

IBM IBM Research

Find News Products Support Business solutions **Inside IBM** Interest groups

Web Service Outsourcing Manager

Dynamic Web Service Flow Composition Framework

1. Home	<h3>Introduction</h3> <p>A business user wants a number of activities in his/her business process. The activities can be implemented or realized by Web services. With the activities in mind, the user can create a process model considering their execution order. Web Services Outsourcing Manager (WSOM) is a software framework providing a mathematical model for dynamic business process flow composition using existing Web services to meet the business users' requirements and the preference. This Web interface to the WSOM framework enables a business user:</p> <ol style="list-style-type: none">1. Define a Business Process Model by specifying the preferences and relationships activities.2. Define Business Rules associated with activities.3. Generate an XML Requirement Document specifying the defined process model with the rules.4. Run the engine and find a Business Solution that fulfills the requirements of the activities.5. Generate an XML Solution Document specifying the business solution.
2. Process Model	
3. Business Rules	
4. Requirement Document	
5. Business Solution	
6. Solution Document	

Demo Scenario

In this demo, we present a **business process** scenario for a soccer fan planning a trip for watching a game. To show the capabilities of the WSOM framework, this demo uses a particular process model as shown below:

OM

Example: Process Model

alphaWorks: Web Service Outsourcing Manager - Microsoft Internet Explorer

File Edit View Favorites Tools Help Links » Back Forward Stop Home Search Favorites History

Address http://localhost:8080/servlet/com.ibm.wsom.SpecifyPreferences

1. [Home](#) **2. Process Model** [Previous](#) [New Activity](#) [Next](#)

2. [Process Model](#)

3. [Business Rules](#)

4. [Requirement Document](#)

5. [Business Solution](#)

6. [Solution Document](#)

In this step, the user creates a business process model by defining each **business activity** in the model with

1. Zero or more following activities,
2. Business requirements for various factors, e.g., cost, time, benefit, and quality, and

To create an entire process model, the user needs to repetitively use this step for each and every activity.

Select the target service	Match Ticket	
Select one or more following services	<input type="checkbox"/> Start	
	<input type="checkbox"/> Match Ticket	
	<input checked="" type="checkbox"/> Transport Ticket	
	<input type="checkbox"/> Hotel	
	<input type="checkbox"/> Shopping	
	<input type="checkbox"/> News Collection	
	<input type="checkbox"/> Pickup	
	<input type="checkbox"/> Travel	
	<input type="checkbox"/> Food	
	<input type="checkbox"/> Match	
<input type="checkbox"/> End		
Requirements for target service	Cost (\$)	100
	Time (Days)	5
	Discount (\$)	10
	Quality (0 - 1.0)	0.9

Save Reset

Example: Business Rules Associated with Activities

alphaWorks: Web Service Outsourcing Manager - Microsoft Internet Explorer

File Edit View Favorites Tools Help Links » Back Forward Home Search Favorites History

Address http://localhost:8080/servlet/com.ibm.wsom.SpecifyBusinessRules

IBM Research

Find News Products Support Business solutions **Inside IBM** Interest groups

Web Service Outsourcing Manager

Dynamic Web Service Flow Composition Framework

- [Home](#)
- [Process Model](#)
- [Business Rules](#)**
- [Requirement Document](#)
- [Business Solution](#)
- [Solution Document](#)

3. Business Rules

[Previous](#) [New Rule](#) [Next](#)

In this step, the user specify various business rules associated with business activities. The user can define a business rule by specifying

1. Business rule type,
2. Business activity,
3. Business rule priority, and
4. Consideration factor and its maximum allowable value.

To create an entire set of necessary business rules, the user needs to repetitively use this step.

Select a rule type	Condition-Service
Select a service cluster	Match Ticket
Rule priority (The bigger, the higher.)	7
Condition (Maximum allowable)	Cost (\$) 300

Save Reset

Example: Requirement Annotation Document Creation

The screenshot shows a Microsoft Internet Explorer browser window displaying the IBM Research Web Service Outsourcing Manager. The browser's address bar shows the URL: `http://localhost:8080/servlet/com.ibm.wsom.GenerateBPOL`. The page features the IBM Research logo at the top, followed by a navigation menu with options: Find, News, Products, Support, Business solutions, Inside IBM (highlighted), and Interest groups. The main heading reads "Web Service Outsourcing Manager" and "Dynamic Web Service Flow Composition Framework". A numbered list on the left side includes: 1. Home, 2. Process Model, 3. Business Rules, 4. Requirement Document, 5. Business Solution, and 6. Solution Document. The current page is titled "4. XML Requirement Document" and includes "Previous" and "Next" navigation links. The main content area states: "Your XML Requirement Document (in BPOL) is created. You can [download](#) the Requirement Document. Now you are ready to generate the optimal [Business Solution](#). (This will take a few minutes. Please be patient.)" At the bottom, there is a footer with links: Research home, IBM home, Order, Privacy, Legal, and Contact IBM. The browser's status bar at the bottom shows the URL and "Local intranet".

Step 5: Create Business Solution

alphaWorks: Web Service Outsourcing Manager - Microsoft Internet Explorer

Address <http://localhost:8080/servlet/com.ibm.wsom.GetBusinessSolution>

IBM Research

Find News Products Support Business solutions **Inside IBM** Interest groups

Web Service Outsourcing Manager

Dynamic Web Service Flow Composition Framework

1. [Home](#)

2. [Process Model](#)

3. [Business Rules](#)

4. [Requirement Document](#)

5. **[Business Solution](#)** [Previous](#) [Next](#)

6. [Solution Document](#)

Your Business Solution is generated. You can review the solution in an XML [Solution Document](#).

Free, Regular Train, Kia Hotel, Beijing's Modern Business City, Soccer Week, Supper Shuttle, China Travel Agent, Korea Food, Korea World Cup Students Association,

Research home IBM home Order Privacy Legal Contact IBM

Research home Local intranet

Web Services Flow Language Generation

The screenshot shows a Microsoft Internet Explorer browser window. The title bar reads "alphaWorks: Web Service Outsourcing Manager - Microsoft Internet Explorer". The address bar shows "http://localhost:8080/servlet/com.ibm.wsom.GenerateWSFLSkeleton". The page content includes the IBM Research logo and a navigation menu with "Inside IBM" highlighted. The main heading is "Web Service Outsourcing Manager" followed by "Dynamic Web Service Flow Composition Framework". A list of links is on the left, and the main content area shows "6. XML Solution Document" with a "Previous" link and a "Home" link. The text below the heading states: "Your XML Solution Document (in WSFL) is created. You can download the Solution Document. This is the end of the demo of using WSOM for business solutions. Thanks! You can go back Home to model another business proces." A footer contains links for "Research home", "IBM home", "Order", "Privacy", "Legal", and "Contact IBM".

alphaWorks: Web Service Outsourcing Manager - Microsoft Internet Explorer

File Edit View Favorites Tools Help Links » Back Forward Stop Home Search Favorites History Print

Address http://localhost:8080/servlet/com.ibm.wsom.GenerateWSFLSkeleton

IBM IBM Research

Find News Products Support Business solutions **Inside IBM** Interest groups

Web Service Outsourcing Manager

Dynamic Web Service Flow Composition Framework

- [Home](#)
- [Process Model](#)
- [Business Rules](#)
- [Requirement Document](#)
- [Business Solution](#)
- [Solution Document](#)
- [XML Solution Document](#)

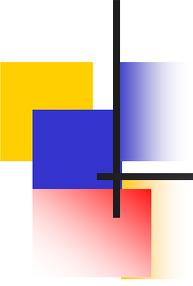
[Previous](#) [Home](#)

Your XML Solution Document (in WSFL) is created. You can [download](#) the Solution Document. This is the end of the demo of using WSOM for business solutions. Thanks!

You can go back [Home](#) to model another business proces.

Research home IBM home Order Privacy Legal Contact IBM

http://localhost:8080/servlet/com.ibm.wsom.GenerateWSFLSkeleton Local intranet



Example: WSOM Eclipse Edition

- Capture Customer's Requirements
- Capture Business Rules
- Generate Requirement Annotation Document
- Configure Optimal Business Process
- Generate WSFL (or BPEL4WS) Skeleton

WSOM (Eclipse Screens)

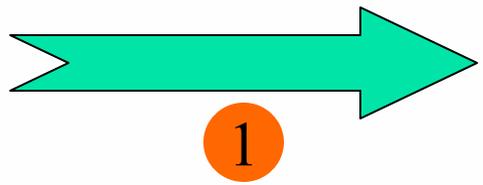
Customer Requirements

2

IBM Web Service Outsourcing Manager

File Edit Analyze Search Help

BPOL Type	Col 1	Col 2	Col 3	Col 4	Col 5
WSOM Console					



Specify Your Preferences

Expected Services:

Followed Expected Services:

- Start
- Match Ticket
- Transport Ticket
- Hotel
- Shopping
- News Collection
- Pickup
- Travel
- Food
- Match
- End

Customer Requirements

Preferences:

Cost:

Time:

Benefit:

Quality:

Included Services:

- Start
- Match Ticket
- Transport Ticket
- Hotel
- Shopping
- News Collection
- Pickup
- Travel
- Food
- Match
- End

OK Cancel

Specify Business Rules

Types:

Contents:

Relevant Service:

Priority:

Condition:

Regular Train
Air China
FIFA
Chinese Soccer Association

Behavior:

Regular Train
Air China
FIFA
Chinese Soccer Association

OK Cancel

Business Rules



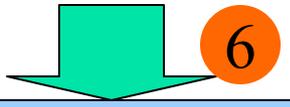
Title barBPOL.xml

File Edit Analyze Search Help

BPOL Type	Get Business Solution ...	2	Col 3	Col 4
Preference	Configure ...		11	22
Preference	Match Ticket		111	222
Preference	Transport Ticket		111	222
Preference	Hotel		111	222
Preference	Shopping		111	222
Preference	News Collection		111	222
Preference	Pickup		111	222
Preference	Travel		111	222
Preference	Food		111	222
Preference	Match		111	222
Preference	End		111	222

Service Selection Algorithm (GA)

Dynamic Business Process Configuration



WSFL or BPEL4WS

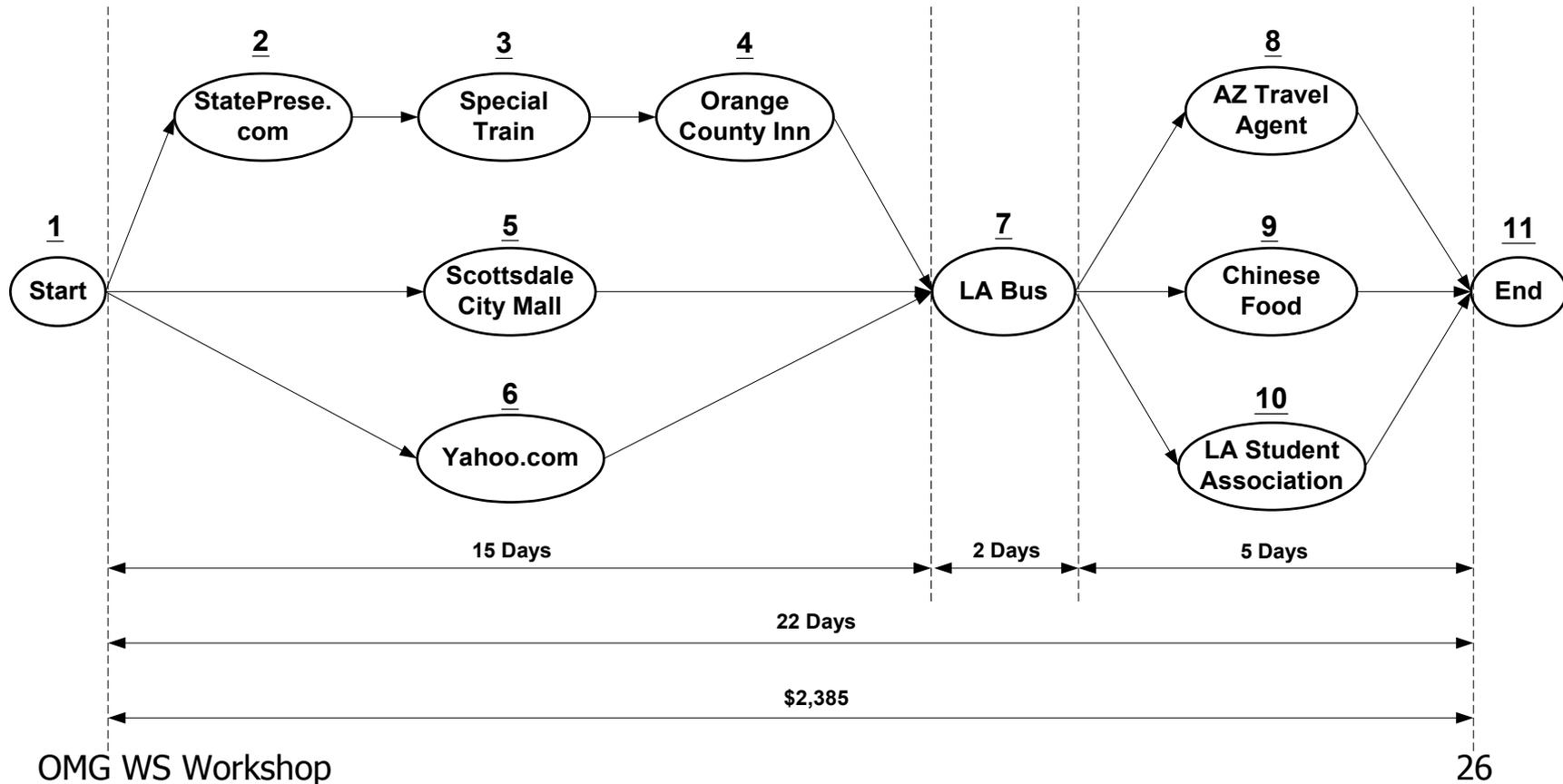
OMA WS workshop

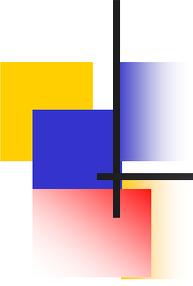
BPOL Creation

Result: Trip Planning Business Process

- The final business process is constructed by the following service set.

$$S^* = \{0010, 001000, 01, 010, 001, 001, 10, 100, 010\}$$



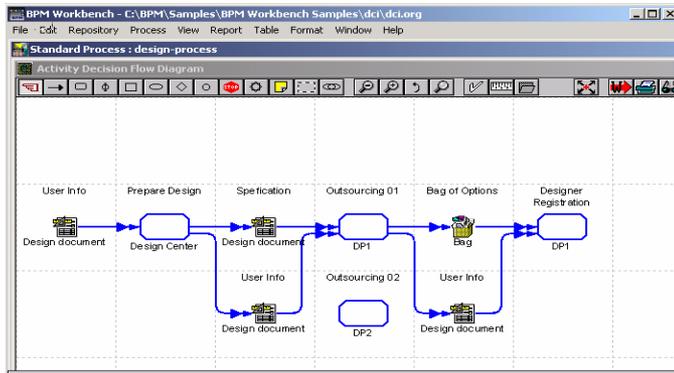


Agenda

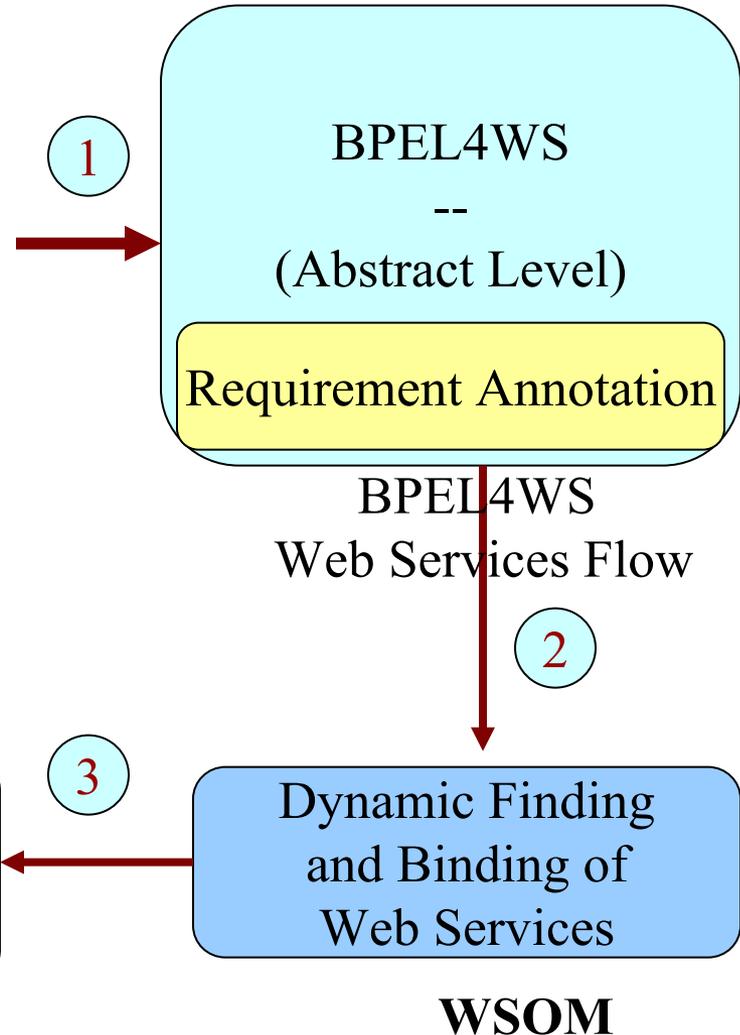
- Introduction
- Adaptive Web Services Composition Framework
 - Major Components
- Research prototype
 - Web based composition portal
 - Eclipse composition toolkit

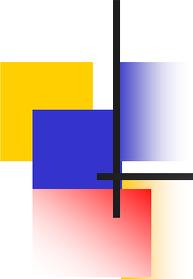
- Summary

Integrating Model Driven Tool with BPEL4WS



Workflow template
(Business level)





Summary

- A framework that enables dynamic composition of Web services flow
 - Using requirement annotation document to capture customers' requirements for Web services outsourcing (Skeleton based)
 - Automatic search script generation
 - Optimal business process configuration to match customer's requirements
- WSOM can be extended to support **Grid Services Composition**

Resources

- Business Process Execution Language (BPEL4WS)
 - www-106.ibm.com/developerworks/webservices/library/ws-bpel/
- Web Services Outsourcing Manager
 - <http://www.alphaworks.ibm.com/tech/WSOM>
- Web Services Toolkit
 - <http://www.alphaworks.ibm.com/tech/webservicestollkit>
 - BE4WS (<http://www.alphaworks.ibm.com/tech/be4ws>)
 - WSIL Explorer
- Conference Invitation
 - **2003 International Conference on Web Services (ICWS'03)**
 - <http://tab.computer.org/tfec/icws03>
 - June 23 - 26, 2003, **Las Vegas, Nevada, USA**