Scenario

Vision: Software over the Web

Technology: Status of Web Services

Engineering: Web Services Engineering

Research Challenges
Vision: Software over the Web
From Computing to Collaboration

- Computing is Commodity
- Collaboration Creates Value

What Software Engineering Can Do for the Web?

Computing
- Web Services

Information/ Data
- Semantic Web

Internet Context=Web

Vision: Software over the Web
Evolution of Information Systems

- From Enterprise to Networked Enterprises
- From Stocked Information to Information Flow

What Customers Want?

Business Unit
Ex: Sales, Warehouse

Enterprise
(Integration)
Ex: ERP

Information Stock

Task
Ex: Data Entry

Networked
Enterprise
(Integration)
Ex: SCM, CRM

Information Flow

Information

Customer

A-Corp
Sales

B-Corp
Distributor

C-Corp
Supplier

A-Corp
ERP

Manufacturing

B-Corp
ERP

Ex: SCM, CRM
**Vision: Software over the Web**

**Information Systems on the Web**

- Open Decentralized World of the Web: What is a Model of Information Systems on the Web?
  - Boundary-less, No Central Control (De-centralized)
  - Dynamic and Autonomous Evolution

- Shifting to Integration: Collaboration across the Organizations
  - From Enterprise to Collaborative Enterprises
  - End-to-End Process Integration on Heterogeneous Platforms and Architectures across Organizations
    - Program: OS, Language, Middleware
    - Data: Language, Semantics, Data Structure

- Lesson Learned from Multiple Standards for the Same Goal: CORBA/DCOM/JavaRMI

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**Vision: Software over the Web**

**What's Wrong with Distributed Objects**

- Limitations with Distributed Object Environment [CORBA, DCOM, JavaRMI]
  - Client/Server Architecture
    - Closed Network Model: Clients Know the Server
    - Tightly Couples with State-full Model
  - Interoperability across Different Platforms
    - Similar but Different Protocol
  - Collaboration across Organizations
    - Interoperability across Firewalls
    - Interoperability at Higher Level

"Service"
**Vision: Software over the Web**

*(My) Vision of Services*

**Business-Service-Computing Model**
- Platform Independence
- Productivity, Interoperability
- Business-Model Independence
- Requirements, Evolution/Agility

**Vision: Software over the Web**

**What are Web Services?**

*(XML) Web Services*
- Internet-based applications fulfilling a specific task or a set of tasks, that can be combined with other.*
- Variations
  - Peer Services, Service Grid, Mobile Web Services

Vision: Software over the Web
Business/ Social Rationale

- **Single Common Ground**
  - IBM, Microsoft, Sun, Oracle, ...

Enabling Software Collaboration

1. **Client-Centric: Presentation Integration**
   - GUI Component: COM/OLE, JavaBeans
   - Composition by GUI (Visual Development Environment)
     - Productivity and Intuitive Comprehension

2. **Server-Centric: Control and Data Integration**
   - Transaction Processing/Business Rules: COM&MTS, J2EE/JTS
   - Structural Composition: Architecture/Pattern
     - Quality and Performance

3. **Network-Centric: Process-Integration**
   - Workflow/Process and Data
   - Semantic Composition: Brokerage
     - Value-Creation and Evolution/Agility
**Vision: Software over the Web**

**Summary: Evolution to Web Services**

Service = Encapsulation of Components

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**Service Provision**

- ASP (Application Service Provider)
- Service Requester
- Web Services
- Service Broker
- Service Provider
- EDI, EC (SCM, eMP), EAI/B2BI

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**Component-Based System**

- Component
- Architecture
- Integration (Middleware)

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**Computing Platform**

- Object

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**1st Generation:**
- (Stand Alone)
- 1991-93
- OLE1.0
  - OCX
  - VBX

**2nd Generation:**
- (Client/Server)
- 1996-7
- ActiveX
  - ActiveX
  - COM
  - DCOM
  - Windows NT 4.0
  - CORBA 2.0 (96)
  - IIOP

**3rd Generation:**
- (Internet)
- 1998-9
- CORBA 3.0
  - CORBA Component Model
  - SOAP, WSDL, UDDI...

**4th Generation:**
- (Web Services)
- 2000-
- .NET Framework
  - XML-Based
  - SOAP, WSDL, UDDI...

**Now**

- Service
- e-speak
- Jini
- ONE

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**Vision: Software over the Web**

**Summary: Evolution to Web Services**

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Scenario

Vision: Software over the Web

Technology: Status of Web Services

Engineering: Web Services Engineering

Research Challenges
Technology: Status of Web Services Architecture

- Service-Oriented Architecture (SOA)
  - Broker (Pattern)
  - Decouple between Requester and Provider
  - UDDI: Publish Subscribe Pattern

<table>
<thead>
<tr>
<th>Service Requester</th>
<th>Service Broker</th>
<th>Service Provider</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)Find</td>
<td>(b)Get</td>
<td>(1)Request</td>
</tr>
<tr>
<td>(2)Find</td>
<td>(3)Get</td>
<td>(4)Request</td>
</tr>
<tr>
<td>(5)Invoke</td>
<td>(6)Reply</td>
<td>(7)Response</td>
</tr>
<tr>
<td>(8)Response</td>
<td>(c)Request</td>
<td>(d)Invoke</td>
</tr>
<tr>
<td>(e)Reply</td>
<td>(f)Response</td>
<td>(g)Reply</td>
</tr>
</tbody>
</table>

Implementation of Services (Components)

Registration with WSDL

Technology: Status of Web Services

SOAP Messaging Models

- 2 Messaging Models
  - Procedure-Oriented (RPC) and Document-Oriented

<table>
<thead>
<tr>
<th>Requester</th>
<th>Application Program</th>
<th>Database</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple Remote Procedure Call of State-less</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Asynchronous Messaging by a Document

<table>
<thead>
<tr>
<th>Service Provider</th>
<th>Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requester A</td>
<td></td>
</tr>
<tr>
<td>Requester B</td>
<td></td>
</tr>
<tr>
<td>Business Process</td>
<td></td>
</tr>
<tr>
<td>Shipping Order</td>
<td></td>
</tr>
<tr>
<td>Database</td>
<td></td>
</tr>
</tbody>
</table>
Scenario

Vision: Software over the Web
Technology: Status of Web Services
Engineering: Web Services Engineering
Research Challenges

Engineering: Web Services Engineering
Web Services Engineering Process

Bridging the Gap between Business to Service

Business Modeling

Real World

Business Systems

Business Ontology Analysis

Business Architecture Analysis

Service Modeling

Service Ontology Analysis

Service Architecture Analysis

Service Implementation and Execution

Service Requester

Service Broker

Service Provider

Service Directory
### Engineering: Web Services Engineering

#### Changing the Software Process & Delivery

From Coding to Component Composition to Dynamic Service Lookup & Use

- **Lookup and Composition (Use) at Run-Time**

#### Custom Development Model

- Req. Analysis
- Design
- Coding
- Unit Test
- Integ. Test
- System Test

#### Component-Based Development Model

- Req. Analysis
- Design
- Component Composition
- Integ. Test
- System Test

#### Service-Oriented Model

- Req. Analysis
- Design
- V&V
- Lookup & Use

### Engineering: Web Services Engineering

#### Changing Software Development/Deployment/Delivery

Network (B2B/ B2C)

- Enterprise Application
- Enterprise Package (ERP)
- Web Services and xSP[ASP (Application Service Provider)]

Enterprise

- Enterprise Relation (SCM)

Business Unit

- Business Application
- Business Package

Task

- Program

Custom Development (Build)

Package (Buy)

Service (Lease/Rental)
Engineering: Web Services Engineering

Many Ms for Many As

Viewing the World with Many “M”s Possibly Inconsistent for Many “A”s

“M”s: Multiple Business Models, Multiple Stakeholders, Multiple Contexts, …

“A”s: Anybody, Anywhere, Anytime

Challenge: Creating (Dynamic) e-Business by Composing Web Services on the Web of (Global) Inconsistency, Incompleteness, … with Assuming No Single Unchanging System

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Engineering: Web Services Engineering

Business Process Modeling Languages

Issues in BPM (Business Process Modeling) Languages

- Underlying Model: Workflow(?)
- Encapsulation and Modularization
- Collaboration/Choreography/Orchestration
- Transaction: Long-Life
- Exceptions
- Timing
- Security, Safety, and Trust

BPM Languages vs Programming/Scripting Languages
Engineering: Web Services Engineering
Underlying Models for BPM Language

**Process Model and Conversational Model**

- **Process Model**: Workflow in an organization for control the process enactment
  - *Ex: BPEL(4WS) [WSFL, XLANG], BPML*
- **Conversational Model**: Interaction protocol among the organizations for dynamic B2B integration
  - *Ex: Ninja (馨者) Gateway and Ninja Process Broker with cpXML (Conversation Policy XML)*

---

Engineering: Web Services Engineering
Encapsulation and Modularization

**2 Levels of Scope: Public and Private**

- **Public Process**: Process across processes
- **Support of Public/Private Process in BPM Languages**
  - *WSFL: Support of Public/Private Process*
  - *XLANG: Support of Public Process and Exceptions*

---

Sales (Public Process)

Buyer → Seller

Selling Process (Private Process)

Order Mgmt → Warehouse Mgmt → Accounting

Warehouse Mgmt (Private Process)

Assignment → Shipping
Engineering: Web Services Engineering
Broker is the Key Player

2 Roles of Broker

- (Dynamic) Design: Find and Composition
  - Find Qualified Web Services
  - Composition and Evaluation
- Execution
  - Execution, Control of Scope, Protocol Binding

Structure of e-Business on the Web:

- Dynamic Composition of Web Services
- Value Network: Collaborate Web Services to Augment Business Value
- Brokerage is the Pivot to Collaborative e-Businesses

e-Business by Collaborating Brokers [Broker Network]
- Dynamics by Changing Collaboration Patterns
**Engineering: Web Services Engineering**

**Business Models on Broker Architecture**

**Common Broker Pattern of Multiple Business Models**

- **(2) Cataloguing**
  - Buy
  - Broker
  - Sell
- **(3) Bidding**
  - Buy
  - Broker
  - Sell
- **(4) Selection**
  - Buy
  - Broker
  - Sell

**Engineering: Web Services Engineering**

**Requirements to Dynamic Brokerage**

- **Brokerage is Essentially Dynamic and Complex**
- **(Dynamic) Positioning**
  - Sell, Buy
- **(Dynamic) Change of Scope**
  - Scope of Call-for-Bid: Open, Close, etc.
- **Negotiation**
  - Dynamic Pricing, Changing Conditions
- **(Dynamic) Change of Business Protocols**
  - One-to-One (for MRO), One-to-Many (for Auction), Many-to-Many (for Double Auction/Exchange)
- **Support of Non-Functional Properties**
  - Performance, Reliability, Security and Trust
Engineering: Web Services Engineering Drama(tic) Model

- Concept: Business/Trade is a Drama
- Modeling with an Extension of Use Cases
  - Introduction of Role and Scene to Use Cases to Enabling Dynamic Collaboration across Business Scenarios
  - Brokerage could be a Role
  - A Scene Defines a Business Context and a Scope
- Service could be a High-Level Use Case
- Mapping to Web Services Platform


Engineering: Web Services Engineering Drama(tic) Model of e-Business

- Actor: An Active Entity
- Role (Personality): Played by an Actor in a Scene
- Service: Task Performed by an Actor with a Role
- Scene: Context of Plays of Actors
- Scenario: A Sequence of Plays in a Scenario
**Engineering: Web Services Engineering**

Drama(tic) Model of e-Business

- **Scenario 1 & 2: Service Aggregation**
  - Composing MRO with Spot Procurement for Varying Demands

- **Scenario 3: Reduction**
  - SCM: Actor b plays both Buyer and Broker

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**Scenario**

Vision: Software over the Web

Technology: Status of Web Services

Engineering: Web Services Engineering

Research Challenges
Research Challenges
Platform Technology

- “2nd Generation” Web Services
  - Variation of Underlying Computing Architectures
    - Peer Services and Service Grid: Symmetric Web Services
    - Mobile Web Services
  - Overcome Vulnerability and Cost of Decentralization
    - Security, Safety and Trust
    - Transaction Processing and Performance
  - Migration of Legacy Applications and Components to Web Services
    - Wrapping

Research Challenges
Development Technology: WebSE

- New Frontier in Software Engineering
  - Process and Methodology
    - New Process for Development and Delivery
      - SOD (Service-On-Demand)?
      - Mapping Real-World (Business) to Web Services
    - Design and V&V of Dynamic Behavior
  - Modeling Networked Enterprises/Businesses
    - BPM Language and Methodology
    - Visual Modeling Language \( UML 2 ++ ? \)
Research Challenges
Development Technology: WebSE

New Frontier in Software Engineering
- Architecture
  - Broker Architecture
- Design for Non-Functional Requirements
  - SLA (Service Level Agreement) and SLM
  - AOSD (Aspect-Oriented Software Development)
  - Security, Safety and Truth
- Semantics: Ontology and Semantic Web
  - (Business) Ontology, Domain Engineering

Research Challenges
Business Technology

Collaborative Enterprise
New Model of “Corporation”
- Re-thinking of Workplace
- Selection of Core Business and Business Outsourcing
  - Outsourcing Business as Web Services
- Social Implication?

Research Challenges
Research Project for Manufacturing Aid

- Web Services for Design and Manufacturing
  - Focus on MSE (Medium and Small Enterprise)

Current Practice
- Design Specs
- Best Practices
- Examples
- Engineering DB
- Internet
- CAM
- CAD
- CAE
- Transform

Service-Oriented Platform
- Design Specs
- Best Practices
- Examples
- Engineering Warehouse
- Engineering DB
- Web Services
- CAD
- CAE

Summary

- Web = New Computing Model
  - Creating a New Layer of “Computing”=Service

- Web Services Technology
  - Rapid Advancement of Platform Technology
  - Engineering is Largely Missing

- Need of Web Services Engineering
  - New Frontier of Software Engineering
  - Lots of Challenges