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Web Services Engineering
Big Promises, and Big Challenges Too

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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

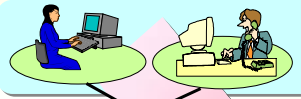
Information / Data
Semantic Web

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?



Task
Ex: Data Entry

Business Unit
Ex: Sales, Warehouse

Information Stock

Enterprise (Integration)
Ex: ERP

A-Corp ERP

Sales | Information | Manufac-turing

B-Corp ERP

Information Flow

Networked Enterprise (Integration)
Ex: SCM, CRM

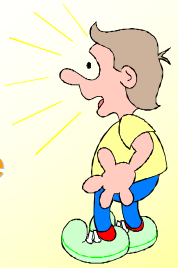
Customer

Information

A-Corp Sales | B-Corp Distributor | C-Corp Supplier

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



Vision: Software over the Web
What's Wrong with Distributed Objects

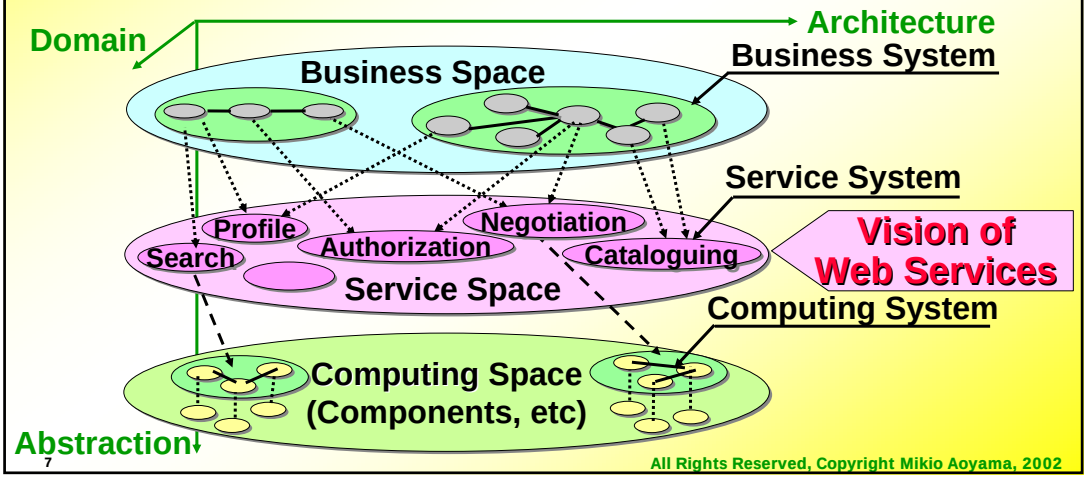
- Limitations with Distributed Object Environment [CORBA, DCOM, JavaRMI]
  - Client/Server Architecture
    - Closed Network Model: Clients Know the Server
    - Tightly Couples with State-full Model
  - Interoperability across Different Platforms
    - Similar but Different Protocol
  - Collaboration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

⇒ Interoperability at Higher Level ⇒ "Service"

Vision: Software over the Web
(My) Vision of Services

Business-Service-Computing Model

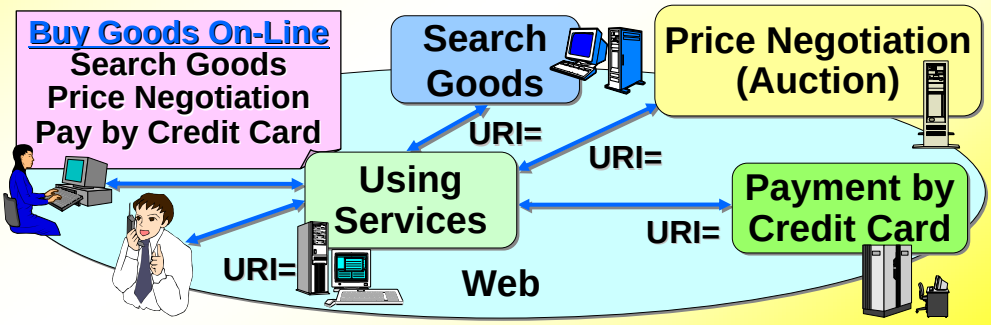
- Platform Independence ⇨ Productivity, Interoperability
- Business-Model Independence ⇨ Requirements, Evolution/Agility



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



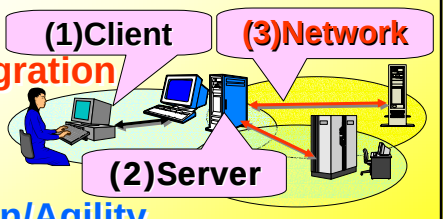
*Reference: *Web Services: Taking e-business to the Next Level*, White Paper, IBM, 2000, http://www-3.ibm.com/services/uddi/papers/e-businessj.pdf

Vision: Software over the Web
Business/Social Rationale

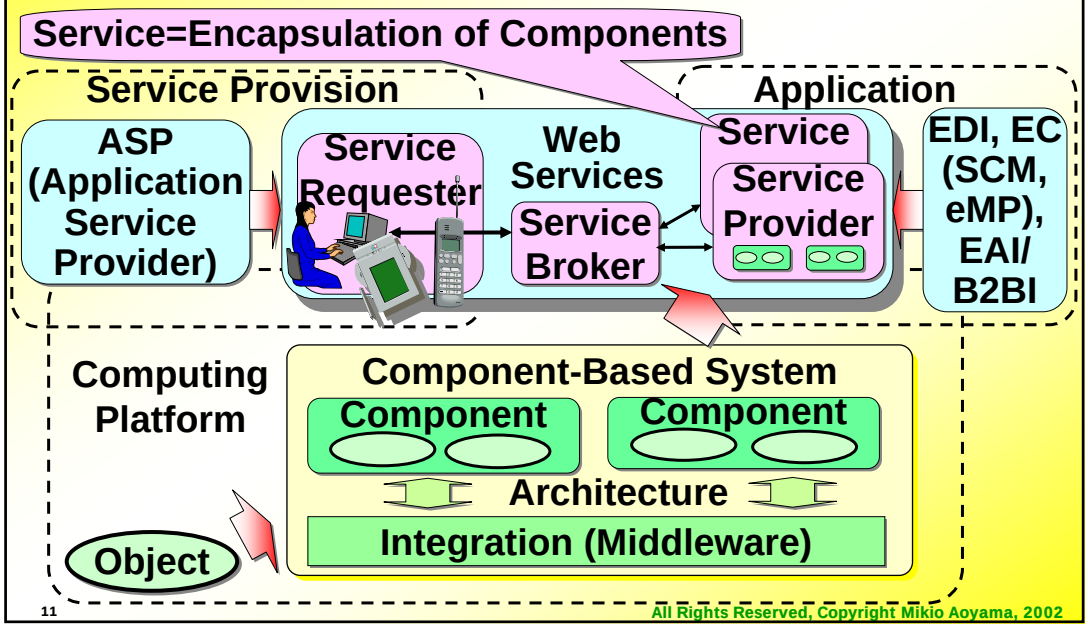
- Single Common Ground
  - IBM, Microsoft, Sun, Oracle, …

Vision: Software over the Web
Enabling Software Collaboration

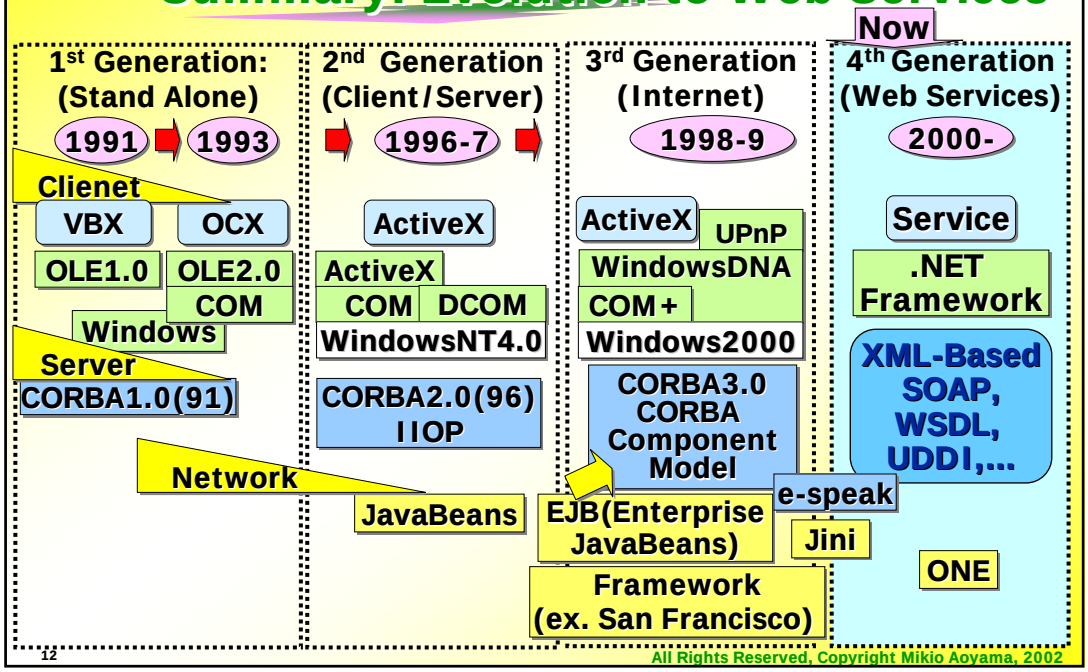
- (1)Client-Centric: Presentation Integration
  - GUI Component: COM/OLE, JavaBeans
  - Composition by GUI (Visual Development Environment)
    - Productivity and Intuitive Comprehension
- (2)Server-Centlic: Control and Data Integration
  - Transaction Processing/Business Rules: COM&MTS, J2EE/JTS
  - 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



Vision: Software over the Web
Summary: Evolution to Web Services



Scenario

Vision: Software over the Web

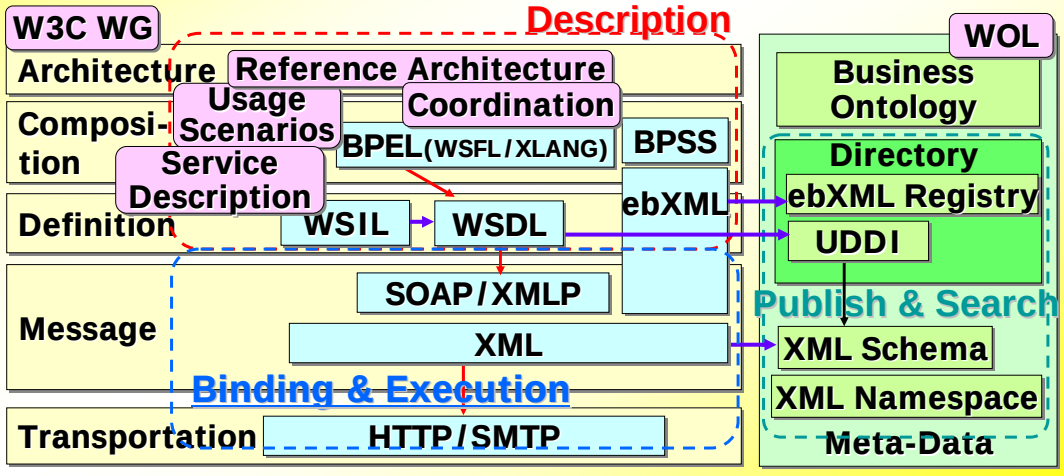
Technology: Status of Web Services

Engineering: Web Services Engineering

Research Challenges

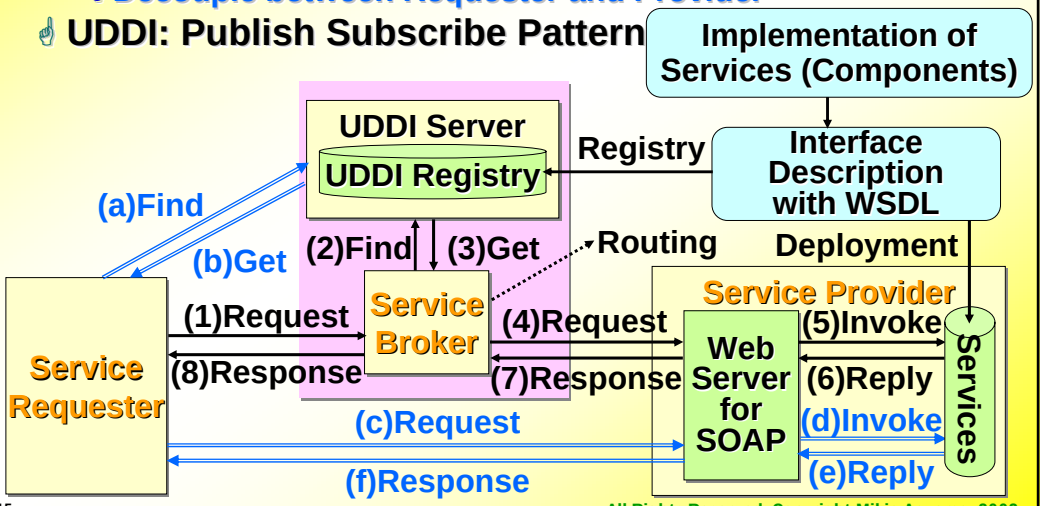
Technology: Status of Web Services
Web Services Platform

- XML-Based Service Enabling Platform
  - 3 Major Technology Stacks
  - Description, Publish & Search, Binding & Execution



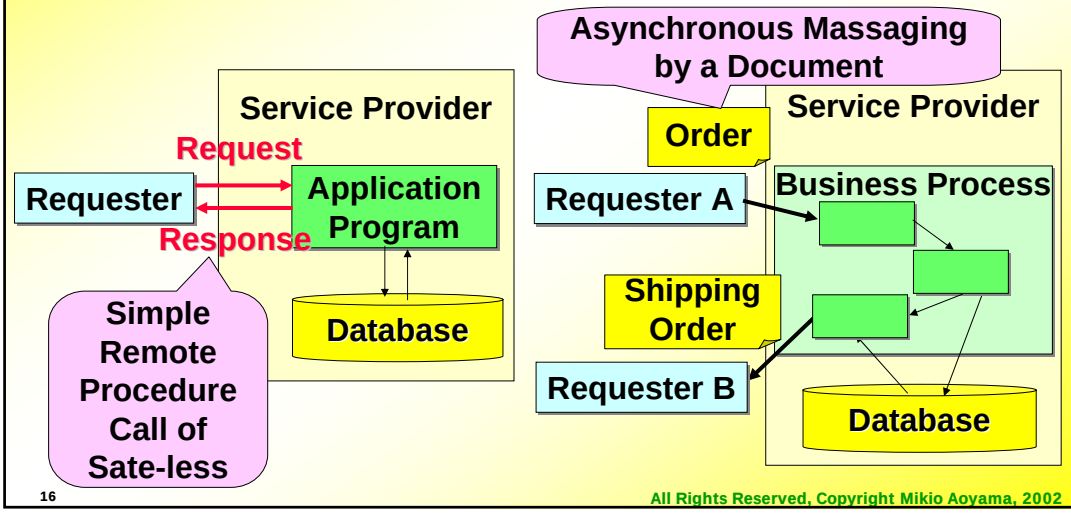
Technology: Status of Web Services Architecture

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



Technology: Status of Web Services SOAP Messaging Models

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



Scenario

Vision: Software over the Web

Technology: Status of Web Services

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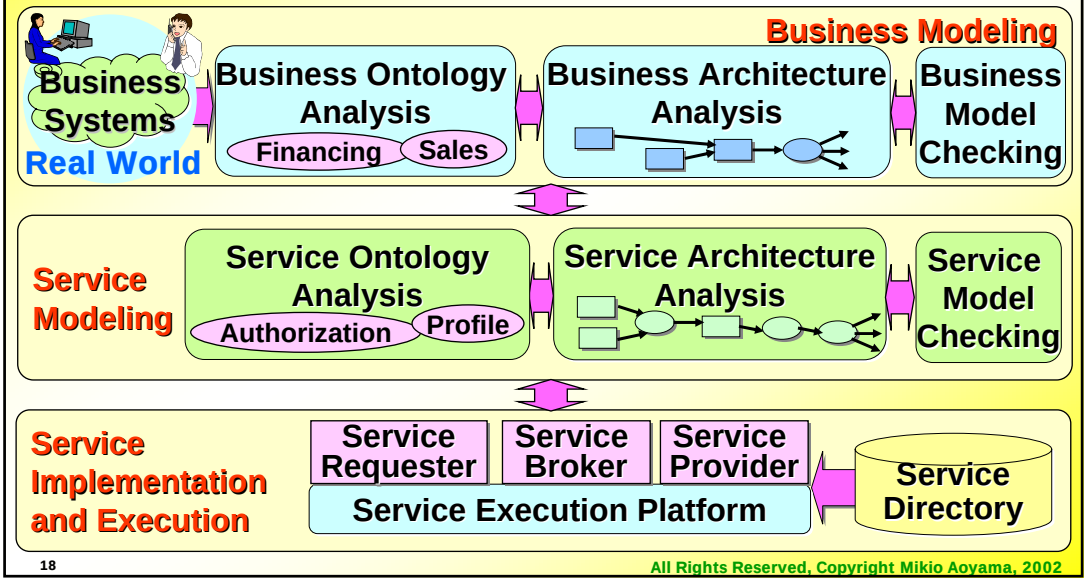
Research Challenges

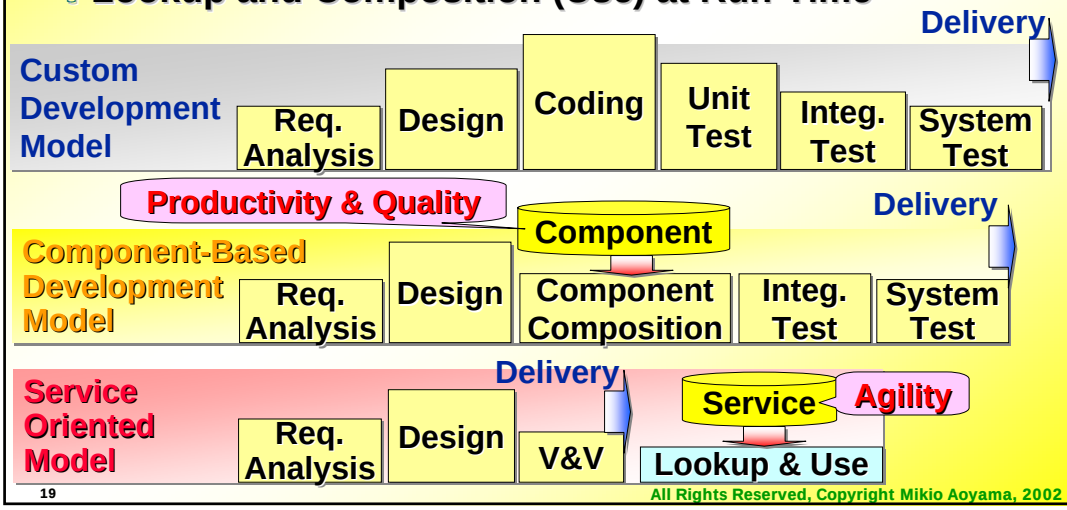
Engineering: Web Services Engineering
Web Services Engineering Process

☞Bridging the Gap between Business to Service

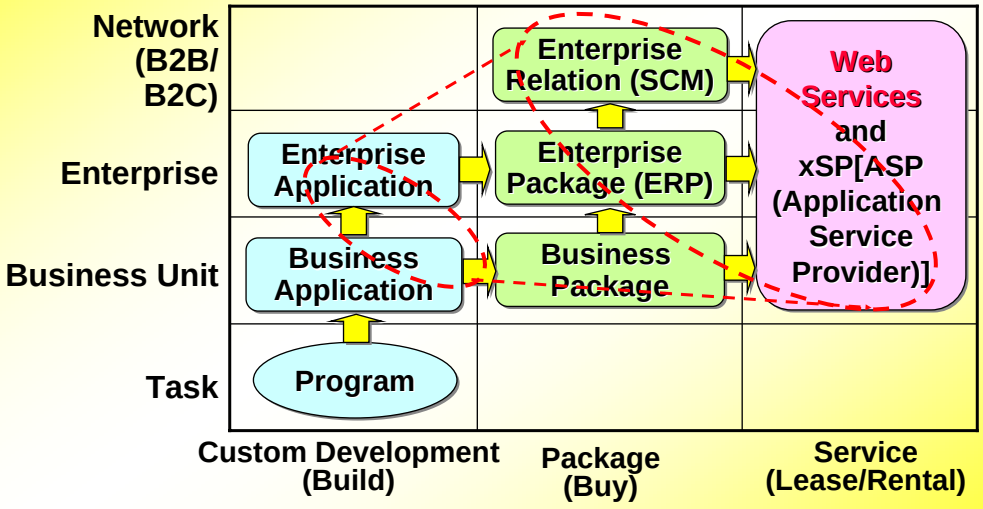


Engineering: Web Services Engineering
Changing the Software Process & Delivery

- From Coding to Component Composition to Dynamic Service Lookup & Use
  - Lookup and Composition (Use) at Run-Time

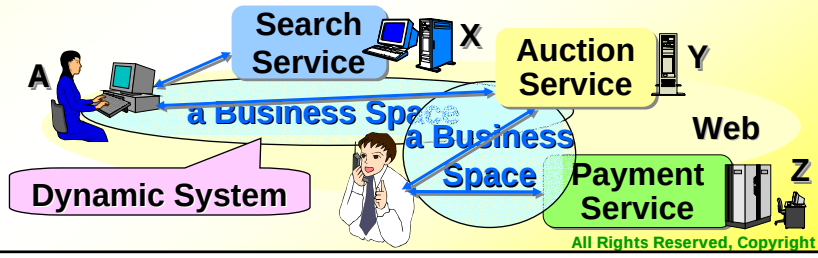


Engineering: Web Services Engineering
Changing Software Development / Deployment / Delivery



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

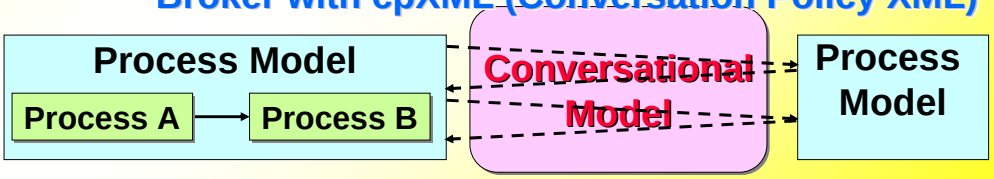


Engineering: Web Services Engineering
Business Process Modeling Languages

- 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

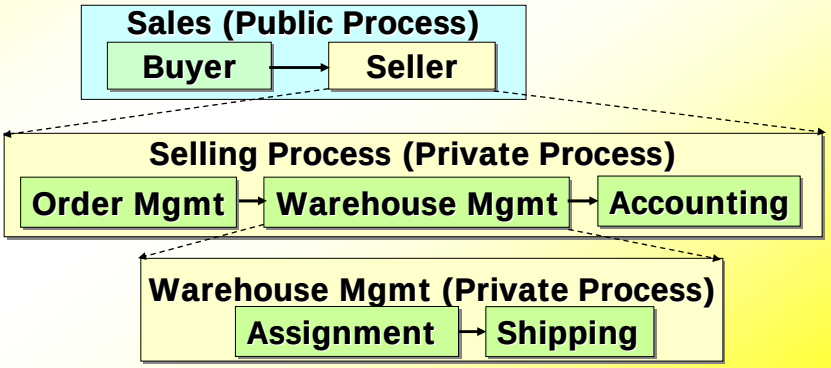
Engineering: Web Services Engineering Underlying Models for BPM Language

- Process Model and Conversational Model
  - Process Model: Workflow in a Organization for Control the Process Enaction
    - Ex: BPEL(4WS)[WSFL, XLANG], BPML
  - Conversational Model: Interaction Protocol among the Organizations for Dynamic B2B Integration
    - Ex: Ninja (忍者) Gateway and Ninja Process Broker with cpXML (Conversation Policy XML)



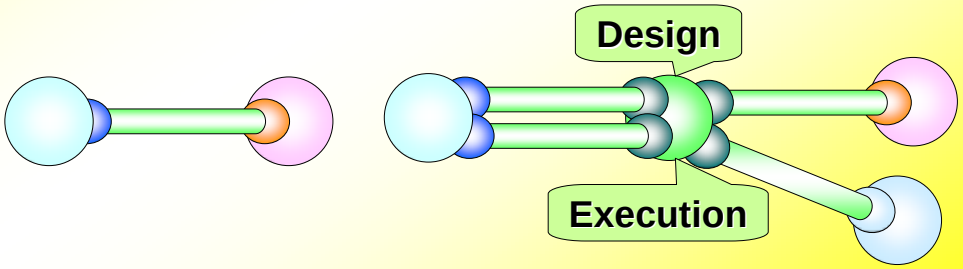
Engineering: Web Services Engineering Encapsulation and Modularization

- 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



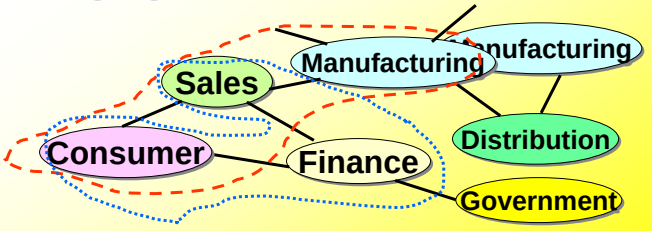
Engineering: Web Services Engineering
Broker is the Key Player

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



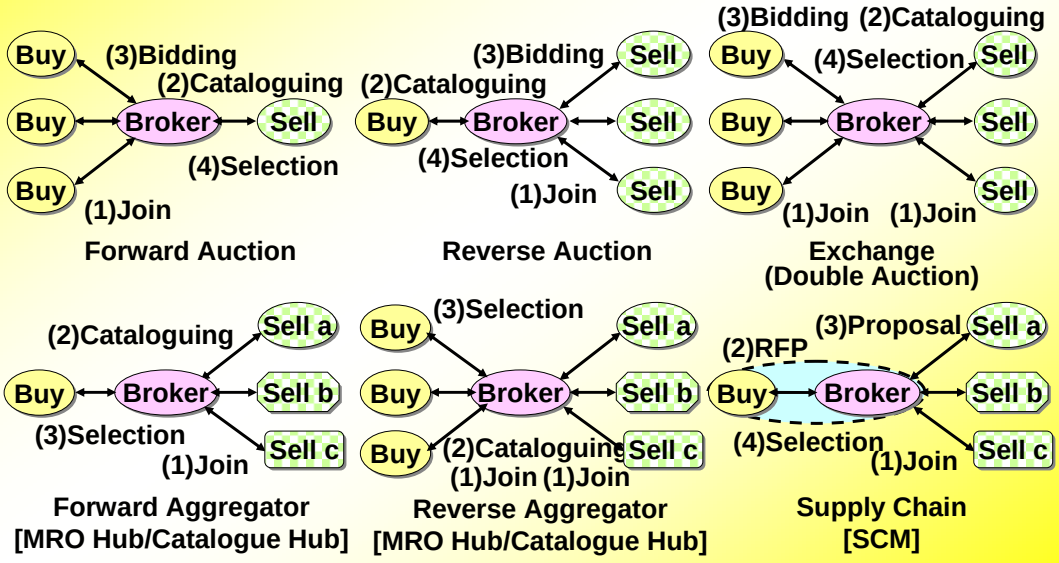
Engineering: Web Services Engineering
Dynamic e-Business by Collaborating Brokers

- 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



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

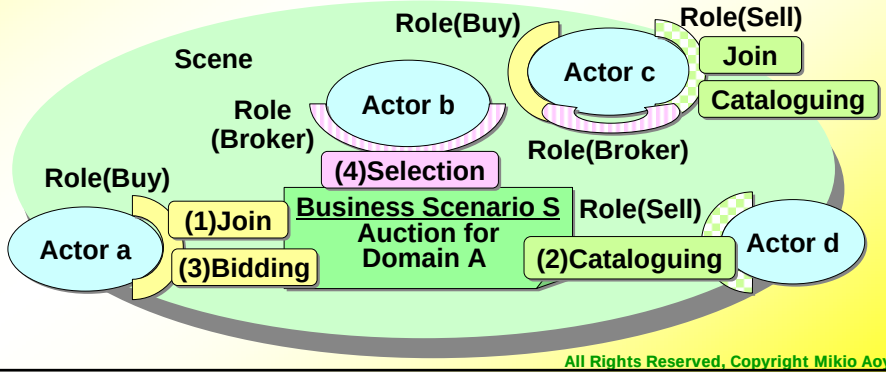
Engineering: Web Services Engineering Drama(tic) Model

- 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

Reference: M. Aoyama, A Business-Driven Web Service Creation Methodology, *Proc. WebSE 2002 (International Workshop on Web Services Engineering) in Proc. IEEE/IPSJ SAINT 2002 (2002 Symposium on Applications and the Internet),* Feb. 2002, Nara, pp. 225-228.

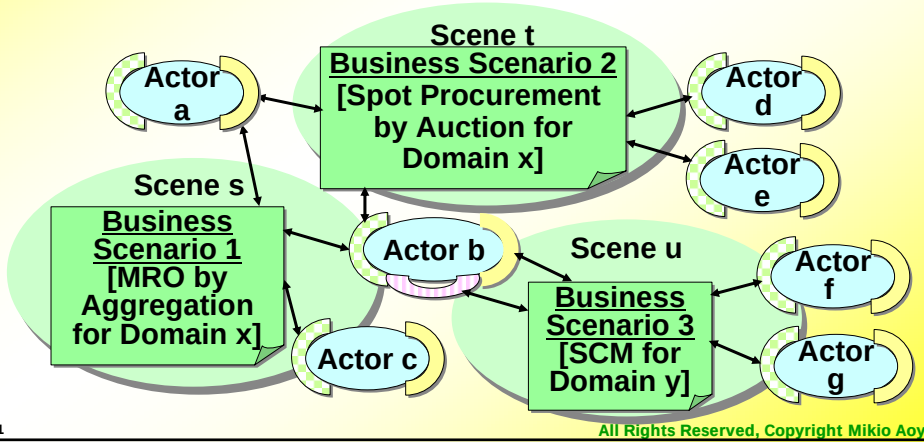
Engineering: Web Services Engineering Drama(tic) Model of e-Business

- 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



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

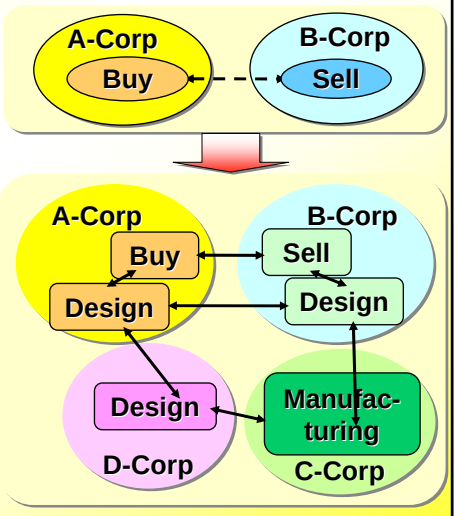
- New Frontier in Software Engineering
  - Process and Methodology
    - New Process for Development and Delivery
      - SOD (Service-On-Demand)?
      - Mapping Real-World (Business) to Web Services
    - Design and V&V of Dynamic Behavior
  - Modeling Networked Enterprises/Businesses
    - BPM Language 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

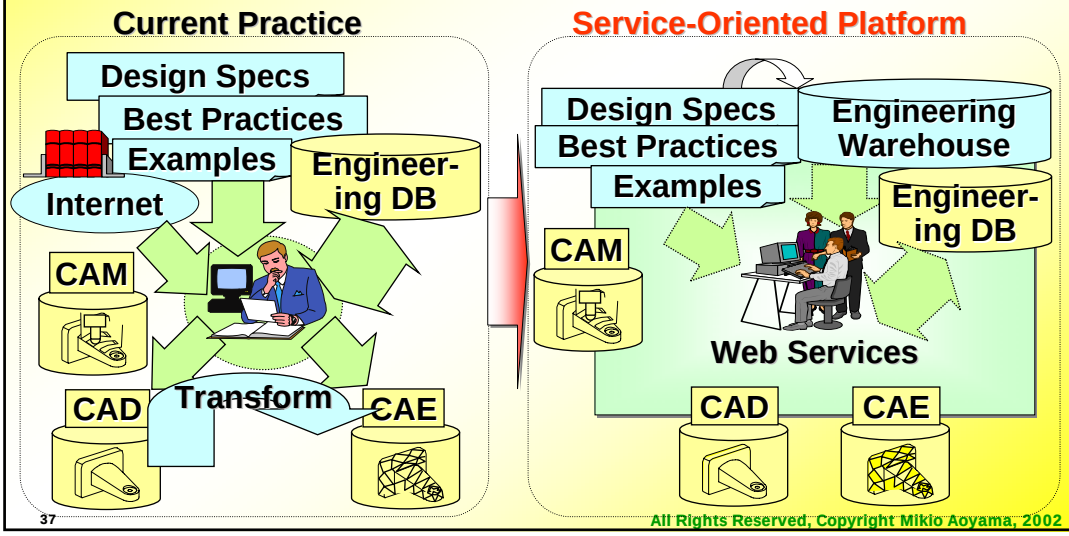
- Collaborative Enterprise
- New Model of "Corporation"
  - Re-thinking of Workplace
  - Selection of Core Business and Business Outsourcing
    - Outsourcing Business as Web Services
  - Social Implication?



Reference: J. Hagel III and J. S. Brown, Your Next IT Strategy, *Harvard Business Review*, Oct. 2001.

Research Challenges
Research Project for Manufacturing Aid

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



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