APNOMS 2005 Tutorial

Introduction to Service-Oriented Computing, Service-Oriented Architecture, and Service Management

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We are NISE: Network Information and Software Engineering

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Okinawa, Japan

Architecture of the Topics

6. Challenges of SOC/SOA/SOD

4. SOD (Service-Oriented Development)

Business Applications | 5. Service Management

3. SOA (Service-Oriented Architecture): Loosely-Coupled Architecture and Development Technologies on SOC

2. SOC (Service-Oriented Computing): Standard Platform Based on Web Services and Related Technologies

1. Where SOC/SOA Comes from

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Filling the Gap Between IT and Business

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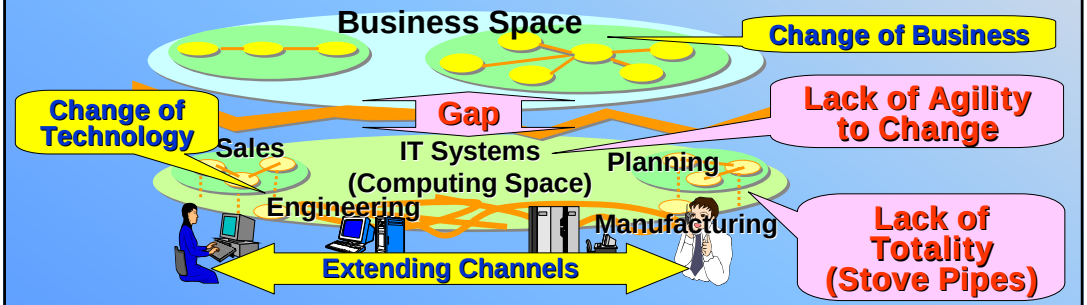
1. Where SOC/SOA Comes from

Where SOC/SOA Come from Challenges of Enterprise Systems

- **Widening the Gap Between IT and Businesses**
  - Increasing IT Spending and Unclear ROI (Return On Investment)
- **Lack of Total Optimization**
  - Many Packages for Partial Optimization and Increasing Comlexity
- **Lack of Agility to Change**
  - Change of Business Model/Process, Creating New Business
  - Change of Technology: Platform and Engineering
  - Extending Channels: PC Client, Web, B2B, Mobile



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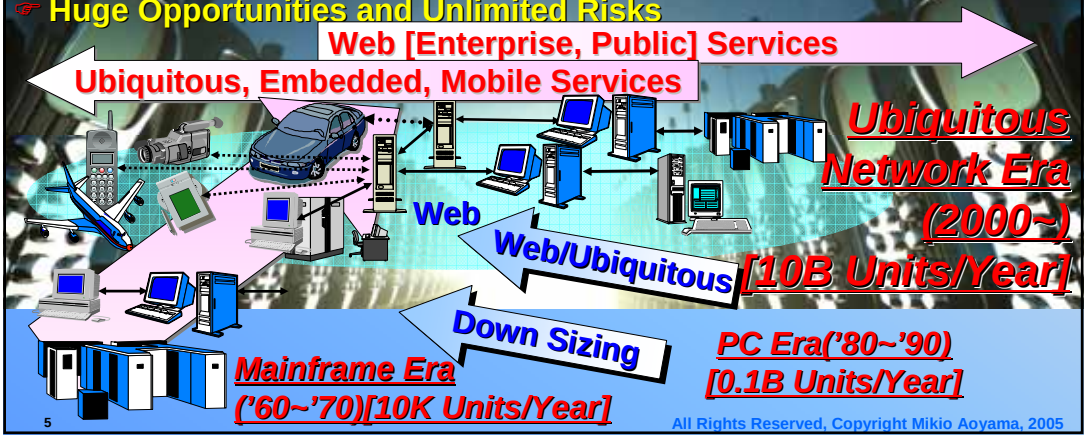
Where SOC/SOA Come from Emerging Embedded/Ubiquitous & Network

- Networked from Embedded/Ubiquitous to Enterprise
  - Diverse/Dense Software "Seamlessly" Connected Everywhere
  - Two Faces of Software: Products and Services (Mobile Phones with e-Wallet)
- 3rd Wave of Software Evolution or Crisis?
  - Huge Demands to Embedded/Ubiquitous Software
  - Most Embedded Developers are NOT Software Engineering Professionals
- Huge Opportunities and Unlimited Risks



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Where SOC/SOA Come from Challenges of Networked Enterprise Software

- Evolution onto Open and Decentralized Network
  - Web is Boundary-less, Center-less
  - Evolution is Dynamic, and (Locally) Autonomic
- From System to System-of-Systems
  - End-to-End within/across Different Organizations with Different Platforms and Architectures
    - Integration Nightmare of Spaghetti Systems
  - Interoperability/Collaboration
    - Program Interface: OS, Languages, Middleware
    - Semantics of Data: Ontology (Vocabulary, Relationship), Data Structure, Languages, Encoding

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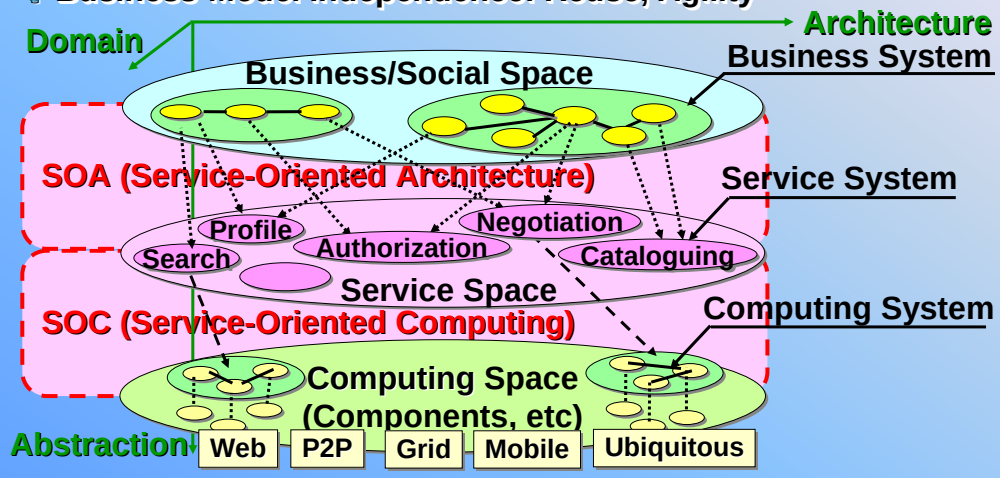
Where SOC/SOA Come from SOC and SOA

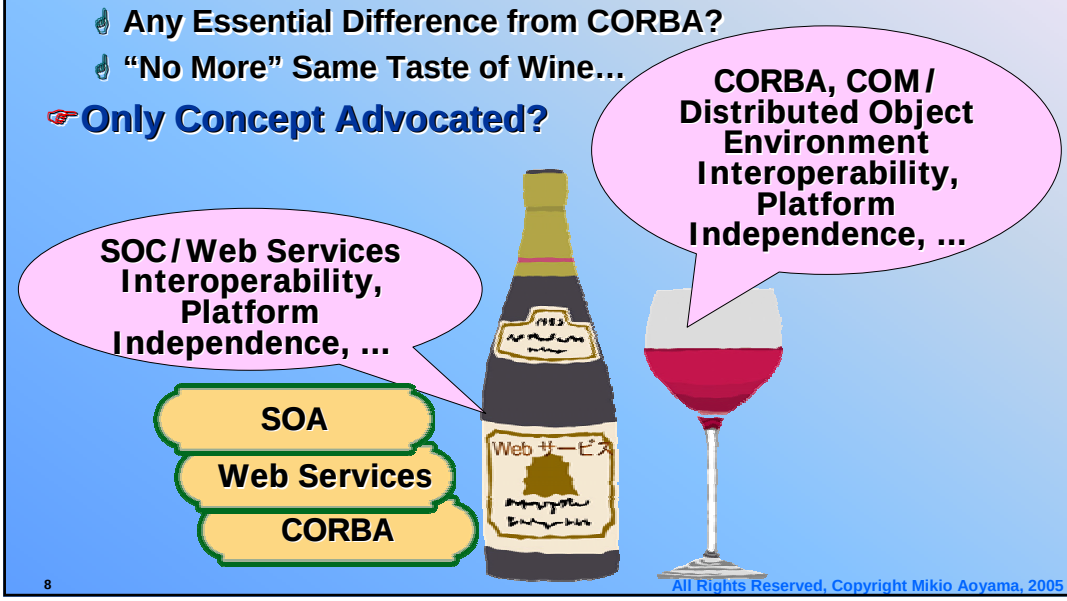
- Business/Society-Service-Computing Model
  - Platform Independence: Productivity, Interoperability/Channels
  - Business-Model Independence: Reuse, Agility



References: M. Aoyama, Web Services Engineering, *Engineering Information Systems in the Internet Context,* Kluwer Academic, Sep. 2002, pp. 1-8.

Where SOC/SOA Come from Old Wine in New Bottles?

- SOC/SOA Are NOT New?: Any Essential Change
  - Any Essential Difference from CORBA?
  - "No More" Same Taste of Wine…
- Only Concept Advocated?



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Where SOC/SOA Come from Lessons from DOEs' Mistakes

DOE, EAI/MOM

- Targeted, but Unable to Realize
  - True Interoperability, Platform Independence

Multiple Standards (CORBA, COM) → SOC (Service-Oriented Computing): Unified Computing Platform

- New Environmental Changes
  - Web, Business Integration, On-Demand Business

Evolution of SOC Created Basis for SOA

Architectural Miss-match between Client/Server and Web → SOA (Service-Oriented Architecture): New Architecture for Web/ Loosely Coupled Computing

DOE: Distributed Object Environment
EAI: Enterprise Application Integration, MOM: Message-Oriented Middleware
CORBA: Common Object Request Broker Architecture, COM: Component Object Model

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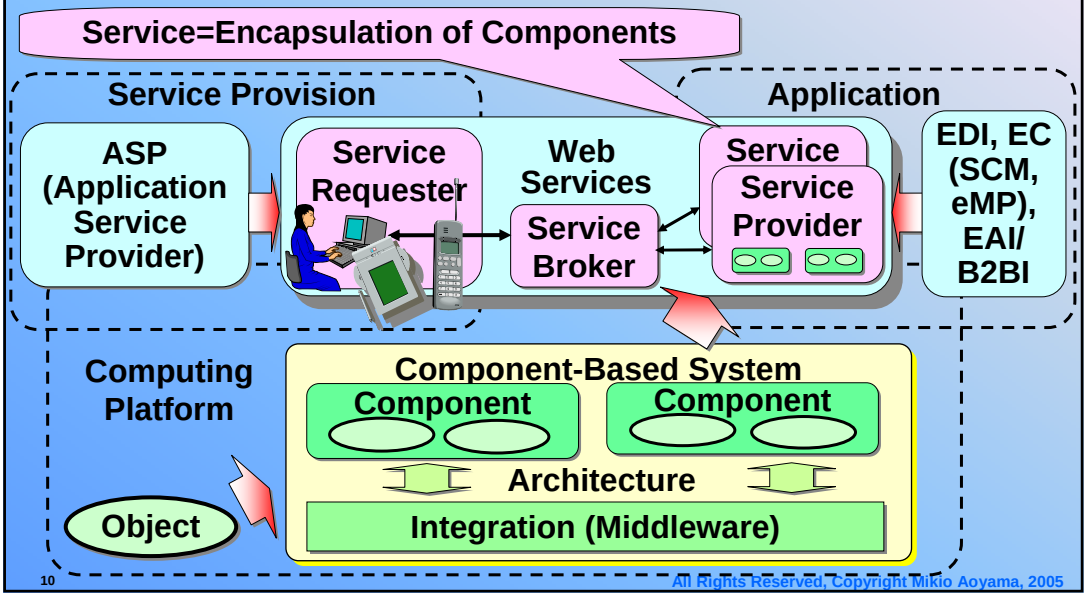
Where SOC/SOA Come from From Object/Component to Web Services

- 3 Driving Forces: Component, ASP, e-Business



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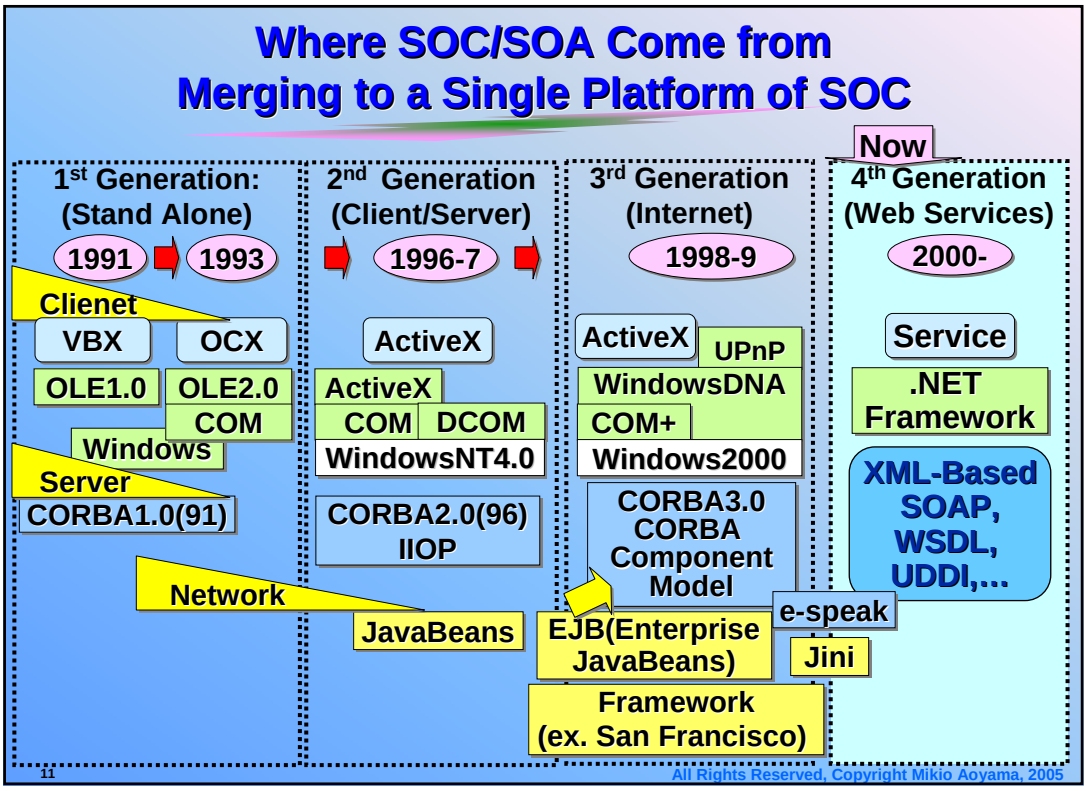
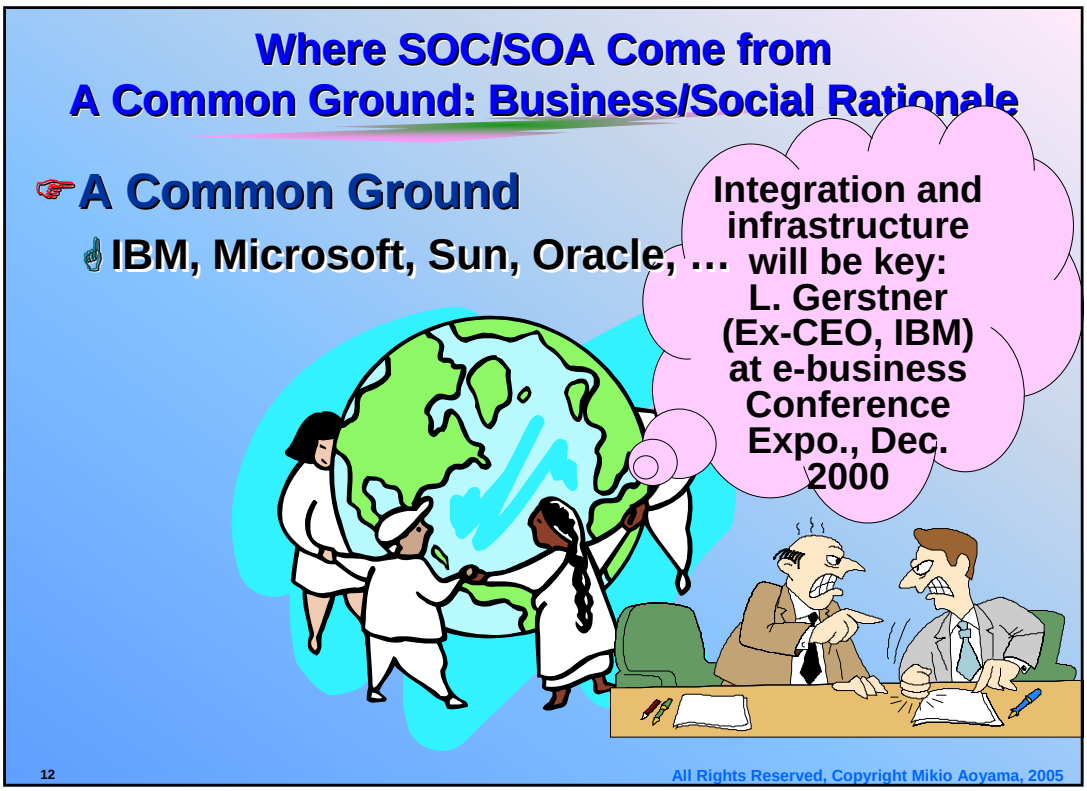
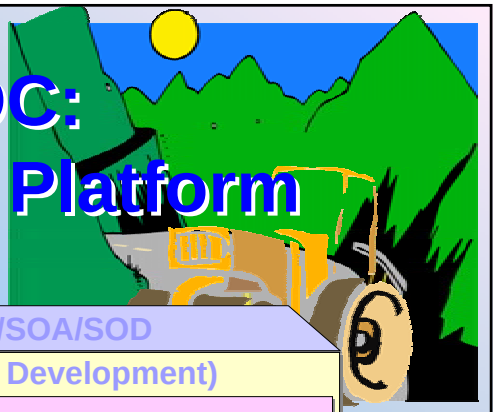




2. SOC: A Common Platform



6. Challenges of SOC/SOA/SOD

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2. SOC (Service-Oriented Computing): Standard Platform Based on Web Services and Related Technologies

1. Where SOC/SOA Comes from

SOC: A Common Platform Services and Web Services

- Definition of Service
  - A service is a set of functions accessible via a prescribed interface
- Definition of Service [D. Nickull, An Introduction to the OASIS Reference Model for Service-Oriented Architecture (SOA), OASIS SOA Reference Model TC, http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=soa-rm]
  - A service is a set of behaviors accessible via a prescribed interface

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SOC: A Common Platform
Services and Web Services

- Definition of Web Services [D. Booth, et al., W3C Web Services Architecture, W3C Working Group Note 11 February 2004, http://www.w3.org/TR/ws-arch/]
  - A Web service is a software system designed to support *interoperable machine-to-machine interaction over a network*.
  - It has an interface described in a machine-processable format (specifically WSDL).
  - Other systems interact with the Web service in a manner prescribed by its description using SOAP messages, typically conveyed using HTTP with an XML serialization in conjunction with other Web-related standards.

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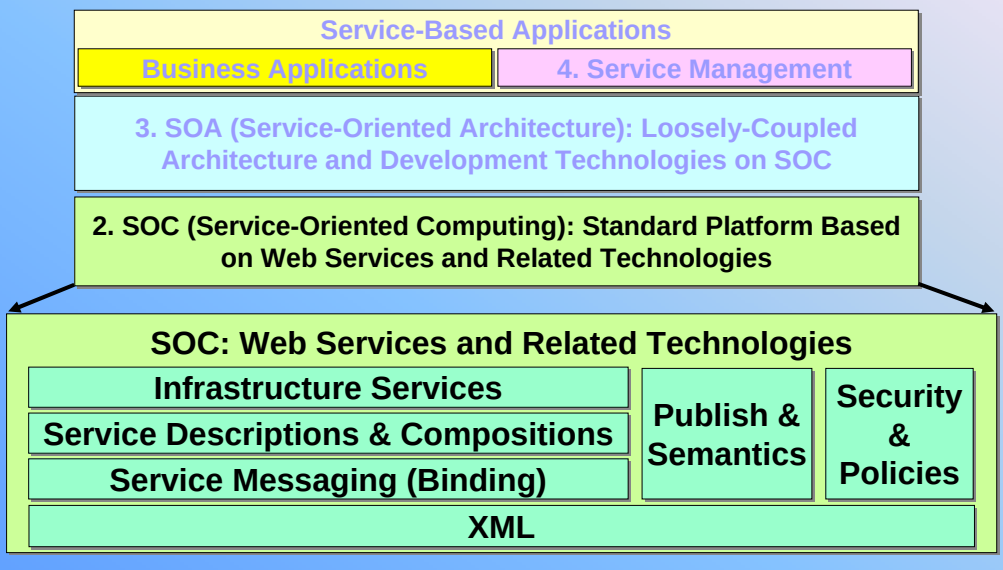
SOC: A Common Platform
Web Services and Related Technologies

- Web Services are Core SOC Technology



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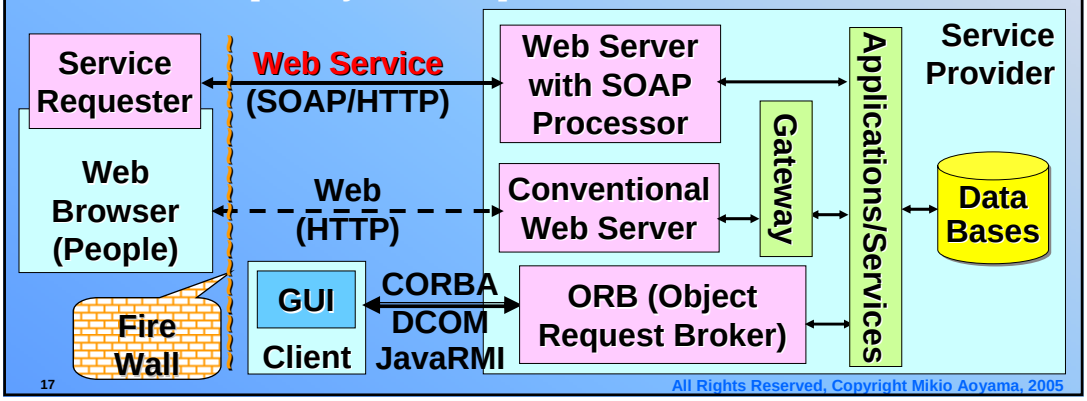
SOC: A Common Platform
Web Services, Web and DOE

- Difference in Interoperability
  - Web Services: Interoperability among Computers across Firewall [over HTTP]
  - Web: Web Access by People across Firewall [over HTTP]
  - Distributed Object Environment (CORBA/DCOM): Interoperability among Client/Server Computers inside Firewall [Binary Protocol]



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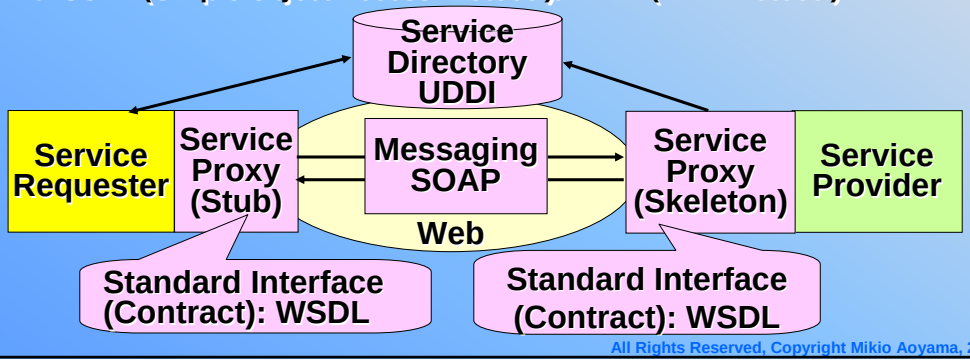
SOC: A Common Platform
Web Services: 3 Core Technologies

- Service Description: Standard Interface Definition Language
  - WSDL (Web Services Description Language
- Publish and Discovery: Directory of Service Interfaces and Attributes
  - UDDI (Universal Description, Discovery, and Integration)
- Messaging and Binding: Standard Messaging Format for Service Invocation
  - SOAP (Simple Object Access Protocol)/ XMLP (XML Protocol)



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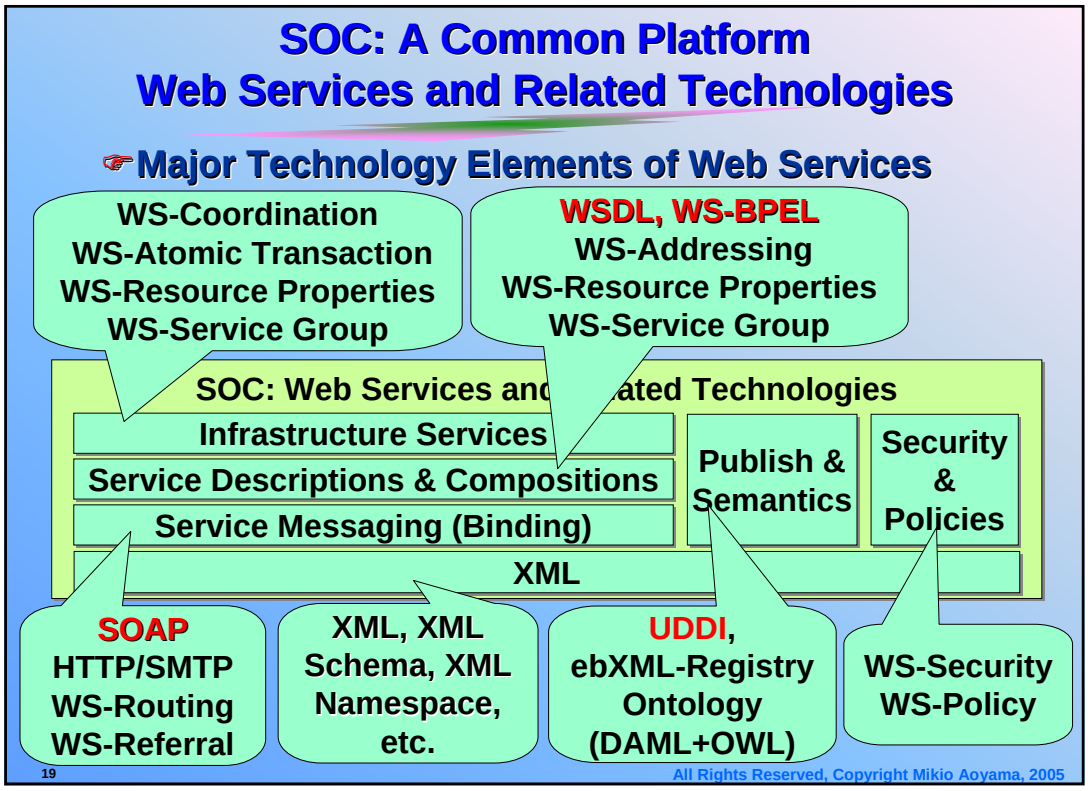

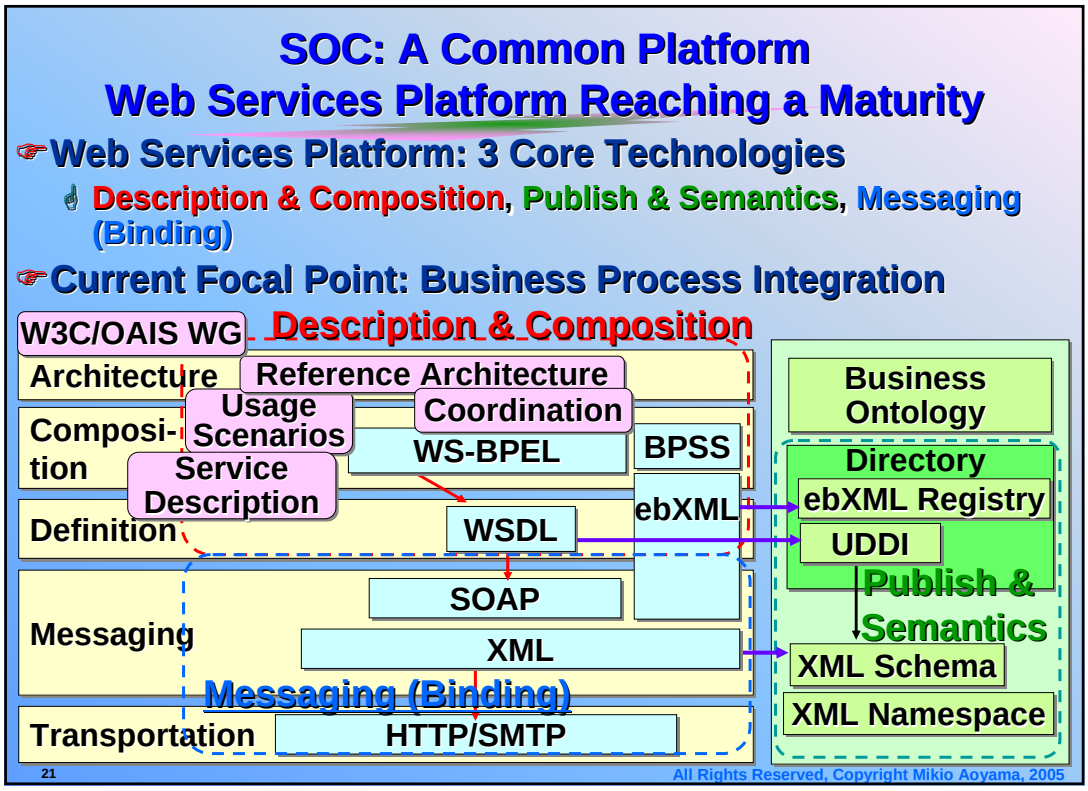

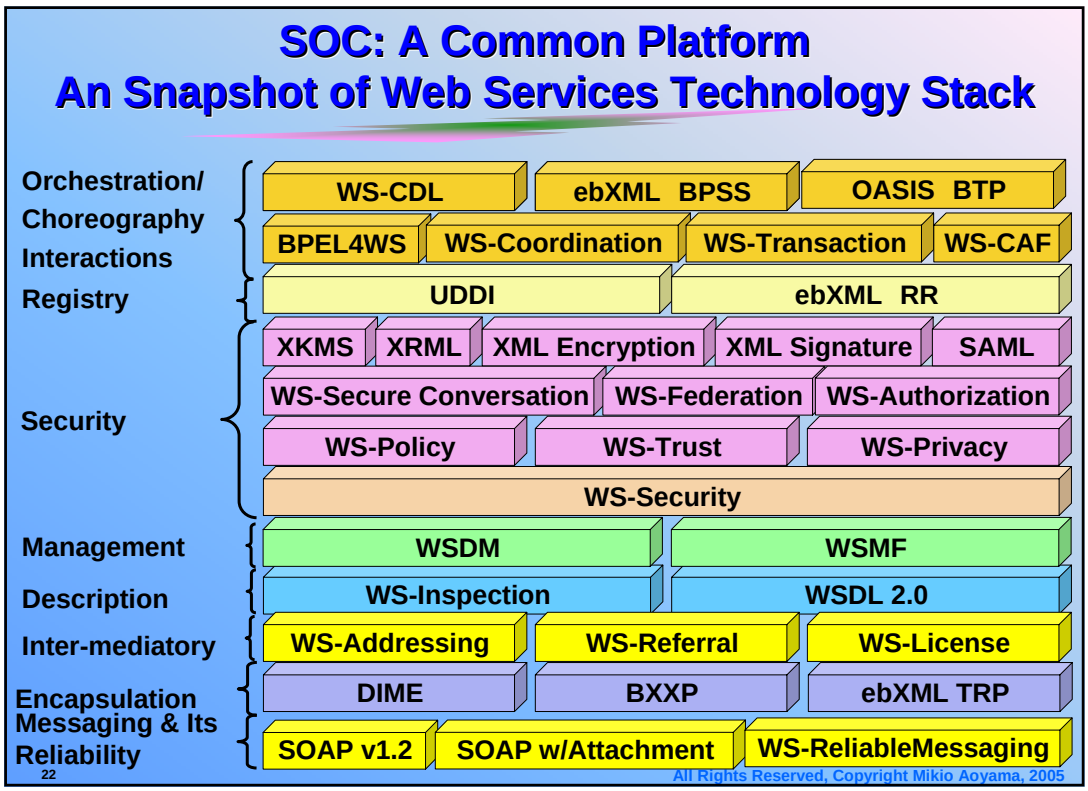

SOC: A Common Platform
Some Notable Standards: Evolution and Status

Technology	Description	Developers	Standardization
SOAP/ XMLP	Light-weight messaging protocol	Developmentor, Microsoft, et al.	W3C: V1.1 (Apr. 2000), V1.2 WD (Jul. 2001)
WSDL	Interface definition language for Web services	IBM, Microsoft (Sep. 2000)	W3C: V1.1 (Mar. 2001), V1.2 (WD, Jun. 2003), V. 2.0 (WD, May 2005)
UDDI	APIs for Service directory	BEA, IBM, Microsoft, (Jul. 2002)	UDDI Initiative (Ariba, IBM, Microsoft, et al.), V1(Sep. 2000), V2(Jun. 2001), Service-in (May 2001), OASIS V3 (Feb. 2005)
WS-BPEL (BPEL4WS)	Language for describing service composition	IBM, Microsoft (Aug. 2002)	V1.0 (Aug. 2002), V1.1 (May 2003), Submitted to OASIS TC,V2.0 (WD, May 2005)
WSDM	APIs for managing systems and Web services	BEA, Fujitsu, HP, Hitachi, IBM, SAP, et al.	OASIS V1.0 (Mar. 2005)

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SOC: A Common Platform
Some Notable Standards: Specifications

Technology	Organization	Reference URL
XML	W3C XML Specification	http://www.w3.org/XML/
XML Schema	W3C XML Schema	http://www.w3.org/XML/Schema
SOAP/XMLP	W3C XML Protocol Working Group	WG Webpage with Specifications: http://www.w3.org/2000/xp/Group/
WSDL	Web Services Description Working Group	WG Webpage with Specifications: http://www.w3.org/2002/ws/desc/
UDDI	OASIS UDDI Specification Technical Committee	UDDI V 3.0 Specification: http://uddi.org/pubs/uddi_v3.htm
WS-BPEL (BPEL4WS)	OASIS Web Services Business Process Execution Language (WSBPEL) TC	TC Webpage: http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=wsbpel
WSDM	OASIS Web Services Distributed Management (WSDM) TC	TC Webpage with Specifications: http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=wsdm

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SOC: A Common Platform
A Brief Review of XML

- Student Directory in HTML and XML

```
<html> <head>
<Title> 学生名簿 </Title>
</head>
<body>
<h1> 鈴木一郎 </h1>
<h2>学生番号:2000IT001</h2>
<p>TEL: 0561-89-2011</p>
<p>FAX: 0561-89-2012</p>
</body> </html>
```


```
<?xml version="1.0" encoding="Shift_JIS"?>
<?xml-stylesheet type="text/xsl" href="StudentDirectory.xsl" ?>
<StudentDirectory>
  <Name Pronounce="すずきいちろう">鈴木一郎</Name>
  <StudentID>2000IT001</StudentID>
  <TEL>0561-89-2011</TEL>
  <FAX>0561-89-2012</FAX>
</StudentDirectory>
```

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SOC: A Common Platform
A Brief Review of XML

- Separation of Information (Model) and its Presentation (View)
  - Presentation is Defined by XSL (eXtensible Style Language)

StudentDirectory.xsl

```
<?xml version="1.0" encoding="Shift_JIS" ?>
<xsl:stylesheet xmlns:xsl="http://www.w3.org/TR/WD-xsl">
<xsl:template match="/">
<html>
<head><title>StudentDirectory</title></head>
<body>
<h1><xsl:value-of select="StudentDirectory/Name" /></h1>
<h2><xsl:value-of select="StudentDirectory/StudentID" /></h2>
<p>TEL:<xsl:value-of select="StudentDirectory/TEL" /></p>
<p>FAX:<xsl:value-of select="StudentDirectory/FAX" /></p>
</body>
</html>
</xsl:template>
</xsl:stylesheet>
```

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SOC: A Common Platform
A Brief Review of XML

- XML (eXtensibel Markup Language)
  - XML is Not a Language, but a Meta-language to Define New Languages (i.e Extensible)
  - XML is Text-Based and Platform Independent
  - XML is a de facto Format for Data Interchange on the Web
- XML Schema
  - "Self-Descriptive" Definition of XML Document Structure
  - Definition of Element Types
    - Built in Data Types
    - User Definable

```
<element name="Book" type="BookType" />
<complexType name="BookType">
  <element name="Title" type="string" />
  <element name="Author" type="string" />
</complexType>
```

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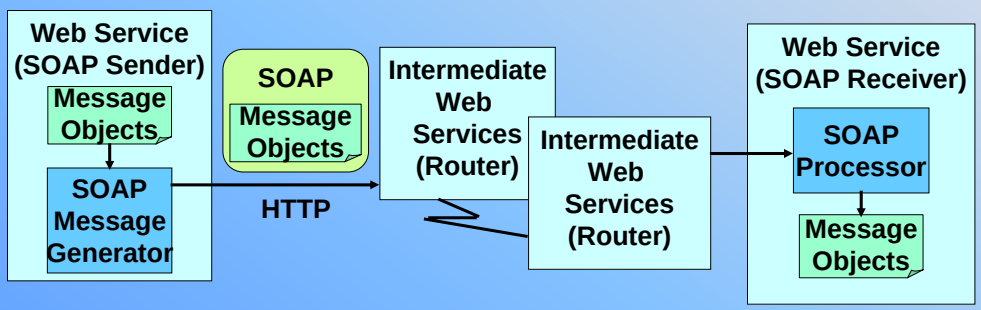
SOC: A Common Platform
SOAP: Communication Model

- SOAP (Used be Acronym of "Simple Object Access Protocol", but No Longer be)
  - SOAP is Messaging Protocol (Envelopes) between Applications/Web Services
  - MEP (Message Exchange Pattern): One-Way



References: XML Protocol WG, http://www.w3.org/2000/xp/Group/.
N. Mitra (ed.), SOAP Version 1.2 Part 0: Primer, W3C Recommendation, Jun. 2003, http://www.w3.org/TR/soap12-part0/

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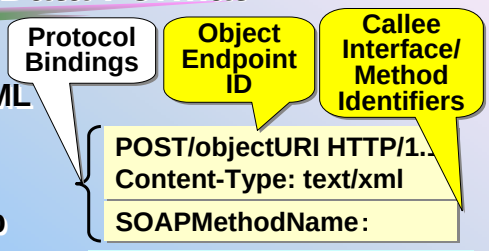
SOC: A Common Platform
SOAP: Protocol Data Format

- SOAP Protocol Data Format
  - Extensible Envelop Based on XML
- SOAP Elements
  - SOAP Message = Protocol Binding Header + SOAP Envelop
  - Protocol Binding Header: Specifying the Transport Protocol for each Hop: HTTP, SMTP, …
  - SOAP Envelope= SOAP Header + SOAP Body
  - SOAP Header: Control Information on the SOAP Body, e.g. Routing, Security, …
    - Extensions for Content-Based
  - SOAP Body: Message Body to the SOAP Receiver



<Envelope>
<Header>
Header Block 1
.....
Header Block N
</Header>
<Body>
Body Element 1
.....
Body element M
</Body>

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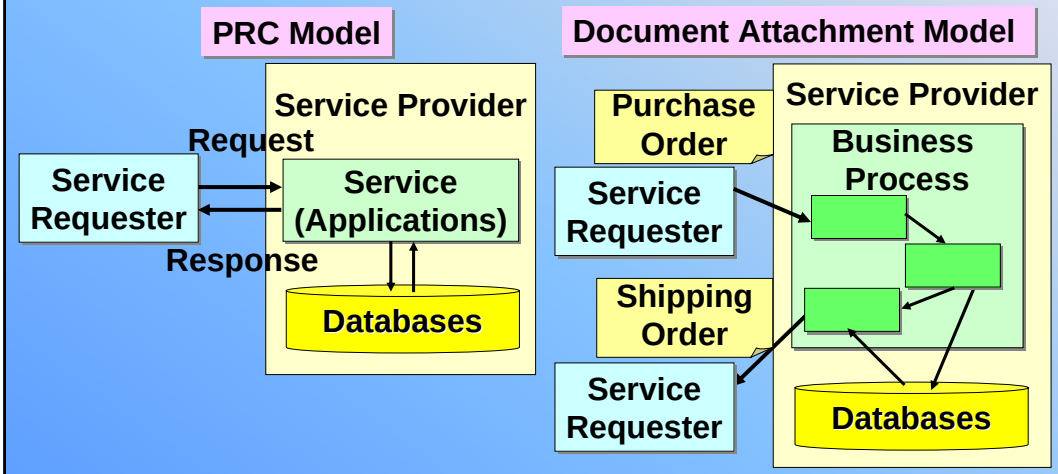
SOC: A Common Platform
SOAP: 2 Messaging Models

- 2 Messaging Models of SOAP
  - Remote Procedure Call (RPC): Synchronous Messaging
  - Documented Attachment: Asynchronous Messaging



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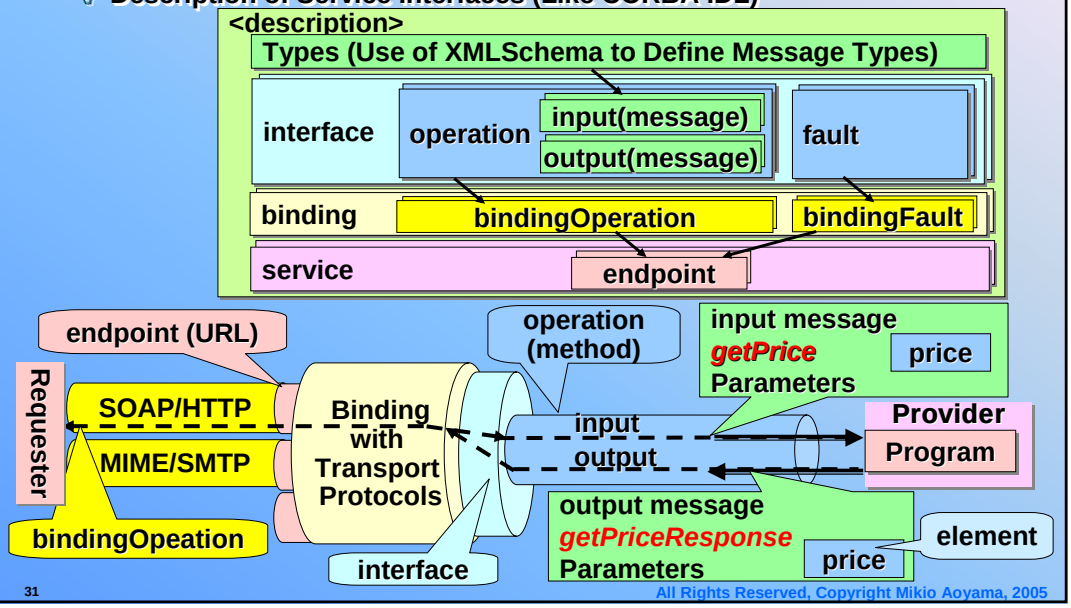
SOC: A Common Platform
WSDL: Interface Model

- WSDL(Web Services Description Language) v 2.0
  - Description of Service Interfaces (Like CORBA IDL)



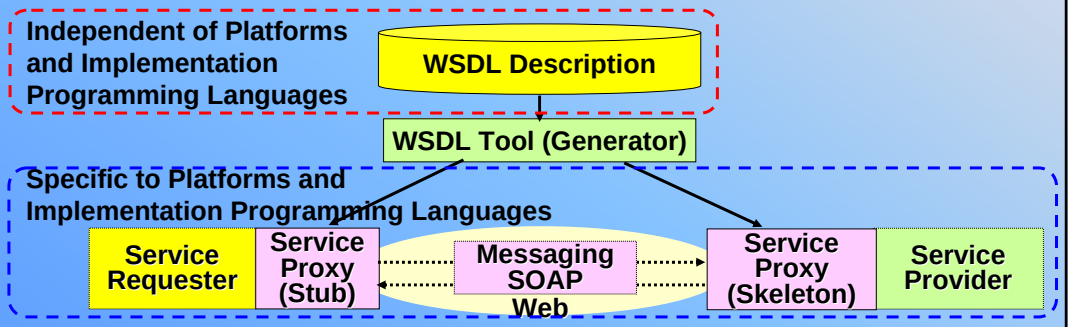
SOC: A Common Platform
WSDL: Interface Syntax

```
<?xml version="1.0" encoding="utf-8" ?>
<description
   xmlns="http://www.w3.org/2005/08/wsdl“   … >
 . . .
 <types>                                              types定義
   <xs:schema xmlns="http://www.w3.org/2001/XMLSchema“>  …  </xs:schema>
 </types>
<interface name="retrieveDetailsInterface">           interface定義
   <operation name="retrieve“ pattern="http://www.w3.org/2005/08/wsdl/in-out"> …
 </interface>
 <binding name="reservationSOAPBinding"
        interface="tns:reservationInterface“          . . . >   binding定義
   . . .
 </binding>
 <service name="reservationService"
     interface="tns:reservationInterface">            service定義
   <endpoint name="reservationEndpoint"
          binding="tns:reservationSOAPBinding"
          address ="http://greath.example.com/2004/reservation"/>
 </service>
</description>
```

References: Web Services Description Language (WSDL) Version 2.0 Part 0: Prime, W3C, Aug. 2005.

SOC: A Common Platform
WSDL: Usage Model at Design Time

- Design Time
  - WSDL Description is Used for Generating Service Proxies
  - Describe Services':
    - Functionality (What) in <interface>
    - Interaction (Binding) in <binding>: Ex.: SOAP binding
    - Location of Provision (Endpoint) in <endpoint>



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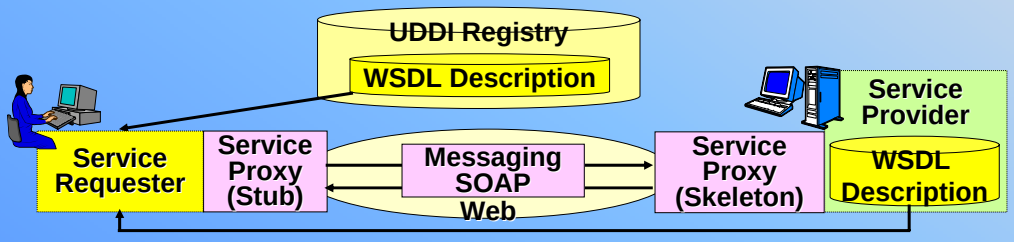
SOC: A Common Platform
WSDL: Usage Model at Run Time

- 2 Usage Patterns of WSDL Description at Run Time
  - Get WSDL Description from UDDI Registry
  - Get WSDL Description from Service Provider
- Usage (at Present)
  - Binding and Endpoint Information for Messaging
- Dynamic Message Addressing with WS-Addressing
  - http://www.w3.org/Submission/ws-addressing/



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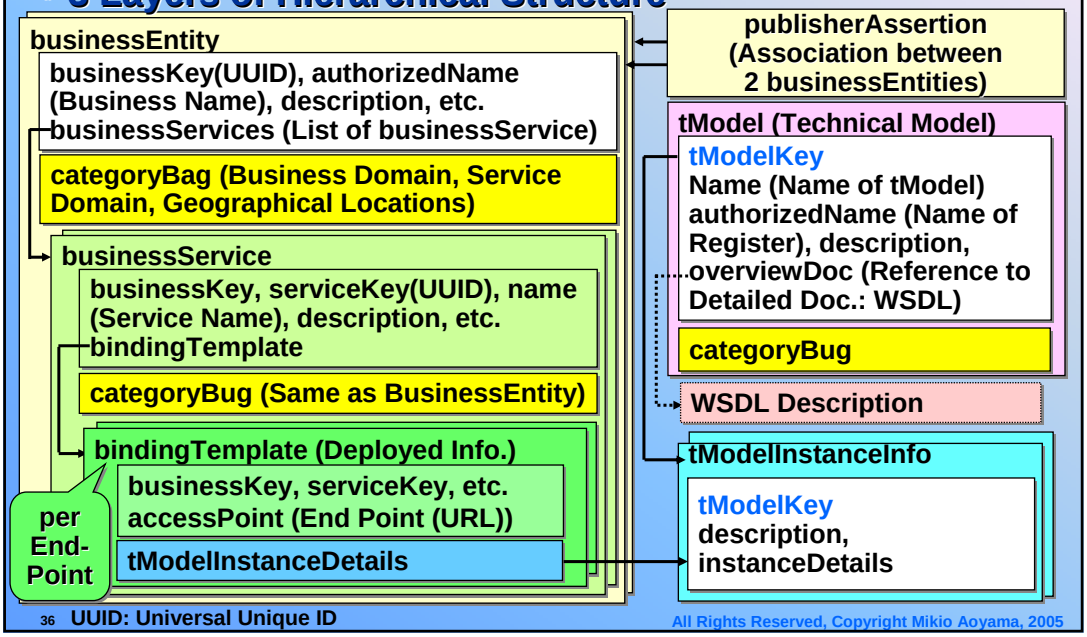
SOC: A Common Platform
UDDI: Overview

- UDDI(Universal Description, Discovery, and Integration)
  - Directory for Service Interfaces
- Functions of UDDI
  - Service Registration (Publish), Service Search (Find/Discovery)
- Usage of UDDI: Publish-Find-Bind Pattern (Same as DNS)
- Open Global UDDI Service
  - Sep. 2000: IBM, Microsoft, 2001: SAP Jointed,
  - Oct. 2002: NTT Communications for Asia-Pacific
- Standardization: OASIS UDDI Spec TC
  - Feb. 2005: V. 3.0 Approved as OASIS Standard
    - http://uddi.org/pubs/uddi_v3.htm
- Status of UDDI: Not Widely Accepted Yet

OASIS: Organization for the Advancement of Structured Information Standards

SOC: A Common Platform
UDDI: Directory Structure (v. 3.0)

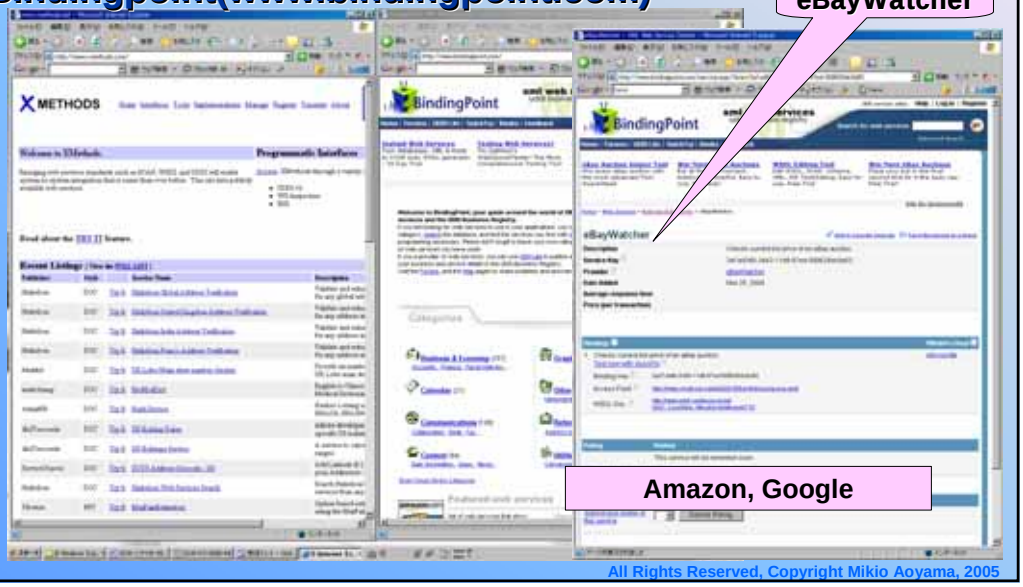
- 3 Layers of Hierarchical Structure



UUID: Universal Unique ID

SOC: A Common Platform
Examples of Web Services: Portals of Web Services

- Xmethods(www.xmethods.com)
- Bindingpoint(www.bindingpoint.com)



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SOC: A Common Platform
On-Demand Web Service Providers

- Salesforce.com [http://www.salesforce.com]
  - On-Demand CRM: On-Demand Service Provider of CRM & SFA
  - Number of Clients: 15,500[As of August 1, 2005 from the Web]
- RightNow Technologies [http://www.rightnow.com/]
  - On-Demand CRM
- CORIO [http://www.corio.com/] (Acquired by IBM in Mar. 2005)
  - On-Demand ERP (Enterprise Resource Planning), etc
- On-Demand Service Technologies
  - IBM: On Demand Operating Environment
    - http://www-306.ibm.com/software/info/ openenvironment/
  - Microsoft: DSI (Dynamic Systems Initiative)
    - www.microsoft.com/windowsserversystem/dsi/default.mspx
  - CISCO: AON (Application-Oriented Networking)
    - http://www.cisco.com/en/US/products/ps6455/index.html

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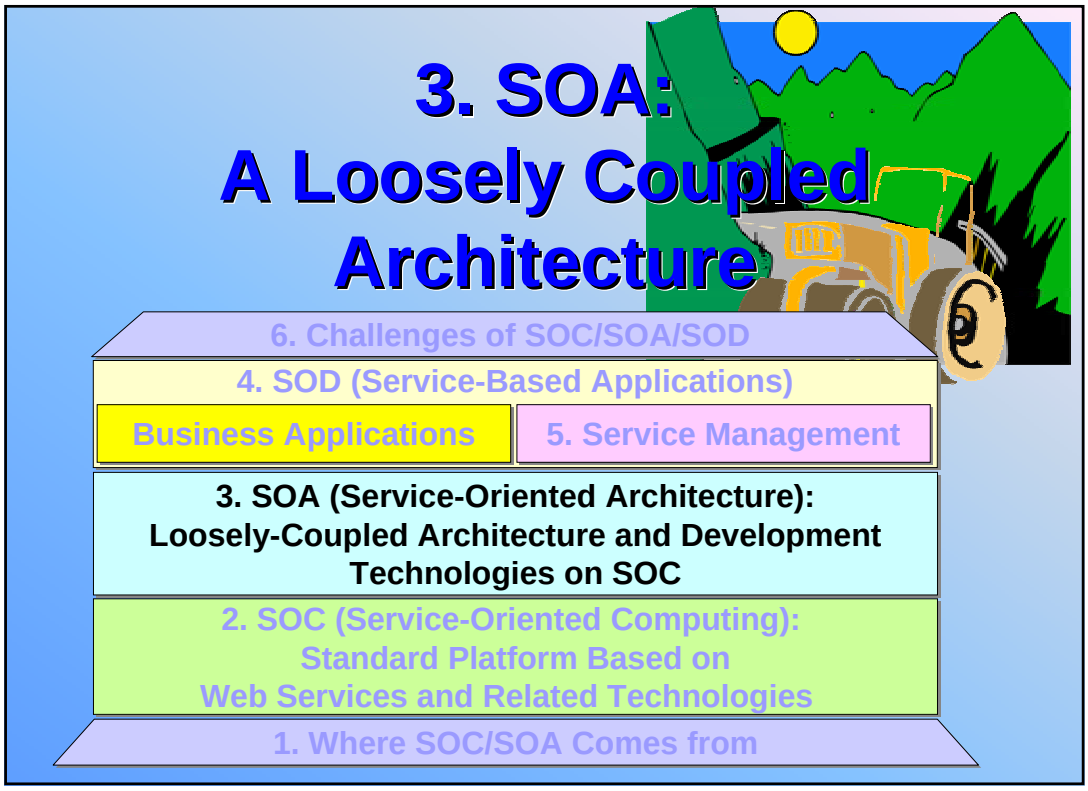

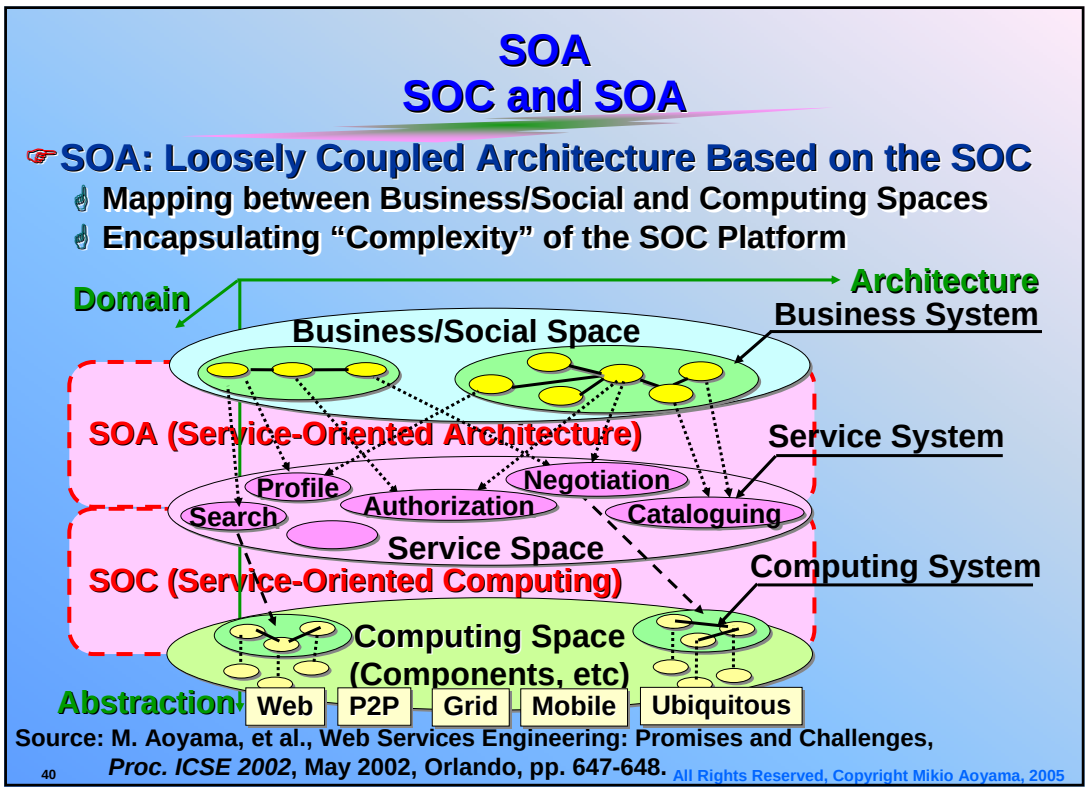

SOA
Definition of SOA (1/2)

- SOA is:
- A Service-Oriented Architecture (SOA) is a style of design that guides all aspects of creating and using business services throughout their lifecycle (from conception to retirement), as well as defining and provisioning the IT infrastructure that allows different applications to exchange data and participate in business process regardless of the operating systems or programming languages underlying those applications.

Source: E. Newcomer and G. Lomow, Understanding SOA with Web Services, Addison Wesley, 2005.

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SOA
Definition of SOA (2/2)

- An important goal of an SOA is to help align IT capabilities with business goals.

IDC Survey of 204 IT Executive
Top Priority of IT for Business Competitiveness
Adopting Applications to Business [36%]

- Another goal of an SOA is to provide an agile technical infrastructure that can be quickly and easily reconfigured as business requirements change.

Source: E. Newcomer and G. Lomow, Understanding SOA with Web Services, Addison Wesley, 2005.

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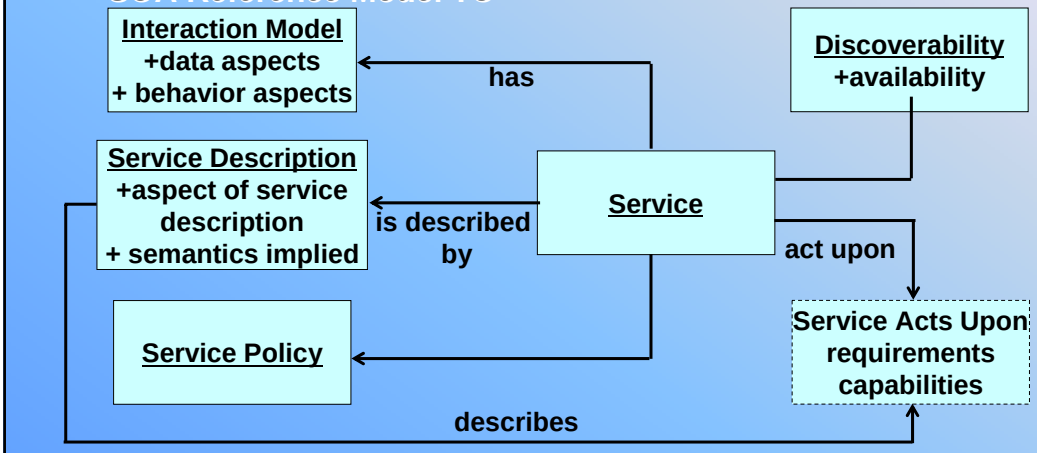
SOA
OASIS SOA Reference Model (Draft)

- SOA Has no AGREED Common Definition yet
- An Reference Model of SOA is under Discussion at OASIS SOA Reference Model TC



Source: D. Nickull, An Introduction to the OASIS Reference Model for Service-Oriented Architecture (SOA), Aug. 2005, http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=soa-rm.

SOA
Essentials of SOA

- 4 Key Elements of SOA
  - Loosely Coupled
  - Well-Defined Service Interface
  - Meaningful Abstraction of Service
  - Standard-Based
- Loosely Coupled Architecture
  - From Client/Server to Publish/Subscribe Architecture
  - Find Services at Run-Time instead of Design-Time:
    - Contents/Semantic-Based Lookup
  - From Component-Ownership to Component-Usage
    - Component-Based: Dynamic Binding at Run-Time
    - Service-Based: Dynamic ***Finding***-and-Binding at Run-Time
- Platform of SOA
  - Platform Independent, but Web Services are at the Center Place

SOA
Publish/Subscribe (Pub/Sub) Architecture

- Model
  - Many-to-Many Application-Level Communication Architecture
- Decoupling: Architectural Characteristics
  - Space Decoupling (Anonymity): Interacting Parties Do Not Need to Know Each Other
  - Time Decoupling: Interacting Partners Do Not Need to be Active at the Same Time
  - Synchronization Decoupling (Decoupling in Flow): Sending and Receipt Do Not Happen in the Main Flow of Control of the Publisher and Subscriber, and Do Not Happen in a Synchronous Manner

References:
P. TH. Eugster, The Many Faces of Publish/Subscribe, *ACM Computing Survey*, Vol. 35, No. 2, Jun. 2003, pp. 114-131.
R. Baldoni, et al., The Evolution of Publish/Subscribe Communication Systems, *Future Directions of Distributed Computing*, LNCS Vol. 2584, Springer Verlag, 2003, pp. 137-141.

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SOA
Publish/Subscribe Architecture: 3 Types

- 3 Types: Topic-Based, Content-Based, and Type-Based
- Topic-Based Publish/Subscribe
  - Exchange Information through a Topic (a Set of Predefined Subjects) Distinguishing Logical Channels
  - Static
  - Ex.: Tibco Rendezvous http://www.tibco.com/software/enterprise_backbone/rendezvous.jsp
- Content-Based Publish/Subscribe
  - Information is Delivered Based on the Contents
  - More Flexible and Dynamic than Topic-Based
  - Ex.: SIENA: http://serl.cs.colorado.edu/~alw/doc/papers/
  - Gryphon: http://www.research.ibm.com/distributedmessaging/gryphon.html
- Type-Based
  - Classification of Content by Type

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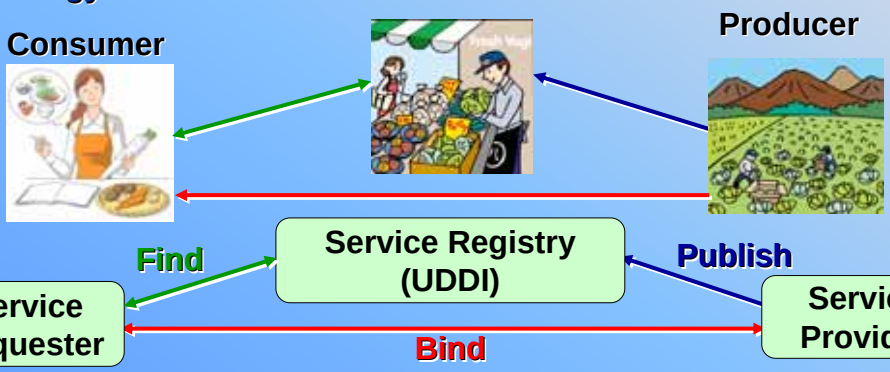
SOA
Implication of Publish/Subscribe Architecture

- Publish/Subscribe Architecture for Loosely Coupled Computing
  - Decoupling: No Direct Interactions between Requester and Provider
  - Discovery at Run-Time (when Buying) rather than Design-Time (Plan)
- Analogy to Social Architecture



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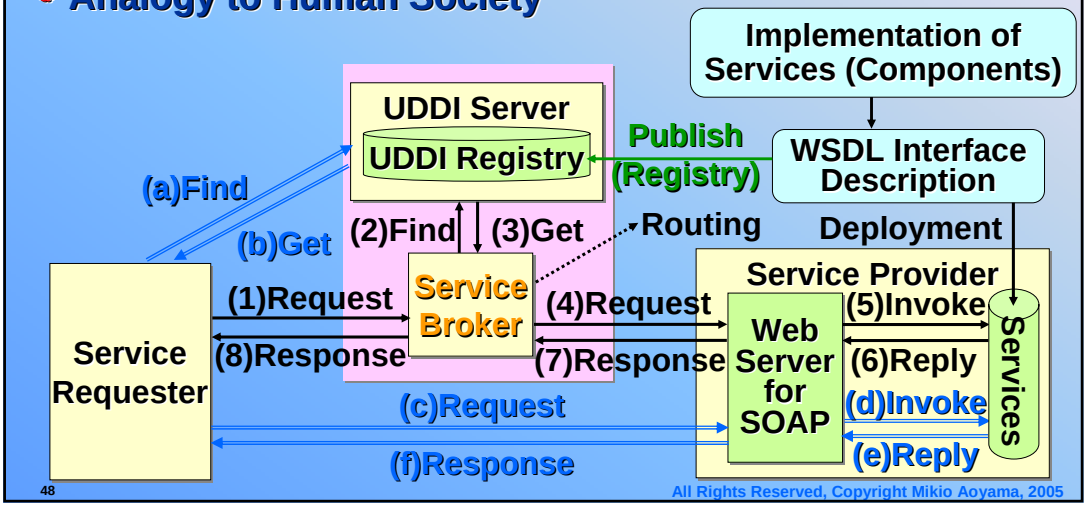
SOA
Triangle Broker Architecture on SOA

- Broker/Intermediary Architecture
  - Decoupling between Requester and Provider
  - Better Binding between Requester and Provider
- Analogy to Human Society



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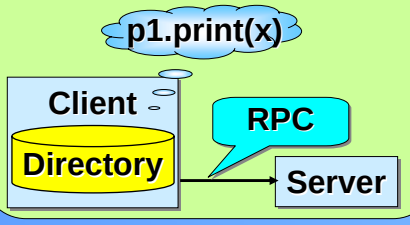
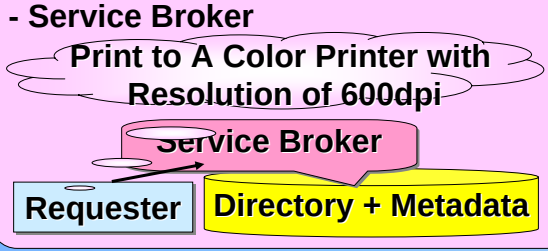
SOA
Semantic-Based Service Lookup

- Semantic-Based: Service Lookup and Routing Based on Service and Content
  - Abstraction: From Address-Based to Attribute-Based
  - Dynamic Lookup: From Design-Time to Run-Time
- Tradeoff of Flexibility and Performance

DOE
- Direct Lookup at Client
- Address-Based
- Lack of Brokerage



Service-Based
- Attribute-Based Lookup with Rich Metadata
- XML-Namespace
- Service Broker



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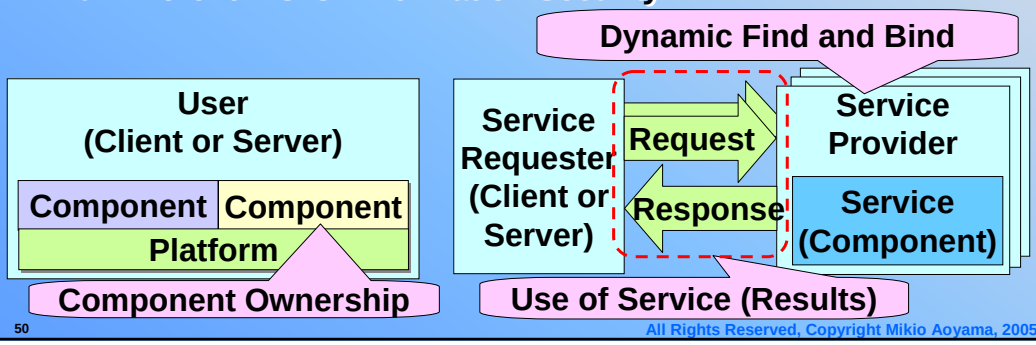
SOA
From Component Ownership to Service Use

- From Ownership to Use
  - Component-Based: Composition at User machine
  - Service-Oriented: Component Use (Remote Computing) at Service Providers/Brokers
- Implication of Change
  - Change of Software Business Model
  - Different Risks: Information Security



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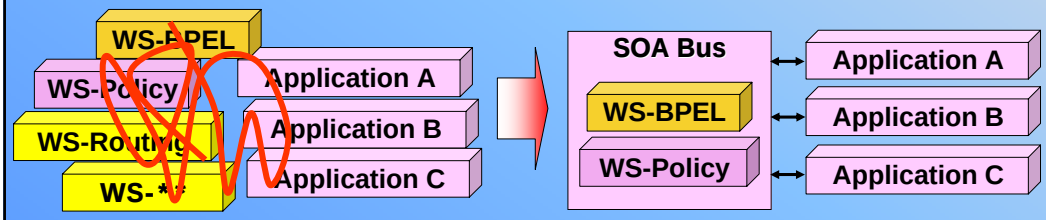
SOA
SOA Platform: Complicated SOC Standards

- SOC Standards Get Complicated
  - Too Many Standards: Technical Barrier to Application Developers
  - Deviation from the Simplicity Philosophy behind of SOC/SOA
- Need of Common Platform to Integrate Technologies for Application Development and Application Integration
  - Platform for Packaging Underlying Technologies
  - Platform for (Enterprise) Application Integration
- Platforms
  - Based on Network Architecture: WSN (Web Services Network)
  - Based on Bus Architecture: ESB (Enterprise Service Bus)
    - F. Leymann (IBM), Jump Onto the Bus, ICSOC (Int'l Conf. on SOC) 2003.



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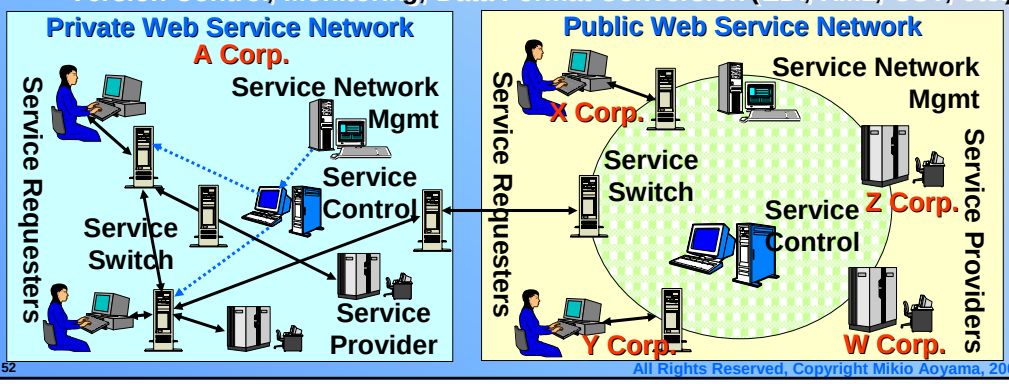
SOA
SOA Platform: WSN (Web Service Network)

- Telephone Network Model: Business Dial-tone
  - Public Web Service Network: Network Operator
    - Ex.: Grand Central Communications (May 2001~)
  - Private Web Service Network: Providing Software
    - Ex.: Blue Titan Software
- Infrastructure Services of WSN
  - Security, Access Control, Message Routing, Service Directory and Service Version Control, Monitoring, Data Format Conversion (EDI, XML, CSV, etc.)



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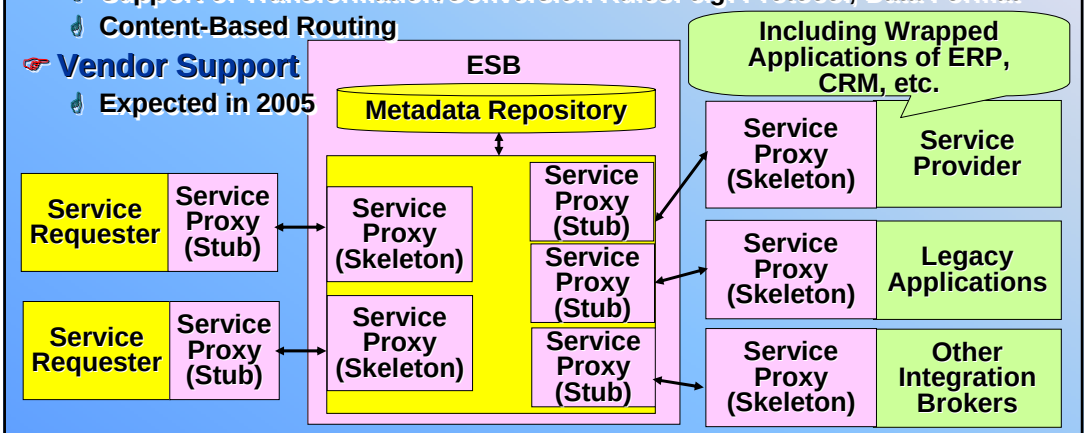
SOA
SOA Platform: ESB (Enterprise Service Bus)

- ESB (Enterprise Service Bus)
  - An Integration Broker for SOC/SOA
- Characteristics of ESB
  - Metadata Centric: Repository of Service Interface and its Dynamic Change
  - Support of Transformation/Conversion Rules: e.g. Protocol, Data Format
  - Content-Based Routing
- Vendor Support
  - Expected in 2005



Reference: D. A. Chappell, Enterprise Service Bus, O'Reilly, 2004.

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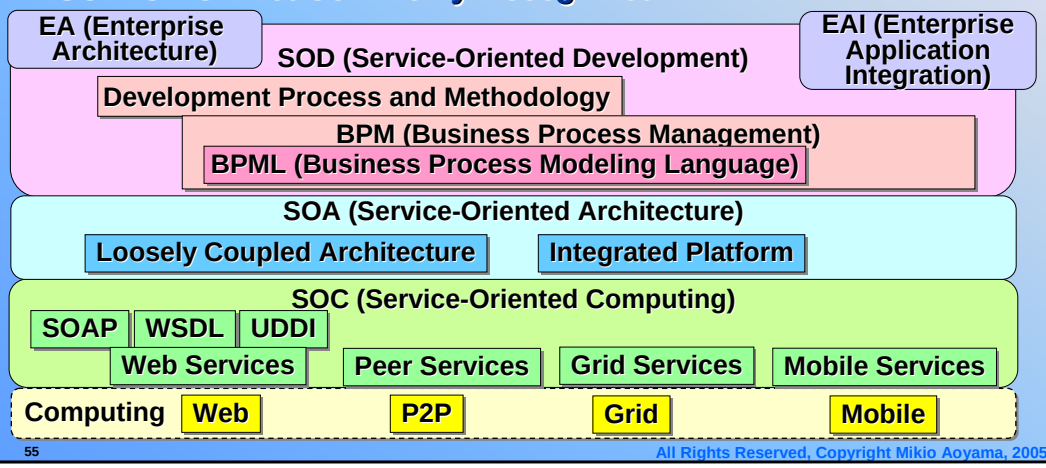
4. SOD (Service-Oriented Development)

SOD
Framework of SOD

- SOD (Service-Oriented Development): Engineering Businesses with Services (Based on SOA/SOC)
  - BPM (Business Process Management): Developing Business Application with Services
- SOD is NOT Yet Commonly Recognized



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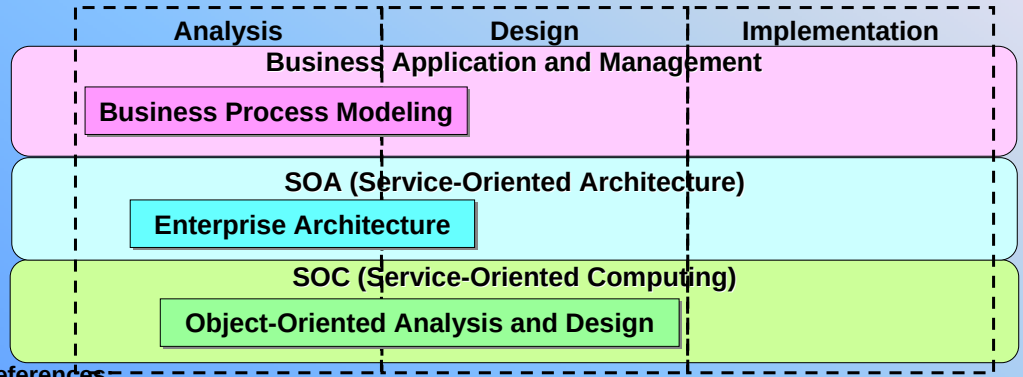
SOD
Essentials of SOD

- A Total Development Framework is Necessary
  - Conventional Development Technologies Provide Only Partial and Fragmental Solutions



References:

M. Aoyama, Web Services Engineering, *Engineering Information Systems in the Internet Context,* Kluwer Academic, Sep. 2002, pp. 1-8.
O. Zimmermann, et al., Elements of Service-Oriented Analysis and Design, Jun. 2004, http://www-128.ibm.com/developerworks/webservices/library/ws-soad1/

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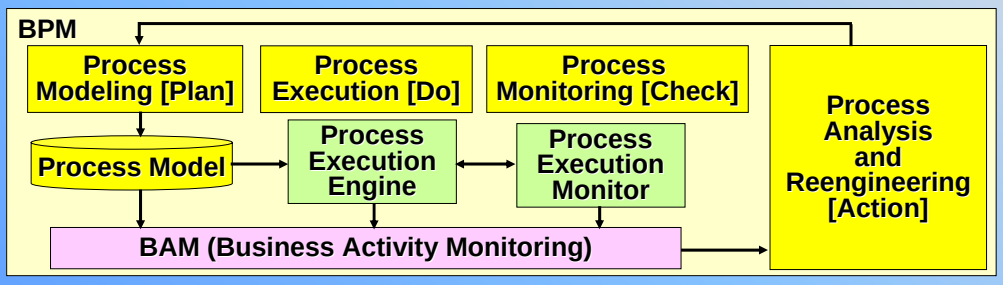
SOD
BPM (Business Process Management)

- BPM (Business Process Management)
- BPM Framework
  - Process Modeling: Description of Business Process
  - Process Execution: Execution of Process in WS-BPEL
  - Process Monitoring: Collecting Process Execution Statistics
  - BAM (Business Activity Monitoring): Business Analysis and Reporting Based on Process Execution Statistics



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SOD
Service Composition

- Technologies for Composing Web Services
  - Mechanisms for Composing Web Services
    - Dynamic Composition of Web Services through Static and Stateless WSDL Interface
  - Systematic Mapping Business Process to (Composite) Services
    - Aligning Web Services with Business Goals
  - Separating Business Process and Business Logic (Rules)
    - Make Business Process Reconfigurable and Agile
  - Automate Business Process
    - Productivity of Business Process
  - Incremental and Evolvable
    - Migration of Legacy Process and Systems

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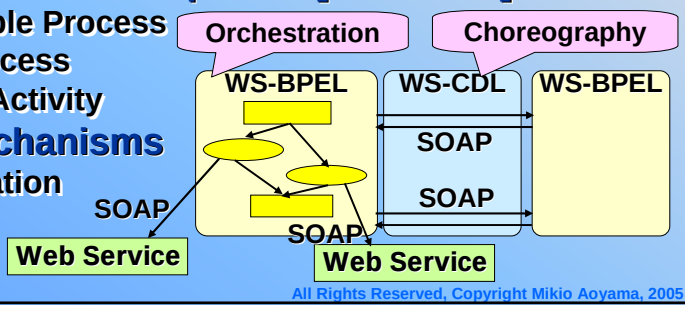
SOD
BPML: Language Concepts

- BPML (Business Process Modeling Language)
- 2 Models of BPML
  - Orchestration): Inside an Organization
    - Ex.: WS-BPEL (Web Services Business Process Execution Language)
  - Choreography: Across Organizations
    - Ex.: WS-CDL (Web Services Choreography Description Language)
- Language Mechanisms: Scope etc. [WS-BPEL]
  - Abstract/Executable Process
  - Public/Private Process
  - Atomic/Complex Activity
- Needs of New Mechanisms
  - Dynamic Participation



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SOD
BPML: Languages and Standardization

- Status: Multiple Candidates
  - WS-BPEL is Gaining Momentum
  - WS-BPLE and WS-CDL are Complimentary, but …

BPML	Developer	Standardization
WS-BPEL (Web Services BPEL)[OASIS] = BPEL(4WS) (Business Process Execution Language for Web Services)	IBM, Microsoft, BEA	OASIS WS-BPEL: V. 1.0 (Aug. 2002) V. 1.1 (May 2003), Submitted to OASIS TC,V2.0 (WD, May 2005)
WS-CDL (Web Services Choreography Description Language)	BEA, SAP, Sun, Intalio	W3C, V 1.0 WD (Mar. 2004)
BPML (Business Process Modeling Language)	BPMI (Business Process Modeling Initiative) .org	V1.0 (Jun. 2002)
BPSS (Business Process Schema Specification)	ebXML	Submitted to OASIS OASIS V.1.1 (May 2001)

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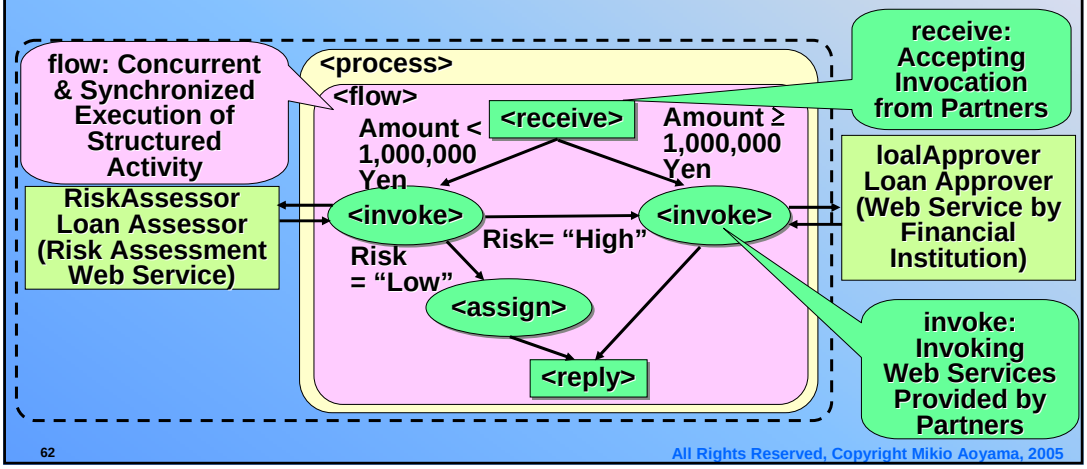
SOD
WS-BPEL: Language Mechanisms

- **Architecture**
  - Business Process = Composite Web Services
  - Process Execution: Workflow Model (Procedure-Oriented)
- **Language Mechanisms**
  - Compliant to XML/XML Schema/WSDL
  - 2 Levels of Abstractions: Abstract and Executable Processes
  - Recursive and Type-Based Composition: Composed at portType Not at the port (i.e. Instance) Level
  - 4 Binding Schemes: Static and Dynamic Binding
  - Content-Based Messaging: No Object Reference, but Explicit Use of Content by "Properties and Correlation Sets"

References:
N. Mukhi, Reference Guide for Creating BPEL4WS Documents, Nov. 2002, http://www-128.ibm.com/developerworks/webservices/library/ws-bpws4jed/index.html
M. J. Duftler, et al., Business Process with BPEL4WS: Learning BPEL4WS, Part 5, Mar. 2003, http://www-128.ibm.com/developerworks/webservices/library/ws-bpelcol5/.
K. Mantell, From UML to BPEL, Sep. 2003, http://www-128.ibm.com/developerworks/webservices/library/ws-uml2bpel/

SOD
An Example of WS-BPEL: BPEL Model

- **Loan Assessment Process**
  - Internal Web Service: riskAssesor for amount < 1,000,000
  - External Web Service: loanApprover for amount ≥ 1,000,000

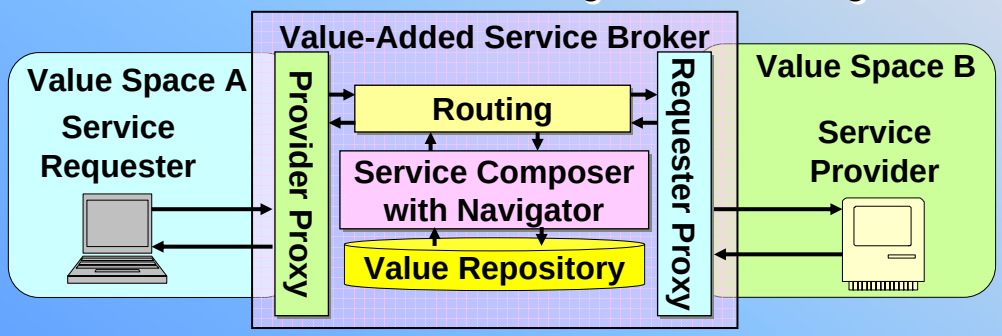


SOD
An Example of WS-BPEL: BPEL Program (Part)

```
<process name="loanApprovalProcess" ...>
...
  <flow>
    <receive name="receive1" partner="customer"
        portType="apns:loanApprover" operation="approve" variable="request“ createInstance="yes">
      <source linkName="receive-to-assess"
          transitionCondition="bpws:getVariableData('request', 'amount')<1000000"/>
      ...
    </receive>
    <invoke name="invokeAssessor" partner="assessor" portType="asns:riskAssessor"
        operation="check" inputVariable="request"  outputVariable="riskAssessment">
      <target linkName="receive-to-assess"/>
      <source linkName="assess-to-setMessage"
          transitionCondition="bpws:getVariableData('riskAssessment', 'risk'='Low')"/>
      ...
    </invoke>
    <assign name="assign">
      <target linkName="assess-to-setMessage"/>
      <source linkName="setMessage-to-reply"/>
      ...
</assign>
    ...
</flow>
</process>
```


SOD
Value-Added Service Broker

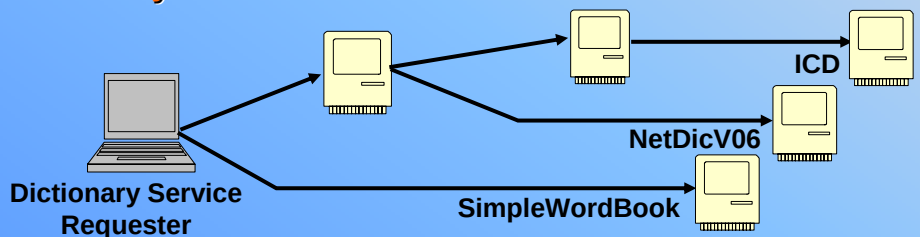
- Value-Added Service Composition by Brokerage
  - Service Composer: Navigation of Composition Patterns by Value
    - Meta-model: Ontology of Value
  - Content-Based Service Routing with WS-Routing



References: K. Nakamura, A. Tsuge, and M. Aoyama, Value-Based Dynamic Collaboration of Web Services, IPSJ SIGSE, Vol. 2003-SE-144, Mar. 2004, pp. 123-130 (In Japanese).

SOD
Value-Added Service Broker: Dictionary Example

- Navigated Collaboration of 3 Dictionary Services
  - ICD Service by @IT: Dictionary Specific to IT
    - Rich in IT Domain, but Narrow
  - NetDicV06 Service by Sanseido (Dictionary Publisher): Qualified General Dictionary by Japanese Publisher
    - Highly Reliable, Very Wide but Shallow
  - SimpleWordBook: Developed by Students in our Laboratory Specific to Software Engineering
    - Very Narrow Domain and Possible Incorrectness



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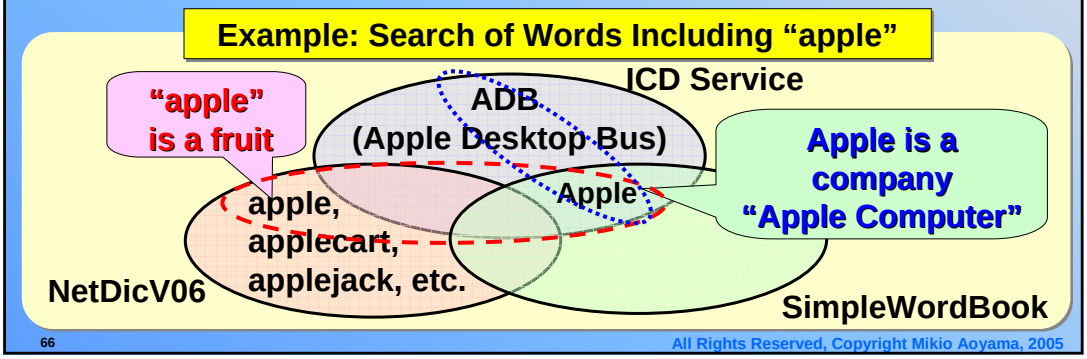
SOD
Value-Added Service Broker: Dictionary Example

- Increase the Value (Reliability) of Information
  - Enrich the Information by Multiple Dictionary
  - ICD Service and SimpleWordBook: Possible to Search Technical Terms: e.g. “Apple Computer”
  - ICD Service: Provide Rich Information: Company History
  - NetDicV06 Service: “Apple” and its Associated Idioms



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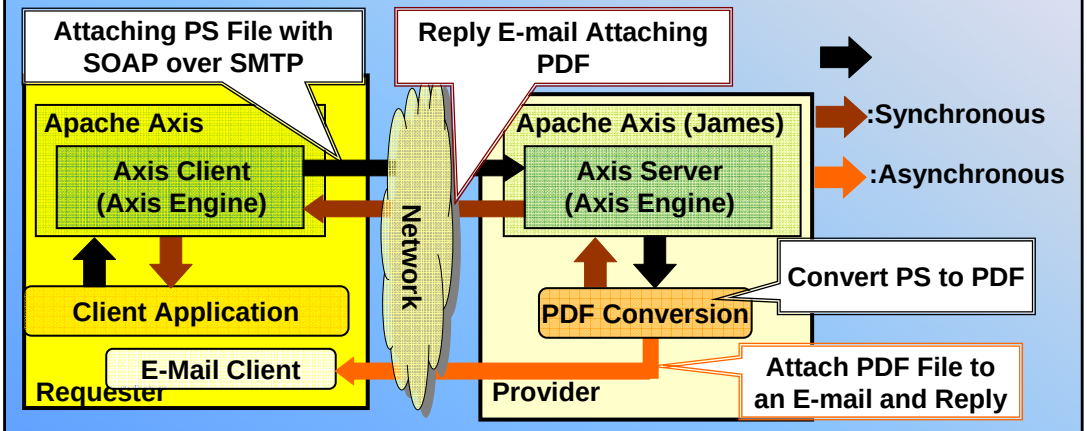
SOD
Asynchronous Service Composition over SMTP

- A Prototype of Asynchronous Composition of Web Services
  - Application Protocol: SOAP over SMTP
  - An Example: PDF Conversion: Attaching Documents to be Converted



References: A. Mori and M. Aoyama, Asynchronous Web Services Architecture over SMTP and its Evaluation, IPSJ SIGSE, Vol. 2005-SE-147, Mar. 2005, pp. 73-80 (In Japanese).

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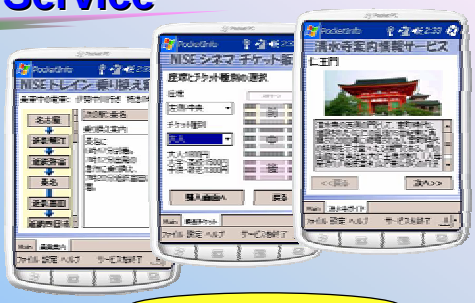
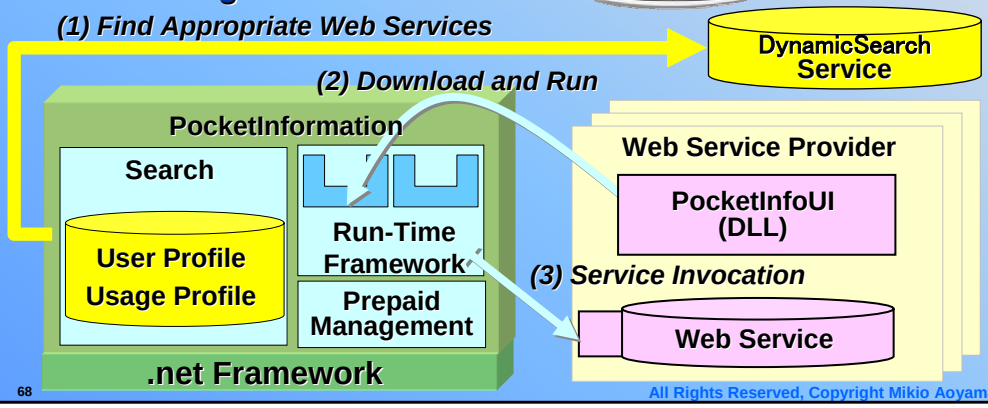
SOD
Mobile (Web) Service

- PocketInformation: A Prototype System for Mobile Web Services
  - 2nd Prize Awarded at Software Design Competition in Japan of Imagine Cup 2005 (Sponsor: Microsoft) [Mar. 2005]
- Concept: Context-Aware Service Provisioning





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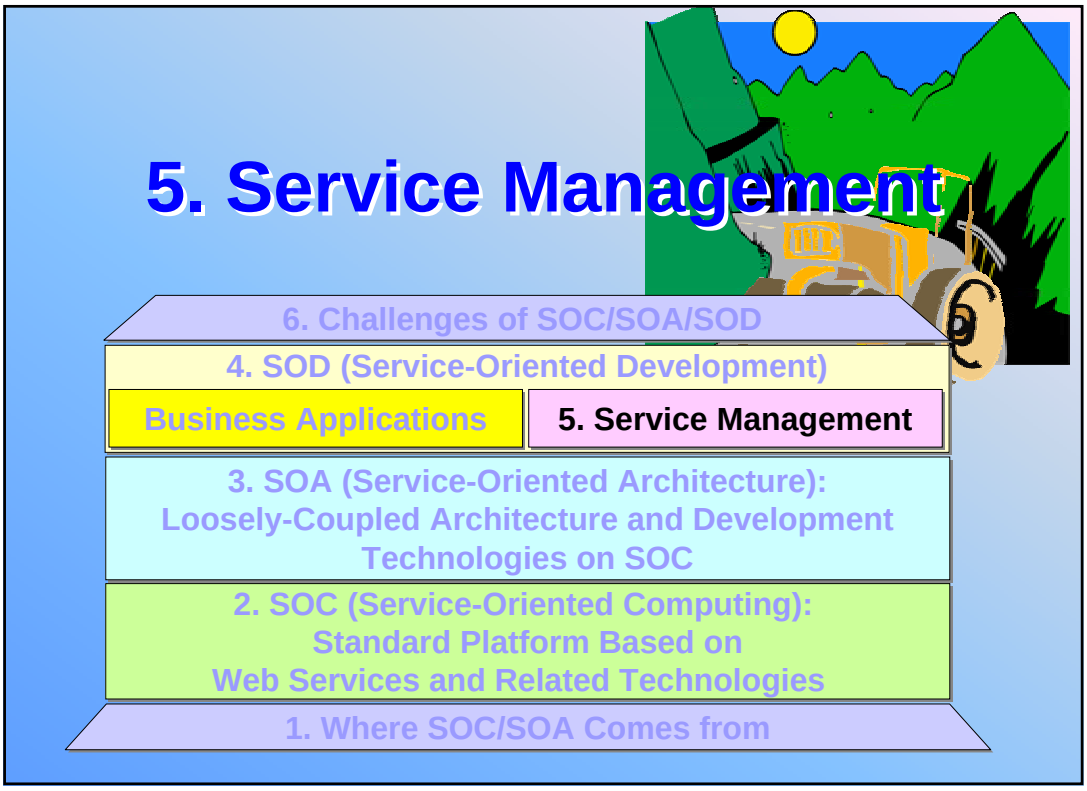

Web Services Distributed Management (WSDM)

- Web Services Distributed Management (WSDM) 1.0
  - Approved as OASIS Standard in Mar. 2005
  - Developers: HP, IBM, CA, etc.
- 2 Frameworks for Enterprise and Network Systems Management
- Management *USING* Web Services: MUWS
- Management *OF* Web Services: MOUS

References:

OASIS Web Services Distributed Management TC, http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=wsdm
B. Murray (ed.), Web Services Distributed Management: Primer, WD, OASIS, Jul. 2005 http://www.oasis-open.org/committees/download.php/13872/wd-wsdm-primer-08.doc
B. Murray, et al., Management Using Web Services: A Proposed Architecture and Roadmap, Jun. 2005, http://devresource.hp.com/drc/resources/muwsarch/index.jsp
H. Kreger, A Little Wisdom about WSDM, Mar. 2005, http://www-128.ibm.com/developerworks/webservices/library/ws-wisdom/

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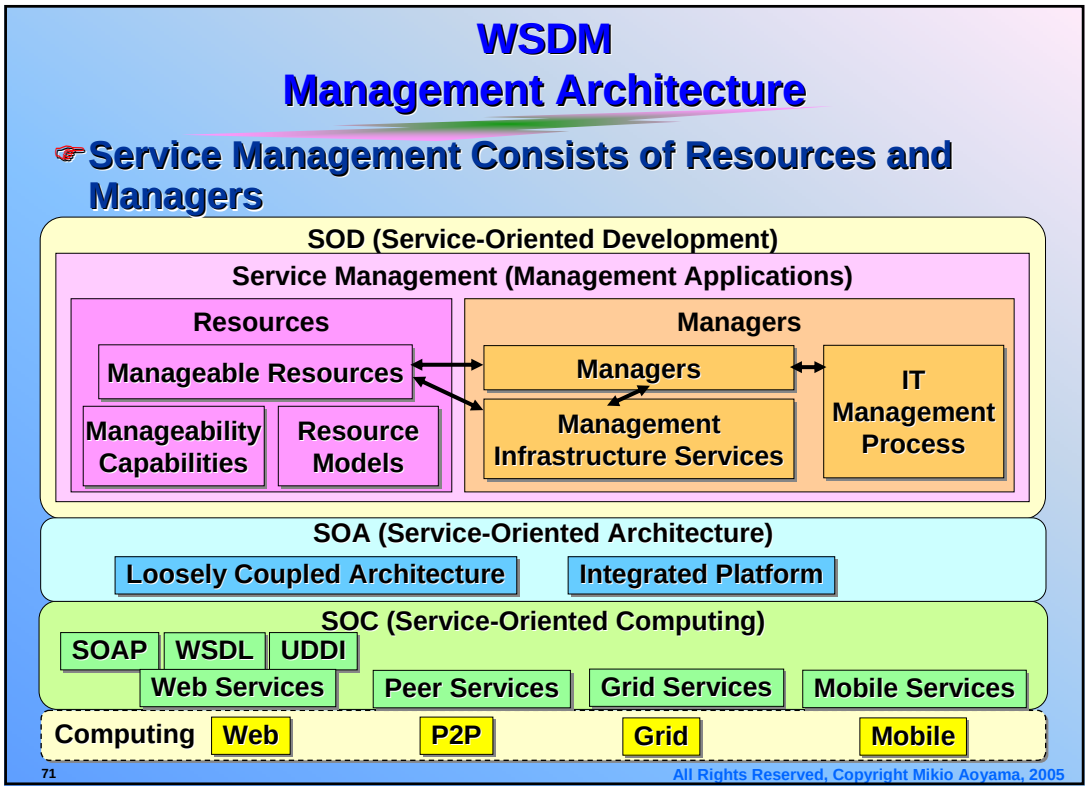
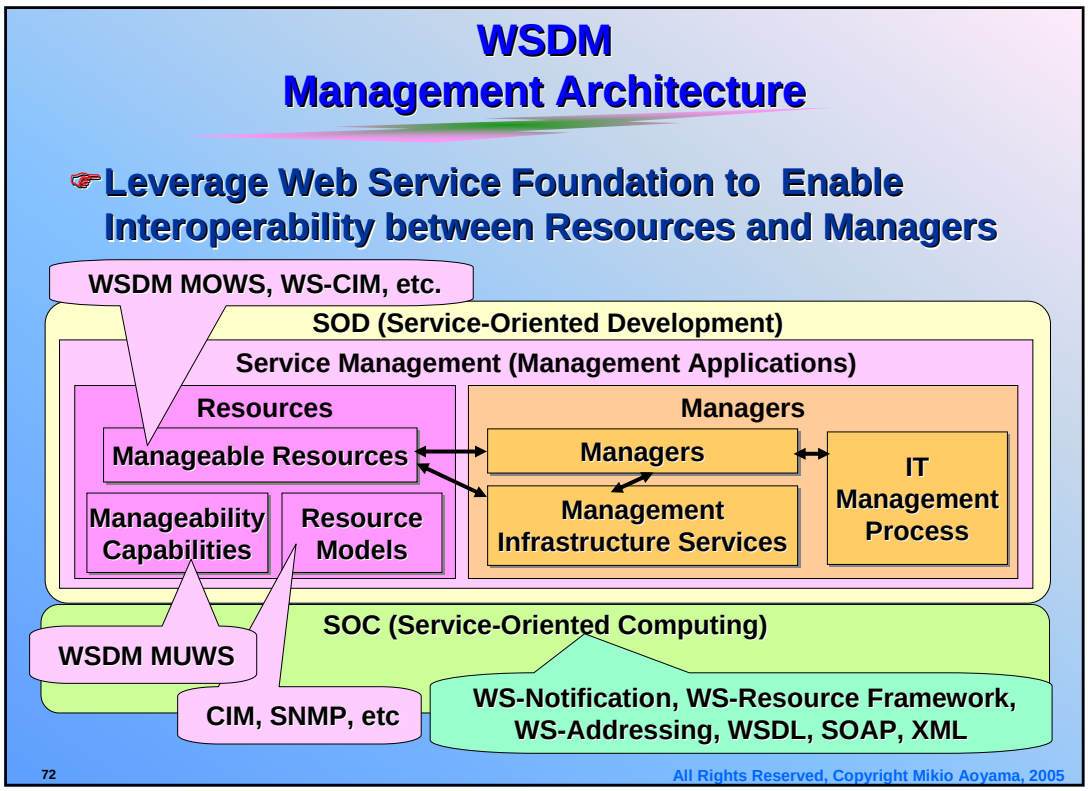
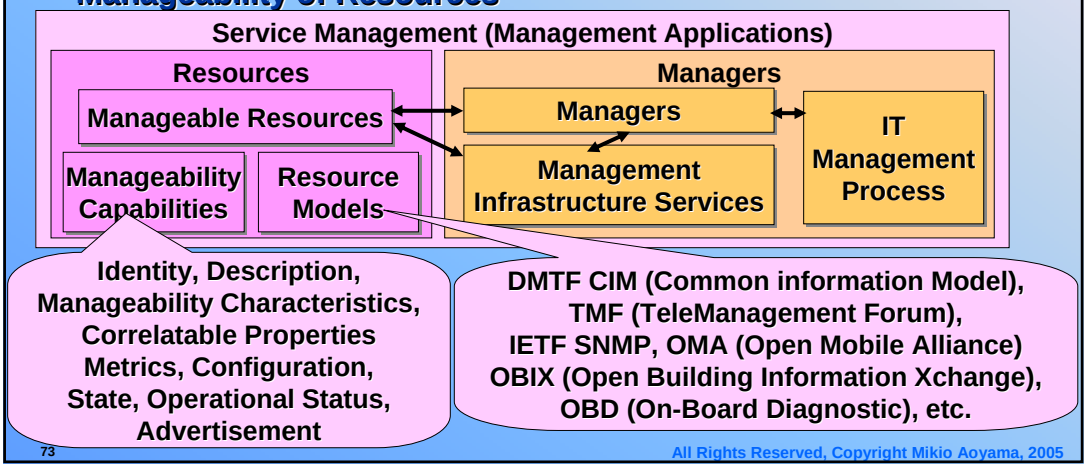




WSDM
Resources

- Manageable Resources: Hardware/Software Resources Exposed as Web Services
- Manageability Capabilities: A Set of Descriptions to Enable a Management Task
- Resource Models: A Set of Information Models Defining the Manageability of Resources



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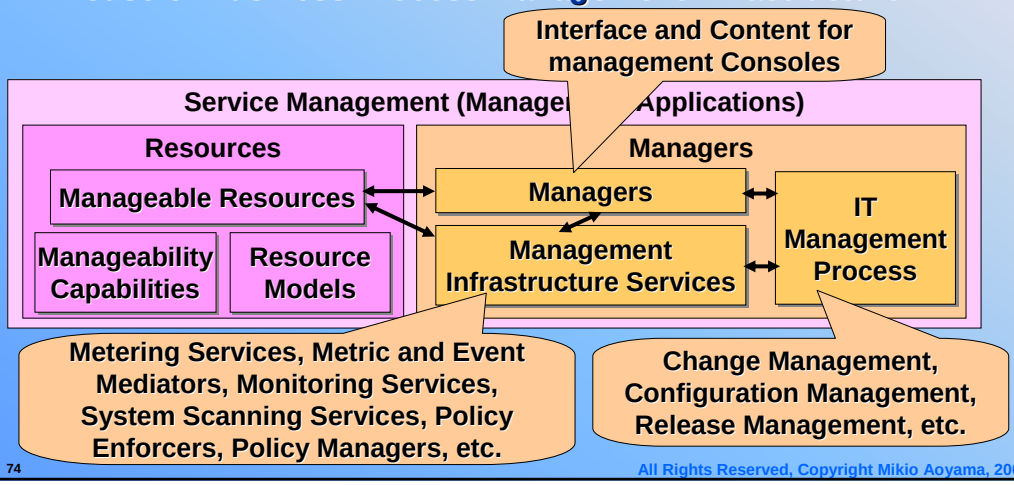
WSDM
Managers

- Managers are Web Services Applications
- Leverage Web Services Technologies to Describe and Execute Management Processes
  - Ex.: WS-BPEL
- Reuse of Business Process Management Infrastructure



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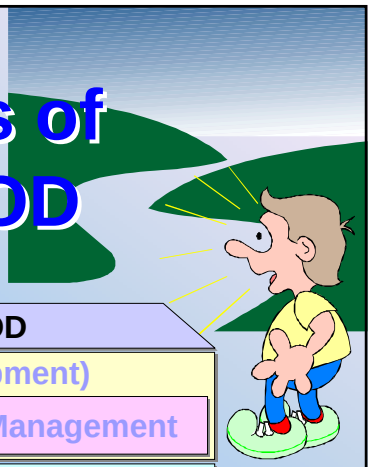
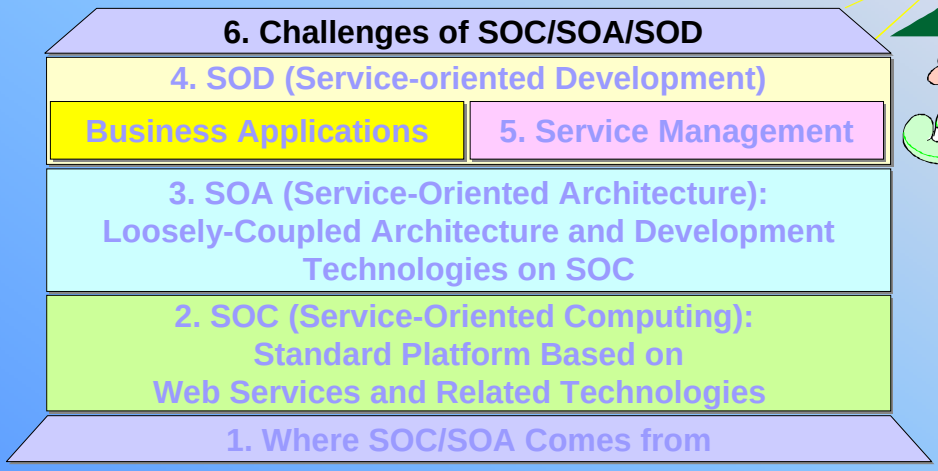
6. Challenges of SOC/SOA/SOD





Challenges of SOC/SOA/SOD Needs of Research and Development

- Need of SOD: Bridging Business Goals and IT
  - Development of Total Methodology
  - Business Engineering
    - Analysis and Design of Business
  - Fusion of Communications and Software
    - Service Networking
- Encapsulating Technologies Complexity
  - ESB
  - Lightweight Web Services (SOC/SOA)
- Emerging Services and Competitiveness
  - Value-Added Service Broker
  - Mobile and Embedded/Ubiquitous Services

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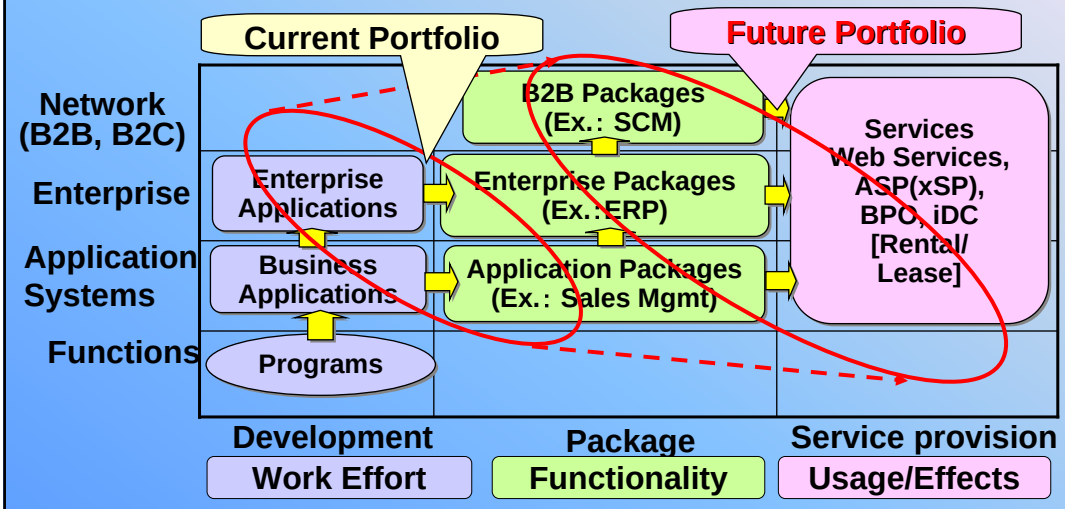
Challenges of SOC/SOA/SOD
Diversifying Software Business Models

- 3 Models of Software Businesses
  - 2 Faces of Software: Products and Services
  - From Products to Services: SI, Solution Businesses



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Challenges of SOC/SOA/SOD
Communities, Conferences, Standardizing Bodies

- 2 Standardizing Bodies
  - W3C (Platform-Oriented?), OASIS (Application-Oriented?)
- Research Communities
  - Web Services: Software Engineering, Object-Oriented
  - Semantic Web: Data Modeling, AI
- Conference on Web Services
  - General Conferences
    - ACM OOPSLA (Object-Oriented), ICSE (Software Engineering), APSEC (Software Engineering), WWW , XML
  - Specialized Conferences
    - ICWS(3rd IEEE Int'l Conf. on Web Services) [Jul. 2005, Orlando, USA], http://conferences.computer.org/icws/2005/
    - ICSOC (3rd ACM Int'l Conf. on Service-Oriented Computing, [Dec. 2005, Amsterdam, The Netherlands], http://www.icsoc.org/

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Summary

- Where SOC/SOA Comes from: Integration is the Key
  - From Distributed Object Computing/Components to Services
- SOC: Web Services with XML-Based Standard Interface
  - WSDL, SOAP, (UDDI)
- SOA: Loosely Coupled Dynamic Architecture on the SOC
  - Publish/Subscribe Architecture
- SOD Align IT with Business the SOC/SOA
  - BPML (WS-BPEL, etc.): Mapping Business to SOC/SOA
- Service Management
  - Emerging Standard WSDM to Unify the Resource Management over the Web
- Many Opportunities and Challenges

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References

[1] T. Aoki (ed.), *Web Service Computing*, IEICE, 2005 (In Japanese).
[2] M. Aoyama, A Business-Driven Web Service Creation Methodology, *Proc. WebSE 2002 (Int'l Workshop on Web Services Engineering)*, Feb. 2002, pp. 225-228.
[3] M. Aoyama, Web Services Engineering, *Engineering Information Systems in the Internet Context* , Kluwer Academic, Sep. 2002, pp. 1-8.
[4] D. A. Chappell, *Enterprise Service Bus*, O'Reilly, 2004.
[5] M. Cusumano, The Business of Software, Free Press, 2004.
[6] J. Hagel III, *Out of the Box*, Harvard Business School Press, 2002.
[7] D. Kaye, *Loosely Coupled: The Missing Pieces of Web Services*, Rds Associates, 2003.
[8] H. Maruyama, et al., *XML and Java: Developing Web Applications*, 2nd ed., Addison Wesley, 2002.
[9] E. Newcomer, et al., *Understanding SOA with Web Services*, Addison Wesley, 2005.
[10] OASIS (Organization for the Advancement of Structured Information Standards), http://www.oasis-open.org/.
[11] M. P. Papazoglou, D. Georgakopoulos, eds.), Service-Oriented Computing, *Communications of the ACM*, Vol. 46, No. 10, Oct. 2003, pp. 24-60.
[12] Z. Stojanovic, et al. (eds.), *Service-Oriented Software Systems Engineering*, Idea Group Pub., 2005.
[13] TMF (TeleManagement Forum), http://www.tmforum.org/.
[14] S. Weerawarana, et al., *Web Services Platform Architecture*, Prentice Hall PTR, 2005.
[15] W3C (World Wide Web Consortium), http://www.w3.org/.

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