

3rd International Semantic Web Conference (ISWC2004)

Workshop on Semantic Web Services:

Preparing to Meet the World of Business Applications

November 8, 2004, Hiroshima, Japan

Challenges of Ubiquitous Semantic Web Services

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Scenario



Vision: Software over the Web

Technology: Status of Web Services

Engineering: Web Services Engineering

Example: Value-Added Service Broker

Research Challenges

Vision: Software over the Web

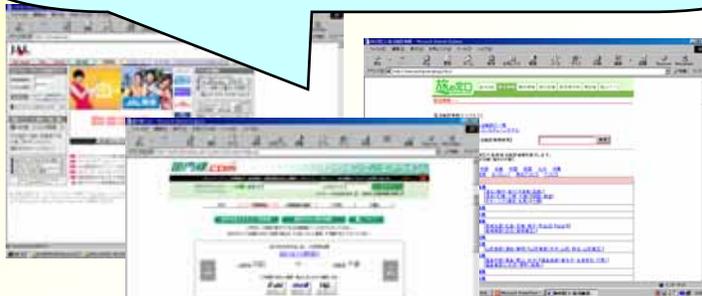
Two Faces of Web

☞ “Program = Algorithm + Data Structure”

☞ Semantic Web Services

☞ To Bridge the Semantic Gap of Web Services

Computing
Web Services/
SOC



SOC: Service-Oriented Computing

Information/Data
Semantic Web



Semantic
Web
Services

Web
Grid/P2P/Mobile

Vision: Software over the Web

Two Directions of Computing

3rd Wave of IT Evolution?

From PC(0.1B Unit/Year) to Ubiquitous Network (10B+ Unit/Year)

Dense Software Connected Everywhere: Diversity & Interactions

Shifting of User Expectations

Computing is Commodity, Collaboration Creates Value

Network [Enterprise, Public Services]

Ubiquitous, Embedded, Mobile

Ubiquitous
Network Era

(2000~)

[10B Unit/Year]

Web

Web

Down Sizing

Mainframe Era
('60~'70)[10K Unit/Year]

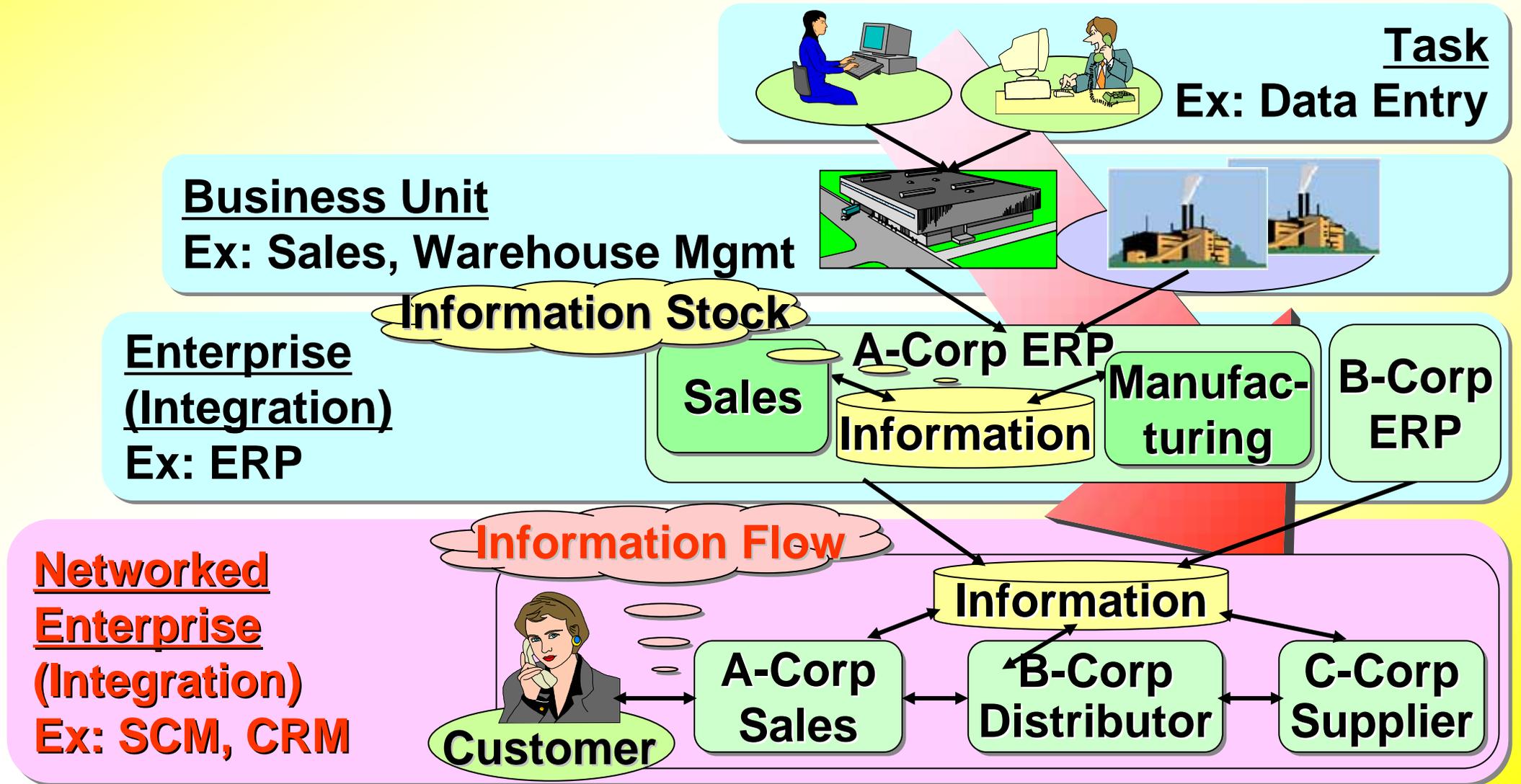
PC Era('80~'90)
[0.1B Unit/Year]

Vision: Software over the Web

Evolution of Information Systems

➡ From Enterprise to Networked Enterprises

➡ From Information Stock to Information Flow

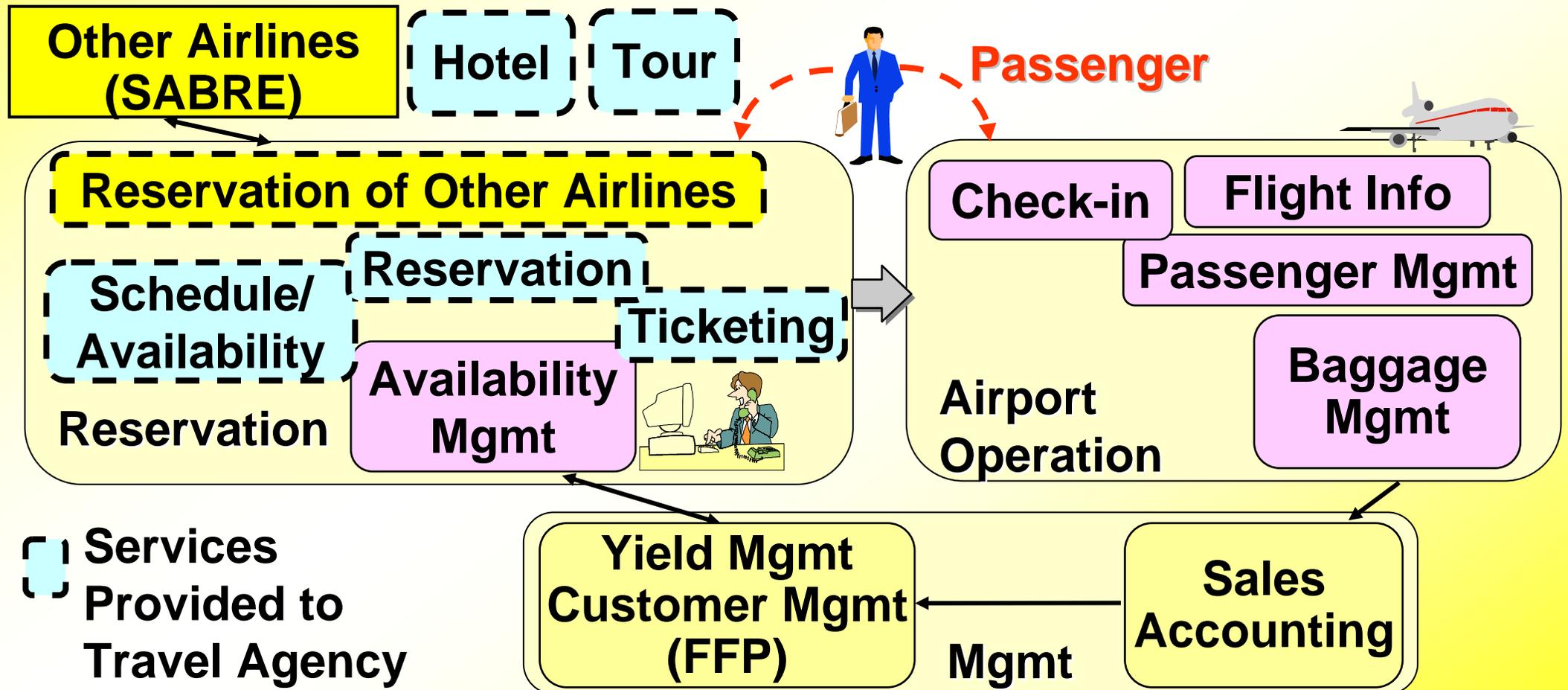


Vision: Software over the Web

Collaboration Creates Synergy Effect

✎ Airline Computer Reservation System (CRS)

✎ Collaboration is the Essential Requirements



Vision: Software over the Web

Collaboration Maximizes End-to-End Value Added

☞ Collaboration along with End-to-End Process

- ☞ Cost Cutting: Optimization over the End-to-End Process
- ☞ Value-Added: Better Customer Satisfaction: Aggregation, Agility

☞ Different Aspects of Two Ends: User and Business

B2C, P2P

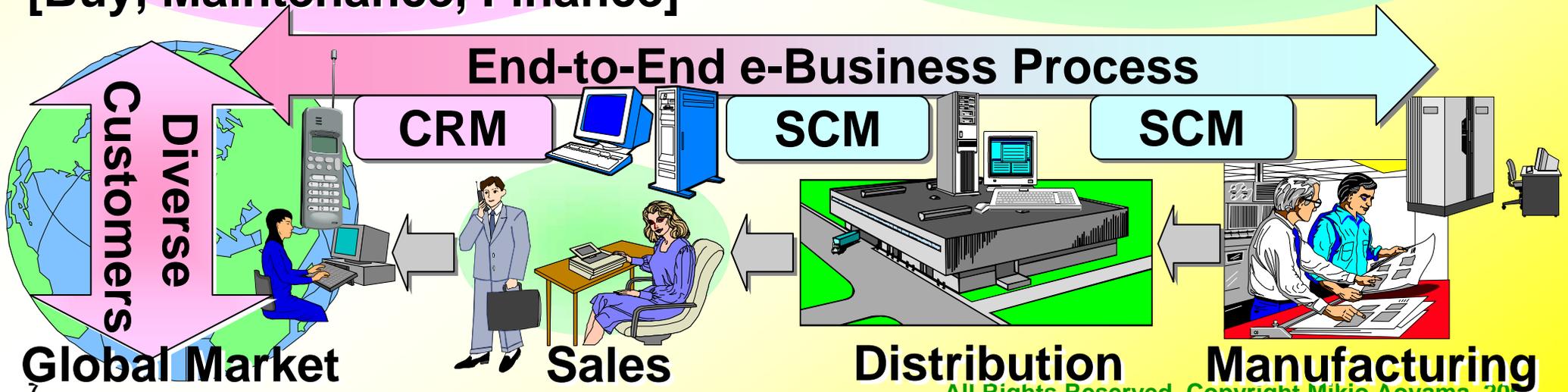
- ✎ Direct Connection
- ✎ Service Integration
(One Stop Service)

[Buy, Maintenance, Finance]

B2B, B2M2B

- ✎ Business Process Collaboration
- ✎ New Business Model/Market
[SCM, e-Marketplace]

End-to-End e-Business Process



Vision: Software over the Web

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

Vision: Software over the Web

Emerging Ubiquitous/Embedded Systems: ITS

☞ **“ITS Revolution”**: ITS, Telematic, VRM

☞ Safety, Environment, Convenience, Entertainment

☞ **“Mobile” Collaboration of Automobile with**

☞ Ground System, Manufacturer, Service Providers

Services at Garage
CRM (Maintenance),
Information (Recall)

Services at Rest Area
Area Guide
(Restaurants, Parking)

Services for Driving
Driving Assistance,
Navigation, Diagnostics,
Entertainment

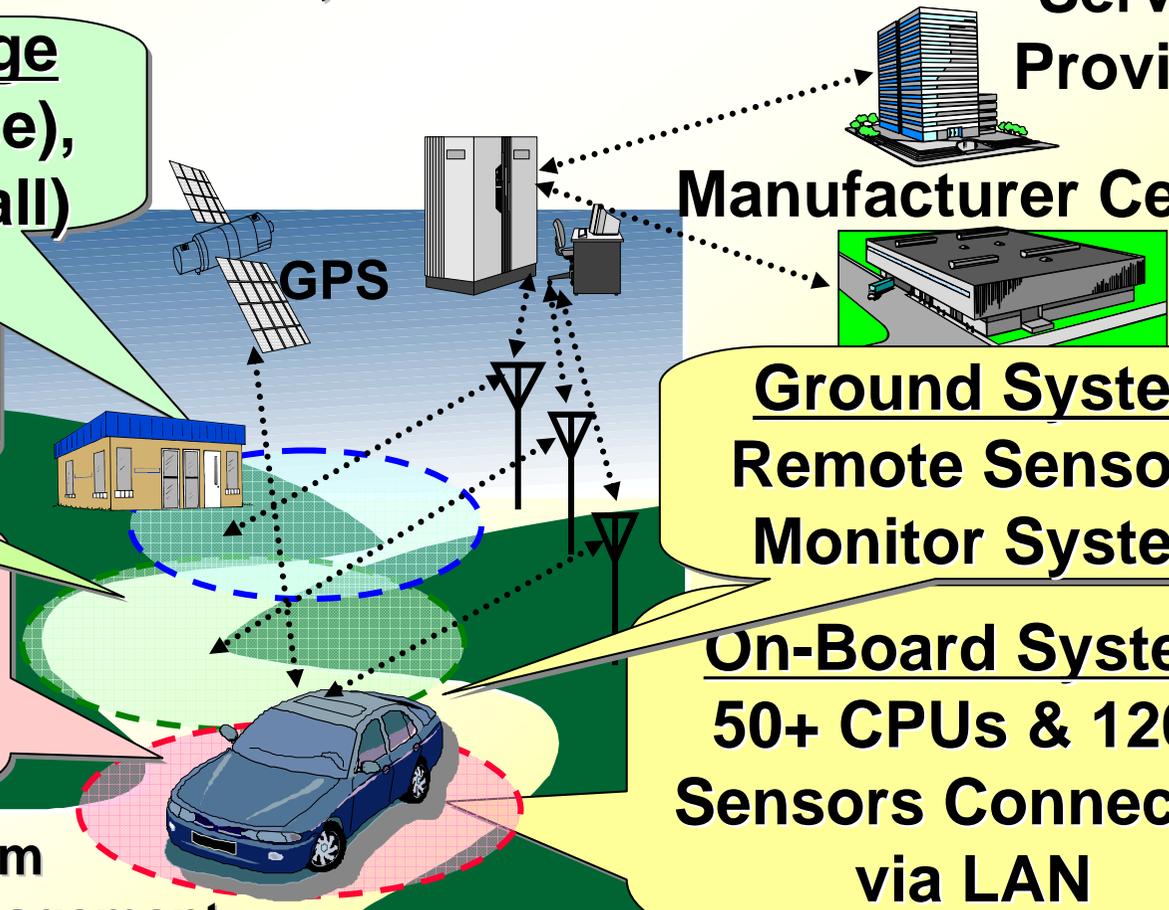
ITS: Intelligent Transport System
VRM: Vehicle Relationship Management

Service
Providers

Manufacturer Center

Ground System
Remote Sensors,
Monitor System

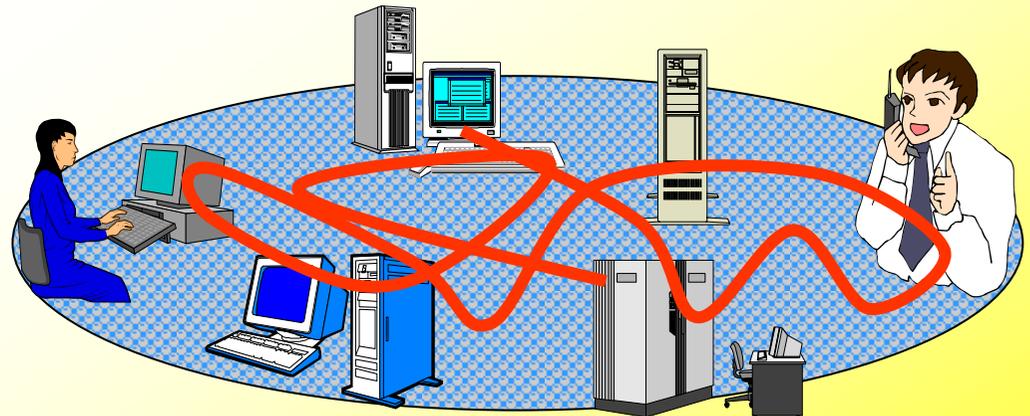
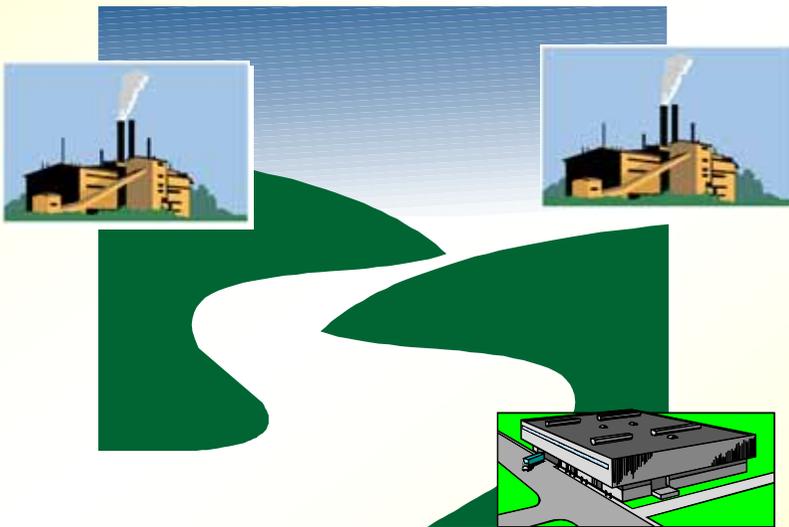
On-Board System
50+ CPUs & 120+
Sensors Connected
via LAN



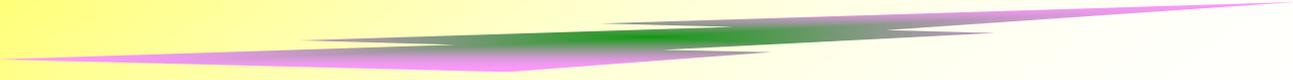
Vision: Software over the Web

Software over the Web Forms an Society

- 👉 **Key to E-Business/Software Society:**
Collaboration of Software Systems across Organizational Boundaries
- 👉 **Human Society: Collaboration of People**



Scenario

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Vision: Software over the Web

Technology: Evolution of Web Services

Engineering: Web Services Engineering

Example: Value-Added Service Broker

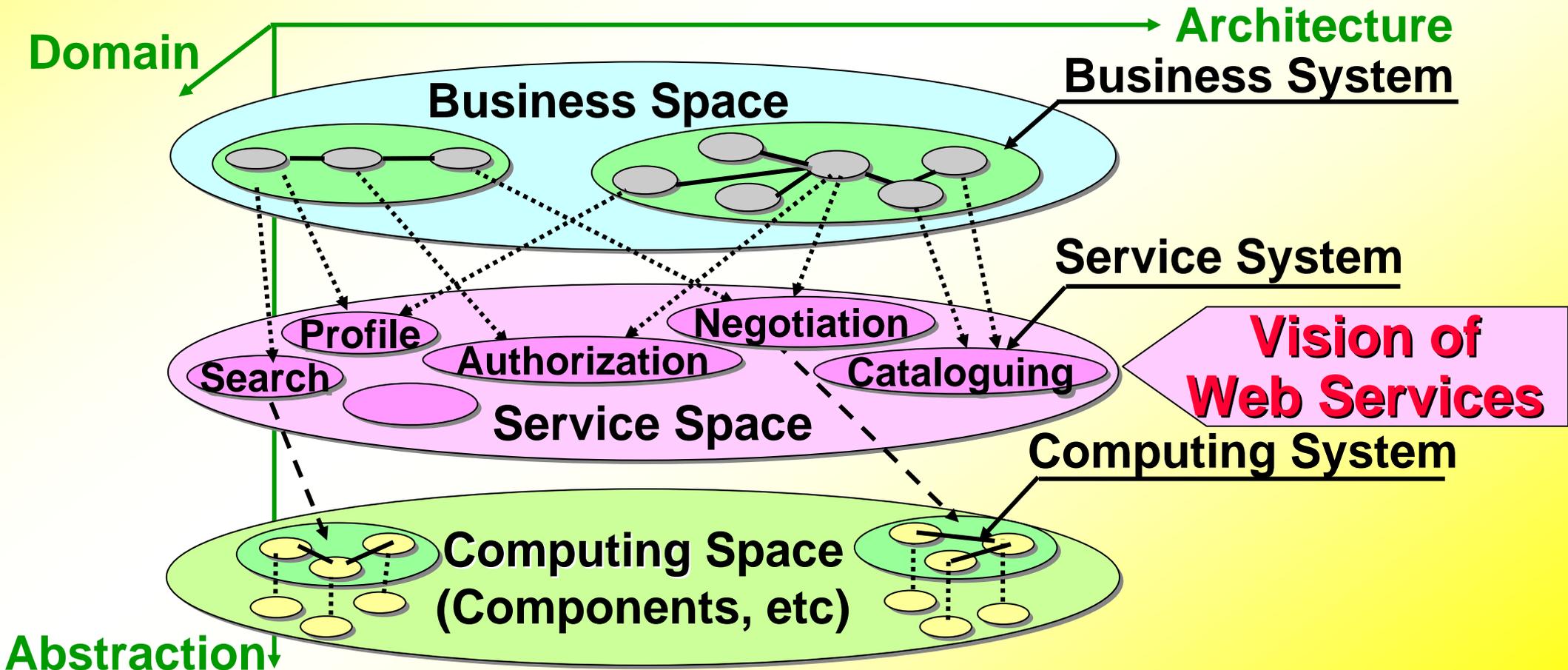
Research Challenges

Technology: Evolution of Web Services (My) Vision of Web Services

👉 Business-Service-Computing Model

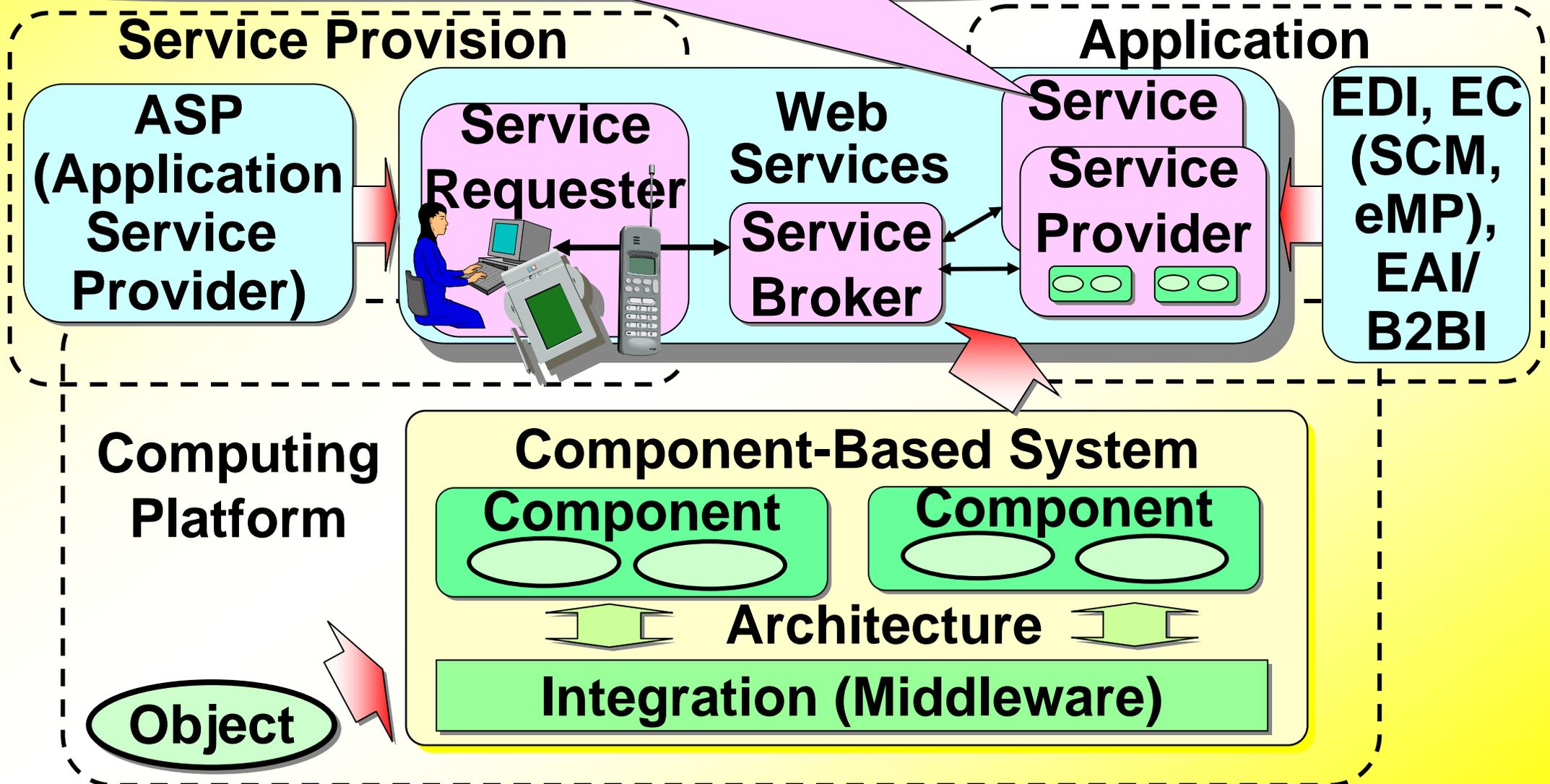
👉 Platform Independence: Productivity, Interoperability

👉 Business-Model Independence: Reuse, Evolution/Agile



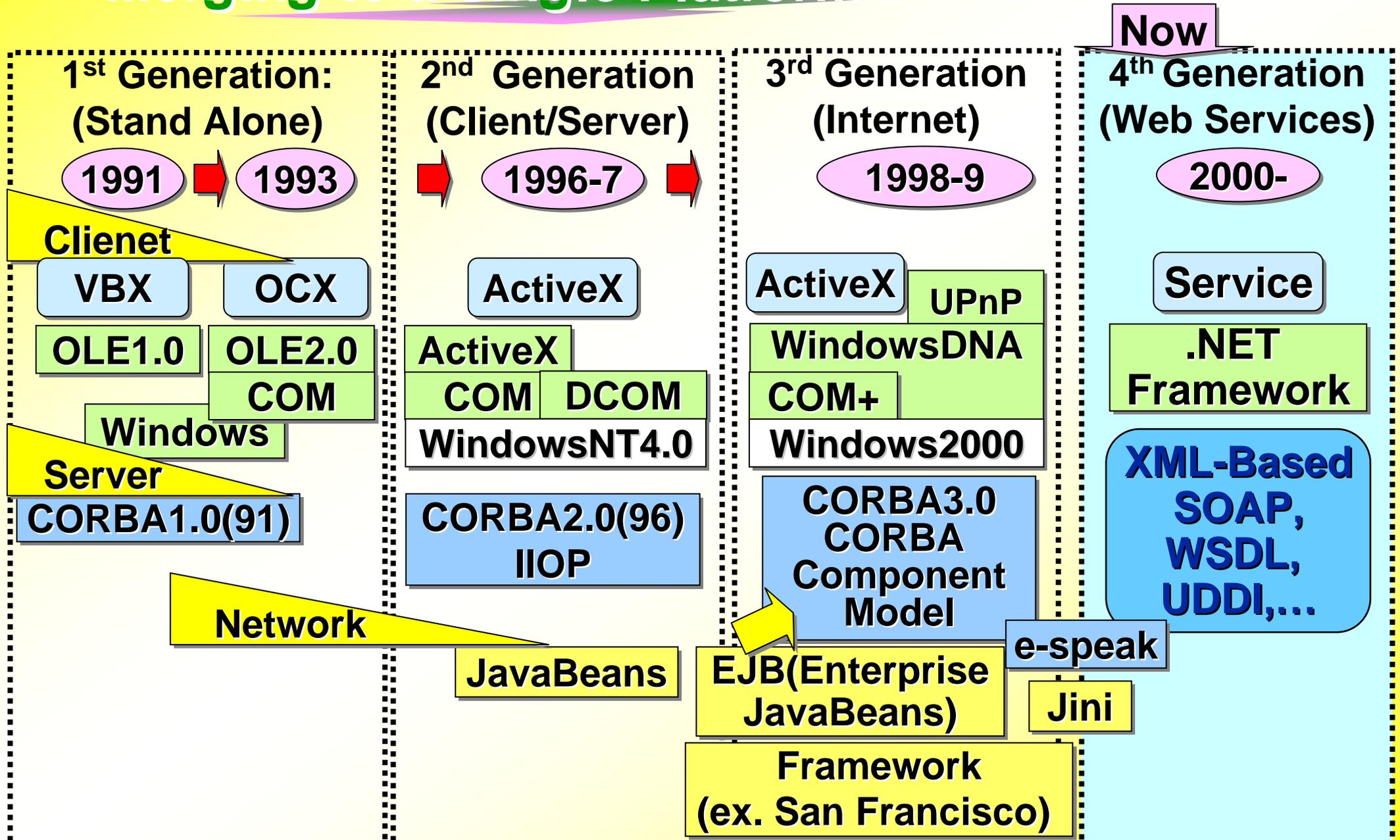
Technology: Evolution of Web Services From Object/Component to Web Services

Service=Encapsulation of Components



Technology: Evolution of Web Services

Merging to a Single Platform of Web Services



Technology: Evolution of Web Services Business/Social Rationale

👉 Single Common Ground

👉 IBM, Microsoft, Sun, Oracle, ...



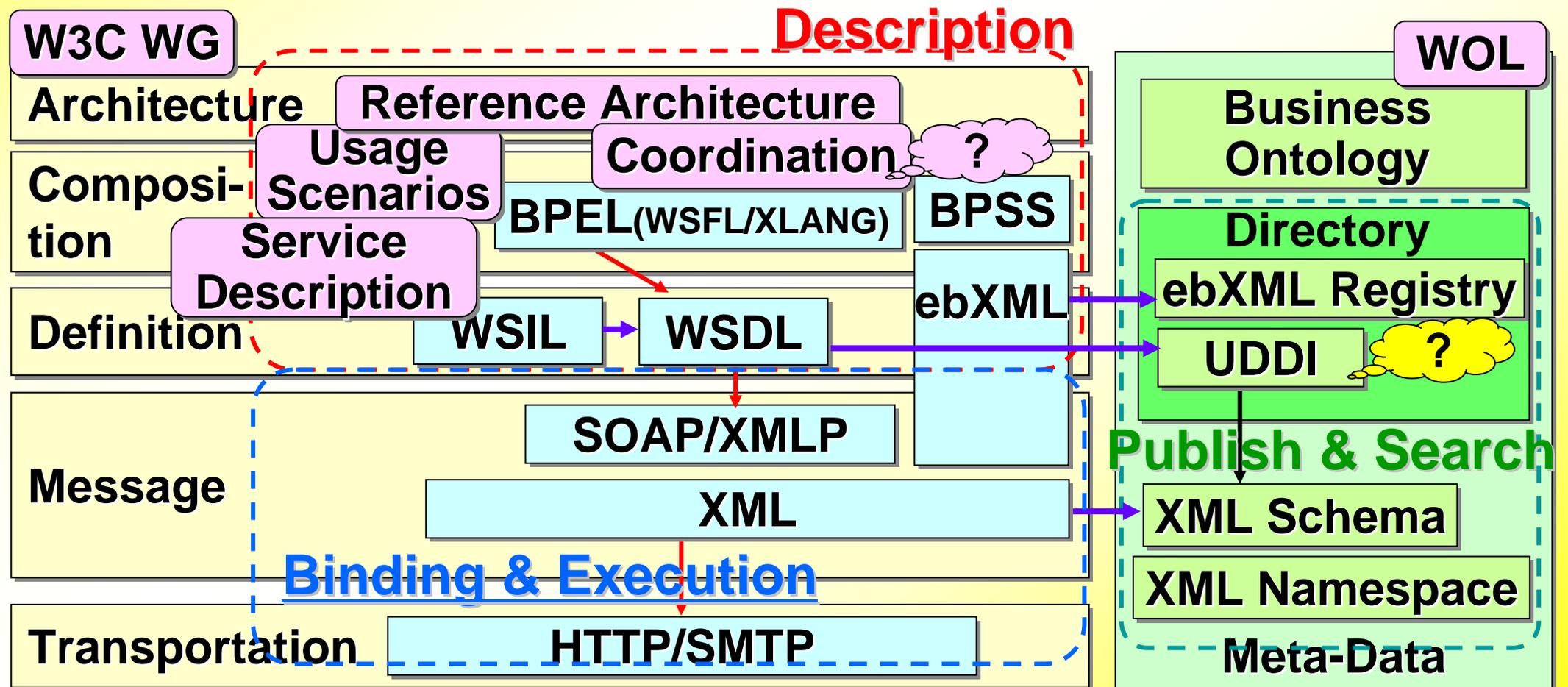
Technology: Evolution of Web Services

Web Services Platform Reaching a Maturity

Web Services Platform: 3 Major Technology Stacks

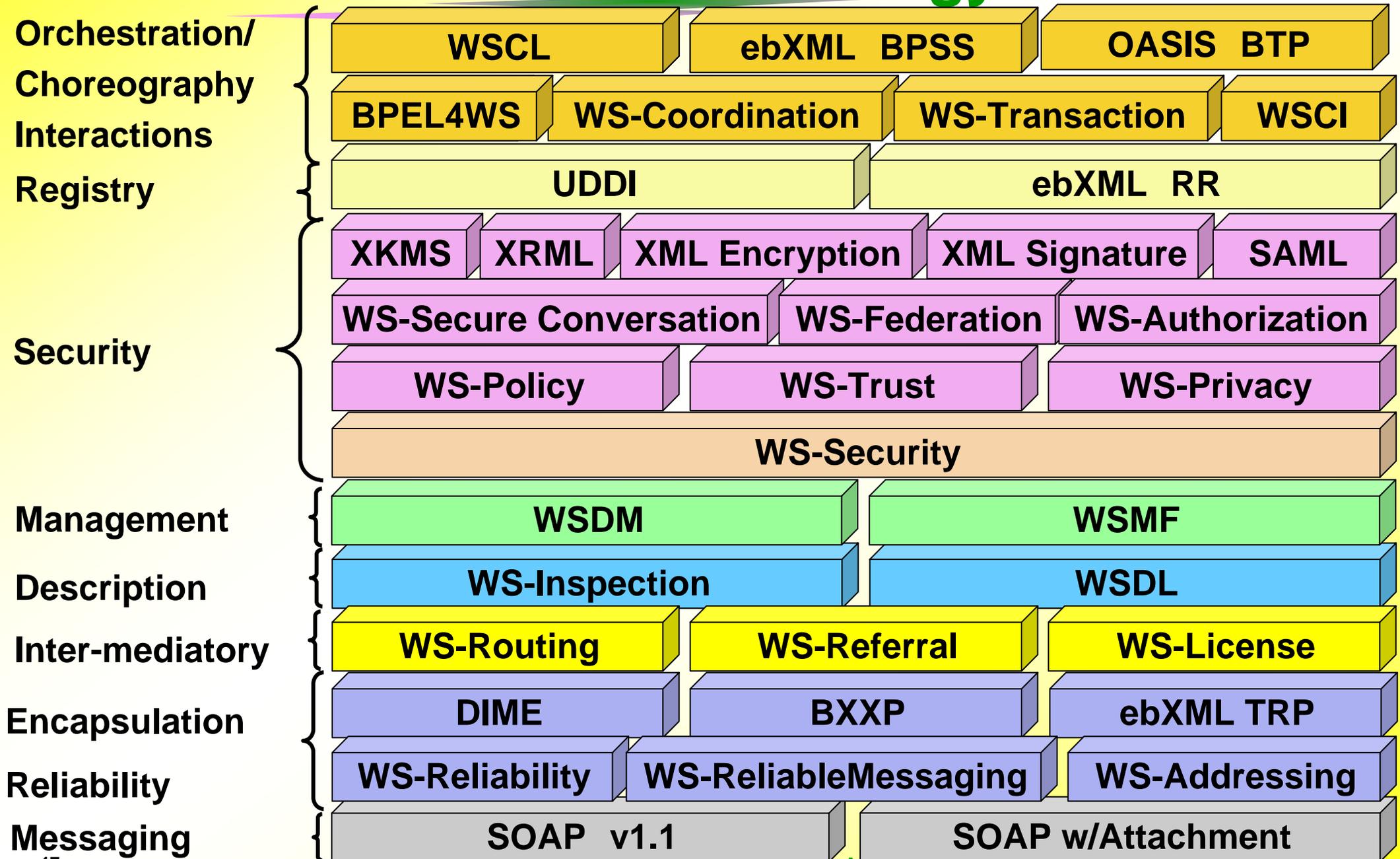
👉 **Description**, **Publish & Search**, **Binding & Execution**

Current Issues: Business Process Orchestration



Technology: Evolution of Web Services

Web Services Technology Stack



Technology: Evolution of Web Services

Essentials of SOA

☞ SOA: Architecture for Dynamic Collaboration

- ☞ Architecture: From Client/Server to Publish/Subscribe
- ☞ Program/Service Discovery: From Design-Time to Run-Time based on Semantic/Contents
- ☞ From Ownership to Usage

☞ Dynamic Discovery/Binding of Components/Services

- ☞ Component-Based: Run-Time Binding
 - ☞ Ex: DLL (Dynamic Link Library) on Windows
- ☞ Service-Oriented: Dynamic **Discovery** and Binding of Services

Technology: Evolution of Web Services

Implication of Publish/Subscribe Architecture

👉 Publish-Find-Bind Pattern

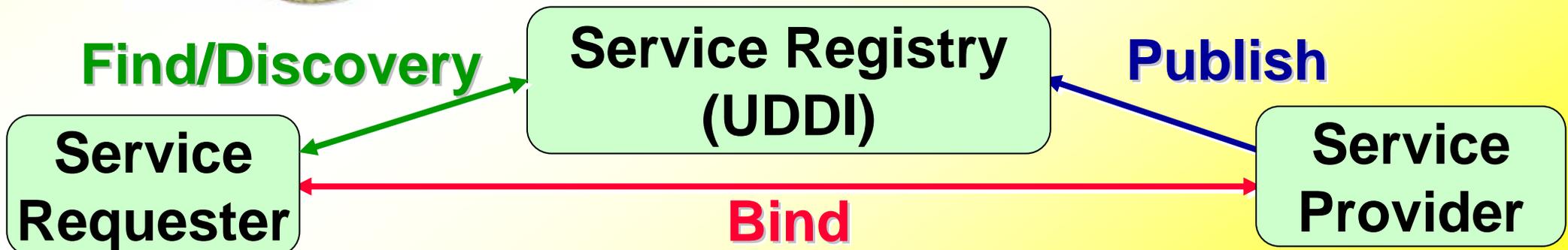
- 👉 Decoupling: No Direct Interactions between Requester and Provider
- 👉 Discovery at Run-Time (when Buying) rather than Design-Time (Plan)

👉 Analogy to Social Architecture

Consumer



Producer



Technology: Evolution of Web Services

Web Services Ecosystem

👉 Web Services Form an Ecosystem

👉 Diverse Services Emerging on the Web

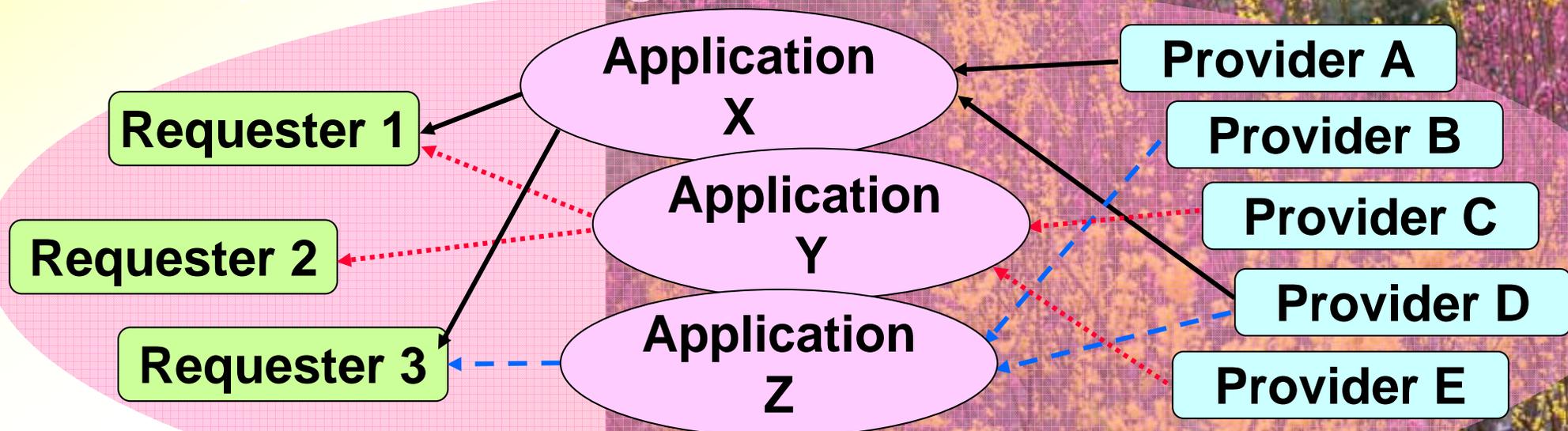
👉 Amazon, Google, Microsoft Office 2003 Research Service

👉 Application = Binding Services for Business

👉 Unlike Physical Ecosystems, Web Services are:

👉 Almost Free from Physical Constraints: Diversity, Scope

👉 Dynamic Changing at Real-Time



Web Services Ecosystem

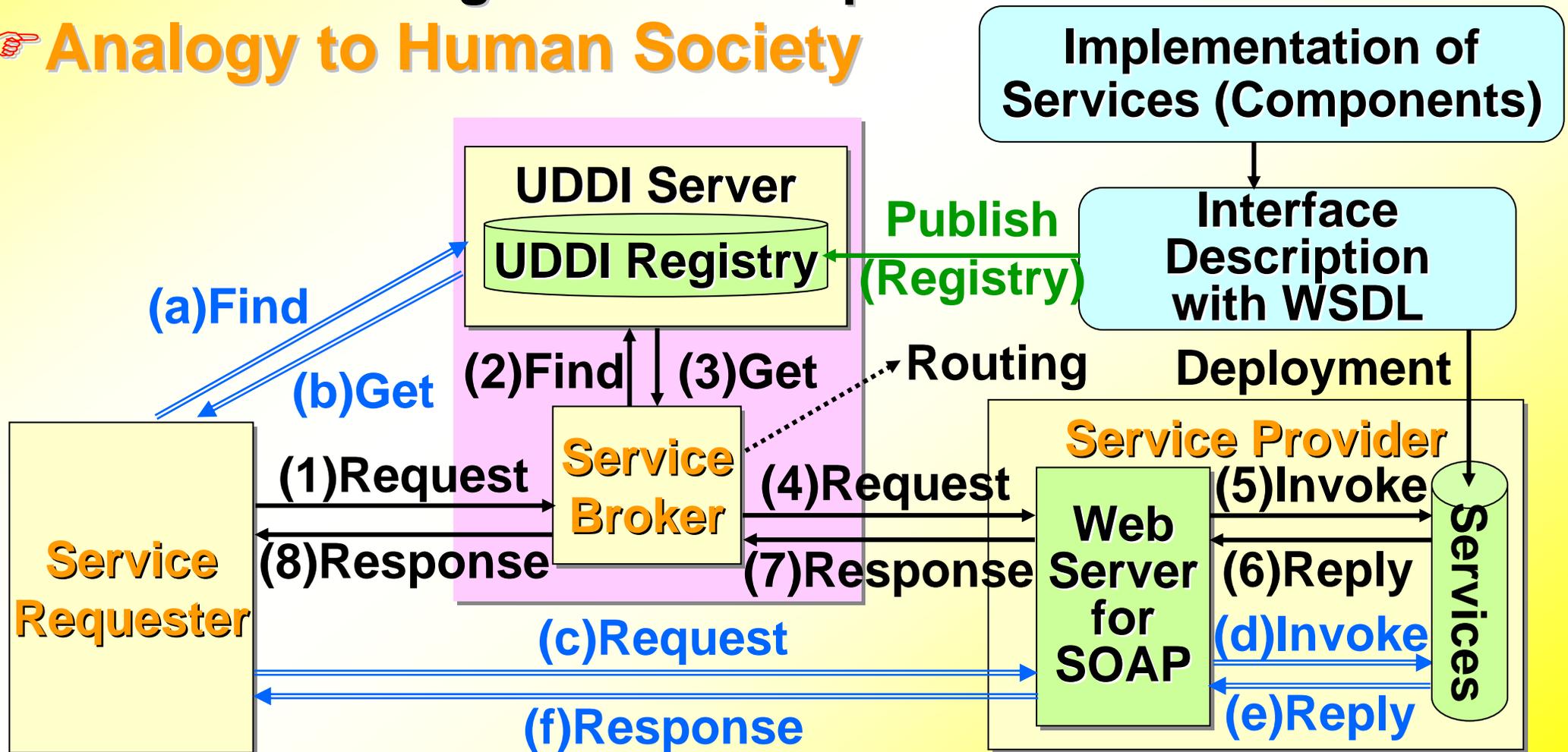
Technology: Evolution of Web Services

Broker Architecture on SOA

👉 Broker/Intermediary Architecture

- 👉 Decoupling between Requester and Provider
- 👉 Better Binding between Requester and Provider

👉 Analogy to Human Society



Scenario



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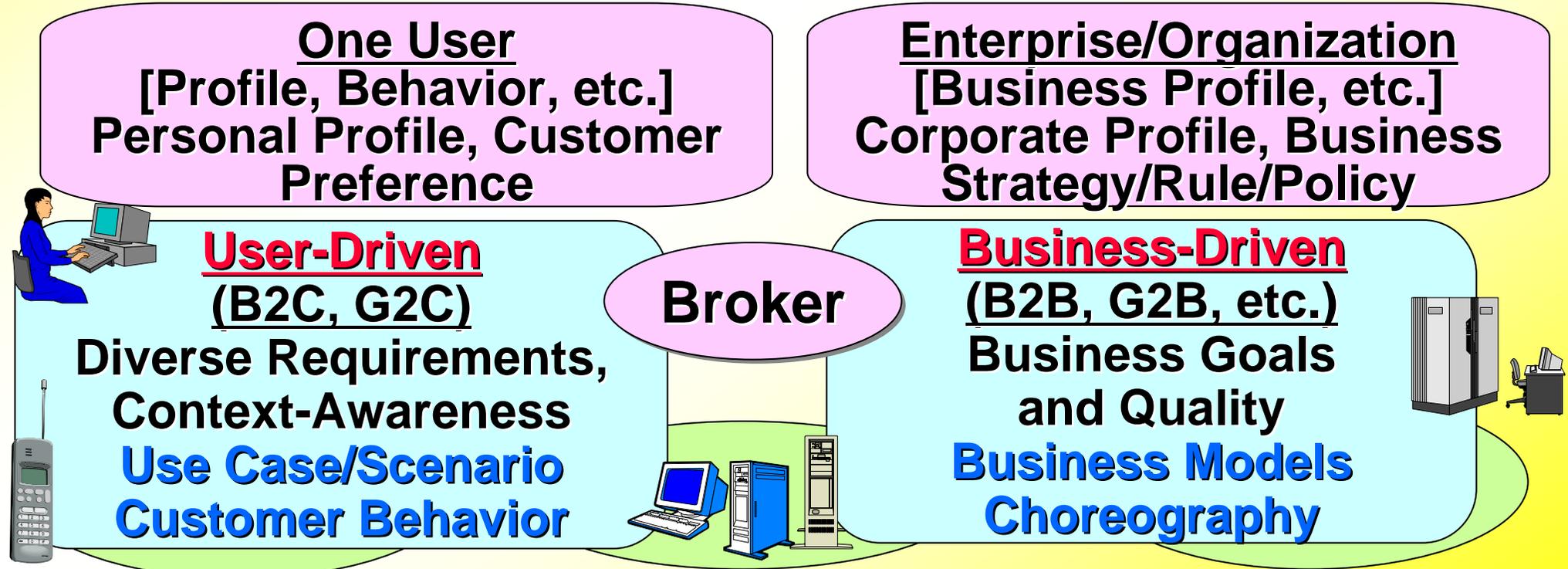
Research Challenges

Engineering: Web Services Engineering

User-Driven and Business-Driven

Two Ends

- 👉 **User-Driven: Diverse Requirements, Context-Awareness by Use Case/Scenario**
- 👉 **Business-Driven: Business Goals and Quality by Business Modeling (e.g. EA: Enterprise Architecture)**



Engineering: Web Services Engineering

Broker is the Key Player

👉 2 Roles of Broker

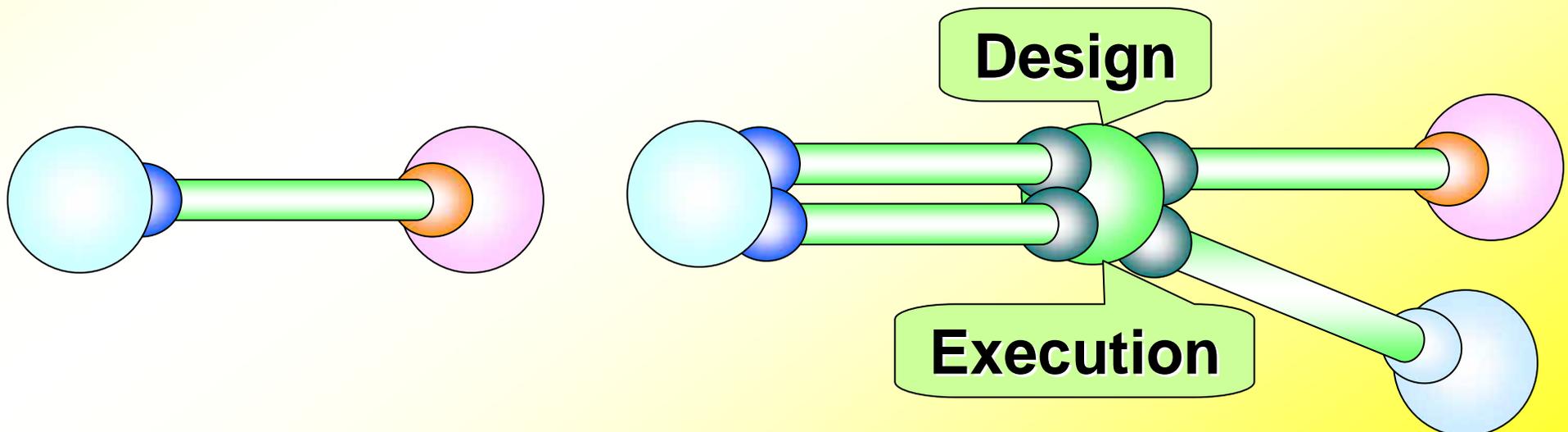
👉 (On Demand) Design: Find and Composition

👋 Find Qualified Web Services

👋 Composition and Evaluation

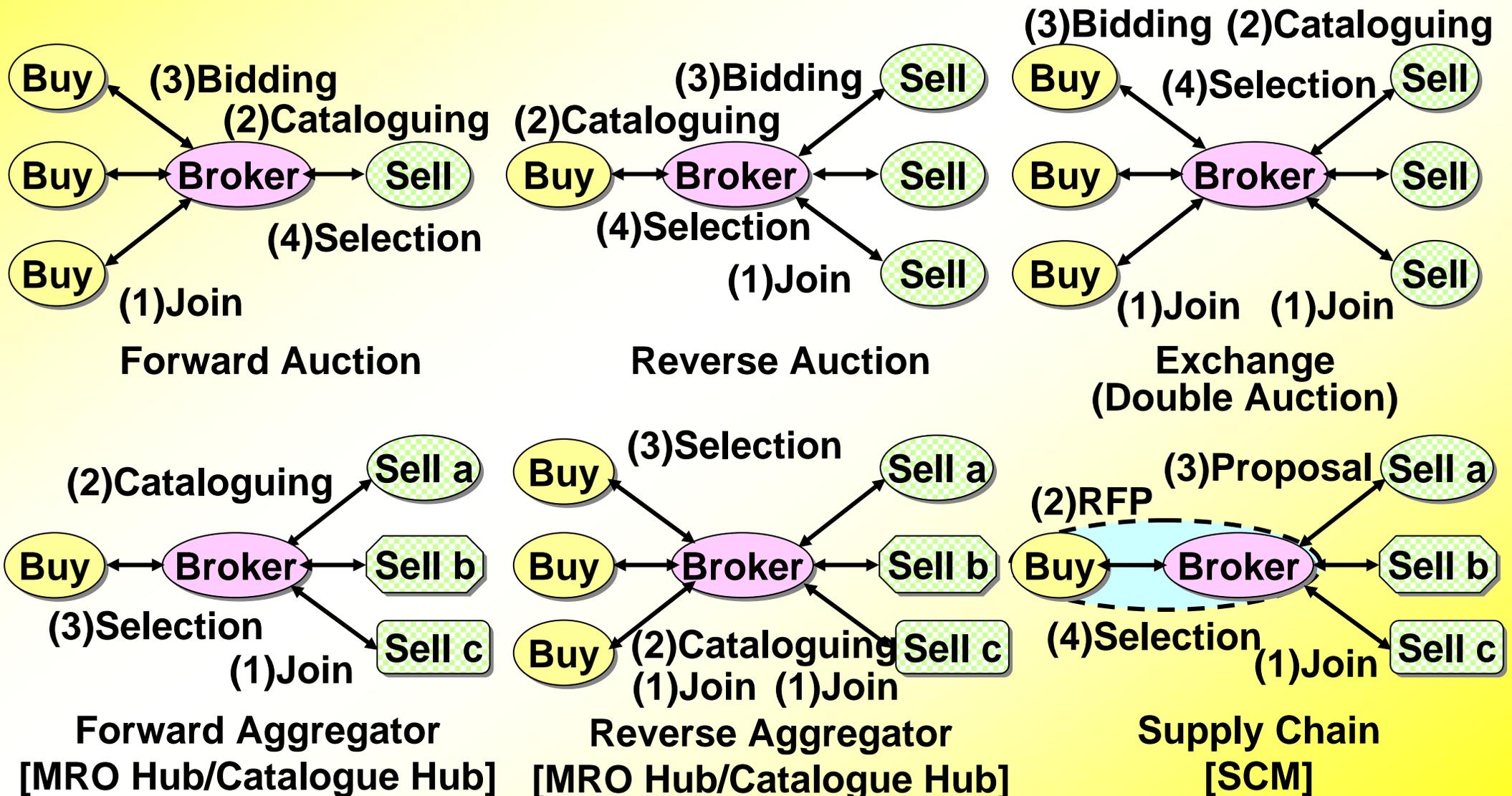
👉 (On Demand) Execution

👋 Execution, Control of Scope, Protocol Binding



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 e-Business Value Chain by Collaborating Brokers

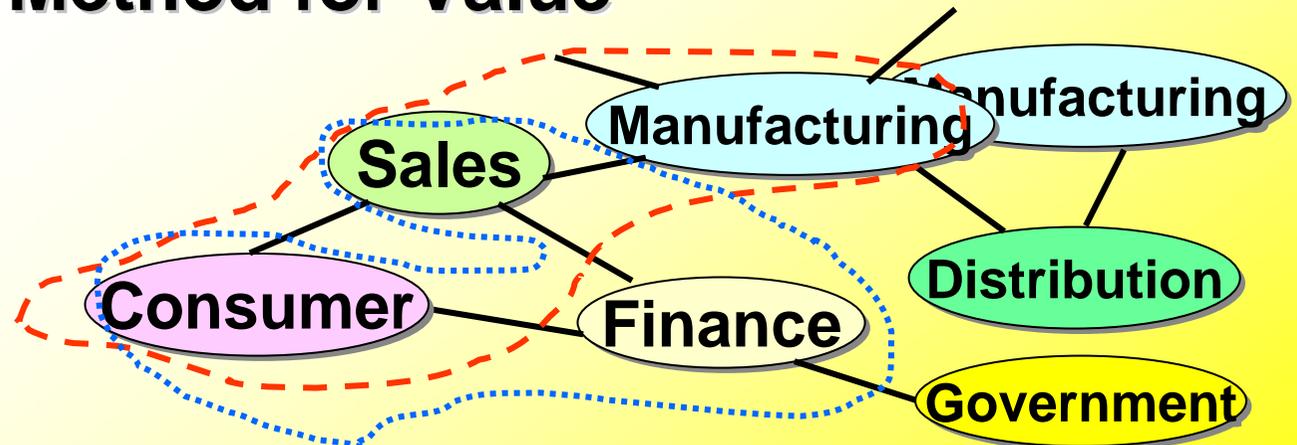
👉 e-Business Value Chain on the Web

- 👉 Dynamic Composition and Routing of Web Services
- 👉 Value Network: Collaborate Web Services to Augment Business Value

👋 Ex. Web Services Network: “Business Dial Tone”

👉 e-Business by Collaborating Brokers [Broker Network]

- 👉 Dynamics by Changing Collaboration Patterns
- 👉 Need Navigation Method for Value



Engineering: Web Services Engineering Drama(tic) Model for Collaborating Brokers

☞ **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**

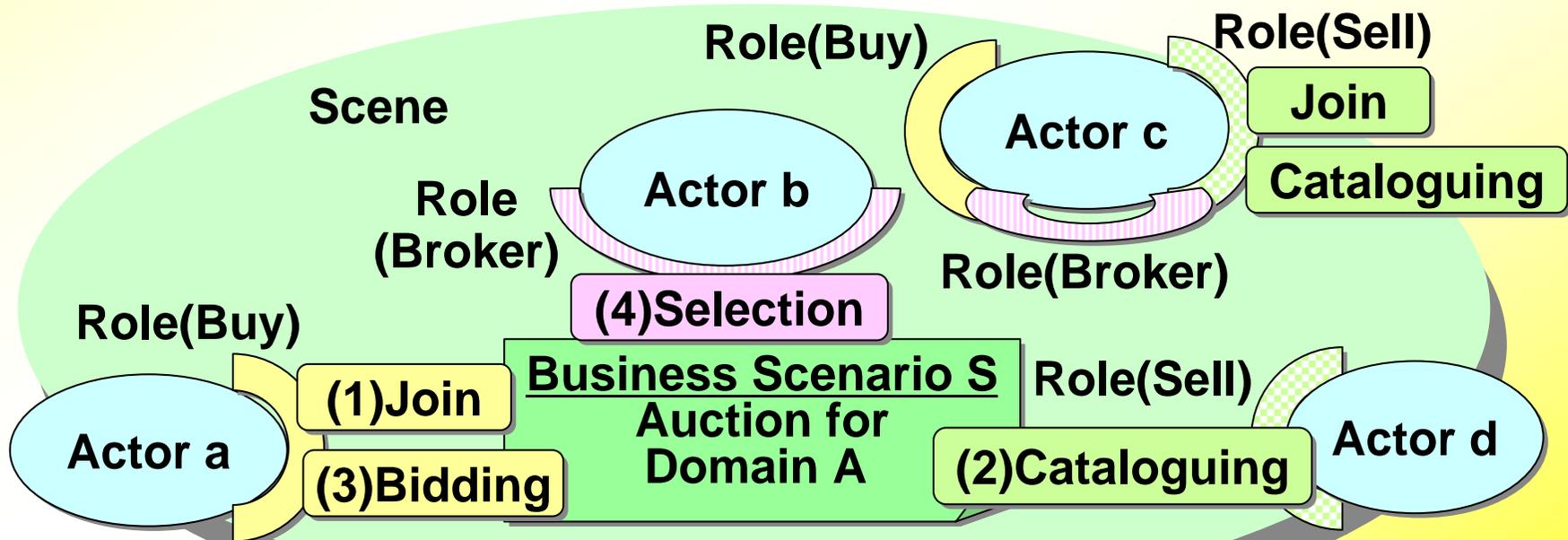
☞ **Service could be a High-Level Use Case**

☞ **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, pp. 225-228.

Engineering: Web Services Engineering Drama(tic) Model for Collaborating Brokers

- ➡ **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**



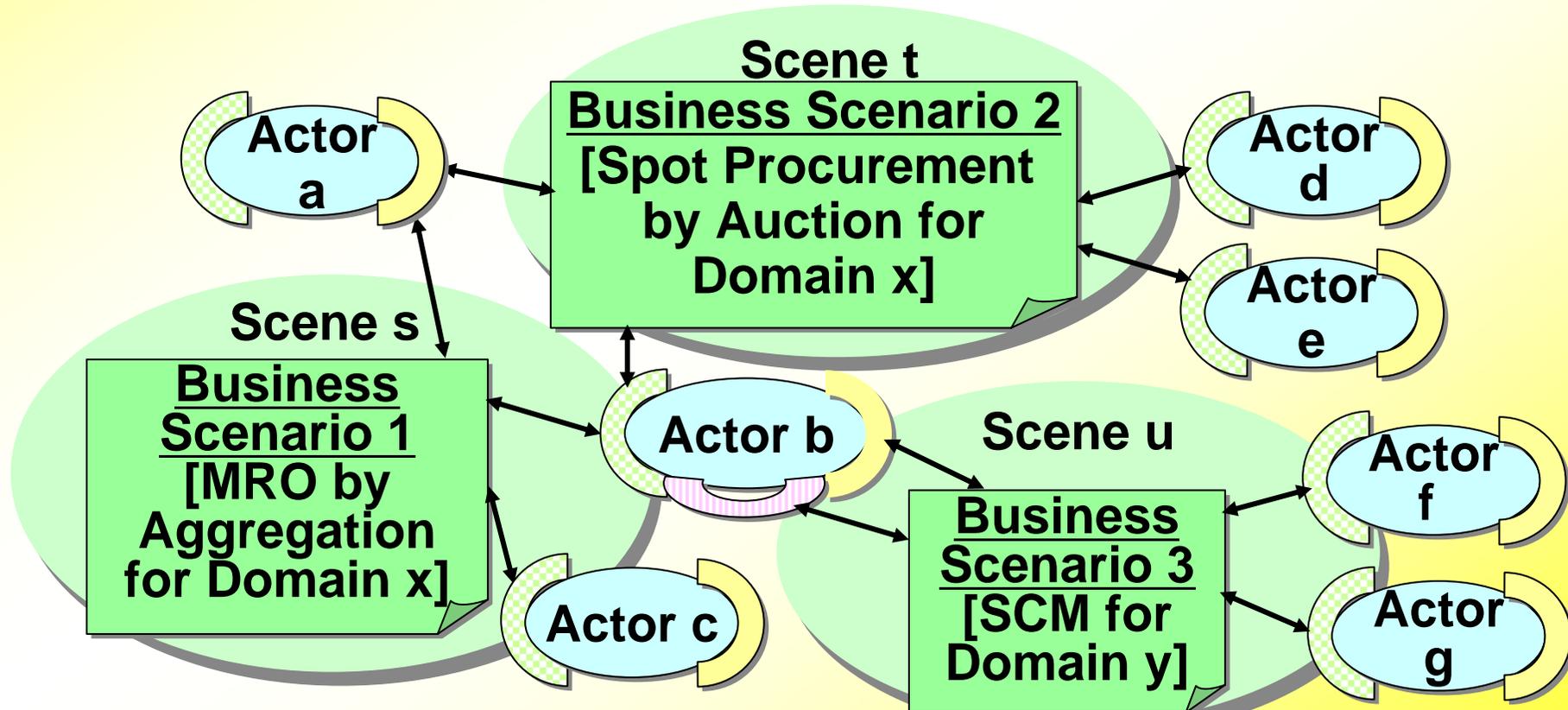
Engineering: Web Services Engineering Drama(tic) Model for Collaborating Brokers

Scenario 1&2: Service Aggregation

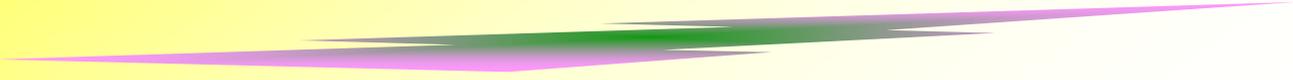
Composing MRO with Spot Procurement for Varying Demands

Scenario 3: Reduction

SCM: Actor b plays both Buyer and Broker



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Research Challenges

Value-Added Service Broker

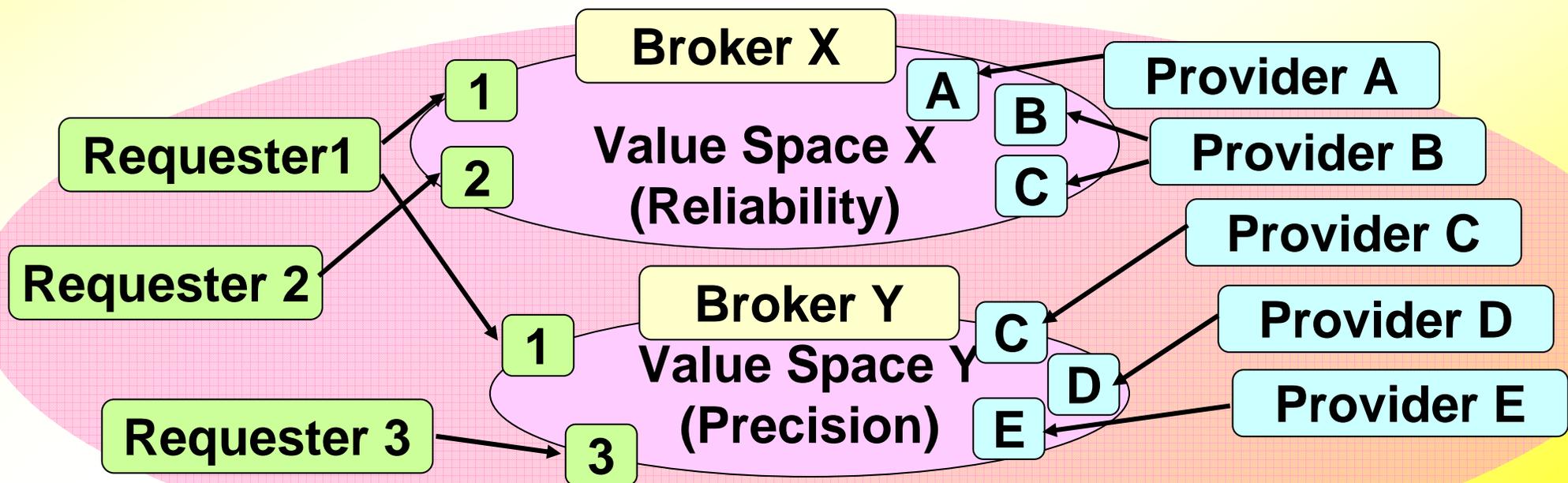
Binding Services by Value

Dynamic (Context-based) Composition by Value Spaces in Web Services Ecosystem

Local “Semantic” Space to Provide a Specific Value

Provide Service Attributes: QoS, SL (Service Level), etc

Composing the Services Based on the Value



Web Services Ecosystem

Value-Added Service Broker

Prototype of Value-Added Service Broker

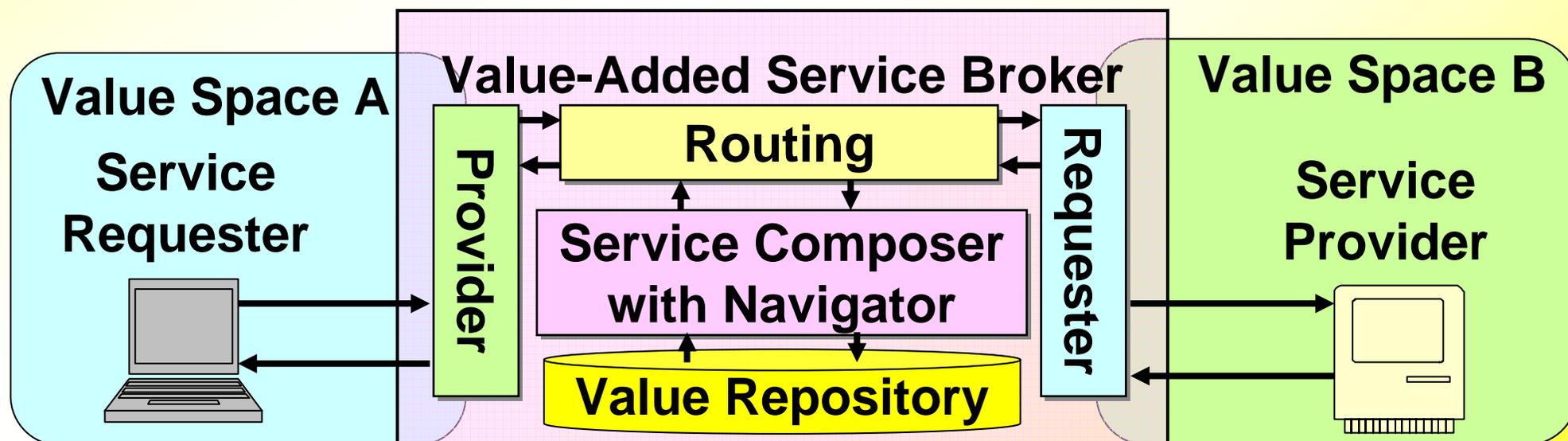
Value-Added Service Composition by Brokerage

Service Composer: Navigation of Composition Patterns by Value

Meta-model: Simple Ontology of Value

Content-Based Service Routing with WS-Routing

Extending SOAP Message and Rerouting by Broker



Value-Added Service Broker

Example: Dynamic Dictionary System

👉 Navigated Collaboration of 3 Dictionary Systems

👉 ICD Service by @IT: Dictionary Specific to IT

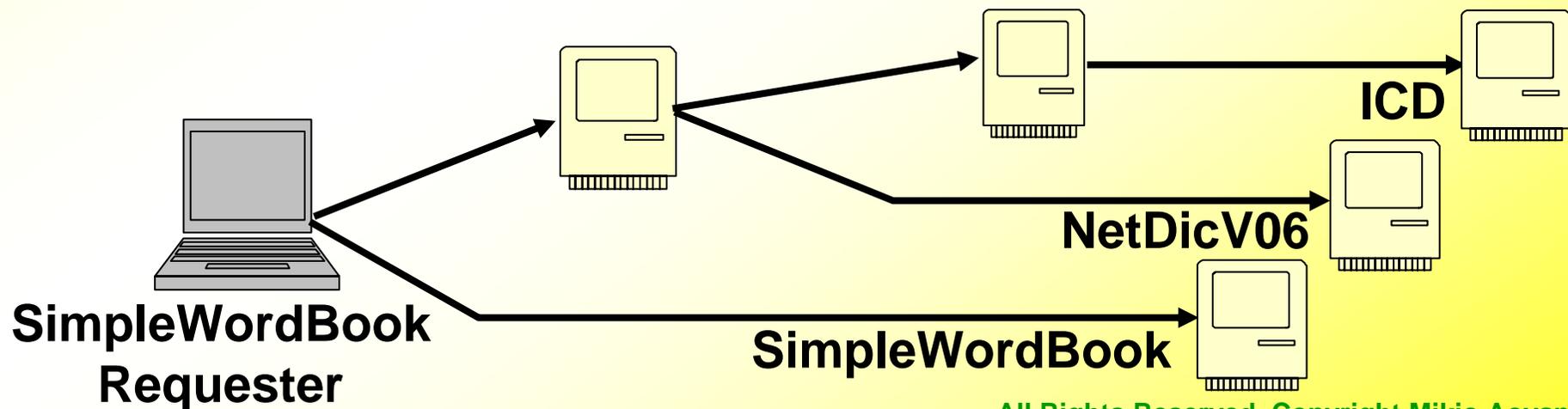
👉 Rich in IT Domain, but Narrow

👉 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

👉 Rich in Very Narrow Domain and Possible Incorrectness



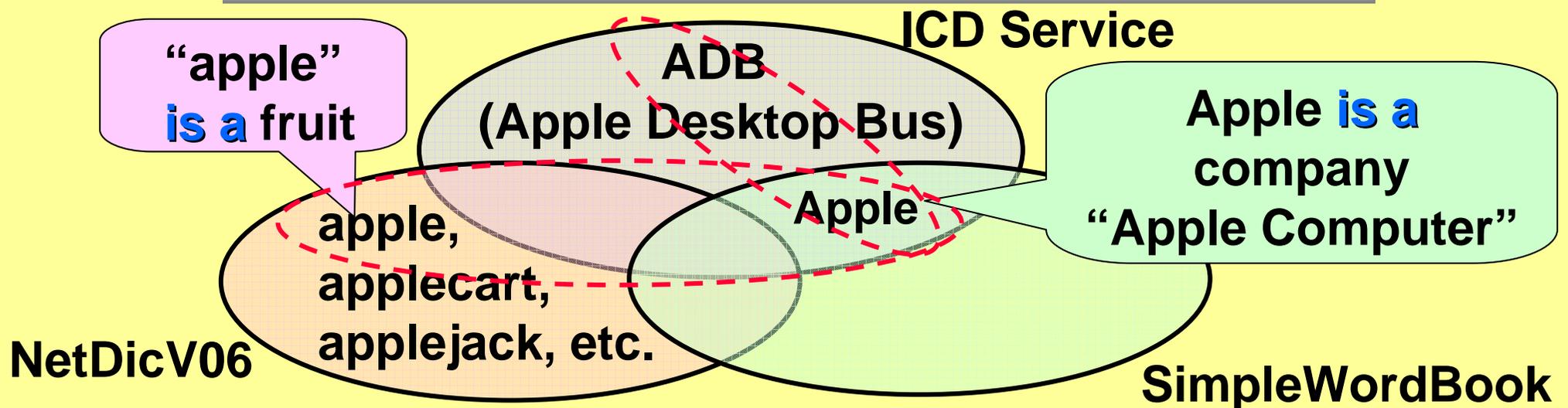
Value-Added Service Broker

Example: Dynamic Dictionary System

☞ 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

Example: Search of Words Including “apple”



Value-Added Service Broker

Example: Calculation System

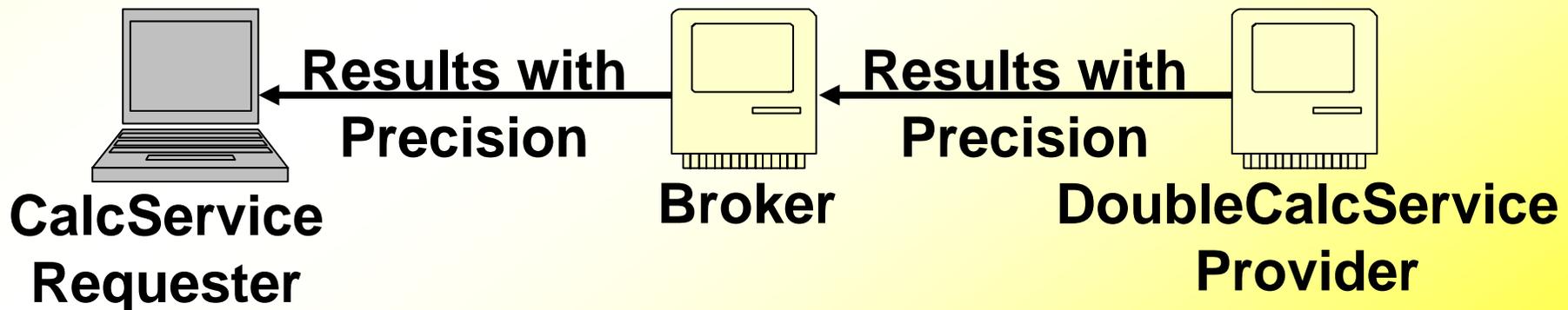
👉 Precision-Guaranteed Calculation System

👉 Combining Different Computing Services

👋 Ex. Specific Math Package

👉 Guarantee the Precision across End-to-End Processing

👋 Ex. Data Type Conversion: Integer and Double



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Research Challenges

Research Challenges Platform Technology

“2nd Generation”: From Web Services to SOC

Extension of Platform Computing Architectures

 Peer Services and Service Grid: Symmetric Web Services

 Mobile Services

Overcome Vulnerability and Cost of Decentralization

 Security, Safety and Trust

 (Long-Life) Transactions and Performance

Migration of Legacy Applications and Components to SOC

 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

👉 SOA

👉 Broker Architecture

👉 Design for Non-Functional Requirements

👉 SLA (Service Level Agreement) and SLM

👉 AOSD (Aspect-Oriented Software Development)

👉 Security, Safety and Truth

👉 Better Integration of Semantics: Ontology and Semantic Web

👉 (Business) Ontology, Domain Engineering

Summary

Web = New Computing Model

 **Creating a New Layer of “Computing”=Service/SOC**

 **Collaboration is the Key**

Web Services Technology

 **Rapid Advancement of Platform Technology**

 **Business Orchestration is the Issue**

Need of Web Services Engineering

 **Engineering on SOA and Broker Architecture**

Semantic Web Services

 **Integration of SOC/SOA and Semantic Web**

Sense of Beauty in Design

Diversity and Balance/Collaboration



Thank You

Questions ?