SOA Research Agenda

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Hard Problems in SOA Workshop
January 30, 2008

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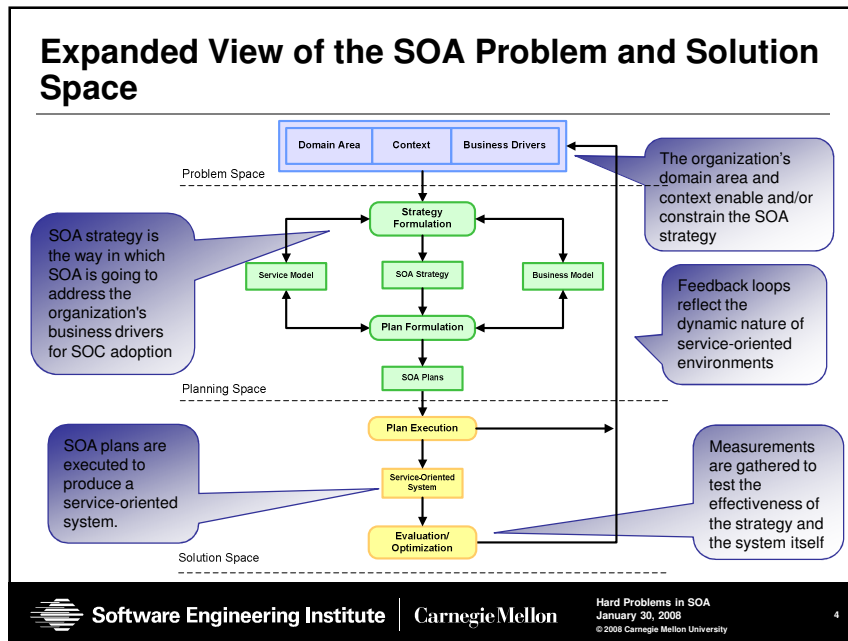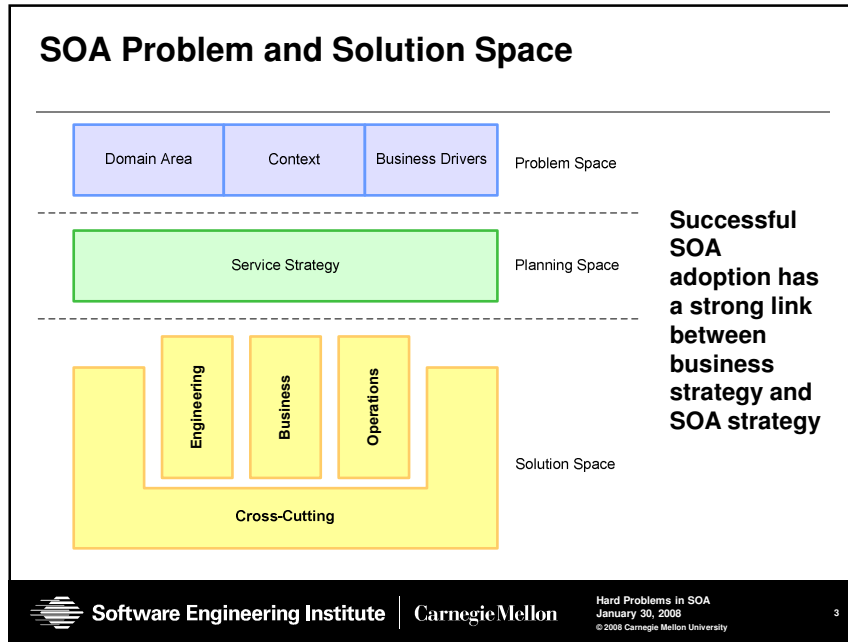© 2008 Carnegie Mellon University

Approach

- Broadened the scope of the research agenda to show that we are interested in more than just SOA as an architectural style

- Performed an extensive literature review and looked at case studies of successful SOA adoption

- Created a service-oriented system development lifecycle that supports the strategic approach to SOA adoption shown in case studies

- Identified areas of SOA research necessary to fill in the gaps

- Validated end evolved finding through multiple workshops and interviews

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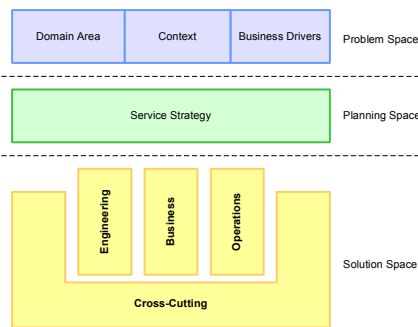© 2008 Carnegie Mellon University

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SOA Problem and Solution Space

| Domain Area | Context | Business Drivers | Problem Space |

| Service Strategy | Planning Space |

Engineering

Business

Operations

Cross-Cutting

Solution Space

Successful SOA adoption has a strong link between business strategy and SOA strategy

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Expanded View of the SOA Problem and Solution Space

| Domain Area | Context | Business Drivers |

Problem Space

Strategy Formulation

Service Model — SOA Strategy — Business Model

Plan Formulation

SOA Plans

Planning Space

Plan Execution

Service-Oriented System

Evaluation/ Optimization

Solution Space

The organization's domain area and context enable and/or constrain the SOA strategy

SOA strategy is the way in which SOA is going to address the organization's business drivers for SOC adoption

Feedback loops reflect the dynamic nature of service-oriented environments

SOA plans are executed to produce a service-oriented system.

Measurements are gathered to test the effectiveness of the strategy and the system itself

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Mapping Between Phases, Activities and Indicators

PHASES	P1: Analysis	P2: Positioning	P3: Assessment	P4: Planning	P5: Construction	P6: Transition	P7: Production
ACTIVITIES							
A1: Business Objectives Specification	+++	++	+				++
A2: Business Intelligence and Information Gathering		+++	+	++	+		
A3: Risk Analysis	++		+++	+++	++	+	
A4: Prototyping				++	+		
A5: Implementation				+	+++	++	
A6: Integration					++	+++	++
A7: Adoption						++	+++
A8: Maintenance						+	++
A9: Management						++	+++
INDICATORS							
I1: Financial Indicator Measurements	++		+	+++			
I2: Technology Indicator Measurements			+	++	++	+	++
I3: User Rating Measurements						++	+++
I4: Compliance Indicators	+			++	+	++	+++

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Relationship between Solution Space and Research Topics

| Domain Area | Context | Business Drivers | Problem Space |

Service Strategy — Planning Space

Engineering | Business | Operations
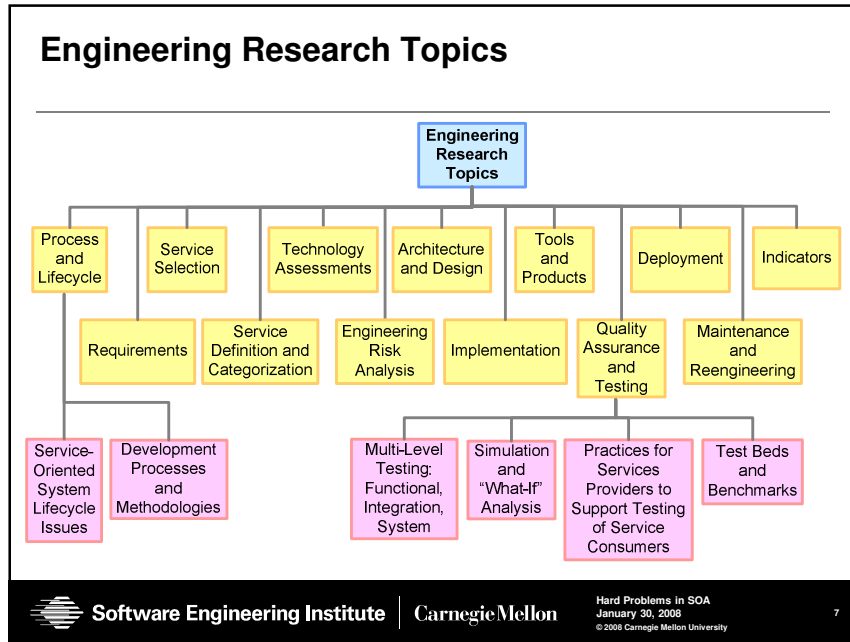Cross-Cutting — Solution Space

The development of a service-oriented system requires business, engineering and operations to be made, as well as other cross-cutting decisions.

Our proposed taxonomy of research topics is divided into these decision areas.

The research topics correspond to areas where new/more/different research is needed to support a strategic approach to service-oriented systems development

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Engineering Research Topics

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                              Engineering
                               Research
                                Topics

  Process      Service     Technology    Architecture    Tools         Deployment      Indicators
  and          Selection   Assessments   and Design      and
  Lifecycle                                               Products

               Requirements  Service     Engineering    Implementation  Quality        Maintenance
                             Definition and  Risk                        Assurance      and
                             Categorization  Analysis                    and            Reengineering
                                                                         Testing

  Service-     Development                 Multi-Level    Simulation     Practices for   Test Beds
  Oriented     Processes                   Testing:       and            Services        and
  System       and                         Functional,    "What-If"      Providers to    Benchmarks
  Lifecycle    Methodologies               Integration,   Analysis       Support Testing
  Issues                                   System                        of Service
                                                                         Consumers
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Development Processes and Methodologies—Rationale

Development processes and methodologies have to deal with a very dynamic SOA environment—market, business processes, technology

- State of "Perpetual Beta"—though we do not like the term, it does indicate constant evolution

More and more SOA-based development is concerned with security and governance—how does this fit into processes?
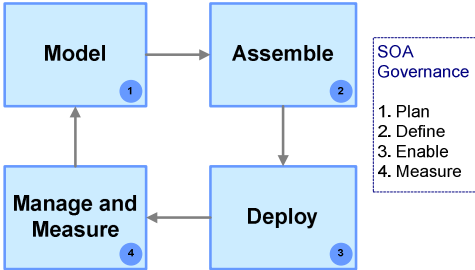
- Policy-Driven Development—following policies through to deployment

SOA is business-driven and demand-driven

- Business-Driven Development—business requirements drive service design and construction
- Business-Process Oriented Development

SOA is more about reuse and less about development

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Development Processes and Methodologies—Current Efforts

Model → Assemble

SOA Governance
1. Plan
2. Define
3. Enable
4. Measure

Manage and Measure ← Deploy

Application lifecycle management and integrated development environments are incorporating SOA lifecycle elements

Integration between Business Process Modeling (BPM) and SOA

SEI is working on CMMI-SVC—applies to service providers in general

Most agree that SOA lifecycle models should parallel SOA Governance issues and concerns

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Development Processes and Methodologies—Challenges and Gaps

There is some work that makes the distinction between service provider and consumer, but most development processes are targeted to single-organization development environments

Software development processes for SOA environments have been identified, but there are few concrete processes

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System Testing—Rationale

In SOA environment, system testing means end-to-end testing

The problem is that in SOA environments, systems components are distributed, deployed on heterogeneous platforms, and often not even available

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System Testing—Current Efforts

Tool vendors provide multi-layer and multi-attribute testing

- Business process, messages, service, regression
- Interoperability, performance, load, vulnerability

Most testing tools are incapable of building composite interdependent tests across technology platforms, languages and systems

Most testing tools assume control over all elements of the service-oriented system

- Sometimes client developers typically only have access to interfaces (e.g. WSDLs) and lack access to code
- Some research into use of gray-box testing (limited knowledge)

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System Testing—Challenges and Gaps

Dynamic testing in distributed, heterogeneous environments

Service certification

- What does a certification process look like? What can be certified?

Enhanced service repositories that provide test cases for services

- How are test cases specified?

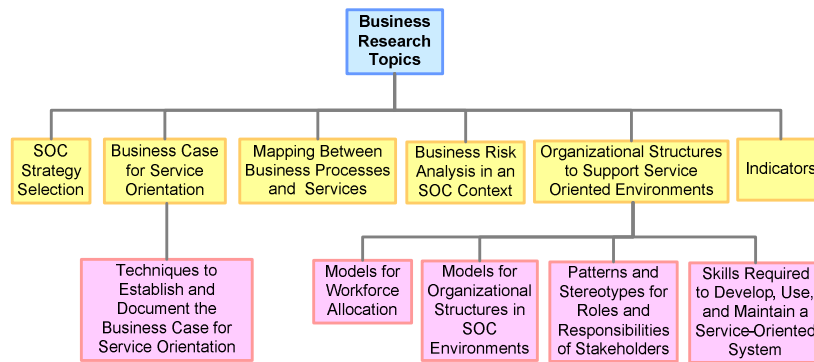Test-aware interfaces for service consumers to test services

- Requires providers to have test instances of services

Maybe the solution is to accept that it is not possible and prepare for the fact that you can't always do end-to-end testing?

- Simulations
- Best practices for exception handling

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Business Research Topics

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                    Business
                    Research
                    Topics
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| SOC Strategy Selection | Business Case for Service Orientation | Mapping Between Business Processes and Services | Business Risk Analysis in an SOC Context | Organizational Structures to Support Service Oriented Environments | Indicators |

Techniques to Establish and Document the Business Case for Service Orientation

Models for Workforce Allocation

Models for Organizational Structures in SOC Environments

Patterns and Stereotypes for Roles and Responsibilities of Stakeholders

Skills Required to Develop, Use, and Maintain a Service-Oriented System

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Business Case—Rationale

At a high level there is recognition that SOA can provide business agility, adaptability, legacy leverage, and integration with business partners

Given these goals, an important criterion for making business decisions concerns the amount of investment that is required for SOA adoption and the projected payoff over a certain period of time

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Business Case—Current Efforts

Current work identifies the business value of SOA

- E-Commerce (Tilley et al, 2003)
- Enterprise Application Integration (Tilley et al, 2003)
- E-services (Messinger et al, 2006)
- Case studies provide anecdotal evidence of value
- Self-service Technology (Pujari, 2004)
- Banking (Australian, US, Finnnish cases)
- Online services (Zeithaml et al, 2005)

These are examples of point solutions

A comprehensive framework for understanding the business value of SOA has not yet been developed

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Business Case—Challenges and Gaps

More vendor-neutral data needs to be gathered

- Current efforts have focused on individual case studies
- There have not been analyses that can be generalized
- There is a lack of rigor in current analyses

What is the nature of the data that needs to be gathered?

- What constitutes a successful SOA implementation?
- How is ROI measured?
  - How to measure the abstract benefits of SOA? Infrastructure consolidation? Server and application virtualization? Cost of service reuse? Business agility?
  - Are there common elements that can be identified between ROI case studies?
- There is not a commonly agreed upon framework for operationalizing benefits

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Organizational Structures—Rationale

Moving toward a service-oriented environment is a cultural shift for organizations

- Especially if there has not been a business process focus

Require restructuring of business as well as IT organizational structures

Organization structure will drive roles and responsibilities, budget and development

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Organizational Structures—Current Efforts

Very little evidence in the public domain that organizations have gone too far on the SOA path

- Most SOA case studies are pilot efforts or internal integration projects

Some enterprises are doing their own restructuring and creating their own organizational structures

- Several success stories have indicated a reorganization around business processes and the importance of business process owners

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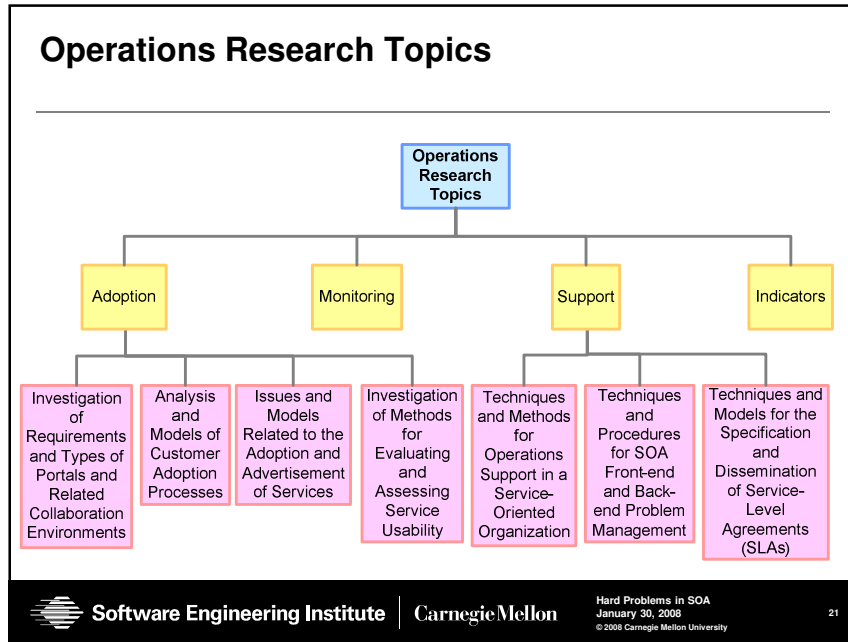## Organizational Structures—Challenges and Gaps

Inside an enterprise, services will be consumed across various lines of business (LOB)

Need to answer the following questions:

- How does having shared services change the existing organizational structure inside an enterprise?
- Who funds these shared services?
- Who owns these shared services and is responsible for creating and maintaining them?
- Are there variations between effective organizational structure by organization type, domain and culture?

Best practices and guidelines are needed that are based on success stories (in specific domains) and can be leveraged by other organizations

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Operations Research Topics

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                              ┌─────────────┐
                              │ Operations  │
                              │  Research   │
                              │   Topics    │
                              └─────────────┘
        ┌──────────────┬──────────────┬──────────────┐
   ┌─────────┐    ┌──────────┐   ┌─────────┐   ┌──────────┐
   │ Adoption│    │Monitoring│   │ Support │   │Indicators│
   └─────────┘    └──────────┘   └─────────┘   └──────────┘
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| Investigation of Requirements and Types of Portals and Related Collaboration Environments | Analysis and Models of Customer Adoption Processes | Issues and Models Related to the Adoption and Advertisement of Services | Investigation of Methods for Evaluating and Assessing Service Usability | Techniques and Methods for Operations Support in a Service-Oriented Organization | Techniques and Procedures for SOA Front-end and Back-end Problem Management | Techniques and Models for the Specification and Dissemination of Service-Level Agreements (SLAs) |

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Service Level Agreements (SLA)—Rationale

Formal and bilateral contract between service provider and consumer to specify the requirements and uses of specific services

Essential for establishing trust between service providers and service consumers

Can be used to differentiate and select from various available services in a competitive market

Can help service providers anticipate demand and plan their resource allocation accordingly

Can be used a mechanism for risk mitigation

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Service Level Agreements—Current Efforts

Web Service Level Agreements (WSLA) is a specification and reference implementation by IBM

CBDI provides basic guidance on how to approach SLAs

- From a service consumer and from a service provider perspective
- More high-level than the WSLA approach

Active research in the area of modeling and implementing various quality of services (QoS) in service-oriented and dynamic environments

- Most SLAs are based on specifying the required QoS

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Service Level Agreements—Challenges and Gaps

Creating a generic and standardized framework for service level management across enterprises as well as across various lines of business inside an organization

Providing appropriate automation and support for

- Mapping contractual service level agreements to standard and actionable implementations
- Monitoring and management of service level at runtime

More work needs to be done in understanding QoS of composite services, especially when lower level services in a composite service are provided by different providers

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Service Usability—Rationale

A market of third-party service brokers and providers is emerging

In this service market, the characteristics that make a service more or less attractive are unclear. These characteristics can include:

- Capabilities
- SLAs
- Usability

The characteristics that make a service more usable or less usable are also unclear. These can include:

- Interface design
- Options in message protocols, language and others
- Add-ons such as test cases and test instances
- Metadata

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Service Usability—Current Efforts

Many guidelines for service interface design have been published

- Good service interface design does not necessarily map directly to usability—a very good but complex service may not promote usability

Concept of service usability and user-centered service design is starting to emerge—involvement of service consumer in service interface design

- Similar to work of Jakob Nielsen, Larry Constantine, and others on user-centered design and usability techniques
- The ability to establish user-centered services is more complex in large organizations or groups of organizations where service developers do not have access to service consumers

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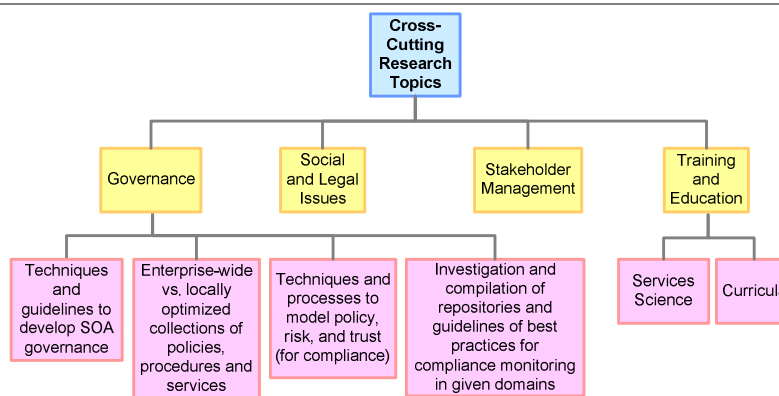© 2008 Carnegie Mellon University

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Service Usability—Challenges and Gaps

- What characterizes usability in a service-oriented context?

- What are lessons learned from user interface design and user-centered design that can be applied to service interface design?

- What does the service market look like?

  - What are service consumers looking for?

- How can these issues be captured and embedded in best practice for service engineering?

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Cross-Cutting Research Topics

Cross-Cutting Research Topics

Governance	Social and Legal Issues	Stakeholder Management	Training and Education

| Techniques and guidelines to develop SOA governance | Enterprise-wide vs. locally optimized collections of policies, procedures and services | Techniques and processes to model policy, risk, and trust (for compliance) | Investigation and compilation of repositories and guidelines of best practices for compliance monitoring in given domains | Services Science | Curricula |

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SOA Governance—Rationale

Business and IT managers cite the need for effective governance as a key enabling factor for additional progress

Effective SOA governance requires rules that

- Define roles and responsibilities
- Define appropriate use of standards
- Make explicit the expectations of a diverse set of stakeholders
- Provide for service level agreements
- Monitor compliance through metrics and automatic recording and reporting

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SOA Governance—Current Efforts

A number of organizations have developed sophisticated models of SOA governance (IBM, AgilePath, Software AG)

These models focus on

- Relationship to corporate enterprise architecture
- Use of registries
- SOA lifecycle management
- Defining and monitoring service level agreements (SLAs)
- Defining and analyzing metrics on policy enforcement, effectiveness of services and use of services

A number of tools have begun to automatically incorporate metrics and aspects of governance

Research efforts have begun to identify roles and responsibilities

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SOA Governance—Challenges and Gaps

- Current efforts are a starting point
    - However, they are still vendor-driven
- Current case studies are anecdotal and idiosyncratic
- There is not an abstract model for SOA governance and its variations within different situations

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Services Science—Rationale

Services science is a concept that merges technology with an understanding of business processes and organization, an identification of critical problems, and the tools that can be applied to correct them

The term was coined by IBM. It applies to services in general. It is becoming accepted in industry and the academic world as an area of active research

- SSME (Services Science, Management and Engineering)

It recognizes the move from an agrarian-based to a manufacturing-based to an information-based economy

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Services Science—Current Efforts

SSME educational programs have begun at universities in the US, Canada, Brazil, UK, Finland, Sweden, Israel, China, and Hong Kong

- Is it just the next "cool program"?

Research Manifesto for Services Science (Chesbrough & Spohrer) poses a challenge for services science:

- The need for a unified model for service innovation

The Emergence of Service Science (Spohrer & Maglio) calls for a research agenda to understand service system evolution

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Services Science—Challenges and Gaps

How does services sciences fit into already "packed" curricula in computer science, business, and IT curriculums?

- Skills include business and information technology, as well as the human factors that go into a successful services operation
- What programs does it fit better in?
- Are new cross-disciplinary programs needed?

What SOA-specific aspects can be extracted from services science?

How can these aspects be operationalized?

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Conclusions on Key Challenges [1]

Engineering challenges are significant if SOA is to be used in "advanced ways"

- Semantics
- Dynamic discovery and composition
- Real time applications

Main challenges for enterprise applications are related to business and operations, and not engineering. As third-party services become the new business model, there needs to be support for

- Service-level agreements
- Runtime monitoring
- End-to-end testing involving third parties
- Pricing models for third-party services
- Service usability—from a design and an adoption perspective

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Emerging Business Model: Third-Party Services

- SEEC Inc—insurance and financial service provider (http://www.seec.com)
- Amazon Web Services—services for businesses, consumers, Amazon associates, sellers, and other developers (http://www.amazon.com)
- IBM SOA Business Catalog—SOA assets in general (http://catalog.lotus.com)
- StrikeIron—data service broker (http://www.strikeiron.com)
- Programmable Web—Web service catalog and mashup toolbox (http://www.programmableweb.com)

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Conclusions on Key Challenges 2

There are some areas where what is needed is not more basic research, but rather non-vendor surveys, studies and experiments to produce more concrete guidance

- SOA governance
- Business case for SOA adoption
- ROI for SOA adoption
- Development processes and practices for SOA-based development

There needs to be more collaborative research between industry and academia to create real practices

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