

## Evolution and Maintenance of SOA-Based Systems at SAS

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### Abstract

*As SOA-based systems are becoming more common, there is a need to consider how traditional IT roles and responsibilities need to change. This paper proposes a framework for roles that are required for evolving and maintaining SOA-based systems. It builds on work on traditional IT roles, as well as insights emerging from current research on SOA. The paper also presents a questionnaire for collecting data from organizations on roles that they use for SOA-based systems maintenance and evolution. Results from a pilot use of the questionnaire with Scandinavian Airline Systems (SAS) are presented.*

### 1. Introduction

The software community has long recognized the value of defining roles when managing software systems. Deciding on “who does what” is a fundamental part of collaboration. It implies defining work objectives, identifying responsibilities to meet the objectives, and distributing them among different roles. It is only in this way that organizations perform effectively and efficiently [7].

Traditional software processes have been well analyzed and there is broad consensus on the basic roles needed to efficiently develop, evolve and maintain software systems. These roles however may not be easily transferred to the context of development in service-oriented architecture (SOA) environments. Due to specific SOA characteristics, many processes and roles of the traditional software lifecycle need to be rethought [3, 9].

In this paper, we suggest a framework for SOA roles and conduct a pilot study to investigate how they are implemented at Scandinavian Airline Systems (SAS). The remainder of this paper is as follows. Section 2 describes the methodology for our study. Section 3 outlines the perspectives and challenges of

developing and maintaining SOA-based systems. Section 4 describes two aspects of SOA adoption that have an effect on the maintenance and evolution of SOA-based systems. Sections 5 and 6 present the framework for SOA roles and describe how they are implemented at SAS. Finally, Section 7 contains conclusions and identifies research challenges in the maintenance and evolution of SOA-based systems.

### 2. Methodology

In this section, we present the methodology taken when conducting our study. Section 2.1 presents an overview of steps that we took. Section 2.2 presents and describes the questionnaire used.

#### 2.1 Steps of the Study

Although a number of tasks in SOA environments are different from those in traditional environments, the traditional roles offer a starting point for defining SOA roles and associated processes [2, 3, 5]. For this reason, our first step was to identify roles that are relevant within the traditional evolution and maintenance domain.

Our second step was to elicit unique characteristics of SOA-based systems and procedures for evolving and maintaining them. These characteristics originate from the distinguishing features of SOA, supporting technologies such as Web Services, and the new business model created by SOA.

Using these characteristics as a baseline, we designated the SOA roles, placed them into a framework, and created a questionnaire. We then interviewed representatives from SAS. Our interviewees were the Director of Methods and IT Architecture and the Manager of Corporate and Agent Systems. We finally analyzed the interview results using the questionnaire.

<p><b>PART I</b> This part of the survey focuses on understanding your approach to the development, maintenance and evolution of SOA-based systems.</p> <p><b>Organizational level</b></p> <ol style="list-style-type: none"> <li>1. In what stage of the SOA adoption is the organisation?             <ul style="list-style-type: none"> <li>- Proof of concept, single application</li> <li>- Process integration, multiple applications within a single business unit</li> <li>- Process flexibility, multiple applications in multiple business units</li> <li>- Continuous adaptation and evolution, full SOA adoption</li> </ul> </li> <li>2. What types of services are deployed in the organization?</li> <li>3. What types of applications use the deployed services?</li> <li>4. Is the organization a consumer of external services? If so, what kinds of services, and where do they come from?</li> <li>5. Is the organization a service provider for external entities? If so, for what types of external entities?</li> <li>6. What departments or areas within your organization are responsible for SOA projects?</li> <li>7. The SOA infrastructure allows the discovery of services and the data exchange between application and services. Could you describe, at a high level, the existing SOA infrastructure, e.g. the standards it you uses, how services are connected to it, how services are registered and discovered.</li> </ol> <p><b>SOA Development and Maintenance Roles and Responsibilities</b></p> <p><b>SOA Project Management</b></p> <ol style="list-style-type: none"> <li>8. Number of people in the total development and maintenance area.</li> <li>9. Number of people dedicated to SOA projects.</li> <li>10. How are SOA projects staffed and managed? Are SOA projects for new development managed differently from SOA projects for maintenance and evolution? If so, could you specify how.</li> <li>11. Is service development and maintenance separate from application development and maintenance?</li> </ol> <p><b>SOA Support</b></p> <ol style="list-style-type: none"> <li>12. What are the roles and relationships for support of SOA-based applications?</li> <li>13. What is the process for handling problem reports and change requests in SOA-based applications?</li> </ol>	<p><b>SOA Strategy and Governance</b></p> <ol style="list-style-type: none"> <li>14. Is there an SOA strategy in place? If so, who is responsible for its creation and evolution, and how is the strategy developed?</li> <li>15. What are the roles and responsibilities for creation, maintenance, and enforcement of SOA governance?</li> <li>16. Is there a process for SOA-based application development and maintenance? Is it different from the traditional application development and maintenance process? Is there a separate process for service development and maintenance?</li> <li>17. Who owns and maintains the SOA infrastructure? Is this a different area within the organization?</li> <li>18. Who is in charge of security in the SOA environment?</li> <li>19. Are there specific SOA-related metrics? If so, what are they, and who is responsible for modeling, monitoring and controlling the measurement process?</li> </ol> <p><b>SOA Design and Quality Management</b></p> <ol style="list-style-type: none"> <li>20. What is the process for identification of services?</li> <li>21. What are roles and relationships for the development of new services (service interfaces to new code as well as service interfaces to existing systems)?</li> <li>22. What are roles and relationships for the development of new applications?</li> <li>23. Is there a business process approach to the definition of services and applications?</li> <li>24. How are services and applications integrated and tested? If applicable, how do test and integration procedures vary when a third-party service provider is involved?</li> <li>25. Who maintains the list or repository of existing services?</li> <li>26. How are application, infrastructure and service releases handled in this environment?</li> </ol> <p><b>PART II</b></p> <ol style="list-style-type: none"> <li>27. Which of the roles from the figure exist within your organization?</li> <li>28. Are there any roles on this list that you do not believe are necessary for SOA-based systems development? Which ones? Why?</li> <li>29. Are there any roles that are missing in the framework and you believe are necessary for SOA-based systems development? Why?</li> <li>30. What are some of the challenges and problems you faced when introducing SOA?</li> <li>31. What are some lessons learned?</li> </ol>
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Figure 1. Questionnaire

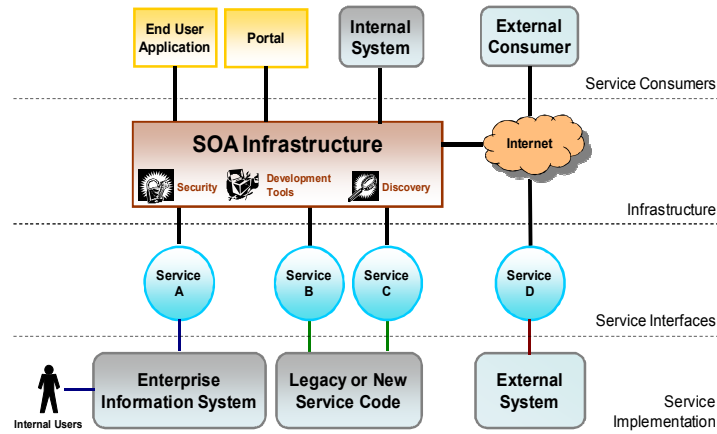
## 2.2 The Questionnaire

Based on work previously conducted on roles in traditional maintenance and evolution, as well as data that we have been synthesizing on critical SOA research topics, we developed an initial framework for SOA roles [4, 6]. This framework provided a starting point for our analysis and an initial set of hypotheses to guide the interviews. We developed interview questions around the topics that have emerged from the framework on SOA roles and the SOA research topics in a semi-structured way. Because the work is exploratory, we did not frame the questions as closed-end survey questions. The semi-structured approach enabled us to focus our data gathering around relevant topics and served as a checklist to cover all of these topics. However, it did not prematurely force the respondents to choose categories that may not be relevant.

The questionnaire, illustrated in Figure 1, has 30 questions, and is divided into two parts. It takes about one and a half hours to administer. Within an organization, individuals responsible for SOA management are the most appropriate ones to respond to it.

Part 1 captures basic information about developing and evolving SOA-based systems. It starts by gathering background information on the organization's stage of SOA adoption, responsibility for different aspects of SOA projects, and the types of applications and services that are deployed. It then focuses on each of the primary SOA development and maintenance roles from the initial framework that we have developed, and gathers data on roles and processes and how they are staffed and managed.

Part 2 presents the proposed framework and obtains input on its relevance within the organization, as well as on roles and responsibilities that may be missing or inaccurate.



**Figure 2. Components of an SOA-Based System**

### 3. Building Blocks of SOA-Based Systems

As illustrated at a very high level in Figure 2, an SOA-based system consists of 1) services, 2) service consumers that discover and use services, and 3) an SOA infrastructure that connects applications to services. In this context, the SOA infrastructure provides a standard communication mechanism between consumers and services. Each consumer invokes the services in the same way. Each service ideally represents a business task and provides an interface that is invoked through a data format and protocol that is understood by all the potential consumers of that service. In this setting, services could be globally distributed across organizations and reconfigured into new business processes as organizations evolve [10].

Different sets of roles and processes are required to develop these different components of an SOA-based system. In this section, we highlight different sets of challenges and tasks for each of these component developers. These challenges and tasks have implications for the roles for SOA-based systems that we outline in Section 5.

Infrastructure developers focus on providing a stable infrastructure that includes standards, infrastructure services, and development tools. The infrastructure supports the protocol and data formats of the service's current and potential clients. Tasks for infrastructure developers include:

- Selecting standards and products to implement as part of the infrastructure
- Developing a set of infrastructure services such as discovery, communication, and security

- Identifying and developing binding mechanisms to satisfy the largest set of potential service consumers
- Providing tools for service consumer and service developers
- Documenting and supporting the infrastructure.

Service consumer developers focus on the discovery, composition and invocation of services, either statically at design time or dynamically at runtime. Key tasks for service consumer developers are:

- Understanding SOA infrastructure
- Discovering appropriate services to be incorporated into applications
- Retrieving and understanding service description documentation
- Invoking identified services in consumer applications, including any data conversions, error handling and availability handling
- Testing services for correctness in the context of the application being developed

Service providers focus on the description and granularity of services, so that consumers can easily locate and use them with acceptable Quality of Service (QoS). Tasks include:

- Understanding requirements of potential service consumers
- Understanding SOA infrastructure
- Developing code that receives the service request, translates it to calls to new or existing systems, and produces a response
- Describing and publishing the service
- Developing service initialization code and operational procedures

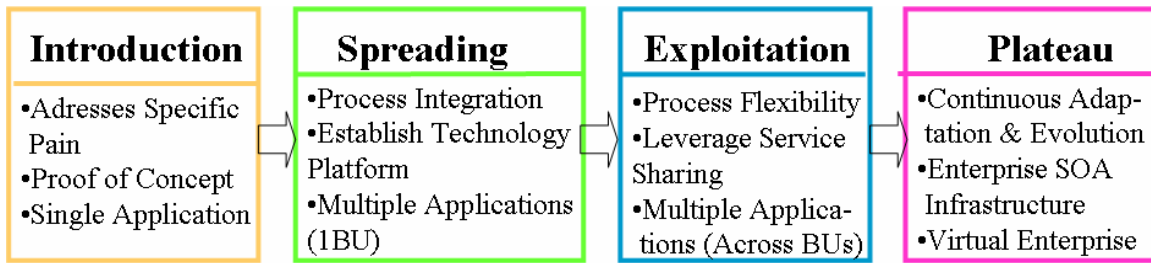


Figure 3. Levels of SOA Adoption [13]

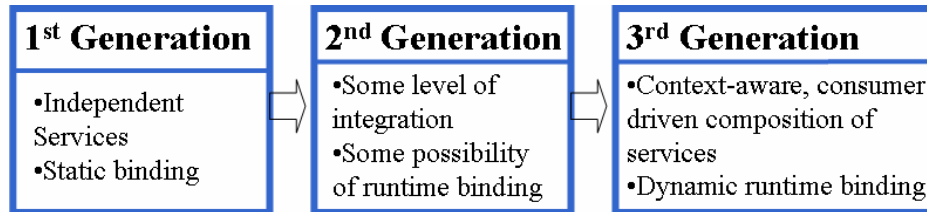


Figure 4. Generations of SOA-Based Systems [1]

With the increasing popularity of software as a service, it is becoming common for each of these components to be developed by different organizations. The tasks and risks associated with the development of each will largely depend on the distribution of the development effort across multiple organizations. If the three types of components are developed within the same organization, the challenges are less. However, if the development is distributed across multiple organizations, decisions made locally by any one of these development groups can have an effect on the other groups. Distributed development thus has an additional impact on the roles that are defined for development, maintenance and evolution.

#### 4. SOA Adoption Issues

There are two aspects to SOA adoption. One aspect has to do with the pace at which an organization adopts SOA and the other has to do with the technical complexity level at which an organization adopts SOA.

Schulte [13] recently identified four levels of SOA adoption that promote a staged and disciplined approach to SOA adoption. These levels or stages are explained below and illustrated in Figure 3.

- *Introduction:* In this stage, the organization is addressing a specific pain that it believes can be solved by SOA adoption. The organization develops a proof of concept in which a single application uses one or more deployed services.
- *Spreading:* In this stage, the organization has proven the value of SOA adoption and has gained

some knowledge of SOA-based systems. The focus is now on process integration. A technology platform for the SOA-based system is established and the goal is to have multiple applications within a single business using deployed services.

- *Exploitation:* In this stage, the organization has successfully done process integration through SOA within a single business unit. The focus now is on process flexibility. The goal is to scale the effort to multiple applications in multiple business units sharing and using deployed services.
- *Plateau:* In this stage, the organization has established SOA as the norm for development. The organization is using SOA as a mechanism for continuous adaptation and evolution through an enterprise SOA infrastructure that promotes and supports SOA-based development. The goal is a virtual enterprise where there are services supporting all tasks within the organization.

Another aspect of adoption has to do with the complexity of the services that an organization wishes to deploy. As illustrated in Figure 4, this complexity can be viewed from a generational point of view [1].

- *First Generation:* Services are independent and typically correspond to service interfaces to legacy systems. Applications statically bind to services at compile time.
- *Second generation:* There is some integration between services either at the business process level (horizontal) or at the domain level (vertical). Applications typically bind to services at compile

or installation time, although there is some possibility of runtime binding.

- *Third generation:* There is a level of complexity that enables context-aware, consumer-driven, dynamic composition of services. Applications bind to services at runtime on an as-needed basis.

The level of adoption as well as the desired complexity for SOA-based systems will largely determine the complexity of the roles that are necessary for their evolution and maintenance.

## 5. Roles Required for SOA-Based Systems Development, Evolution and Maintenance

Given the characteristics, tasks and challenges of SOA-based systems, an initial set of roles is proposed for developing, evolving, maintaining and supporting these systems. These roles take into consideration the influence of business owners on the development process, as well as a shift in focus for software engineers.

For business owners, the SOA approach focuses on business processes and the aggregation of services and business processes into end-to-end business process flows. Business processes and process modeling are key elements for designing systems. Therefore, the business processes form one basis for the analysis of individual roles [8].

For software engineers, SOA-based systems introduce new concerns, different from those they are faced with in developing and evolving traditional systems. The focus shifts from the implementation of the software system to the understanding of the purpose of the individual components, and their role and cooperation with other services within a combined business process [2, 14, 15].

The suggested roles, outlined in Figure 5, are categorized into four groups. They are defined at a general level and are applicable to the three role players, as outlined in Section 3. However, for distributed development environments, they will have to be adapted to deal, for example, with services that are external to an organization developing an SOA-based system, or for organizations that are strictly service providers with a potentially unknown set of service consumers.

The roles in our framework correspond to the responsibilities (or tasks) for managing SOA systems. This does not mean that there is one-to-one relationship between the roles and persons. One person may be assigned several roles, or several persons may be assigned one role. The allocation cardinality

depends on the size and complexity of the applications managed and of the processes used.

### 5.1. SOA Support Roles

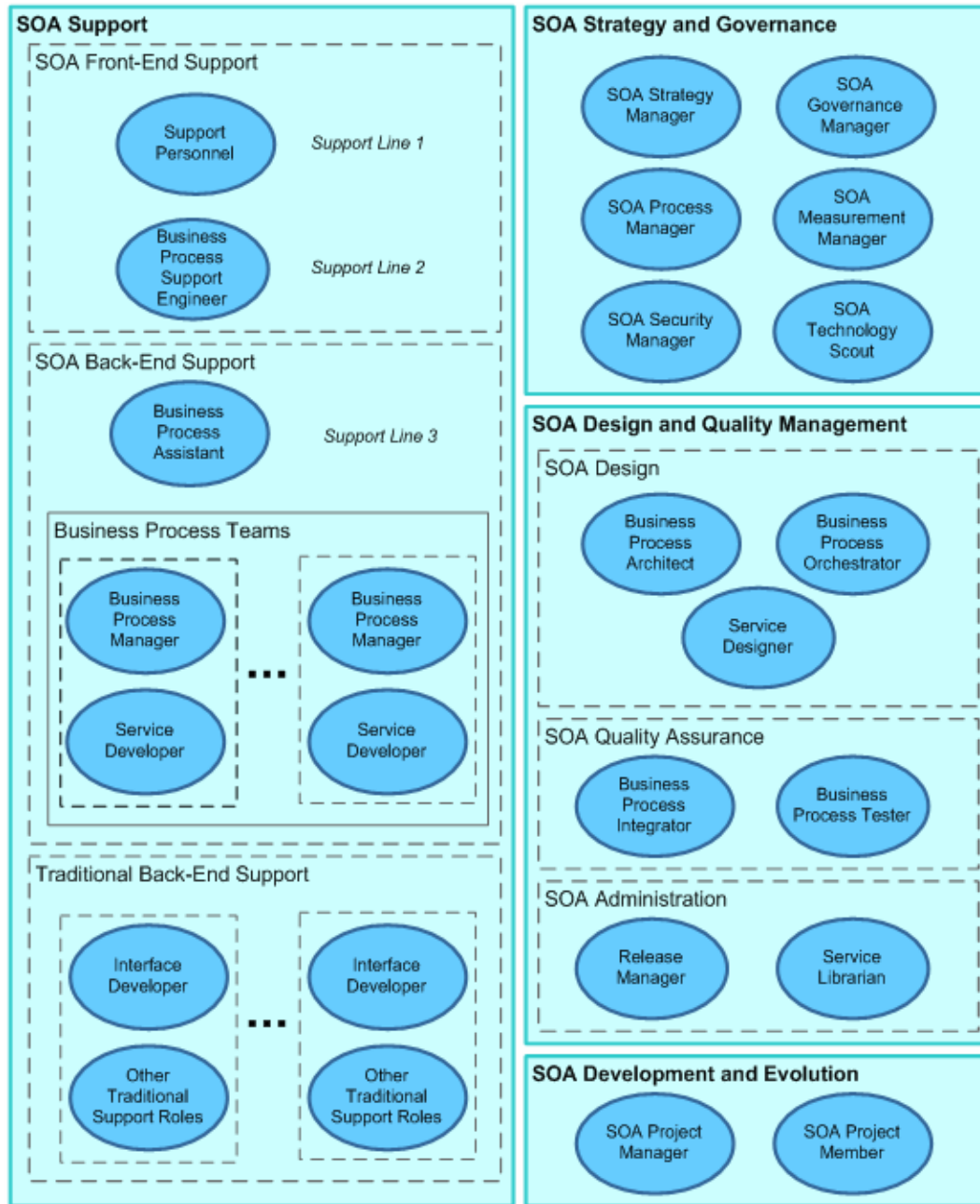
This role group is responsible for supporting deployed SOA-based systems. The group is divided into the different layers that problem reports and change requests go through.

**SOA Front-End Support:** This group is responsible for supporting the SOA-based applications that are in direct contact with customers. Individuals in these roles need to be acquainted with the business processes and their underlying structure, so that they can support the customers in their daily operation. Specific roles include:

- *Support Personnel:* Assists customers in the daily operation of business processes, accepts reports on problems or changes in business processes, and escalates and monitors problems/change reports to the *Business Process Support Personnel* role, if necessary.
- *Business Process Support Personnel:* Confirms reported problems in business processes, identifies workarounds, if any, and escalates and monitors problems/change requests to the *SOA Back-End Support* role group after having confirmed the problem.

**SOA Back-End Support:** This group is responsible for creating, evolving, maintaining and reusing services and business processes. Individuals in this role have deep knowledge of business processes and services that support them. Specific roles include those of:

- *Business Process Assistant:* Performs initial analysis of problems and change requests coming from the *SOA Front-End Support* role group and assigns them to teams involved in change implementation. This role is necessary due to high complexity and reusability of business processes and services.
- *Business Process Manager:* Manages Business Process Teams, analyzes problem reports and change requests to business processes, validates required changes with the *SOA Design* role group, and assigns development, maintenance and evolution activities.
- *Service Developer:* Performs service development, evolution and maintenance activities as assigned by the *Business Process Manager*.



**Figure 5. SOA-Based System Development, Evolution and Maintenance Roles**

**Traditional Back-End Support:** This group is responsible for creating, evolving and maintaining the interfaces to the traditional systems that provide the functionality required by the services. The primary role in this group is that of *Interface Developer* who is responsible for designing the interface to the organization’s traditional systems, implementing the interface, and testing the interface. The effect on these traditional roles will not be the tasks that they perform,

but rather the frequency with which they are performed.

**5.2. SOA Strategy and Governance Roles**

This role group is responsible for the management and governance of SOA-based systems, based on an overall SOA strategy. This group ensures that business needs are met on a strategic, tactical and operational level.

This group also has a cross-enterprise responsibility and authority to prioritize business processes. Individuals in these roles need to possess deep technical expertise as well as an understanding of the role of SOA within the context of the business. Specific roles include:

- *SOA Strategy Manager*: Creates and evolves the organization's SOA strategy to support business needs.
- *SOA Governance Manager*: Creates and evolves policies and procedures for design-time and runtime governance.
- *SOA Process Manager*: Creates and evolves the organization's development, evolution and maintenance processes.
- *SOA Measurement Manager*: Defines the overall development, evolution and maintenance process measurement process model, monitors and controls the measurement process, and provides feedback to the rest of the organization.
- *SOA Security Manager*: Creates, monitors and controls security policies and strategic plans for all SOA-based systems.
- *SOA Technology Scout*: Provides technical direction for SOA implementation; promotes effective adoption of products, standards, and processes; and assesses technology trends to determine appropriateness for use within the organization. This role also interacts with the SOA Infrastructure provider (usually IT) to make sure that the infrastructure meets the business and technical needs.

### 5.3. SOA Design and Quality Management Roles

This role group is responsible for modeling and architecture of business processes, integration of business processes along with assurance of their interoperability and quality, service repository management, and administration of SOA-based systems releases.

**SOA Design:** This group is responsible for the modeling and architecture of business processes and their mapping to new or existing services. Specific roles include:

- *Business Process Architect*: Designs the business process architecture and its components, defines architectural components in terms of service consumers, infrastructure, services, and connectors among them, makes decisions on major architectural changes to business processes, and analyzes business requirements and translates

them to architectural components. In large organizations, when managing complex business processes, it might be necessary to split this group into global and local architects.

- *Business Process Orchestrator*: Models and orchestrates business processes by assembling services (lower-level business processes) [11].
- *Service Designer*: Models services (data, function, states, interfaces, etc.) and assists the *Business Process Orchestrator* role in modeling and orchestrating business processes, as well as the mapping between business processes and services.

**SOA Quality Assurance:** This group is responsible for integrating the business processes and assuring their interoperability and quality. Specific roles include:

- *Business Process Integrator*: Integrates business process components and assures their interoperability.
- *Business Process Tester*: Tests the overall business processes and validates them against their functional and non-functional requirements.

**SOA Administration:** This group is responsible for administrating the SOA-based systems and their releases. Specific roles include:

- *Service Librarian*: Responsible for the service repository as a whole. This role ensures that correct data is published and maintained about all services, and manages the repository of all services so they can be discovered and accessed.
- *Release Manager*: Maintains control over releases and documentation for the SOA infrastructure and the services that are available.

### 5.4. SOA Development and Evolution Roles

As with traditional development and evolution, minor development and changes to business processes and their components are conducted in teams. Major development and changes, however, are conducted in projects. For this reason, there is the need for the following roles:

- *SOA Project Manager*: Responsible for managing projects, defining project plans, implementing the plans, and monitoring the project.
- *SOA Project Member*: This role may be composed of a group of different roles coming from various *Business Process Teams*, *SOA Designers*, *SOA Quality Assurance* and other role groups.

## 6. SOA-Based Systems Practices at SAS

In this section, current practice for the maintenance and evolution of SOA-based systems maintenance at SAS is presented. Section 5.1 introduces how SAS uses SOA, and Section 5.2 reports on how SAS has implemented the roles as defined in our framework.

## 6.1. Introduction to SAS

### 6.1.1. Presentation of SAS and its Services.

SAS AB is the Nordic region's largest listed airline and travel group. It offers air transport and related services from its base in Northern Europe.

SAS is in the process of adopting SOA. They are currently at the *Exploitation* phase of Schulte's SOA adoption life-cycle [13], which means that they have defined multiple SOA-based applications, which are used in multiple business units.

SAS has deployed a number of data and functional services. Examples of data services are retrieval and update of customer data, corporate agreements, business intelligence statistics, and various reports. Functional services are customer-oriented, such as the check-in service. These services can be used by various applications. For instance, the check-in service can be used by the check-in kiosk, check-in website, and the SAS mobile Internet site.

SAS is both a consumer and provider of external services. As a *Star Alliance* partner, it consumes an external service that routes messages among partners, for example, to update Star Alliance upgrade awards. As an external service producer, SAS provides various services for banks and travel card companies. An example is a service that allows SEB Bank to directly connect to SAS systems in order to issue a new travel card.

### 6.1.2. Organizational Issues.

SAS does not have a specific department dedicated to SOA-based systems development. Any IT organization can develop services. For example, even though there is an SOA strategy for SAS, the organization that the interviewees belong to is still not aligned with the strategy.

### 6.1.3. SOA Infrastructure at SAS.

SAS does not have a concrete SOA infrastructure, such as an enterprise service bus. Services are implemented using basic Web Service technologies such as SOAP, HTTP, WS-I Basic Profile, and standards defined for the airline industry such as IATA. Applications bind to services at compile time.

Many vendors have tried to convince SAS to implement an SOA infrastructure. Because SAS has a limited number of known partners, it does not need facilities to dynamically discover services. Instead, SAS needs help in identifying, planning and creating services, and keeping track of them in a repository or registry.

## 6.2. SOA Roles at SAS

**SOA Support:** Development is managed by IT but actual programming is done by contractors. The developers and maintainers for traditional systems are in the same group as the developers and maintainers for service-oriented systems, but there is a limited set of developers and maintainers with SOA and Web Service expertise that are assigned to SOA projects. The *Support Line 1* role exists, but all it does is receive problem reports. Many times, technicians at this level are not aware, and do not need to be aware, that they are supporting Web services. The *Support Line 2* role does not exist, but SAS does recognize the need for this role that is more aware of SOA and of the different service consumers for a service. Regarding the roles at Support Line 3, SAS has two types of roles: (1) the owners of the traditional systems performing the *Service Interface Developer* role, and (2) individuals having expertise in SOA technology.

**SOA Strategy and Governance:** Consistent with the fact that there is not a specific SOA business unit, SAS addresses SOA issues within the context of its overall IT strategy and governance, rather than by developing a specific strategy and governance procedure for SOA. The enterprise architecture group and architecture review board help to identify where general services are appropriate. Each organizational unit is responsible for its own SOA processes and for developing and monitoring Service Level Agreements (SLAs) for services within its jurisdiction. Processes for security, testing and metrics are handled within the context of standard IT governance procedures.

The *SOA Strategy Manager*, *SOA Governance Manager* and *SOA Security Manager* roles are performed by the *SOA Architect*. The *SOA Technology Scout* role is performed by one of the architects in the maintenance department. Given that they do not have a special process for SOA-based development and maintenance, the role of *SOA Process Manager* does not exist. There is a *Process Manager* for the SAS development process. The role of *SOA Measurement Manager* does not exist either. This is due to the fact that SAS has not defined any measurement process for systems in general.



**SOA Design and Quality Management:**

- **SOA Design:** There is the role of overall *SOA Architect*. The *Service Designer* and *Business Process Orchestrator* roles are performed by the architect assigned to the SOA-related project.
- **SOA Quality Assurance:** The *Business Process Integrator* and *Business Process Tester* roles are performed by the maintenance personnel assigned to the SOA-related project.
- **SOA Administration:** There is a central repository that records which services are available and provides documentation for accessing services. However, the responsibility for the development and use of services rests with individual projects. SAS does not have a name for this role that manages the repository. The release process for services or applications that use services is no different than for other systems. SAS has two release processes: the more heavyweight process is used for new development or evolution that is done as a project and the lightweight release process is used for minor changes [5].

**SOA Development and Evolution:** The roles of *SOA Project Manager* and *SOA Project Member* exist at SAS. However, they are not dedicated to only SOA systems. This is because most of the services are developed and evolved in a project form together with traditional systems.

**7. SAS Challenges and Lessons Learned**

SAS is aware of the complexity that having multiple service consumers adds to the development of services. One of the challenges they are currently facing is prioritizing change requests that come from different consumers. For example, a partner could place a high-priority on a specific change request that may be a lower priority for SAS.

A second challenge is that even though SAS IT management acknowledges the importance of the responsibilities that have been assigned to the different roles, they tend to look at these responsibilities as tasks assigned to people, as opposed to roles.

A third challenge is the development of “generic” services that fit more than one business process. SAS experience is that requirements tend to be biased by a particular business area. The management of architecture documentation and SLAs is also difficult because architecture documents and SLAs are created for specific Web services.

When asked for lessons learned from their experience, SAS recommended that organizations be

careful about claims made by vendors about the need for commercial SOA infrastructures, such as an Enterprise Service Bus (ESB). SAS has not implemented an ESB because they do not regard it as necessary for implementing SOA. From the SAS perspective, it is more important to identify and plan services and keep track of services in a repository or registry. SAS also suggests that organizations should implement SOA in small chunks instead of taking a “big bang” or enterprise-wide approach from the beginning.

**8. Conclusions**

In this paper, we have suggested a framework for roles for SOA-based systems maintenance and evolution. As a first step, we conducted a pilot study to investigate how they are implemented at SAS. In summary, our results show that:

- Regarding the support roles in our framework, the roles at *Support Line 1* and *2* are needed. Support technicians at *Support Line 2* should be knowledgeable about SOA-based systems and the consumers using them. The roles of *Support Line 3* exist at SAS; although they do not have specific names.
- Most of the *SOA Strategy and Governance* roles in the framework are implemented, except for *SOA Measurement* and *SOA Process Manager*. We understand it that this is due to the fact that SAS is at the third level of SOA adoption (see Figure 3) and that its SOA-based systems are in the second generation level (see Figure 4).
- All the roles belonging to the *SOA Design and Quality Management* are implemented. However, these roles at SAS are not always distinguished from other traditional roles.

With our results, we conclude that the majority of the roles suggested in our framework are implemented at SAS. SAS IT managers judge that our framework is complete with respect to the roles it covers. Despite this, we believe that our framework needs to evolve. More studies need to be conducted, not only to identify SOA roles but also to find out the following:

- How can current methods for evolving and maintaining SOA-based systems be changed to make them compatible with the SOA roles [12]?
- How should traditional, agile, distributed, collaborative and component-based development methods be factored into the SOA-based systems development and evolution cycle?
- What additional skills are needed if these roles are fulfilled by individuals in traditional roles?

- What additional roles are needed to manage SOA-based systems?
- How do these roles vary in small versus large organizations?
- How do these roles vary in a distributed environment?
- How do these roles vary across enterprises?
- Are there differences between government and industry organizations?
- Are there cross cultural differences?
- How can these initial distinctions be verified?
- What types of metrics are appropriate?

To answer these questions is a challenging task. Substantial research effort is required not only to find the right answers, but also to formulate the next set of questions in this highly evolvable environment.

The next steps in this work are to validate the proposed role groups with organizations developing and maintaining SOA-based systems, in parallel with finding the answers to the above questions.

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