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ABSTRACT

The need for transformation from today's inflexible business environment to an agile enterprise that can change direction rapidly has never been greater - Enterprise Architecture (EA) is widely accepted as an essential mechanism for ensuring agility and consistency, compliance and efficiency. EA provides a common view of the primary resources of any enterprise such as the people, processes and technology and how they integrate to provide the primary drivers of the enterprise. In this thesis, we propose our view for achieving an Enterprise Architecture Framework (EAF), as it relates to Service Oriented Architecture. SOA – an architectural style that promotes business-aligned enterprise services. SOA is the industry preferred method for delivering sustainable agility. Agility here refers to the business’s ability to quickly and effectively respond to changes, opportunities and threats so as to compete effectively. This thesis also presents the different perspectives of EA and SOA along with a new comprehensive definition for Service Oriented Architecture based on the author’s interaction with people from various industrial backgrounds and years of industry and consulting experience. In addition, researchers attempt to provide the common characteristics or features that they observe in organizations that have modified the existing EA frameworks such as the ZACHMAN, TOGAF, DODAF, etc., to their changing business needs. Finally, the author discusses the results based on the survey, conducted to understand how the members of the Association for Enterprise Integration view the need for EA and SOA.
# TABLE OF CONTENTS

List of Figures .................................................................................................................. vii

Acknowledgments .............................................................................................................. viii

Chapter 1. Introduction........................................................................................................ 1

1.1 Motivation...................................................................................................................... 2

1.2 Literature Review/ Theoretical Justification............................................................... 2

1.3 Research Questions .................................................................................................... 3

1.4 Thesis Outline .............................................................................................................. 4

Chapter 2. Enterprise Architecture Framework .................................................................. 5

2.1 Enterprise Architecture definition.............................................................................. 6

2.2 Overview of Existing Enterprise Architecture framework ..................................... 8

2.2.1 TOGAF - The Open Group Architecture Framework ....................................... 8

2.2.2 ZACHMAN Framework.......................................................................................... 11

2.3 Comparison of ZACHMAN and TOGAF................................................................. 13

Chapter 3. Service Oriented Architecture ........................................................................... 15

3.1 Is SOA a confusion?.................................................................................................... 16
3.2 Existing definitions of SOA.........................................................16
3.3 SOA - A New Definition..........................................................18
3.4 Elucidation of Concepts Behind SOA.........................................18
3.5 Different perspectives of SOA.....................................................19
  3.5.1 Top Down Approach............................................................20
  3.5.2 Bottom Up Approach..........................................................20
  3.5.3 Top Down and Bottom Up together - Middle Level Approach.....20
3.6 An Abstract Reference Model....................................................21
3.7 SOA - An Architectural style....................................................23
3.8 Beyond Web Services..............................................................24
3.9 SOA Benefits............................................................................25

Chapter 4. Enterprise Architecture & Service Oriented Architecture...........27

  4.1 Mapping ZACHMAN To SOA.....................................................28
  4.2 Mapping TOGAF To SOA.........................................................30

Chapter 5. Survey Results - Discussion .............................................32

  5.1 Adoption of EA.................................................................33
  5.2 EA Framework.................................................................34
  5.3 Adoption of SOA.................................................................37
  5.4 SOA in relation to EA..........................................................38
  5.5 Need for SOA framework.....................................................40
  5.6 SOA Performance Metric & Maturity level...............................42
List of Figures

2.1 Zachman Framework (Zachman, 2007).................................................................12
4.1 Mapping SOA to Zachman[17]..............................................................29
5.1 Benefits of using EA within organizations......................................................33
5.2 Enterprise Architecture Framework – Use .................................................35
5.3 SOA Adoption.........................................................................................38
5.4 Relationship between EA and SOA..........................................................39
5.5 Modifications made to EA for adopting SOA............................................40
5.6 SOA performance metric and maturity level [12] ......................................42
5.7 SOA Reusability [12]................................................................................43
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Chapter 1

Introduction

The need for transformation from today's inflexible business environment to an agile enterprise that can change direction rapidly has never been greater. Yet the structures, processes and systems that we have today are inflexible: they are incapable of rapid change. More computer hardware, or software, or packages, or staff, or outsourcing are not the solution. They are part of the problem. The solution needs methods for rapid business change - with systems that also change in lock-step. This is not a computer problem. It is a business problem. In order to address this growing gap between IT and business, companies are adopting an end-to-end Enterprise Architecture approach that would help re-align IT developments with business objectives. But the problem does not end here, because the challenging market conditions, competitive pressures and new technologies are leading many companies to re-evaluate the way they purchase, deploy, manage and use business applications. Software buyers want applications that will leverage their existing investments. Customers demand solutions that provide quantifiable performance improvements. These forces are driving the software industry to deliver breakthrough technology, with many of these breakthroughs at the foundation layer. Service-oriented architectures (SOAs), specifically, are at the cusp of change.
1.1 Motivation

There are many reasons why we chose to research on EA and SOA and how they are viewed in the IT Architecture domain. Initially, when we started of our research we were curious to understand the impact of EA within an organization but later as we delved deeper into it, we realized that SOA was also making waves in the IT departments across companies and was often understood to be either equal to EA or something that would work well with EA and so on. The purpose of this research is to clearly define the relationship between EA and SOA and at what point do companies need to adopt SOA while implementing an EA framework within their organizations. During the course of this research, we had ample opportunities to interact with top level IT professionals and research analysts from Gartner, CSC, TOGAF et al., which gave us a better understanding of this subject matter.

1.2 Literature Review / Theoretical justification

The literature review was mainly done to understand where exactly EA and SOA stand in the IT industry at large and whether any prior work has been done to identify the similarities/differences of EA & SOA. Upon our review, it was clear that there are some [15] who advocate that SOA is equal to EA. But, based on our literature review, survey and one-on-one interviews with Enterprise architects from TOGAF, Gartner, CSC, et al., we find that SOA is a part of EA and that they both are complimentary concepts that work well with each other.
Although, there is so much of hype out there in the IT industry about EA and SOA, our research shows that organizations are either in the initial stages of SOA adoption or just crossed over their initial stages adopting SOA into their environments. So, in conclusion, the thought of SOA becoming equal to EA or SOA merging with EA is too far and difficult to be conceived at present.

1.2 Research Questions

SOA is tasked to bridge the gap between business and IT through the business-aligned services. It is very obvious to see that EA and SOA share a similar goal. Here it is much easier to state that, EA is a framework that covers all the dimensions of IT architecture for the enterprise, and SOA provides an architectural strategy that uses the concept of “services” as the underlining business-IT alignment entity. However, EA itself is a challenging but still confusing concept to adopt [7] although almost all IT departments can’t run without a robust enterprise architecture. So, through this research, we sought to address the following questions:

- **If organizations are finding EA as a challenging and a confusing concept, how do they fit SOA with EA, which would be even more challenging and how do organizations view the relationship between EA and SOA?**
- **Do they see any business impacts by adopting SOA?**
- **If at all companies see any business impacts, are they in a higher levels/stages of SOA adoption?**
Thus, one other purpose of this thesis is to understand how different organizations view the value of Enterprise architecture frameworks towards Service oriented architecture and how good they are in addressing business needs. Most of the previous researches done in this area mainly concentrated on one or the other (i.e) either on EA or on SOA. As it is getting extremely difficult for IT to respond quickly to new business models that require integration across business unit [4, 5], we sought to concentrate on carefully understanding the relationship between EA and SOA their impact on business.

1.3 Thesis Outline

In light of the above mentioned research motivation, we have organized the reminder of this thesis as follows: In chapters 2 and 3, we present the necessary background knowledge about Enterprise architecture and SOA, in chapter 4 we attempt to discuss as to how SOA fits in with EA and in chapter 5, we discuss the key findings from our survey. Finally, we establish our conclusions based on the survey in Chapter 6 and towards the end of thesis we list all the biblical references that we have used throughout this research.
Chapter 2

Enterprise Architecture

There are a number of ways to define the term “Architecture”. Gartner defines architecture as “an abstraction or design of a system, its structure, components and how they interrelate”, which is very similar to the dictionary meaning, which states that the term architecture refers to any kind of socio-technical system, and stands for the fundamental organization of its components and their relationships to each other and the environment as well as the design rules for developing and structuring the system. The components are depicted in the form of a building plan while reducing insignificant aspects. Architectures are usually differentiated in several types according to their main objects they refer to. Usually the types are integrated into a cohesive structure, the Enterprise Architecture. These Enterprise Architectures are an emerging approach for capturing complex knowledge about organizations and technology. However, several enterprise architectures have different structures. The business architecture is the result of defining the business strategies, processes and functional requirements. The information architecture describes the data’s logical aspects, as well as the management of the data resources. The application architecture is focused on developing and implementing applications to fulfill business requirements. The technical architecture provides the foundation that supports the application, data and business processes. It identifies and plans the computing services that form the technical infrastructure of the enterprise. These architectures are related to each other.
2.1 Enterprise Architecture definitions

There are a number of definitions available for the term Enterprise Architecture but there aren’t any precise definitions of architecture or architectural descriptions as these terms relate to enterprises, systems, or software. But the IEEE, the US department of defense (DOD) and other authorities in the industry agree that, architecture is about the structure of important things, their components, and how the components fit and work together to fulfill some purpose.

The EA is the Enterprise structure and the operation blueprint describing the current and future states of the Enterprise, in terms of Business, Technology, People and Information views, and the transformation roadmap, process, program and portfolio, all linked together by an EA framework.

1. Enterprise Architecture consists of the vision, principles, standards and processes that guide the purchase, design and deployment of technology within an enterprise. Enterprise Architecture describes the interrelationships between business processes, information, applications and underlying infrastructure for that enterprise, and provides best practices for technology purchase, design and deployment.

   Enterprise Architecture structures and processes govern adherence to an organization’s technology strategy and provide a managed environment for the introduction of new technology.

   -- CoBiT Expert

2. Enterprise architecture is a blueprint that describes the current and desired state of an organization or functional area in both logical and technical terms, as well as a plan for transitioning between the two states. Enterprise architectures are a recognized tenet of
organizational transformation and IT management in public and private organizations. Without enterprise architecture, it is unlikely that an organization will be able to transform business processes and modernize supporting systems to minimize overlap and maximize interoperability.


3. An EA is a conceptual framework that describes how an enterprise is constructed by defining its primary components and the relationships among these components.

-- Melody A. Rood, The MITRE Corporation

4. Enterprise architecture is the process of translating business vision and strategy into effective enterprise change by creating, communicating and improving the key principles and models that describe the enterprise's future state and enable its evolution. The scope of the enterprise architecture includes the people, processes, information and technology of the enterprise, and their relationships to one another and to the external environment. Enterprise architects compose holistic solutions that address the business challenges of the enterprise and support the governance needed to implement them [23]. – Gartner

5. Enterprise Architecture is the organizing logic for business processes and IT infrastructure reflecting the integration and standardization requirements of the company’s operating model [23].

6. In its simplest terms, enterprise architecture is the process of aligning a business's strategic vision with its information technology. It connects different business units for synergistic communication and collaboration, creating a more seamless customer (or end-user) experience.

-- Diann Daniel
2.2 Overview of Existing Enterprise Architecture framework

There are a number of Enterprise Architecture frameworks available that organizations can adopt based on their business purpose. However, here we would like to briefly elaborate on the TOGAF framework, as it is one of the most widely used frameworks based on our survey analysis results. In the same vein, in order to understand why the ZACHMAN framework is currently not being used as much as TOGAF is, in spite of ZACHMAN framework being the very first Enterprise Architecture Framework to be developed is also discussed below.

2.2.1 TOGAF

The Open Group Architecture Framework, or TOGAF, provides a methodology for analyzing a specific enterprise situation and turning that analysis into actionable artifacts. Originally designed as a way to develop technology architecture for an organization, TOGAF has evolved into a methodology for analyzing the overall business architecture. **TOGAF ADM** - The first part of TOGAF is a methodology for developing architecture design, which is called the Architecture Development Method (ADM). It has the following nine basic phases:

- **Preliminary phase: Framework and principles.** To get everyone on board with the plan.
- **Phase A: Architecture vision.** Define scope and vision and map the overall strategy.
• **Phase B: Business architecture.** Describe current and target business architectures and determine the gap between them.

• **Phase C: Information system architectures.** Develop target architectures for data and applications.

• **Phase D: Technology architecture.** Create the overall target architecture that will be implemented in future phases.

• **Phase E: Opportunities and solutions.** Develop the overall strategy, determining what will be bought, built or reused, and how the architecture described in phase D will be implemented.

• **Phase F: Migration planning.** To prioritize projects and develop migration plan.

• **Phase G: Implementation governance.** Determine how oversight to the implementation will be provided.

• **Phase H: Architecture change management.** To monitor the running system for necessary changes and determine whether to start a new cycle, looping back to the preliminary phase.

These phases provide a standardized way of analyzing the enterprise and planning and managing the actual implementation.

The second major part of TOGAF is the Enterprise Continuum. This collection of architectural building blocks and models enable us to not only build our architecture design more easily, but also to eliminate ambiguity when discussing various concepts.
and items involved in the analysis and implementation -- which can be a problem even between groups within a single organization.

**TOGAF is an architecture framework** - a set of methods and tools for developing a broad range of different IT architectures. It enables IT users to design, evaluate, and build the right architecture for their organization, and reduces the costs of planning, designing, and implementing architectures based on open systems solutions.

The key to TOGAF remains a reliable, practical method - the TOGAF Architecture Development Method (ADM) - for defining business needs and developing an architecture that meets those needs, utilizing the elements of TOGAF and other architectural assets available to the organization.

Although a number of enterprise frameworks exist, there is no accepted industry standard method for developing enterprise architecture. The goal with TOGAF is to work towards making the TOGAF ADM just such an industry standard method, which is neutral towards tools and technologies, and can be used for developing the products associated with any recognized enterprise framework - such as the Zachman Framework, Federal Enterprise Architecture Framework (FEAF), Treasury Enterprise Architecture Framework (TEAF), and C4ISR/DoD Framework - that the architect feels is appropriate for a particular architecture.

The TOGAF ADM therefore does not prescribe any specific set of enterprise architecture deliverables - although it does describe a set by way of example. Rather, TOGAF is designed to be used with whatever set of deliverables the TOGAF user feels is
most appropriate. That may be the set of deliverables described in TOGAF itself; or it may be the set associated with another framework, such as the Zachman Framework, FEAF, etc.

In fact, TOGAF always describes an example taxonomy of the kinds of views that an architect might consider developing, and it provides guidelines for making the choice, and for developing particular views, if chosen.

With the migration of TOGAF to an enterprise architecture framework, this flexibility becomes even more important. TOGAF is not intended to compete with these other frameworks; rather, it is intended to perform a unique role, in distilling what these other frameworks have to offer, and providing a generic ADM that can be adapted for use with any of these other frameworks.

TOGAF is as a vehicle and repository for practical, experience-based information on how to go about the process of enterprise architecture, providing a generic method with which specific sets of deliverables, specific reference models, and other relevant architectural assets, can be integrated.

2.2.2 ZACHMAN FRAMEWORK

The concept of EA started with John Zachman’s “A framework for Information Systems Architecture” published in the IBM Systems Journal Volume 26, Issue 3. (Zachman, 1987). Zachman states that “to keep the business from disintegrating, the concept of information systems architecture is becoming less an option and more a
necessity for establishing some order and control in the investment of information systems resources” (Zachman, 1987). Before actually discussing information systems architecture, he draws parallels to the field of classical architecture. In classical architecture, there are different deliverables or representations that an architect has during the construction of a building.

![Zachman Framework](image)

Figure 2.1. Zachman Framework

The different representations are bubble charts, architect’s drawings, architect’s plans, contractor’s plans, shop plans, and the building itself. Each representation is a deliverable along the process of designing a building from the most abstract bubble charts to the actual building itself. Zachman further explains that the models and the different representations can be mapped to cells along an x-y axis. This allows the architecture to
be grouped by cells of different classifications. Zachman created the Zachman Institute for Framework Advancement (ZIFA) to further develop the Zachman framework. The Zachman Framework can be represented by a 6 by 6 grid of cells.

2.3 Comparison of Zachman and TOGAF

Both Zachman and TOGAF are classified as EA Frameworks which help address system complexity and the alignment of business and IT. Roger Sessions compared the top 4 EA Frameworks in (Sessions, 2007). In this article he describes the Zachman Framework more of a taxonomy or classification of architectural assets. There is not much help in how to go about classifying the artifacts into the Zachman Framework as there is no process or instructions to go about doing this.

TOGAF is built to map onto other EA Frameworks, including the Zachman Framework. TOGAF provides more detailed steps with a set out process with templates where the Zachman Framework does not provide any implementation details. The TOGAF Framework is described as a process to generate an Enterprise Architecture. The three main components of the TOGAF help an organization define their Enterprise Architecture. The ADM process may be used to incrementally define the baseline architecture and how to achieve the target architecture. The Enterprise Continuum is a repository for storing the architectural assets. The TOGAF Resource Base provides templates and guidelines to help in the process. There is nothing prohibiting the use of more than one EA Framework. The Open Group even lays out steps on mapping the TOGAF ADM towards the Zachman Framework. The Open Group maps out how to use
the ADM to populate the Zachman Framework in various steps, from the preliminary phase and Phases A, B, C, and D. The Architecture Development Method (ADM) is generally regarded as the strength of the TOGAF EA framework.

The Zachman framework is generic as “it does not prescribe or describe any particular method, representation technique, or automated tool” (The Open Group, 2006g). The open group mentions that “the scope of the four architecture domains of TOGAF align very well with the first four rows of the Zachman Framework” (The Open Group, 2006h). The combination of the strengths of differing EA Frameworks could be of better value for certain organizations.
Chapter 3

Service Oriented Architecture

As business and Information Technology have become increasingly intertwined, the strategic alignment of the two has emerged as a major corporate issue. So much so that it has almost become impossible to design one without another.

Although, the strategic relationship between business and information technology has been chronicled as far back as the 1970s, when Harvard Business School Prof. Richard L. Nolan expounded his “stages theory” of the business/IT relationship, the emergence of IT from the back room to the forefront of e-business brings the alignment issue under the spotlight like never before. And as the economy softens, the potential efficiencies and competitive advantages afforded by technology become all the more crucial. So, altering business processes inevitably requires system changes. Here comes the challenge of designing systems in such a way that accommodating most business process changes simply requires re-arranging existing business services. But the business processes involve more than just the functionality of systems. They involve information. Information is central to business processes, and these processes determine what information is required and how it should be managed. That is when SOA gets into picture, when a SOA is built, it is necessary to package significant portion of the systems functionality and related information in the form of services. A service here is nothing but a bundling of information and functionality required to manage it.
3.1 Is SOA a paradox?

Although SOA appears to be at the top of the hype curve now, the most haunting question that we would like to address in this thesis are detailed in the forthcoming chapters. SOA definitely reduces cost through service re-use and by promoting modularity at service level, enables the flexibility and agility required to respond the greater change, but what is SOA? Is it a technology or architecture or a product? There is plethora of perspectives available out there for SOA and how it relates to EA. This in fact motivated us to delve deeper into this topic in order to better understand how the members of important organizations such as the, “Association for Enterprise Integration” (AEI) would view SOA and EA in their perspective. In this chapter, we would like to highlight few of the existing definitions of SOA and based on our extensive literature survey and the survey conducted within the AEI we have come up with a new comprehensive definition for SOA. After defining the term SOA, we describe the most generic view/ perspective of SOA. Then we address few of the above mentioned questions in this chapter.

3.2 Existing Definitions for SOA

Many organizations such as IBM, OASIS, to name a few, have taken the task of defining what constitutes a service, but while they may maintain their esoteric view on the definition there does exist commonalities between those definitions. These common features are analyzed after quoting all these definitions. Here we present a few definitions for SOA that would help us to understand what SOA is:
1. SOA is a business-centric IT architectural approach that supports integrating business as linked, repeatable business tasks, or services. SOA helps users build composite applications, which are applications that draw upon functionality from multiple sources within and beyond the enterprise to support horizontal business processes.

   **IBM, 2007**

2. SOA is a set of components which can be invoked, and whose interface descriptions can be published and discovered.

   – **World Wide Web Consortium (W3C)**

3. Service Oriented Architecture is an architecture style aimed at designing for change with the aim to reduce cost, deliver faster & better and increase the value of IT.

   – **Capgemini**

4. SOA is a form of technology architecture that adheres to the principles of service orientation. When realized through the Web services technology platform, SOA establishes the potential to support and promote these principles throughout the business process and automation domains of an enterprise.

   – **Thomas Erl, chief architect, XMLTC Consulting Inc.**

5. SOA is a framework enabling application functionality to be provided, discovered and consumed as re-usable Web Services sets. While Web Services do not equal SOA, it’s one of the enabling standards. SOA abstracts complexity and implementation details, making it an ideal architectural mindset to leverage functionality trapped within mainframe/midrange systems.

   – **Scott Rosenbloom is chief strategist with WRQ Inc.**
There are many more definitions but the essence is in the words “service oriented.” These words really speak to the perspective that must be adopted across the enterprise. That is a *service oriented perspective*. This requires adoption of a propensity to share, to look for an existing service that can be reused from within and outside of the immediate organization. Developing a service from the ground up becomes the exception. The potential for business transformation will require strong collaboration with the business to identify business services that can be shared. [11]

### 3.3 SOA – A New Definition

SOA is an architectural design or pattern aligning both the IT and conceptual business architecture by utilizing reusable services, which are built using the existing business resources; that would help an organization to achieve their business goals without impeding the flow of information within the system. The business resources could mean anything from an application to a business partner in this context.

### 3.4 Elucidation of Concepts Behind SOA

At its core, SOA is a distributed architecture that focuses mainly on the concept of services that helps business processes. The beauty behind SOA that makes this keyword very popular is the translation of a set of independent, but collaborative services, to the completion of business process. Considering our definition above, we could point out the following core ideas behind SOA:
1. Firstly, it is very necessary to think of **SOA from a business perspective**, as SOA is not intended to develop different kind of software. It is explicitly developed to focus on the business applications.

2. Secondly, the idea of **black-box is integral to SOA**, which enables the reuse of existing business applications by adding a fairly simple adapter to them, no matter how they were built.

3. Finally, as far as SOA is concerned the emphasis is on **simplicity and autonomy of components**. These components are arranged in a loosely coupled fashion in order to allow easy flow of communication between components within SOA. Each component offers a small range of simple services to other components.

4. In order to provide well-defined business service, SOA components are orchestrated to link together through business processes SOA creates a simple arrangement of components that can, collectively, deliver a very complex business service.

### 3.5 Different perspectives of SOA

We see SOA as the most misunderstood technologies as there are a number of different perspectives of SOA available out there in the market and here in this section the author would like to analyze the most commonly used pattern in SOA adoption – The top-down and bottom-up approach. [9]
3.5.1 Top-down approach

A top-down approach takes a broader, more enterprise perspective and a more strategic point of view. This means that the top-down approach considers enterprise issues. It is concerned with the overall set of enterprise requirements, now and over time. It is as concerned with how the specific application fits into the overall enterprise, its strategy and roadmap as it is concerned with a particular application and its tactical requirements.[9]

3.5.2 Bottom up approach

Bottom-up SOA starts from a perspective of existing systems, technology or common services. The scope of bottom-up approaches is typically a specific project with immediate requirements. Generally, the project team doesn’t feel it has the luxury to consider a broader enterprise scope or longer-term timeframe, or doesn’t understand the value of that approach.

3.5.3 Top-down & Bottom-up together - A Middle-level approach

In order to implement SOA, the first step towards it is to identify the services with a business and this identification of business services can be done effectively, if we adopt an iterative process. Iterative process meant here points out the usage of both the top-down and bottom-up processes together. Initially it is necessary to perform a top-down analysis of prospective business services. So, when this is done, the actual process of
building physical services could be accomplished from a bottom-up perspective. What it means is that when a project is engaged in SOA design, it has to both push up into the enterprise scope while at the same time pushing down into immediate deliverables. In other words, the approach produces both higher-level business and information architecture and design artifacts and working and deployed services. And the secret sauce that makes this actually work is the SOA Reference Architecture process of identifying and modeling services as an iterative process. [9]

3.6 An Abstract Reference Model – SOA

The concept of SOA can be viewed from several possible perspectives. As mentioned above, that no single perspective or set of perspectives represents a definitive view of a SOA, from a holistic view these perspectives assist in understanding the underlying architectural requirements. Microsoft believes that there are three abstract capability layers exposed within a SOA:

**Expose** - Expose focuses on how existing IT investments are exposed as a set of broad, standards-based services, enabling these investments to be available to a broader set of consumers. Existing investments are likely to be based upon a set of heterogeneous platforms and vendors. If these applications are unable to natively support Web services a set of application or protocol-specific set of adapters may be required. Service creation can be fine grained (a single service that maps on to a single business process), or coarse grained (multiple services come together to perform a related set of business functions). Expose is also concerned with how the services are implemented. The functionality of
underlying IT resources can be made available natively if they already speak Web services, or can be made available as Web services though use of an adapter. A *Service Implementation Architecture* describes how services are developed, deployed and managed.

**Compose** - Once services are created, they can be combined into more complex services, applications or cross-functional business processes. Because services are exist independently of one another they can be combined and reused with maximum flexibility. As business processes evolve, business rules and practices can be adjusted without constraint from the limitations of the underlying applications. Services compositions enable new cross-functional processes to emerge, allowing the enterprise to adopt new business processes, tune processes for greater efficiency, or improve service levels for customers and partners. A *Service Integration Architecture* describes a set of capabilities for composing services and other components into larger constructs such as business processes. Composing services requires some sort of workflow or orchestration mechanism.

**Consume** - When a new application or business process has been created that functionality must be made available for access (consumption) by IT systems, other services or by end-users. Consumption focuses on delivering new applications that enable increased productivity and enhanced insight into through a broad number of outlets including web portals can be used to rapidly roll out applications that result in new business capabilities or improved productivity. These application roll-outs can be used to measure the return on investment (ROI) in an SOA. A Service Oriented Application Architecture describes how —composed services are made available for consumption
through as business processes, new services or new end-user applications. This concept is sometimes referred to as Composite Applications since it implies service consumption by end-user applications. [24]

3.7 SOA – An Architectural Style

As defined above, SOA is neither a product nor a technology it is just an architectural style that consists of recognizable and reproducible architecture patterns and it is becoming the architectural style of choice in many enterprises. Particularly, in the past few years Service Oriented Architecture (SOA) has risen from being a concept promoted by few to one of the most important architecture styles enterprises are trying to adopt. Though many of the bases upon which SOA is founded are not new, its link to achieving business results makes it very appealing.

Service-oriented architectures (SOA) is an emerging approach that addresses the requirements of loosely coupled, standards-based, and protocol-independent distributed computing. Typically business operations running in an SOA comprise a number of invocations of these different components, often in an event-driven or asynchronous fashion that reflects the underlying business process needs. To build an SOA a highly distributable communications and integration backbone is required. [19]

Modern enterprises need to respond effectively and quickly to opportunities in today’s ever more competitive and global markets. To accommodate business agility, enterprises are supposed to streamline (existing) business processes while exposing the various packaged and home-grown applications found spread throughout the enterprise in
a highly standardized manner. A contemporary approach for addressing these critical issues is embodied by (Web) services that can be easily assembled to form a collection of autonomous and loosely coupled business processes. [19]

The purpose of this architecture is to address the requirements of loosely coupled, standards-based, and protocol-independent distributed computing, mapping enterprise information systems (EIS) appropriately to the overall business process flow. The driving goal of SOA is to eliminate these barriers so that applications integrate and run seamlessly. In this way an SOA can deliver the flexibility and agility that business users require, defining coarsely grained services, this may be aggregated and reused to facilitate ongoing and changing needs of business, as the key building blocks of enterprises.

3.8 SOA – Beyond Web Services

Admittedly, most of us might have mistaken that SOA and web services are one and the same, but this is not the real case for the following reasons:

We know that services communicate between themselves and this communication can involve either simple data passing or it could involve two or more services coordinating some activity. Some means of connecting services to each other is needed. And those connections are nothing but our Web Services.
3.9 SOA Benefits

SOA is valuable to enterprises that need to solve business-critical problems using information technology, including enterprises that want to minimize redundant infrastructure and create a common business interface across customer and employee systems; businesses that need to personalize information to users based on roles and workflows; and organizations that want to use the Internet to boost revenue per customer through cross-selling, up-selling and access via mobile devices.

Enterprises that adopt a service-driven approach experience the following business and IT benefits:

- **Business Benefits of Service-Oriented Architecture**

  1. **Efficiency**: Transform business processes from siloed, replicated processes into highly leveraged, shared services that cost less to maintain.

  2. **Responsiveness**: Rapid adaptation and delivery of key business services to meet market demands for increased service levels to customers, employees, and partners.

  3. **Adaptability**: More effectively rollout changes throughout the business with minimal complexity and effort, saving time and money.

- **IT Benefits of Service-Oriented Architecture**

  1. **Reduced Complexity**: Standards-based compatibility versus point-to-point integration reduces complexity.

  2. **Increased Reuse**: More efficient application/project development and delivery through the reuse of shared services, previously developed and deployed.
3. Legacy Integration: Legacy applications, leveraged as re-usable services, lower the cost of maintenance and integration.

Today’s service-driven enterprises are experiencing these benefits and more as they leverage IT in the rapid development and reliable delivery of new and enhanced services in order to maximize business opportunities.
Enterprise Architecture and Service Oriented Architecture take similar stances to viewing Enterprise IT assets. Both require an enterprise view of the organization to streamline any individual business unit projects to be better aligned. There are SOA architects who are turning to EA Frameworks to help them with their SOA implementations. The Enterprise Architecture Frameworks help guide the architect to a higher, more abstract view of the enterprise’s IT assets and business processes. There are common themes between both the EA world and SOA world.

Our analysis of the survey results shows that close to 55% of the participants agree that they view SOA as a part of EA and another 43% of our respondents see EA and SOA as two complementary concepts that work well together suggesting the importance of both SOA and EA working in tandem.

Having analyzed the results of our survey, it was clear that majority of the participants viewed SOA as an architectural style that fits well within EA. In other words, SOA is being viewed as a part of EA. So, based on this analysis, the author would like to discuss briefly about the mapping of EA, in particular about the mapping of ZACHMAN and TOGAF to SOA.
4.1 Mapping Zachman Framework to SOA

The most popular EA Framework is the Zachman Framework. Enterprise Architecture helps look at IT from an Enterprise level rising above project or line of business views. SOA can benefit by classifying existing IT assets and business processes together. The Zachman Framework, as previously outlined, is presented in two dimensions to map views of the Enterprise. SOA shares similar goals to EA in respects to different views to identify enterprise concerns and interests. Reuse & consolidation through some form of governance are made easier through this visualization. The Zachman Framework provides this matrix to help visualize the Enterprise as a whole. Zapthink, an IT advisory firm, has published some thoughts on how the Zachman Framework can map towards SOA. They state that the Zachman Framework “helps companies organize and prioritize the various perspectives of EA, and this organization applies just as well when the EA is SOA” (Schmelzer, 2006). Due to the similar goals of EA and SOA, it can be seen that the use of an existing framework like Zachman can provide value towards SOA. In mapping this EA framework to SOA, Zapthink outlines that the understanding to be gained among the various Zachman perspectives is the key strength of the framework. They go on to mention that the Zachman framework must be tailored to the specifics of SOA. Zapthink mentions that the “logical starting point for applying the Framework to SOA is the Application Architecture portion at the intersection of the “Function” column and “Logical System Model” row” (Schmelzer, 2006) This is the logical starting point for services which “tackle the problems of integration, asset reuse, and loose coupling of systems” (Schmelzer, 2006)
The services may be mapped into this cell. The adjoining 8 cells then may be described in further iterations. The Zachman framework does not explicitly provide the process of populating the individual cells. The Zachman eBook outlines that slivers of the enterprise may be documented; the same may be done with the services and its affected assets including business processes, networks, and data. These slivers may be either vertical or horizontal in respect to the classification process, the Zachman framework allows one to see relationships emerge among identified assets. The cells which are not populated are gaps to be filled. The organization can populate the cells with known artifacts to create a better picture of what the current architecture is.
4.2 Mapping TOGAF to SOA

The Open Group SOA Working Group published a white paper to “create a high-level understanding of SOA and its relation to enterprise architecture and in particular to TOGAF” (The Open Group, 2007a). This white paper in particular describes how TOGAF can be applied to SOA, by a focus on the eight iterative phases of the TOGAF ADM. This paper will only outline some of the changes provided to these phases:

1. Architecture Vision – the general approach is not changed

2. Business Architecture – 2 major differences
   - An SOA project, it will be natural and desirable to describe the business operations as services.
   - This phase may require describing new business operations and methods for future use, aiding in SOA business agility

3. Information Systems Architecture –
   - Must consider how services will interact with applications that will not be converted (Legacy)

4. Technology Architecture –
   - Specification of SOA specific infrastructure (service bus, registry, etc.) will be required
   - Specification of tools to support the methods of phases B & C

5. Opportunities and Solutions – SOA has little impact

6. Migration Planning – SOA has little impact

7. Governance –
• “Focus on governing the service lifecycle, supporting service infrastructure, and compliance with the SOA of the organization” (The Open Group, 2007a).

8. Architecture Change Management –

• Changes to services should not be considered architecture change and can be covered by Implementation Governance.
Chapter 5

Enterprise Architecture & Service Oriented Architecture - Survey Analysis

To remain competitive, organizations must aggressively address disconnects between business requirements and IT, failure of which directly impacts the enterprise’s ability to make quick, accurate decisions and causes the slow implementation of the determined course of action. For this reason, the gap between IT capability and business needs cannot be allowed to continue. Adoption of a sound EA & SOA approach will help re-align IT with business objectives. Although, there are a number of issues with which EA can provide direct assistance, the principal reward for adopting an enterprise architectural approach is at last to see the ‘business’ and ‘IT’ finding common ground, allowing them to relate with one another. The principal reason as to why an organization should use a SOA is to increase the free flow of information (flexibility) between the different levels of organization and the ultimate goal of SOA would be achieved when the whole enterprise makes use of optimized services that can be dynamically configured based on real-time data.

To better understand how companies use EA & SOA in their IT, we conducted a survey involving Enterprise Architects, and IT Strategists. We sent the survey to the professional group “Association of Enterprise Architects” seeking answers to over 20 questions relating to EA & SOA including the following:

- Main drivers for using EA,
- Frameworks that are used to realize EA and SOA,
5. 1 Adoption of EA – Bridging the gap between IT architecture and business goals

There are different approaches of EA and they represent the different views of users and goals of EA. The two most common views of EA are the ‘IT-centric’ and ‘business process centric’ approaches. IT-centric EA approach is mostly used in the IT world and it is used for generating an architecture that provides an overview of all the different IT models and resources and how they relate to each other. This IT architecture provides a link only up till the business processes and EA is used only as a tool to accomplish those processes. Because of this a lot of companies still view EA as the responsibility of the IT department. Thus, one could see a gap between the business and the IT world. In the case of business centric processes approach, the focus is on the business processes and IT is considered to support these business processes.

It is evident from these views of EA that bridging the communication gap between the business and IT world should be one of the prime motivations for any organization to adopt an EA framework. This was further evident from the survey that a vast majority of the companies view the adoption of an enterprise wide EA program to “better align business and IT strategies” confirming our earlier hypothesis. This goal is closely followed by their need to “support and enable business change” and then by their
need to “Reduce IT cost”, suggesting that companies use EA to not only support their business strategies but also as a driver to “enable” business change. This is a marked change in how companies view EA today than they did a few years ago indicating how the role of EA has evolved.

**Figure 5.1. Benefits of using EA within organizations**

**5.2 EA Framework**

Full advantage of all the benefits that EA has to offer to any Enterprise could be leveraged only when a proper EA framework is adopted based on the organizations’ goals and their current business & IT processes. Although, our survey results showed that the majority of the participants (77%) are currently using an EA program within their organizations, there are still about 10% of the participants who are either not interested or
not planning to use an EA framework although in most cases, the sizes of their IT do not demand one.

Figure 5.2. Enterprise Architecture Framework - Use

There are a number of EA frameworks available in the market and it is up to an organization to either use an existing framework or customize an EA. Among all the available frameworks ZACHMAN, TOGAF and DODAF are a few that are commonly used by organizations these days.

**The Zachman Framework** is a generic classification framework for the Enterprise and it does not prescribe any specific process or tools for completing the mapping or classification process.

In the **TOGAF Framework**, as mentioned elsewhere in the thesis, there are three main components that helps an organization define their Enterprise Architecture.

- The **ADM process** helps to achieve the target architecture from the baseline or existing architecture.
• The **Enterprise Continuum** is a repository for storing the various architectural assets.

• The **TOGAF Resource Base** provides templates and guidelines to help in the process.

  Unlike ZACHMAN, which is a simple and generic framework that does not prescribe or describe any particular method, representation technique, or automated tool (The Open Group, 2006g), TOGAF provides more detailed steps with a set out process with templates where the Zachman Framework does not provide any implementation details.

  The increasing interest in using a very relevant and flexible EA framework that helps organization to align the needs and goals of IT with that of business is reflected in the survey; more than 60% of the participants are using TOGAF as their reference architecture and another 28% of the respondents are using DODAF, followed by ZACHMAN framework.

  Although, we see only 21.6% of the participants as using ZACHMAN as their EA framework, the fact that ZACHMAN is one of the few most important and the first EA frameworks cannot be neglected. Marrying Zachman with TOGAF would be a great idea that organizations could look into in depth in order to overcome the shortcomings that were discussed in the paragraph above. The open group also mentions that “the scope of the four architecture domains of TOGAF align very well with the first four rows of the Zachman Framework” [10].
5.3 Adoption of SOA –a transformation method for EA

Although, Enterprise architecture efforts are mainly focused in developing a map of IT assets and the technology standards - a time-consuming and expensive process, these does not make businesses more flexible, capable or profitable. A mechanism that helps organization to deliver the standardization and that advocates the reusability of those standards is what makes EA the most responsive architecture. With the “advent” of “SOA” there is finally an understanding of the value of architecture, reuse, and services.

Our analysis shows that around 60% of the participants surveyed use SOA and another around 30% of the companies use just the concept of services within their organization. We believe that one of the main reasons behind some organizations only using the concept of services is because they might be smaller size companies that do not have strict policies, security measures, procedures to adopt SOA as an architectural style.

But the survey strongly shows that organizations have implemented SOA as part of their EA frameworks indicating the need for a good EA framework for implementing SOA. So, in order to reap the benefits of SOA, companies must have a full fledged EA framework, because there may be many services that might not be capable of communicating properly because of the limited technology/infrastructure support that cannot be solely offered by SOA without EA.
SOA Adoption

- Using just the concept of services
- Not using SOA
- Currently using SOA

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<thead>
<tr>
<th>Companies using SOA/concept of services within their organization</th>
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Figure 5.3 SOA Adoption

5.4 SOA in relation to EA

Enterprise Architecture and Service Oriented Architecture take similar stances to viewing Enterprise IT assets. Both require an enterprise view of the organization to streamline any individual business unit projects to be better aligned.

Close to 55% of the participants agree that they view SOA as a part of EA and another 43% of our respondents see EA and SOA as two complementary concepts that work well together suggesting the importance of both SOA and EA working in tandem.

Although, EA and SOA could be considered as two separate concepts that works well together and supplement the shortcomings of each other, it is certainly not possible to consider SOA as a replacement for EA. As mentioned in the chapter 2, EA is the organization’s blueprint describing its current and future states as a whole, whereas SOA
is an architectural design or pattern aligning both the IT and conceptual business perspective by utilizing reusable services. This concept of service

![EA & SOA Relationship](image)

Figure 5.4. Relationship between EA and SOA

could also be implemented between the different layers of Enterprise architecture for the easy flow of information between different levels of the organizations. Hence, I believe that it would be more appropriate to view SOA as a means to achieve the overall business goal for which the road is laid by EA. Also, one could view the concept of services/ SOA as an IT strategy that must be tied up with EA to maximize the flexibility, which is what another 43% of our participants agree to as well. Therefore, only when companies try to understand and make the necessary adjustments to EA in such a way that EA can be used for SOA initiatives they could reap the full benefits of EA and SOA.

In order to leverage the full advantages of SOA, it should be teamed with an architecture framework like TOGAF, DODAF to describe a complete system.
5.5 Need for a framework for a SOA

As mentioned earlier that SOA cannot be accomplished without an EA, here we would like to analyze the key features or factors in EA that organizations should look for or incorporate into EA before adopting an SOA. Although, our survey results show that majority of the organizations did not make any changes to EA a considerable few (43%) have modified their EA frameworks to accommodate SOA. So, we would like to present here the features (based on our analyses) that have been either incorporated or changed or removed from the existing EA framework to accommodate EA suggesting the need for a SOA framework that does not have the pitfalls of the EA frameworks used today:

Figure 5.5.Modifications made to EA for adopting SOA

1. Ability to integrate services/ modules between different levels/layers of EA
2. The order in which the various models are developed; and the execution and prioritization of some of the EA steps
3. SOA is a discipline and methodology for implementing EA. Adding iteration to define common services, service providers and brokers to the definition of the EA, if necessary.

4. Business process to be described with "service" and aligned with system.

5. Networks are made as an integral part of EA along with data and process, thereby minimizing the largest element of IT spends.

6. The EA organization could run a SOA Community of Interest (for SOA standards definition and best practice sharing) and a SOA Council for enterprise level governance

7. If EA and SOA were adopted together then the following would be useful to consider:
   - Architecture vision will add the SOA vision
   - Short term and long term goals on SOA should be defined with a well defined strategy.
   - While defining the architecture principles, define the SOA principles also, wherever applicable.

8. Since, most of the organizations surveyed are using TOGAF as their reference architecture, we would like to present here the changes that could be made to ADM cycle in TOGAF:
   - In the ADM cycle, provide the soa flavor while defining the business, data, application and technology architecture.
   - Applying the service identification principles, contract design, policy design wherever applicable – all of which constitutes SOA.
5.6 SOA Performance Metric & Maturity level

An SOA maturity model is used to assess the current state of SOA adoption in any organization. This model helps in understanding what the current state of organization is (As-Is) and helps organization to develop a game plan to achieve the goal state (To-Be). About 67% of the participants said that they are measuring the performance of SOA in their organization. Among those participants who are measuring the performance of SOA, close to 42% of the participants chose, “Service reusability” as the main/important metric for measuring the adoption of SOA within their organization.

![SOA Performance Metric and Maturity Level](image)

Figure 5.6. SOA performance metric and maturity level [12]

Although, a reasonable percentage of organizations have some metric for measuring SOA, still the analyses shows that there aren’t many organizations that have adopted a cross-business unit level of SOA and/or an Enterprise level SOA. Because,
organizations will notice as they move up the ladder in their SOA adoption, that reusability would not be an issue at higher levels as shown in the figure 5.7 But the fact that majority of the organizations are using “Service Reusability” as a key metric clearly shows that there is long way for organizations to go in adopting an SOA before expecting some ROI from the adoption of SOA [13]. Some of the other metrics that were used by companies were, “Time to market reduction “,” cost-reduction”, “Business Alignment”, etc., (<10% each). Hence, we feel that most organizations are still in the fundamental stages of SOA adoption. In order for organizations to use SOA in solving business problems and find new ways to improve efficiencies within their business process, a higher level of SOA adoption/maturity is required.

Figure 5.7.SOA Reusability[12]
Conclusion & Future Work

Although our initial theoretical analysis showed that EA and SOA are generally thought of as two different disciplines but our continued research efforts along with the survey results it is very clearly proved that organizations have implemented SOA as part of their EA frameworks indicates the need for a good EA framework for implementing SOA. So, in order to reap the benefits of SOA, companies must have a full fledged EA framework, because there may be many services that might not be capable of communicating properly because of the limited technology/infrastructure support that cannot be solely offered by SOA without EA. Moreover, EA Frameworks provide structure in achieving the goals of SOA. This is due to the fact that an SOA requires a vision of the Enterprise as a whole. EA Frameworks provide this. Further analysis of our survey results also showed that it would be more appropriate to view SOA as a means to achieve the overall business goal for which the road is laid by EA.

Adopting an EA Framework is not a very easy task at all. Organizations have to do prior research to understand what they are really looking to accomplish by using a framework. Not only that organizations need to know what is the scope of EA, what they can expect from an EA and what does not fit well with an EA. Also, the complexity involved in making applications communicate has to be taken into consideration. Further research has to be done to help organizations understand what really a good EA means and what does not fit an EA.
Bibliography


[14] Ali Arsanjani, IBM “Service-oriented modeling and architecture - How to identify, specify, and realize services for your SOA” IBM.

