

# Study on Enterprise Architecture Development

## 企業架構發展研究

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### ABSTRACT

Most of governments in the world made their investment decisions lack of scientific consideration and it cause serious waste money problems of the IT investment. Enterprise Architecture is the analysis and documentation of an enterprise in its current and future states from an integrated strategy, business, and technology perspective. An EA model is not just useful to provide insight into the current or future situation; it can also be used to evaluate the transition from 'as is' to 'to be'. EA provides analysis methods for assessing both the qualitative impact of changes to architecture and quantitative aspects of architectures, such as performance and cost issues. This research achieves a beneficial model and knowledge of the EA framework and practical tools. This accomplishment may valuable for the business management and academic researches to do applicable plan.

**Key words:**Enterprise Architecture, Structure Behavior Coalescence, TOGAF

### 摘要

大多數世界各國政府在作出其投資決策時都缺乏科學的考量，並造成嚴重的資訊科技投資浪費的問題。企業架構是一項從整合企業策略、經營及技術的角度觀點，針對一個企業其當前和未來的狀態分析和建立文檔。一個企業架構模型不僅提供企業能夠深入了解當前或未來的情況，它也可被用來評估企業從'現在'轉換到'未來'所處的狀態。企業架構提供分析的方法，可以評估定性的結構改變，和量化的架構，如績效和成本的問題。結構與行為合一的企業架構，達到了有益於瞭解企業架構模型，與提供實用的工具的框架和知識。本文所獲得的成就，可適用於企業經營管理和學術研究的發揮其價值。

**關鍵字：**企業架構、結構與行為合一、TOGAF

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## 1. Introduction

The enterprise architecture background, the development of EA frameworks, and study method are discussed in this chapter.

### 1.1 Enterprise Architecture Background

Most of governments in the world made their investment decisions lack of scientific consideration and it cause serious waste money problems of the IT investment. Investments are required to complete a lot of tables, even for a simple case should be approved by 6 to 7 organizations. The effectiveness of enterprise architecture (EA) implementation make government's IT working effectively, reducing costs, and controlling the budget. EA is a scientific method to deal with the complexity of the changing world and challenges.

The EA establishes the organization-wide roadmap to achieve an organization's mission through optimal performance of its core business processes within an efficient information technology (IT) environment. Simply stated, enterprise architectures are "blueprints" for systematically and completely defining an organization's current (as is or baseline) or desired (to be or target) environment. EA is essential for evolving information systems and developing new systems that optimize their mission value. This is accomplished in logical or business terms (e.g., mission, business functions, information flows, and systems environments) and technical terms (e.g., software, hardware, communications), and includes a transition plan for transitioning from the baseline environment to the target environment. EA becomes the world's 500 leading enterprises' core business tool, such as Apple, Panasonic, NOKIA, Intel, NISSAN, P & G, ING, and Paris of France Bank, etc.

### 1.2 The development of EA frameworks

The development of EA frameworks, as shown in Figure, dated back to Zachman publication in 1987. Zachman Framework also only used it as the framework for the use of information systems, and it became the exclusive tool of enterprise

architecture. The Zachman framework had a major influence on one of the earliest attempts by the Department of Defense (DoD) of US government to create an EA. This attempt, known as the Technical Architecture Framework for information Management (TAFIM), was introduced in 1994. Influenced by the benefits promised by the TAFIM, the US Congress passed a bill known as the Clinger-Cohen Act in 1996. This Act mandated that the spirit of the legislation was to require all U.S. federal government agencies to improve their IT investment's effectiveness. The Federal EA framework (FEAF), which was released in 1999, is a result of the Clinger-Cohen Act. FEAF was developed by the Office of Management and Budget (OMB) and renamed the Federal EA (FEA) in 2002, as shown in Figure 1.

DoDAF architecture influenced from the 1990 C<sup>4</sup>ISR systems, C<sup>4</sup>ISR behalf of command, control, communications, information, intelligence, surveillance and investigation, both for military and government use, and can also be used in enterprise management and home appliance industry. It is spreading, not just for the DoD of US, including the NATO defense similar NAF architecture, and the national defense of the United Kingdom to take the MODAF architectures.

The work done on TAFIM was turned over to The Open Group Architecture Framework (TOGAF). Many EA methodologies had come and gone over the past years. TOGAF architecture was from the Architecture Conference 1990, organized by the Open Group, after that it has been the evolution of TOGAF Architecture 9 in February 2009.

Chao (2009) has studied Structure-Behavior Coalescence (SBC) EA since 1999 and used in large enterprises in Taiwan very well. Because structure view and behavior view are the two most prominent ones among multiple views of the EA, integrating structure and behavior views is a way to integrate multiple views of an EA.

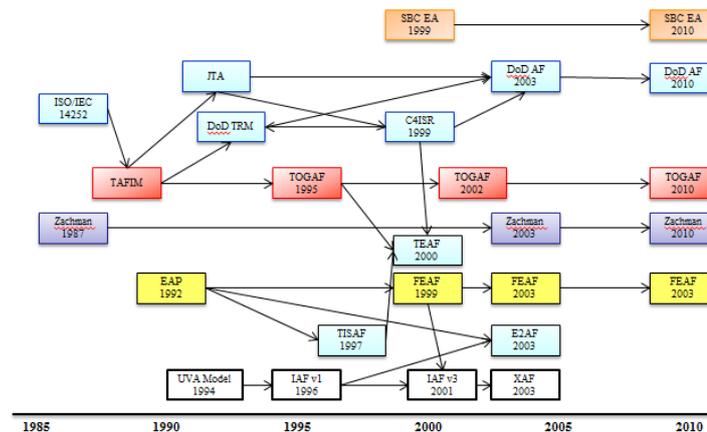


Figure 1 : Development of Enterprise Architecture Frameworks (Modified from Schekkerman 2006)

### 1.3 Study Method

Currently, most EA frameworks are categorized into the process-oriented approach. This research utilizes architecture-oriented EA so that structure view and behavior view are coalesced when decomposing the EA to obtain structural elements and behaviors deriving from interactions among these structure elements.

## 2. Literature Review

The studies about EA: TOGAF, EU-PUBLI.COM, E2AF, EAP, EFAF, TEAF, Zachman Framework, C<sup>4</sup>ISR and DoDAF, SBC are summarized in this chapter.

### 2.1 Definition of Enterprise Architecture

Lankhorst (2013) defined architecture as: fundamental concepts or properties of a system in its environment, embodied in its elements, relationships, and in the principles of its design and evolution. Enterprise: any collection of organizations that has a common set of goals, and/or a single bottom line.

Enterprise architecture: a coherent whole of principles, methods, and models that are used in the design and realization of an enterprise's organizational structure, business processes information systems, and infrastructure.

Architecture is defined as: (1) the art or science of build, specifically the art or practice of designing

and building structures and especially habitable ones; (2) formation or construction resulting from or as if from a conscious act from Merriam-Webster dictionary.

Model is a representation of something, either as a physical object which is usually smaller than the real object, or as a simple description of the object which might be used in calculations. EA models describe the concept of EA. It is similar the elevation view of an architecture drawing.

Ahlemann et al. (2012) studies the discipline of EA Management (EAM) deals with the alignment of business and information systems architectures. EAM has long been regarded as a discipline for IT managers, but he takes a different point of view that he explains how top executives can use EAM for leveraging their strategic planning and controlling processes and how EAM can contribute to sustainable competitive advantage. Based on the analysis of best practices from eight leading European companies from various industries, he presents crucial elements of successful EAM. He outlines what executives need to do in terms of governance, processes, methodologies and culture to bring their management to the next level. Beyond this, he also points how EAM might develop in the next decade allowing today's managers to prepare for the future of architecture management. EA as a management instrument as showed in Figure 2:



Figure 2 : Enterprise architecture as a management instrument (Redrew from Lankhorst (2013), Fig. 1.4)

Schekkerman (2011) studies that “an enterprise architecture establishes the organization-wide roadmap to achieve an organization's mission through optimal performance of its core business processes within an efficient information technology (IT) environment. Simply stated, enterprise architectures are “blueprints” for systematically and completely defining an organization’s current (baseline) or desired (target) environment. EA are essential for evolving information systems and developing new systems that optimize their mission value. This is accomplished in logical or business terms (e.g., mission, business functions, information flows, and systems environments) and technical terms (e.g., software, hardware, communications), and includes a transition plan for transitioning from the baseline environment to the target environment.”

Land et al. (2009) has studied EA for twenty years and they described discipline of EA has matured and leading to a better understanding of the profession of an EA. They provide an overview of EA including the process of creating, applying and maintaining it, thus taking into account the perspectives of CEOs, business managers, enterprise architects, solution architects, designers and engineers. They also provide us a fundamental way of thinking about EA, which will enable enterprises to select and apply the right approach, architecture framework and tools that meet the objective and context of the EA at work.

Ven Den Berg et al. (2010) provide architectural maturity in 18 key areas elaborate the two dimensions of the Quadrant Model: the level of architectural thinking, and on integration within the organization. The level of architectural thinking includes 9 key areas: development of architecture, use of architecture, alignment with business, alignment with the development process, alignment with operations, relationship to the as-is state, roles

and responsibilities, coordination of developments. And on integration within the organization includes 9 key areas: monitoring, quality management, maintenance of the architectural process, maintenance of architectural deliverables, commitment and motivation, architectural roles and training, use of an architectural method, Consultation, Architectural tools, and budgeting and planning.

Bernard (2012) defined EA is driven by strategic goals and business requirements. An equation is given as:

$$EA = S + B + T, \text{ Enterprise Architecture} = \text{Strategy} + \text{Business} + \text{Technology}.$$

Chao (2010) defined only the unity of structure and behavior can create an architecture model. An equation is given as:

$$EA = \text{Structure} + \text{Behavior}.$$

This is a straight-forward, simple representation of the unique holistic value of EA, as is the geometry of the “cube” framework that it derives from. This equation and the EA3 Cube Framework are easy to understand and highly useful in many contexts because they adhere to this principle and capture the essential elements that characterize human organizations.

EA analysis and design are accomplished through the following six basic elements: (1) an EA documentation framework, and (2) an implementation methodology that support the creation of (3) current and (4) future views of the architecture, as well as the development of (5) an EA Management Plan to manage the enterprise’s transition from current to future architectures. There are also several areas common to all levels of the framework that are referred to as (6) “threads” as shown in Figure 3.

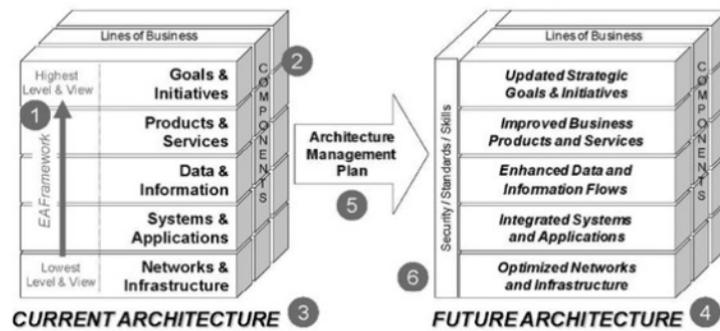


Figure 3 : Basic Elements of EA Analysis and Design (Adopted from Bernard 2012)

Bernard (2013) culminated several decades of experience that he has gained through work initially as an information technology manager and then as a consultant to executives in the public and private sectors. The three major reasons studied are: (1) to help move business and technology planning from a systems and process-level view to a more strategy-driven enterprise-level view, (2) to promote and explain the emerging profession of EA, and (3) to provide the first textbook on the subject of EA, which is suitable for graduate and undergraduate levels of study.

EA was created to provide structure and transparency to the complex world of IT. However, theorists have created additional complexities in Enterprise Architecture by designing Frameworks that are difficult to understand and impractical to implement. Nagesh and Gerry (2011) help turn around Enterprise Architecture organizations. They introduce a simple IDEA Framework that is based on common practices and investments within IT organizations. The Ten Deliverables presented in this book bring structure and clarity to IT organizations of any size, from 10-1000.

Most corporations focus on the budget, investments, and rewards. The same focus rolls downhill to the Information Technology department. The IT department has not successfully communicated the budget and managed to spend it within the limits ( $\pm 10\%$  variance), and everything else may seem irrelevant. With this in mind, Nagesh and Gerry started looking through current IT systems and IT assets to understand (a) where the current funds were being invested, (b) how these investments jelled or were mandated because of the previous investments that had been made by IT, and (c) how the company's business priorities aligned with future technology needs, including the need to meet compliance requirements. Considering and

discovering the answers to these three questions led Nagesh and Gerry to develop a definition of Enterprise Architecture that was based on technology investments - Investment Driven Enterprise Architecture (IDEA) Framework.

The purpose of the IDEA Framework is to provide guidance on how the corporation's future technology will be drafted and communicated. Its method is to utilize actual systems, hardware, people, and business functions in order to establish boundaries within which the IDEA Framework will work. The structure of the IDEA Framework differs from that of many frameworks because it consists of key deliverables that fit into day-to-day activities, and it accommodates an enterprise-wide strategic plan. It also provides for the much-needed interaction between these key deliverables and facilitates contributions from key stakeholders across Business Units and the various IT departments. In essence, the IDEA Framework takes the key deliverables, stakeholders, and organizations, and demonstrates how they dynamically function together.

A major effort in EA is to preserve enterprise's knowledge. Enterprise's knowledge reside in each individual. EA is the effort to discover the hidden knowledge and preserve the enterprise's knowledge in EA repository. The enterprise's knowledge includes enterprise business, enterprise information, and IT solutions.

## 2.2 The Open Group Architecture Framework (TOGAF)

The Open Group Architecture Framework (TOGAF) is a detailed method and a set of supporting tools for developing an Enterprise Architecture. It describes the process for acceptance, production, use and maintenance of Enterprise Architectures. TOGAF is used worldwide by

numerous architects to design, evaluate, and build the right architecture for their organization. Lankhorst et al. (2013) described the correspondence between TOGAF ADM and ArchiMate core extension Are : Preliminary and architecture vision corresponding to motivation; business architecture corresponding

to business; information system architecture corresponding to technology; opportunity and solutions corresponding, migration planning, implementation governance, architecture change management corresponding to implementation and migrations as shown in Figure 4:

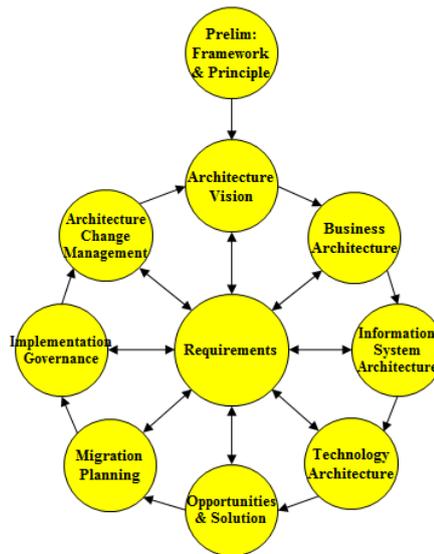


Figure 4 : The Open Group Architecture Framework (TOGAF)

Lankhorst (2013) tries to describe and control an organization's structure, processes, applications, systems and techniques in an integrated way. The unambiguous specification and description of components and their relationships in such an architecture requires a coherent architecture modeling language. Lankhorst (2013) and his co-authors present such an enterprise modeling language that captures the complexity of architectural domains and their relations and allows the construction of integrated enterprise architecture models. They provide architects with concrete instruments that improve their architectural practice. As this is not enough, they additionally present techniques and heuristics for communicating with all relevant stakeholders about these architectures. Since an architecture model is useful not only for providing insight into the current or future situation but can also be used to evaluate the transition from 'as-is' to 'to-be', the authors also describe analysis methods for assessing both the qualitative impact of changes to an architecture and the quantitative aspects of architectures, such as performance and cost issues. The modeling language presented has

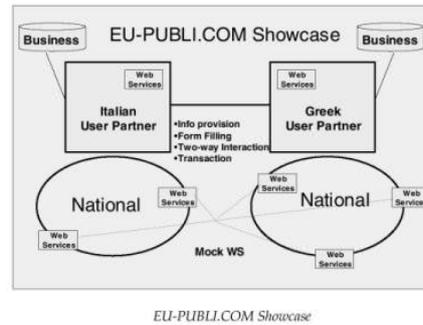
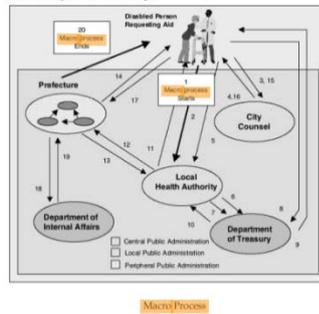
been proven in practice in many real-life case studies and has been adopted by The Open Group as an international standard. So this book is an ideal companion for enterprise IT or business architects in industry as well as for computer or management science students studying the field of enterprise architecture.

Josey (2009) introduced TOGAF Version 9 Enterprise Edition topics such as structure and content of TOGAF, the kinds of architecture that TOGAF addresses, and new in TOGAF 9 etc. Josey (2011) also proved enterprise architecture methodology and framework used by the world's leading organizations to improve business efficiency. It is the most prominent and reliable enterprise architecture standard, ensuring consistent standards, methods, and communication among enterprise architecture professionals. Enterprise architecture professionals fluent in TOGAF standards enjoy greater industry credibility, job effectiveness, and career opportunities. TOGAF helps practitioners avoid being locked into proprietary methods, utilize resources more efficiently and effectively, and realize a greater return on investment.

### 2.3 Enterprise Architecture in Europe EU-PUBLI.COM

Schekkerman (2004) stated the EU-Public.com project introduces information technology to facilitate inter-European collaboration amongst

project can be applied also to facilitate co-operation among Public Administration organizations, within the same European country as well as employees of a single Public Administration organization across different departments, as shown in Figure 5.



Public Administration employees. The result of the Figure 5 : EA in Europe EU-PUBLI.COM (Adopted from: J.Schekkerman, 2003, p. 71, 73)

### 2.4 Extended Enterprise Architecture Framework (E2AF)

The Extended EA Framework forces enterprise architects to ensure that the organization fully benefits from the alignment of business and IT by integrating all EA aspect areas into one overall result, i.e. The enterprise architectural design has to consist of interlinked business, information, information systems, infrastructure, security and governance aspects. The risk taken when not

creating an Extended Enterprise Architecture is that time and money are thrown away due to inefficiencies and insufficient insight in the complexity of the overall structure. The framework is a communication vehicle for all stakeholders involved in an architecture study to explain en show relations, dependencies, influences and complexity of the situation of study (Schekkerman 2004, 2006), as shown in Figure 6.

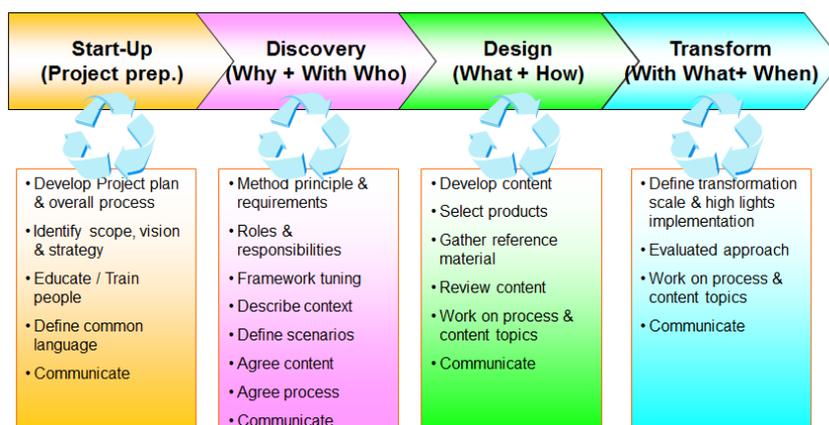


Figure 6 : Extended Enterprise Architecture Framework (E2AF)

### 2.5 Enterprise Architecture Planning (EAP)

Enterprise Architecture Planning is a process

for defining the top two layers of Zachman Framework. EAP results in a high-level blueprint of

data, applications, and technology that will be a cost-effective long-term solution, not merely a quick-fix. EAP is complementary to Business Process Improvement (BPI) and Re-Engineering, indeed one company conducted both EAP and BPI at the same time with the same team. Widespread

management participation and representation provides a business perspective, credibility, and demystifies the systems planning processes (Spewaket al. 1993, Schekkerman, 2004), as shown in Figure 7.

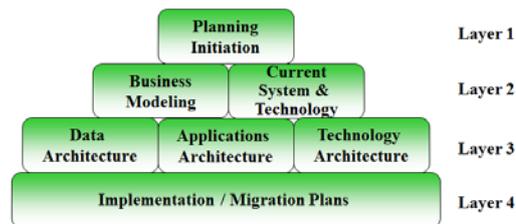


Figure7 : Enterprise Architecture Planning (EAP)

### 2.6 Federal Enterprise Architecture Framework (FEAF)

In September 1999, the Federal CIO Council published the Federal EA Framework (FEAF). The FEAF provides guidance in describing architectures for multi-organizational functional segments of the Federal Government. This architecture serves as a

reference point to facilitate the efficient and effective coordination of common business processes, technology insertion, information flows, systems, and investments among Federal Agencies. The FEAF provides a structure to develop, maintain, and implement top-level operating environments and support implementation of IT systems as shown in Figure 8.

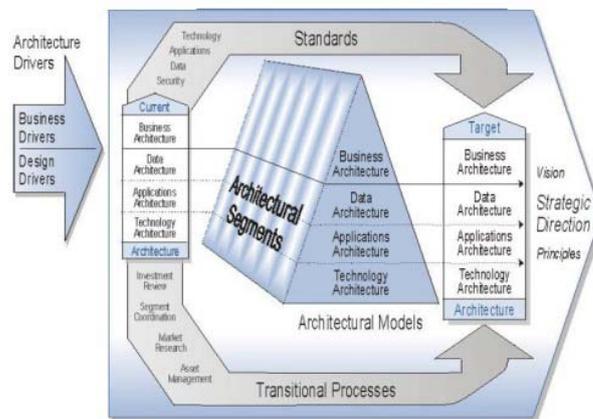


Figure8 : Structure of the Federal EA Framework (FEAF) (Adopted from CIO, 2001)

### 2.7 Treasury Enterprise Architecture Framework (TEAF)

In July 2000, the Department of the Treasury published the Treasury Enterprise Architecture Framework (TEAF). The TEAF provides (1) guidance to Treasury bureaus concerning the development and evolution of information systems architecture; (2) a unifying concept, common

principles, technologies, and standards for information systems; and (3) a template for the development of the EA. The TEAF describes an architectural framework that supports Treasury's business processes in terms of products. This framework guides the development and redesign of the business processes for various bureaus in order to meet the requirements of recent legislation in a

rapidly changing technology environment. The TEAF prescribes architectural views and delineates a set of notional products to portray these views. The TEAF's functional, information and organizational architecture views collectively model the organization's processes, procedures, and business operations. By grounding the architecture in the business of the organization, the TEAF

defines the core business procedures and enterprise processes. Through its explicit models, a TEAF-based architecture enables the identification and reasoning of enterprise- and system-level concerns and investment decisions. Figure illustrates the TEAF framework (CIO 2001, Schekkerman 2004), as shown in Figure 9.

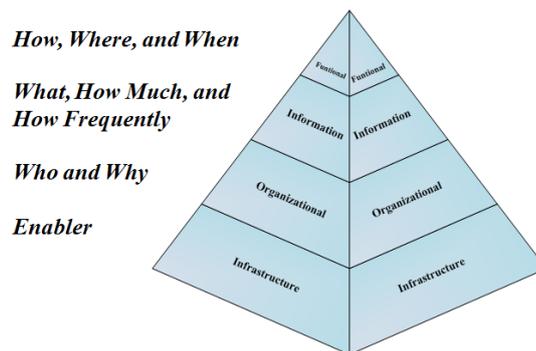


Figure 9 : Treasury Enterprise Architecture Framework (TEAF) (Redrew from CIO 2001)

### 2.8 Zachman Framework

Zachman (1987) introduced the first and best-known enterprise architecture framework. The framework as it applies to enterprises is simply a logical structure for classifying and organizing the descriptive representations of an enterprise that are significant to the management of the enterprise as well as to the development of the enterprise's systems. The framework, as shown in Figure 10, in its most simple form depicts the design artifacts that constitute the intersection between the roles in the design process: that is, owner, designer, and builder; and the product abstractions: that is, what

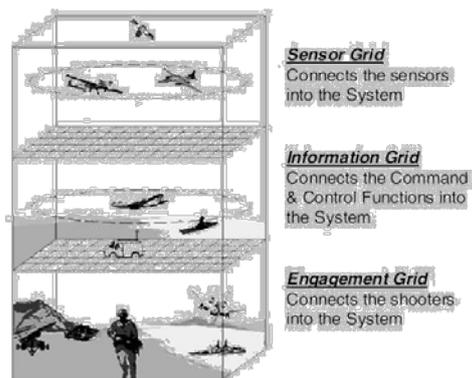
(material) it is made of, how (process) it works and where (geometry) the components are relative to one another. In the Information Age, the enterprise is increasing in complexity and is changing. The EA is the determinant of survival in the Information Age. The Zachman Framework is the ontology for describing the enterprise. The Framework (ontology) is a structure whereas a methodology is a process. A structure is not a process. A structure establishes definition whereas a process provides transformation. Processes based on ontological structure will be predictable and produce repeatable results.



Figure 10 : The Zachman Framework (From Visual Analyst)

## 2.9 C<sup>4</sup>ISR and DoDAF

The Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C<sup>4</sup>ISR) Architecture Framework was originally developed in 1996, for the DoD, US to ensure a common unifying approach for the commands, military services, and defense agencies to follow in describing their various architectures. The framework was named as DoD Architecture Framework (DoDAF) in 2003.



Although DoDAF has a rather specific target, it can be extended to system architectures that are more general. DoDAF sees the architecture description as an integration of three main views: operational view, system view, and technical view. A number of concepts and fundamental definitions, e.g., architecture, architecture description, views are provided (Schekkerman 2004, Schekkerman 2008, Lankhorst et al. 2013), as shown in Figure 11.

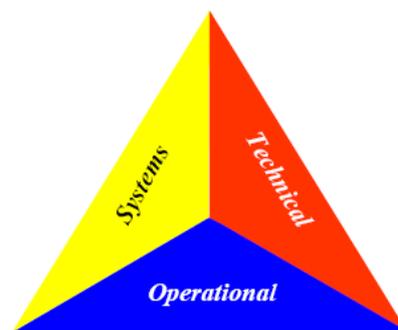


Figure 11 : C4ISR and DoDAF

## 2.10 Structure-Behavior Coalescence (SBC) Architecture

An enterprise is complex that it comprises multiple views such as structure, behavior, information, business, application, data, technology, planner, owner, designer, and builder views. Accordingly, an enterprise is defined as a set of interacting components forming an integrated whole of that enterprise's multiple views. EA is an application of SBC architecture on the enterprise system. SBC enterprise view model contains: planner's view, owner's view, designer's view, and builder's view. SBC architecture description language (SBC-ADL), based on the structure-behavior coalescence, consists of six fundamental diagrams. These diagrams are: (a) architecture hierarchy diagram (AHD), (b) framework diagram (FD), (c) component operation diagram (COD), (d) component connection diagram (CCD), (e) structure-behavior coalescence diagram (SBCD), and (f) interaction flow diagram (IFD) (Chao 2011, Chao and Chung 2011, Chao 2012), as shown in Figure 12.

Through the architecture hierarchy diagram (AHD), architects shall clearly observe the multi-level decomposition and composition of a system. AHD is the most fundamental diagram to achieve structure-behavior coalescence. In a system, if the components, and among them and the external environment's actors to interact, these interactions (inter-process communication or message passing) will lead to the systems behavior. That is, "interaction" lays an important factor in coalescing structures with behaviors for a system.

Enterprise architecture is on the rise. Chao and Chuang (2011) introduce and elaborate of the EA of purchasing and sales management; we may understand clearly how the SBC architecture helps architects effectively perform architecting to productively construct fruitful EA. Li et al. (2008) and Ma (2011) applied SBC architecture to study on software testing management and architecture-oriented information security risk assessment model to grip the implicit knowledge in the enterprises to reduce risk and cost.

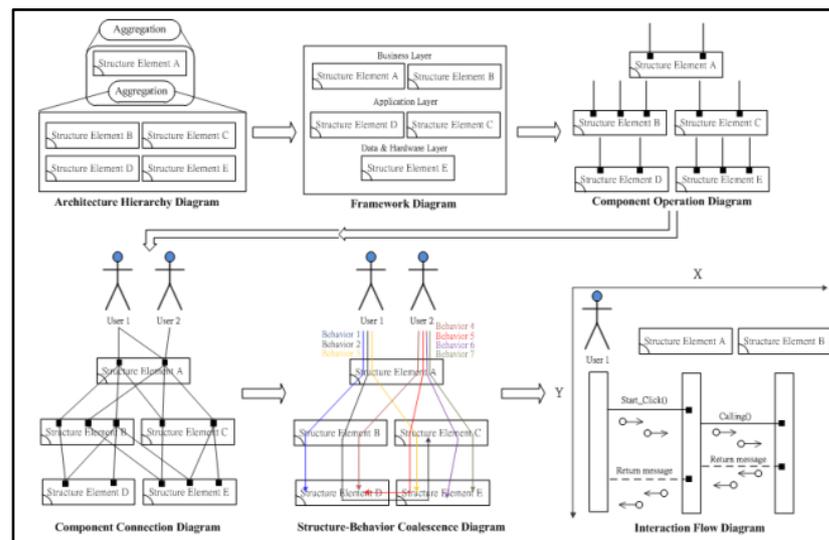


Figure 12 : The six golden rules and their relationship for SBC (Adopted from Ma 2011)

### 3. The tools for EA

The EA tools Enterprise Architect, ArchiMate for TOGAF, Visual Analyst, and Zachman Framework Visible Analyst are studied.

#### 3.1 Enterprise Architect

Reynolds (2009) stated business Architecture is a disciplined approach to creating and maintaining business models that enhance enterprise accountabilities and improve decision-making. Business Architecture's value proposition, unlike other disciplines, is to increase organizational effectiveness by mapping and modeling the business to the organization's business vision and strategic goals. The book is an introduction to this burgeoning new field. It explains what Business Architecture is, what a good, sustainable one should include, and explains how to implement a business architecture practically within the reader's environment. Extensive examples and case studies are included to clarify points and demonstrate clearly to the reader how they too can begin to build business architecture within their organization.

Enterprise Architect is a Comprehensive UML analysis and design tool with characteristics: Rich modeling for business, software and systems; Full traceability from requirements to deployment; Code engineering in over 10 languages; Scalable, team-based repository; Enterprise frameworks, mind maps, BPMN.

#### 3.2 ArchiMate for TOGAF

ArchiMate, an Open Group Standard, is an open and independent modeling language for EA that is supported by different tool vendors and consulting firms. ArchiMate provides instruments to enable enterprise architects to describe, analyze and visualize the relationships among business domains in an unambiguous way. Just as an architectural drawing in classical building architecture describes the various aspects of the construction and use of a building, ArchiMate offers a common language for describing the construction and operation of business processes, organizational structures, information flows, IT systems, and technical infrastructure. This insight helps stakeholders to design, assess, and communicate the consequences of decisions and changes within and between these business domains.

ArchiMate offers a visual language to model and capture EA. It provides a means to visualize relationships within and between different domains. These domains primarily include products/services, processes, organization, data applications and technical infrastructure. With 3 types of layers, ArchiMate provides a way to look at service-oriented models. From top to bottom, they are business, application and technology. The further we go down, the more information we get in terms of implementation (Visual Paradigm, 2013). The price for ArchiMate of Visual Paradigm is US\$999, as shown in Figure 13.

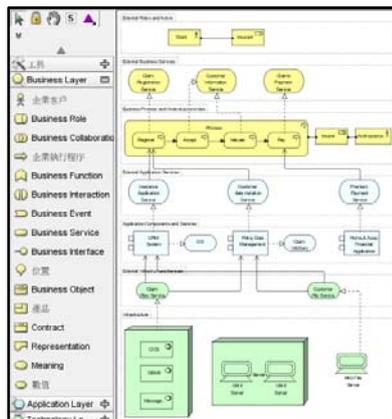


Figure 13 : EA Demowith ArchiMateofAgilian 10.1 (Visual Paradigm, 2013)

Novay and its partners started the ArchiMate R&D project in 2002, they wanted to develop better means for communicating enterprise architectures. The ownership of ArchiMate was transferred to The Open Group and became a standard in 2009. The Open Group published version 2.0 of the ArchiMate language for enterprise architecture modeling on January 31, 2012. ArchiMate 2.0 provides a number of important extensions that make the fit between TOGAF and ArchiMate even closer. It improves collaboration through clearer understanding across multiple functions, including business executives, enterprise architects, systems analysts, software engineers, business process consultants and infrastructure engineers.

### 3.3 Zachman Framework Visible Analyst

Visible Enterprise with EA/Modeling tools can be used to strategic planning, data modeling, business process modeling (BPMN), UML Modeling, and structured analysis and design modeling. Visible enterprise enables enterprises to build complex client/server applications and databases. Allows data, processes, and objects to be modeled in multiple notations, including complete analysis and design UML, for effective software engineering. Most widely used modeling and design product in universities and colleges. Generates model information in multiple forms, including COBOL, C, Visual Basic, SQL, and XML. The price of Enterprise Architecture/Modeling Tools is US\$2995, as shown in Figure 14.

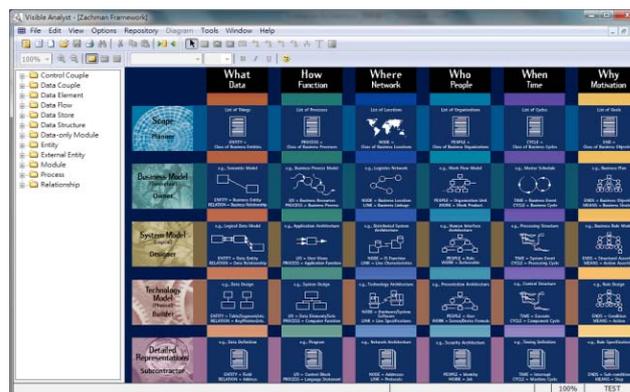


Figure 14 : Visible Analyst 2009interface for Zachman Framework

## 4. Comparisons between Current EAs

Five existing EA frameworks today such

as DoDAF, TOGAF, Zeckman, FEAF, and SBCF are studied. These EA frameworks are compared with

eight criteria: architecture, processes, model, complexity, hierarchy, system view, Integration and tools. Most of the EA frameworks have high complexity to be followed and applied to practical enterprise operations.

When reviewing an EA tool's basic functionality, the reviewer has to describe how well the tool performed the different functions needed for the EA development activity. The tool's basic functionality is examined in the following areas: Methodologies and Models; Model Development Interface; Tool Automation; Extendibility and Customization; Analysis and Manipulation; Repository; Deployment Architecture; Costs and Vendor Support; Architecture Results (Prekop et al., 2001; Schekkerman, 2011).

The second dimension, the tool's utility to different professionals, captures the fitness for purpose of the tool, and describes how useful the tool would be to particular professionals. The types of professionals considered were: EAs; Solution Architects: Strategic Planners / Management; Enterprise Program Managers; Software Architects/engineers; External Partners.

Structure and behavior are mutually independent in most of EA frameworks, e.g., ArchiMate and Structure and behavior are unable to integrate. In SBC approach, the behavior is attached to the structure. Therefore, structure and behavior are fully integrated. The drawback for SBCF is lack of automatic tools to draw the diagrams, as shown in Table:

Table Comparisons between Current EAs

Framework	DoDAF	TOGAF	Zeckman	FEAF	SBCF
Architecture	Average	Average	High	High	High
Processes	Average	Average	High	High	High
Model	Average	High	High	Average	High
Complexity	High	High	High	High	Low
Hierarchy	Low	Average	High	High	High
System View	Average	High	High	High	High
Integration	Average	Average	Low	Low	High
Tools	None	ArchiMate	Visible Analyst Visual-Paradigm	None	Draw by visio software

## 5. Conclusions and Recommendations

The conclusions and recommendations of this research are described in this chapter.

### 5.1 Conclusions

In this study, the EA frameworks are intensively studied. Full benefit logic of EA is described as follows: EA can decrease complexity of systems, reduced time-to market systems, faster introduction new products, increased revenue, and finally increased return on invested capital (ROI). On the other hand, EA can decrease complexity of systems, low maintenance and exploitation costs, cost reduction, and then further increasing ROI.

Working with architecture can be aided by architectural tools. They should be well suited to enterprise task. Using tools in an integrated manner, preferably with the support of a repository, maximizes their efficiency and effectiveness. We study the tools for EA such as ArchiMate, Zackman, and six golden rules for SBCF and they may save a

lot of money and effort to search and then apply to the enterprises.

### 5.2 Recommendations

An understanding of cloud technology innovation is becoming increasingly essential for IT practitioners, as entrepreneurs realize the business requirements fulfillment potential of an enterprise perspective of cloud computing. Mahmood and Hill (2010) provide a single point of reference for state-of-the-art cloud computing design and implementation techniques. They examine cloud computing from the perspective of EA, asking the question; how do we realize new business potential with our EA? We proposed a SBC architecture development process, The center is SBC framework and surrounded by 8 architectures: cloud EA, cloud application architecture, cloud data architecture, cloud technology architecture, cloud integration architecture, cloud management architecture, cloud security architecture, and cloud governance architecture, as shown in Figure 15.

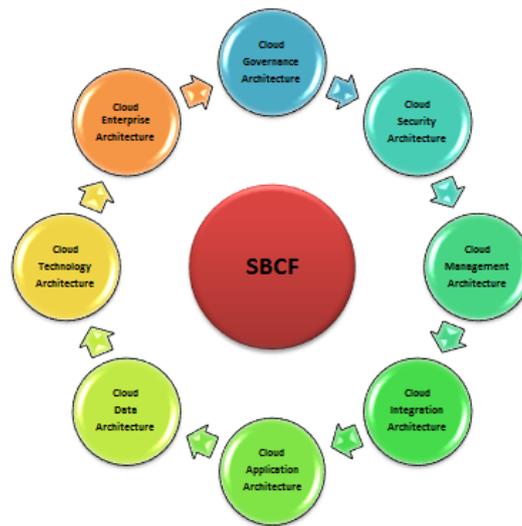


Figure 15 : Proposed Cloud Enterprise Architecture for SBCF

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