

# **A Review of Commercial Related Architecture Frameworks and their Feasibility to C4I System**

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## **Abstract**

Architecture plays a major role in the development of information systems. The architecture frameworks standards are rapidly evolving. These are widely used in defense as well as in commercial industries. These are used in architecture modeling. They provide structure and systematic approach to designing systems. In this paper, we are providing a systematic review of architecture frameworks that are being used as standards in commercial and defense information system development process such as C4I system. This review may help the researcher to understand basis of existing frameworks briefly. Further, a comparison of commercial related architecture frameworks is presented in this work.

**Keywords:** Architecture Framework (AF), View, Architecture Description Language (ADL), Enterprise Architecture Framework (EAF), C4I system

## **1. Introduction**

This paper presents a systematic review of different architecture frameworks that are milestones in the development of information systems. There are two main categories of architecture framework such as commercial and defense. The commercial frameworks are Zachman framework, The Open Group Architecture Framework (TOGAF), Integrated Architecture framework (IAF), Model Driven Architecture (MDA), Ownership, Business Processes, Applications, Systems, Hardware, and Infrastructure (OBASHI), Sherwood Applied Business Security Architecture (SABSA), SAP Enterprise Architecture Framework (SAP EAF), National Institute of Standards and Technology Enterprise Architecture (NIST EA) and Federal Deposit Insurance Corporation Enterprise Architecture (FDIC EAF). The paper is divided into sections such as background, commercial related architecture frameworks, comparison, feasibility to C4I system and conclusion.

## **2. Background**

An Enterprise Architecture Framework (EAF) is a readymade structure that is used to organize enterprise architecture into complementary views. An Enterprise Architecture (EA) framework is a logical structure for classifying and organizing complex information. The Enterprise Architecture is represented through graphics, models and narratives that describe the enterprise design. To provide consistency across the resulting complex design, the representations are developed according to a unifying architectural framework. A view is a projection of the enterprise architectural model that is

meaningful to one or more system stakeholders such as an analysis view is more significant to business & system analyst and less important to system implementers and testers [4, 5].

### **3. Commercial Related Architecture Frameworks**

There are much architecture used in the development of commercial frameworks but most commonly are Zachman, TOGAF, IAF, MDA, OBASHI, SABSA, SAP EAF, NIST EA and FDIC EAF. Let us briefly discuss them.

#### **3.1. Zachman Framework**

The Zachman Framework is a framework for enterprise architecture, which provides a formal and highly structured way of viewing and defining an enterprise. It is named after its creator John Zachman, who first developed the concept in the 1980s at IBM. It has been updated several times since 1990s [3,4,5]. Now it is a de facto industry standard for Information Technology (IT) department to specify enterprise architectures. It is less popular with the software development or user communities. It is based on two-dimensional classification matrix. One dimension of the Zachman classification matrix is based on six interrogatives (What, How, Where, Who, When, and Why); the other dimension is based on six stakeholder groups (Visionary, Owner, Designer, Builder, Implementer and Worker). The classification matrix is intended to provide a holistic view of the enterprise architecture which is being modeled [1,2]. The advantages of the Zachman Framework approach include an intuitive classification matrix which provides comprehensive coverage for all enterprise architecture stakeholders. The weaknesses of the approach include the generation of voluminous specification documentation, which can be of questionable utility.

Zachman framework has stimulated the development of other enterprise architecture frameworks, such as in the NIST Enterprise Architecture Model, the C4ISR AE, the department of Energy Architecture Environment (DOE AE), and the DoDAF. The Federal Enterprise Architecture Framework (FEAF) is based on the Zachman Framework but only addresses the first three columns of Zachman, using slightly different names, and focuses in the top of the three rows [6].

#### **3.2. IAF (Integrated Architecture Framework)**

IAF is an enterprise architecture framework that covers business, information and technology [7]. This framework has been developed by Capgemini since 1990s, from the experience of practicing architects on projects for clients across the group. The first version was released in 1996 and was based on the Zachman Framework and Spewaks ideas about EA Planning [8].

The Integrated Architecture Framework is:

1. A comprehensive framework to deliver market-leading solutions
2. Adaptable to the specific needs of an organization
3. Scalable from individual projects to enterprise-wide transformation
4. A recognized architecture method in The Open Group's IT Architecture Certification program (ITAC) [9].

Integrated Architecture Framework has evolved based on the real-world experience, and continues to provide strong focus on the need to understand the business needs and drivers, and for all aspects of the architecture and all architectural decisions to be traceable back to these business priorities.

#### **3.3. NIST EA (National Institute of Standards and Technology Enterprise Architecture)**

NIST Enterprise Architecture Model (NIST EA Model) is a reference model for Enterprise Architecture that illustrates the interrelationship of enterprise business, information, and technology environments. This model developed by the National Institute of Standards and Technology (NIST) in

1989, became in the 1990s widely accepted and promoted within the U.S. federal government as an Enterprise Architecture management tool. This NIST Enterprise Architecture Model is the foundation of several U.S. federal Enterprise Architecture frameworks, for example the Federal Enterprise Architecture Framework [10]. This framework is applied on FDIC Enterprise Architecture Framework, FEAf, and NWS (National Weather Service) Enterprise Architecture [11].

### **3.4. TOGAF (The Open Group Architecture Framework)**

The Open Group Architecture Framework is developed by The Open Group in 1995. Its development was encouraged by The US Department of Defense. It is based on Technical Architecture Framework for Information Management (TAFIM), which itself was the result of many years of development effort and many millions of dollars of US Government investment [12]. It is based on four pillars, four architecture domains such as Business, Application, Data, Technology architecture.

### **3.5. SABSA (Sherwood Applied Business Security Architecture)**

This is a framework and methodology for Enterprise Security Architecture and Service Management. It was developed by Fergus Cloughley and Paul Wallis during late 2001 independently from the Zachman Framework, but has a similar structure [13].

It is a formal and structured way of communicating the logical and physical relationships and dependencies between IT assets and resources (Ownership, Business Processes, Applications, Systems, Hardware, and Infrastructure) to define the business services of a modern enterprise [13].

### **3.6. FDIC EAF (Federal Deposit Insurance Corporation Enterprise Architecture).**

This is based on FEAf (Federal Enterprise Architecture Framework) and Zachman Framework for Enterprise Architecture. FDIC started work in 1997 and published its first EA blueprint in December 2002[16]. It emphasizes on security and highlights the importance of security to all other components of the architecture [14]. This framework is also received award Enterprise Architecture Excellence from Zachman Institute for Framework Advancement (ZIFA) for its initiative to manage corporate data collaboratively [15].

The FDIC EA framework includes five components. The first component, the Business Architecture, focuses on FDIC's business needs. The next three components, the Data Architecture, Applications Architecture, and Technical Infrastructure Architectures, focus on the technological capabilities that support the business and information needs. The final component, the Security Architecture, focuses on specific aspects of interest to the Corporation that span the enterprise and must be integral parts of all other architectures [14].

### **3.7. MDA (Model Driven Architecture)**

MDA is a software design approach for the development of software systems. It provides a set of guidelines for the structuring of specifications, which are expressed as models. Model-driven architecture is a kind of domain engineering, and supports model-driven engineering of software systems. It was launched by the Object Management Group (OMG) in 2001[17]. This defines system functionality using a platform-independent model (PIM) using an appropriate domain-specific language. The MDA model is related to multiple standards, including the Unified Modeling Language (UML), the Meta-Object Facility (MOF), XML Metadata Interchange (XMI), Enterprise Distributed Object Computing (EDOC), the Software Process Engineering Metamodel (SPEM), and the Common Warehouse Metamodel (CWM). Executable UML supports MDA through specification of platform-independent models, and the compilation of the platform-independent models into platform-specific models [18].

### **3.8. OBASHI (Ownership, Business Processes, Applications, Systems, Hardware, & Infrastructure)**

The main focus is to manage the flow of data between business assets. It provides a framework and method for capturing, illustrating and modeling the relationships, dependencies and data flows between business and Information technology (IT) assets and resources in a business context. It is a formal and structured way of communicating the logical and physical relationships and dependencies between IT assets and resources (Ownership, Business Processes, Applications, Systems, Hardware, & Infrastructure) to define the business services of a modern enterprise. OBASHI helps you to model, visualise and understand how and why IT assets support business services [19].

### **3.9. SAP EAF (SAP Enterprise Architecture Framework)**

The SAP Enterprise Architecture Framework (EAF) is a methodology and toolset primarily to support the effective adoption of SOA. It is based on The Open Group Architecture Framework (TOGAF) and specifically designed to support packaged solutions and Service-oriented architecture (SOA). SAP EAF is a complementary set of additions to TOGAF to support the specific characteristics of package and service-based architectures. SAP EAF was developed during 2007 by a team of SAP Enterprise Architects, most of whom were TOGAF 8.1 accredited practitioners. SAP EAF was formally launched at the SAP SAPHIRE user conference in Atlanta, USA during 2007. The SAP Enterprise Architecture Framework provides a holistic, open and neutral approach for Enterprise Architecture. It recognises the shift that SOA brings and makes use of accelerators from SAP to speed architecture creation [12. 20].

## **4. Comparison**

The review of commercial related architecture frameworks is described in Table1.

**Table 1:**

Analysis Elements	Zachman	IAF	NIST EA	TOGAF	SABSA	FDIC	MDA	OBASHI	SAP EAF
Developed by	John Zachman	Capgemini	NIST	The Open Group	Fergus Cloughley and Paul Wallis	FDIC	OMG	Fergus Cloughley and Paul Wallis	SAP EA team
Developed in	1980s	1990s	1989	1995	2001	2002	2001	2001	2007
Derived AEs	NIST EA, CAISR AE, DOE AE, DODAF, FEAF								
Application	B	B	BANWS	B	B	B/S	B	B	B
Tool support	YES	YES	YES	YES	YES	YES	YES	YES	YES
Scalability	Much	YES	YES	More	YES	YES	YES	YES	More
Interoperability	YES	YES				YES			More
Architecture Evolution Support	No			YES			YES		

*Table 1 :Comparison of Commercial Related Architecture Frameworks*

\*B: Business, \*S: Security, \*NWS: National Weather Service, \*Blank: Not fully supported

The Zachman Framework for Enterprise Architecture is based on Information System Architecture (ISA) and Extended Information System Architecture (EISA) developed by Zachman. ZF has been widely adopted by the architecture community and it is incorporated into other architecture frameworks. ZF's key goals are for enterprise architecture analysis and modeling and it is concerned with perspectives of constructing an information system.

IAF is an enterprise architecture framework that covers business, information and technology. IAF is based on ZFs. It is comprehensive, adaptable and scalable framework. NIST EA demonstrates

the interrelationship of enterprise business, information, and technology environments. TOGAF consists of four architecture domains such as Business, Application, Data, Technology architecture. SABSA is a framework and methodology for Enterprise Security Architecture and Service Management. It is a formal and structured way of communicating the logical and physical relationships and dependencies between IT assets and resources such as Ownership, Business Processes, Applications, Systems, Hardware, and Infrastructure. FDIC emphasizes on security and highlights the importance of security to all other components of the architecture. It is totally based on FEA and ZF. MDA is a software design approach for the development of software systems. The main focus of OBASHI is to manage the flow of data between business assets. SAP EA provides a holistic, open and neutral approach for Enterprise Architecture.

## **5. Feasibility To C4I System**

Two architecture framework such as FEA (Federal Enterprise Architecture) and MDAF (Model Driven Architecture Framework) are found to be feasible for defense system development such as C4I system. These are described briefly as follows.

### **5.1. FEA (Federal Enterprise Architecture)**

FEA was developed by US Office of Management and Budget (OMB), in September 1999. The focus of this framework is civil, defense, and intelligence that was determined by 124-member Working Group comprised of 30 U.S. federal agencies. It consists of reference models such as Performance Reference Model, Business Reference Model, Service Component Reference Model, Data Reference Model and Technical Reference Model [21].

### **5.2. MDAF (Model Driven Architecture Framework)**

It was launched by the Object Management Group (OMG) in 2001. As defined by the Object Management Group (OMG), MDA is a way to organize and manage enterprise architectures supported by automated tools and services for both defining the models and facilitating transformations between different model types [22].

## **6. Conclusion**

In this paper a review of various commercial related architecture frameworks is presented. Further, a basic comparative analysis is made on the basis of previous research. We also discussed the importance and background of enterprise architecture framework. Mostly defense information system or defense industry application is developed on the basis of standard AFs such as DODAF, and MODAF. While commercial information system or commercial industry application is developed on the standard of AFs such as ZF, IAF, NIST EA, TOGAF, SABSA, FDIC, MDA, OBASHI and SAP EAF. The results of initial review show that the commercial industry enterprise applications are developed and preferred on the AFs such as ZF, TOGAF, MDA, and SAP. While some architecture such as FEA and MDAF may be used in the development process of defense applications such as C4I systems.

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