PUBLISHED BY
bookboon

Pritam De

Enterprise Architecture

Designing a Better Enterprise

PRITAM DEY

ENTERPRISE ARCHITECTURE

DESIGNING A BETTER ENTERPRISE

Enterprise Architecture: Designing a Better Enterprise
1st edition

ISBN 978-87-403-1480-9

CONTENTS

ACKNOWLEDGEMENT

This eBook is a compilation of various Enterprise Architecture thoughts and materials summarized and put together in an easily readable and digestible format. My deep gratitude goes to the Enterprise Architecture pioneers in the industry, framework-provider organizations such as The Open Group, Zachman International, Pragmatic EA, etc., and colleagues whom I have worked with in the Enterprise Architecture discipline. As far as possible, I have tried to cite the source of my references.

DISCLAIMER

The words ‘Enterprise Architecture’ and ‘EA’ are used interchangeably throughout the eBook.

SETTING THE CONTEXT

Most business executives running an organization have confessed to struggling with solving key organizational challenges. While some of the challenges are in siloes, narrow-focused (e.g. a departmental challenge, or a fire-fighting business crisis) and point-in-time, the toughest challenges pertain to issues that span the whole organizations. Some of the top questions that executives ponder over are:

- How do I steer the organization in the right direction?
- How does my organization keep adrift of the changes happening in the industry?
- How do I manage the complexity of the organization?
- How can I keep the organization cohesive, aligned, and in sync with the business objectives?
- Is there a way to get an enterprise-wide view of things so that I can trace the impact of a business decision?
- What is the most efficient way to structure the organization so that the inter-relationships between any areas of the organization can be derived and assessed?

The above challenges have compounded with the increasing embedding of technology and Information Technology. 21st Century organizations are also technology shops in some way. The digital age ensured that organizations are no longer a collection of business, people, processes, and physical assets. There are also presence of 'things' in the organization DNA. These things are mostly Information Technology systems and infrastructure, technology tools, collaboration devices (smartphones, tablets, and mobility devices) and so on. As the result, the organizations have become a quagmire of complexities and challenges.

It is ironical but still true that not all business executives are technology savvy. You may have often heard them saying, "Technology is not my thing." But the reality is as much as they express ignorance of technological tidbits, they cannot avoid technology any longer.

In such a complex scenario, how does organizations and stakeholders make sense of the huge number of assets and processes existing within the organization? Is there a discipline to organize the various layers/domains of an enterprise, organize them in sensible categories, and get a better understanding of the functioning of the enterprise? In other words, does the organization have an enterprise-level architecture? In other words, does it have Enterprise Architecture?

This brings us to the next question. What is an architecture?

ISO/IEC 42010:2007 defines architecture as "***the fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution.***"

Another, albeit simpler, definition of architecture is provided by The Open Group. It defines architecture as "***the structure of components, their inter-relationships, and the principles and guidelines governing their design and evolution over time.***"

Now an organization may have aspects of above architecture in various types. It may have a Business Architecture that defines the structure of the business strategy, processes, and assets. It may have an IT architecture that enables business. However collectively speaking, is there an architecture at an enterprise (or organization) level that is a cohesive whole of all architectural subsets? This pan-organization architecture is called **Enterprise Architecture**.

Let us look at the popular definitions of Enterprise Architecture.

Enterprise Architecture Research Forum (EARF, 2009): '*Enterprise Architecture is the continuous practice of describing the essential elements of a sociotechnical organization, their relationships to each other and to the environment, in order to understand complexity and manage change*'.

Gartner: '*Enterprise architecture (EA) is a discipline for proactively and holistically leading enterprise responses to disruptive forces by identifying and analyzing the execution of change toward desired business vision and outcomes.'*

Institute for Enterprise Architecture Development*: 'Enterprise Architecture is about understanding all of the different elements that go to make up the enterprise and how those elements interrelate.'*

MIT Center for Information Systems Research*: 'Enterprise Architecture is the organizing logic for key business processes and IT capabilities reflecting the integration and standardization requirements of the firm's operating model.'*

The ArchiMate Foundation*: '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.'*

The Open Group*: 'By being inclusive with all other management frameworks, EA is a discipline that helps the Enterprise define, develop and exploit the Boundaryless Information Flow (BIF*) capabilities in order to achieve the Enterprise's Strategic Intent.'*

**Boundaryless Information Flow is a Trademark of The Open Group*

***US Federal Enterprise Architecture Framework (FEAF)**: 'Enterprise architecture is a management practice to maximize the contribution of an agency's resources, IT investments, and system development activities to achieve its performance goals. Architecture describes clear relationships from strategic goals and objectives through investments to measurable performance improvements for the entire enterprise or a portion (or segment) of the enterprise.'*

The common terms across all the above definitions are 'elements', 'relationships', 'change', 'practice', 'organize', etc.

In essence, **Enterprise Architecture is a holistic term for the structure of components within an organization, their inter-relationships, and the principles/guidelines that guide their evolution over time.** Enterprise Architecture is not a point-in-time activity; it is a continuous process of enhancing an organization's ability to manage complexity and change, with an inherent vision of creating and sustaining a coherent and harmonious (in terms of various parts of the organization working together and cohesively) organization.

If Enterprise Architecture is at the level of an organization, why is it called Enterprise Architecture and not Organization Architecture?

This is because: firstly, Organization Architecture is sometimes mistakenly construed as a Human Resource (HR) organization structure. Secondly, the scope of an enterprise is much broader than an organization. An "enterprise" could be a collection of organizations with a common set of goals (TOGAF). The enterprise extends beyond organization to include external partners, vendors, suppliers, government agencies, customers, or geographically distributed organizations. The term "enterprise" in "enterprise architecture" could denote either an entire enterprise (including all its processes, assets, people), or a specific domain within the enterprise. In both cases, the architecture spans crosses multiple systems, and multiple functional groups within the enterprise.

If all the above-mentioned definitions of Enterprise Architecture still confuse you, it is easier to remember EA as an acronym for "Everything Aligned". If you can align everything else within the organization to the business strategy and goals, then the basic objective of Enterprise Architecture is met.

1 WHY DO WE NEED ENTERPRISE ARCHITECTURE

The primary reason for adopting Enterprise Architecture is to manage **complexity** and **change** better.

In today's world, the pace of change and disruption is much greater than what we have encountered any time before. Poorly designed organizations will have a challenging task managing this change.

Complexity is another challenge that today's organizations are confronted with. New business models, overlapping processes & services, conflicting product strategies, global operations across multiple countries (with their own set of laws and regulations), huge IT inventory, siloes of information with no single source of truths, conflicting standards, disjointed technologies, and huge expectations from the customers, employees, and vendors exposes the complexity even further. Bigger and older the organization is, more complex it becomes.

Another challenge is the eternal complaint that their IT department is not efficient enough to deliver on business expectations. Due to the rapid change in business innovation and demand, IT ends up playing the 'catching up' game. There is a huge gap between business expectations and IT delivery – leading to the famous phrase 'Business-IT Alignment gap'.

Therefore unless an enterprise is designed well with all its various engines working harmoniously and in perfect alignment, it faces the risk of losing out on its competitive advantage. Its survival may even be at stake.

Therefore in today's age, Enterprise Architecture is highly recommended to be able to manage the change and complexity better. This can be achieved if the fragmented legacy of business goals & strategies, capability, functions, processes, services, and supporting IT elements (applications, data, and infrastructure) are integrated into a cohesive environment. This can be achieved if organizations are designed to withstand the demands of tomorrow; in other words, they are future-ready.

Enterprise Architecture is a continuous discipline to *design enterprises & business better into a cohesive unit so that business values are delivered better and faster*.

Another advantage of having an Enterprise Architecture is that it provides a holistic blueprint of the enterprise that acts as a collaboration force among business strategy, process, service, applications, information, and infrastructure. The blueprint is extremely helpful for solving problems the solutions for which needs to take into account the larger organization impact. The old siloed-thinking mindset is no longer useful.

Enterprise Architecture is a wonderful, proven, and effective tool for business transformation. An enterprise-wide view of organization that combines business strategy, business & IT architecture, information systems, technology and infrastructure components are the various inputs that go into defining business transformation. Business Transformation is supported by providing the current state of the organization (usually derived from enterprise-wide blueprint), the target landscape, and the gap analysis between them.

As Dr. Pallab Saha (Chief Architect & Head, Wipro Academy of EA) put it in his recent post 'Government Enterprise Architecture Is Hard':

"Enterprise architecture is done to build better enterprises, not merely better IT systems".

2 BENEFITS OF ENTERPRISE ARCHITECTURE

According to The Open Group, the key benefits that can be obtained from Enterprise Architecture are:

- *A more efficient business operation:*
  - *Lower business operation costs*
  - *More agile organization*
  - *Business capabilities shared across the organization*
  - *Lower change management costs*
  - *More flexible workforce*
  - *Improved business productivity*
- *A more efficient IT operation:*
  - *Lower software development, support, and maintenance costs*
  - *Increased portability of applications*
  - *Improved interoperability and easier system and network management*
  - *Improved ability to address critical enterprise-wide issues like security*
  - *Easier upgrade and exchange of system components*
- *Better return on existing investment, reduced risk for future investment:*
  - *Reduced complexity in the business and IT*
  - *Maximum return on investment in existing business and IT infrastructure*
  - *The flexibility to make, buy, or out-source business and IT solutions*
  - *Reduced risk overall in new investments and their cost of ownership*
- *Faster, simpler, and cheaper procurement:*
  - *Buying decisions are simpler, because the information governing procurement is readily available in a coherent plan*
  - *The procurement process is faster – maximizing procurement speed and flexibility without sacrificing architectural coherence*
  - *The ability to procure heterogeneous, multi-vendor open systems*
  - *The ability to secure more economic capabilities*

2.1 ENTERPRISE ARCHITECTURE IN REAL LIFE – EXAMPLES

The idea of Enterprise Architecture is not at all an alien concept in our everyday life. Enterprise Architecture is more akin to a mindset of being able to see the big picture and connect the dots. The ability to manage the traceability of each object to another is the basic thought process of an Enterprise Architect.

Let us take few examples where the concept of Enterprise Architecture is manifested in its basic nature.

2.2 ENTERPRISE ARCHITECTURE AS CITY PLAN (BLUEPRINT)

Imagine the layout of a city. First of all, there is a master plan (vision) of what kind of city is being envisioned or already exists. Based on this vision, there is a division of the city into various zones (example business, residential, government, industrial). There are plans of which type of buildings will be allowed in each zone type. Underneath the city, there is basic infrastructure such as utilities, plumbing, electrical, etc. There are specific guidelines on how buildings would connect into the city infrastructure. Each element of the city (building, roads, infrastructure, connectivity, etc.) are designed as per some standards that are consistent across the city. A city is also subject to its ecosystem and environment. Aspects such as air quality, weather patterns, natural calamity (earthquake, floods, hurricanes) need to be factored in when designing a city. There is also the people aspect – the availability of workforce, convenience of residents, and provision of basic amenities for them (e.g. parks, schools, hospitals, etc.).

The city planning example is very analogous to an enterprise. Just like a city vision, there is organization strategy & vision. The zoning of the city is similar to the various business units and departments of the enterprise. The type of building allowed in each zone is similar to the function of each department or business unit in the enterprise. A remote factory will have different building plan as compared to that of a head office located in central business district of a city. The city infrastructure is similar to the infrastructure in the enterprise. The basic infrastructure of any enterprise are IT (hardware, network, communication lines), and the utility infrastructure (water, electricity, sewage). Just as any city is affected by its surrounding ecosystem and environment, an enterprise is affected by the competition and other factors such as regulations, compliance, disruption in business models, technology shifts, etc. And lastly there is a central people aspect in both the city and enterprise plan.

Every city has a detailed blueprint (map) which help us understand where we are, how we are aligned to the larger city plan (e.g. our decision to build a house or business), how we can strategize to achieve our goals while staying aligned with the city plan and regulations, and finally what capability we can leverage from the city to respond to any event (e.g. responding to federal regulations such as tax, etc.).

Enterprise Architecture is a plan representing the whole enterprise structure that allows us to view aspects of business and IT, and how they interrelate. Also like a city plan, Enterprise Architecture allows us to understand where we are and the impacts of our plans on IT and the business, thereby allowing us to strategize on the most efficient time-saving approaches, and respond with agility to business and technology changes.

2.3 ENTERPRISE ARCHITECTURE AS HUMAN ANATOMY AND PHYSIOLOGY

A human body is a wonderful example of explaining Enterprise Architecture. Adrian Grigoriu has written a wonderful article in eBiz describing how Enterprise Architecture is the science of anatomy and physiology of an Enterprise. He writes:

"*The description of the structure and operation of the Enterprise is done here by analogy with the anatomy and physiology of the body. The structure is dealt with by anatomy while the operation by physiology. Anatomy illustrates the body by depicting its systems in separation (circulatory, nervous, skeletal, muscular systems…) and parts (the head, torso, neck, limbs and organs like lungs, heart, liver). Each of these parts implements body functions. Physiology describes how the vital functions such as breathing, sensory processes etc. operate over these various systems and parts. The digestive process, for instance, depicts the food ingestion, distribution and transformation into energy from mouth to stomach and beyond. The respiratory process shows how the body processes and transports oxygen to organs.*

A body interacts with the environment i.e. eats, breathes, feels…. In the Enterprise, Use Case scenarios describe the interaction with the environment and stakeholders.

A doctor, a surgeon cannot diagnose or operate without being familiar with all the body parts, systems and vital processes. Similarly, an Enterprise Architect cannot operate without knowledge of business Functions, Layers, Views and business Flows. Even more, doctors specialize in one of these systems like in the Enterprise, the domain architects do."

2.4 HUMANE GENOME PROJECT

We all are most likely aware than human body is composed of genes – the carriers of hereditary information. These physical and functional units of heredity are transferred from parents to offspring, and helps to determine some characteristics of the offspring. Genes are composed of deoxyribonucleic acid (DNA) and act as instructions to make molecules called proteins. The Humane Genome Project has estimated that humans have between 20,000 and 25,000 genes (Source: Genetics Home Reference).

One of the major challenges faces by physicians, doctors, and researchers in the 21st century is the origin of diseases. An effective treatment for life-threatening diseases such as AIDS and cancers has flummoxed everyone.

It was felt that the clue to all such diseases could lie in the human genes. If a detailed information about the structure, organization and function of the complete set of human genes could be traced, would that help us understand whether some of these diseases are genetic and probably inherited from our parents?

This enquiry eventually led to the Human Genome Project. The Human Genome Project (HGP) was the international, collaborative research program whose goal was the complete mapping and understanding of all the genes of human beings. All our genes together are known as our "genome."

According to National Human Genome Research Institute, Humane Genome Project researchers have deciphered the human genome in three major ways: determining the order, or "sequence," of all the bases in our genome's DNA; making maps that show the locations of genes for major sections of all our chromosomes; and producing what are called linkage maps, complex versions of the type originated in early Drosophila research, through which inherited traits (such as those for genetic disease) can be tracked over generations.

"*The HGP has revealed that there are probably about 20,500 human genes. The completed human sequence can now identify their locations. This ultimate product of the HGP has given the world a resource of detailed information about the structure, organization and function of the complete set of human genes. This information can be thought of as the basic set of inheritable "instructions" for the development and function of a human being.*"

Upon publication of the majority of the genome in February 2001, Francis Collins, the director of NHGRI, noted that the genome could be thought of in terms of a book with multiple uses: "It's a history book – a narrative of the journey of our species through time. It's a shop manual, with an incredibly detailed blueprint for building every human cell. And it's a transformative textbook of medicine, with insights that will give health care providers immense new powers to treat, prevent and cure disease."

But what has The Human Genome Project go to do with Enterprise Architecture?

If we really try to analyze the crux of HGP, we can decipher that HGP tried to make sense of complexity of human body by understanding the genetic cells, mapping them to one another so that the underlying organization, structure, and function of human genes could be understood. This is, in essence, documenting the current state of human body.

An enterprise is similar to a human body with its many parts (organization units, departments, functions, people, process, assets, etc.). The larger an enterprise becomes, more complex it becomes. Therefore a good practice to manage his complexity is to have a detailed mapping of all the domains of the enterprise. The problems of tomorrow's enterprise can be solved only if there is a good understanding of the current enterprise. A proven tool to accomplish this is to map the whole enterprise using Enterprise Architecture – similar to what HGP managed to accomplish by mapping the human genes.

3 HISTORY OF ENTERPRISE ARCHITECTURE

Enterprise Architecture, as a discipline, was first introduced as a concept in 1987 by John A. Zachman in an article published in the IBM Systems Journal titled "A framework for information systems architecture". He later renamed "Information Systems" framework to "Enterprise Architecture" framework. His framework is known as The Zachman Framework today.

In 1994, the United States Department of Defense (U.S. DoD) introduced the Technical Architecture Framework for Information Management (TAFIM) – a new enterprise architecture framework for defense industry. TAFIM was eventually retired in 1998.

In 1996, Enterprise Architecture received a major boost when U.S. Congress passed the Clinger/Cohen Act. Formerly called the Information Technology Management Reform Act of 1996 (ITMRA), it was designed to improve the way the federal government acquires, uses and disposes information technology (IT). The Office of Management and Budget (OMB) subsequently mandated that "Information Technology Architectures (ITAs) should be consistent with Federal, agency, and bureau information architectures." This eventually led to the US Federal CIO Council initiating the Federal Enterprise Architecture Framework (FEAF) in 1999. Today every federal agency in US is required by OMB to develop an enterprise architecture, and demonstrate its alignment with FEAF.

In 1995, The Open Group Architectural Framework (TOGAF) adopted TAFIM (with permission from DoD). TOGAF states that "*TOGAF® is the de facto global standard for Enterprise Architecture. The Open Group Architecture Forum, comprised of more than 200 enterprises, develops and maintains the TOGAF standard and publishes successive versions at regular intervals.*"

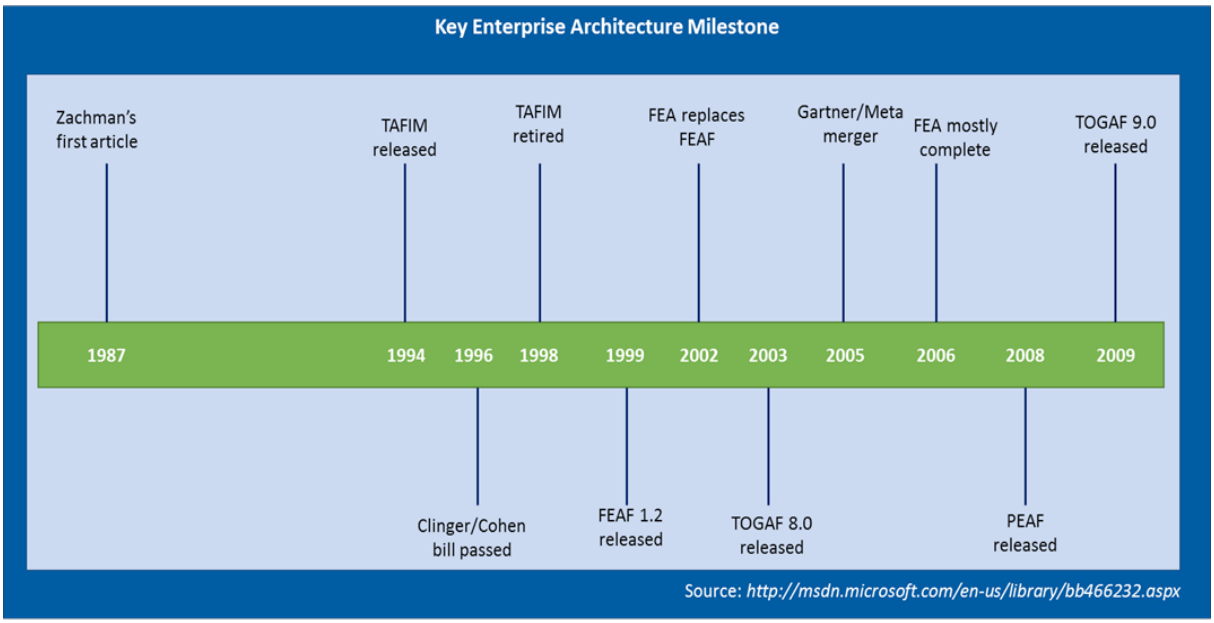

Figure 1: Enterprise Architecture Evolution Timeline

According to The Open Group, "*TOGAF® has been adopted by more than 80% of the world's leading enterprises as the architecture framework and development method of choice, and continues to be evolved by the members of The Open Group Architecture Forum. TOGAF Certification has been achieved by tens of thousands of individuals worldwide.*"

The chief advantages of TOGAF over other Enterprise Architecture frameworks are its ability to ensure that everyone speaks the same architectural language; it is an "open source" framework controlled by The Open Group; has a demonstrable ROI, and provides ease of adoption and implementation.

In 2008, Pragmatic EA launched the Pragmatic EA Framework (PEAF) mainly targeted at enterprises and government bodies on a global scale. It claims that PEAF "Cuts EA to the Bone" by providing an easy toolkit to begin and sustain Enterprise Architecture initiatives.

After TOGAF, the next popular framework is The Zachman Framework, closely followed by FEAF.

There are various other Enterprise Architecture frameworks available in the market created by both private and public sector enterprise. A summary of these frameworks is available in Appendix A.

4 COMPONENTS OF ENTERPRISE ARCHITECTURE

Enterprise Architecture is a fairly broad term that is used to represent and explain multiple domains underneath it.

The main Enterprise Architecture domains are:

a) Business Architecture
b) Application Architecture
c) Data (or Information) Architecture
d) Technology Architecture

Besides above domains, there are also secondary domains such as Strategy Architecture (usually represented as part of Business Architecture), Security Architecture, and Integration Architecture.

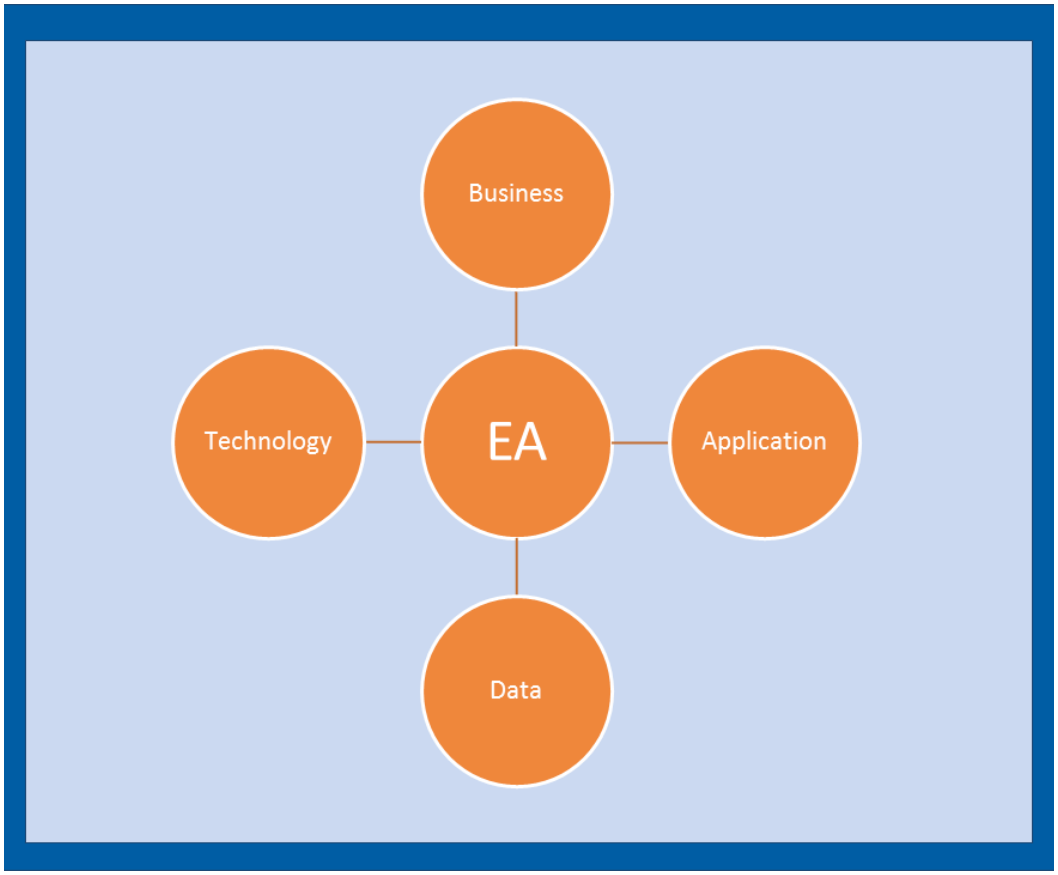

Figure 2: Domains of Enterprise Architecture

4.1 BUSINESS ARCHITECTURE

Business Architecture describes how an organization achieves its business goals. Business Architecture typically consists of the organization's product and service strategy, the organization unit(s) that deliver(s) these products and services, business functions, processes, actors, locations, events, and distribution channels.

Business Architecture is pre-requisite for any Enterprise Architecture work. We have talked about earlier that one of the objectives of undergoing Enterprise Architecture journey is to ensure alignment of business and IT. Needless to say, the alignment starts with business. Therefore business architecture is the first architectural activity that needs to be undertaken.

In most organizations, some elements of business architecture (in the form of business strategy, vision, mission, business goals, business processes, etc.) may already exist. These are good starting point for business architecture activity.

4.2 APPLICATION ARCHITECTURE

Application Architecture describes how an organization's information systems will enable the business architecture. Applications embed business logic and key functions to run the business processes. An example of an information system is Enterprise Resource Planning (ERP). Application Architecture describes the structure of the applications and their interaction to manage data assets and provide business functions.

4.3 DATA ARCHITECTURE

Data Architecture describes the structure and interactions of various data assets that are processed by information systems to deliver business services. The data assets are exist in the form of conceptual, logical, and physical data assets. Data Analytics (such as Big Data, etc.) and data management assets also fall under Data Architecture.

4.4 TECHNOLOGY ARCHITECTURE

Technology Architecture describes the structure and interactions of infrastructure and technology components. Example of infrastructure components used in an organization are storage, servers, hardware, etc.

The four domains explained above form the core pillars of Enterprise Architecture. However they are supported by other domains in ensuring a robust Enterprise Architecture practice. One of them is Security Architecture.

Security Architecture deals with enforcement of robust security practices of an enterprise; it ensures that the Enterprise Architecture being defined do not compromise the security of the organization.

Another domain that aids in good Enterprise Architecture practice is Integration Architecture. Integration Architecture ensures the smooth flow of information between applications by eliminating silos between applications, and connecting new applications with the existing ones. Integration Architecture helps stakeholders keep an eye on a holistic and practical approach to application integration for efficient delivery of business services.

We will cover each of these architecture domains in detail in subsequent sections.

5 BUSINESS ARCHITECTURE

Business Architecture is the first architectural activity that should be undertaken.

The **Business Architecture Working Group of the Object Management Group (OMG) (2010)** describes Business Architecture as "*a blueprint of the enterprise that provides a common understanding of the organization and is used to align strategic objectives and tactical demands.*" *According to the OMG, a blueprint of this type describes "the structure of the enterprise in terms of its governance structure, business processes, and business information.*"

Business Architecture deals with all aspects of business, and how they interact with each other. The key questions that Business Architecture should attempt to answer are:

- What does the business do?
- How does it do it?
- Who are the main stakeholders involved? What are their interests?
- What does the business ecosystem look like?
- What are the core and non-core business capabilities?
- Why does the business exist (think vision, mission, and strategies)?

- What are the main products and services that the business deals with?
- How are the products and services delivered to the end customers?
- How is the value stream of business realized?
- What information does the business need to operate?

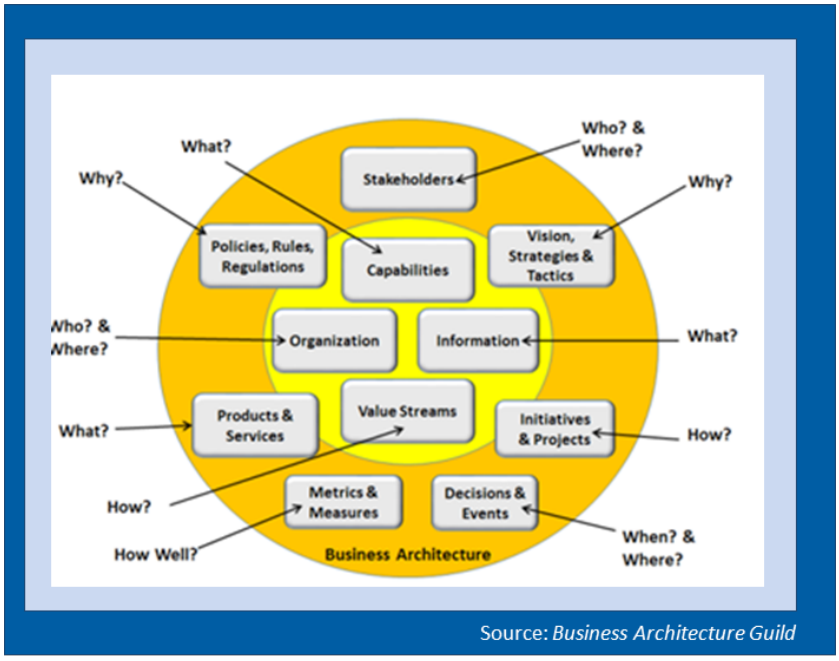

Figure 3: Aspects of the Business Represented by Business Architecture

Organization, Capabilities, Information, and Value Streams represent the core of Business Architecture.

An **Organization** or Organization Unit is "*a self-contained unit of resources with line management responsibility, goals, objectives, and measures.*" (Source: TOGAF)

Capability is defined as an ability that an organization possesses. It is what an organization does to execute its business strategy. For example, Customer Management is a core capability that every company is likely to possess. Capability can be classified as Core or Support depending on how directly or indirectly it participates in the value realization.

While capabilities define what a business does, the **value stream** is an end-to-end collection of activities that deliver value to internal and external stakeholders. (Source: BIZBOK)

Information is defined as "*any communication or representation of facts, data, or opinions, in any medium or form, including textual, numerical, graphic, cartographic, narrative, or audio-visual forms.*" (Source: TOGAF)

While designing Business Architecture, the key question worth keeping in mind is, how can business stakeholders use the business architecture deliverables to get a better understanding of the business of the organization, align strategic initiatives to tactical goals, and identify business transformation opportunities. In simple terms, ***Business Architecture should help business leaders make good business decisions***.

Some of the key Business Architecture deliverables/viewpoints recommended by TOGAF (we will discuss more about this framework later):

Driver/Goal/ Objective Catalog	This catalog provides a cross-organizational reference of how an organization meets its drivers in practical terms through goals, objectives, and (optionally) measures.
Business Service/ Function Catalog	This provides a functional decomposition in a form that can be filtered, reported on, and queried, as a supplement to graphical Functional Decomposition diagrams.
Business Interaction Matrix	This depicts the relationship interactions between organizations and business functions across the enterprise.
Business Footprint Diagram	This describes the links between business goals, organizational units, business functions, and services, and maps these functions to the technical components delivering the required capability.
Functional Decomposition Diagram	This shows the capabilities of an organization that are relevant to the consideration of an architecture.
Business Service/ Information Diagram	This diagram shows the information needed to support one or more business services, what data is consumed by or produced by a business service, and the source of information.
Product Lifecycle Diagram	This assists in understanding the lifecycles of key entities within the enterprise.
Goal/Objective/ Service Diagram	This diagram defines the ways in which a service contributes to the achievement of a business vision or strategy.

6 APPLICATION ARCHITECTURE

Note that applications encapsulate business functionality, and take the form of deployed and operational IT system. E.g. a payroll application is an application supporting payroll functionality. The Application Architecture describes the behavior of applications supporting business, how they interact with each other and with users, how they are accessed (access points e.g. mobile, web, etc.), what data it reads, writes, or updates, and what business functions or services they automate. Application Architecture may also depict the deployment method involving software packages, databases, middleware systems, and infrastructure components (servers, storage, computing systems).

An application architecture is usually depicted in different views depending on the interested stakeholders and the level of level of details they are interested in. Typically there are four views of application architecture as described below.

Conceptual View	Mostly described in abstract terms and meant for business stakeholders
Logical View	Shows main functional components and is independent of technical details of implementation
Physical View	Shows the implementation components and their relationships
Deployment View	Shows how the application will be employed or deployed

According to TOGAF, an Application Architecture usually consists of the following components:

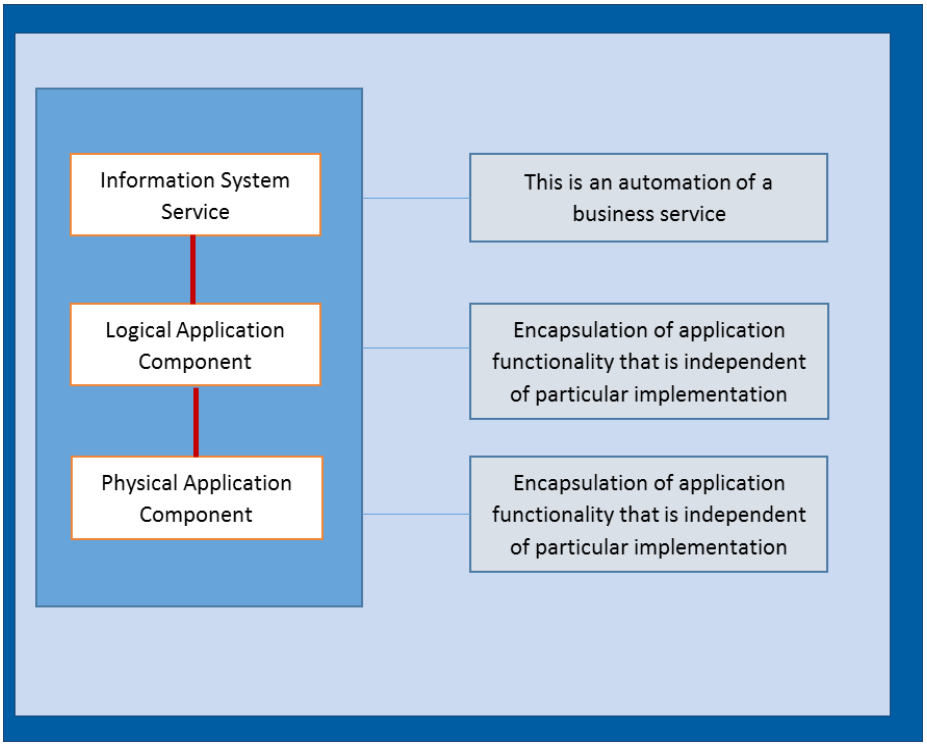

Figure 4: Application Architecture and its Components

Some of the key Application Architecture deliverables/viewpoints recommended by TOGAF (we will discuss more about this framework later) are:

Application/ Organization Matrix	This matrix depicts the relationship between applications and organizational units within the enterprise.
Application/Function Matrix	This matrix depicts the relationship between applications and business functions within the enterprise.
Application Interaction Matrix	This depicts communications relationships between applications.
Enterprise Manageability Diagram	The Enterprise Manageability diagram shows how one or more applications interact with application and technology components that support operational management of a solution.
Application Use-Case Diagram	An Application Use-Case diagram displays the relationships between consumers and providers of application services.
Role/Application Matrix	The purpose of the Role/Application matrix is to depict the relationship between applications and the business roles that use them within the enterprise.

7 DATA ARCHITECTURE

If an application is considered a car, data is the fuel that makes the car run. Data Architecture deals with the models, policies, rules and standards that govern which data is collected, stored, processed, transformed, and utilized by application and data systems.

In addition to above, Data Architecture also addresses data management, data migration, and data governance considerations. Data management enables the effective use of data for business needs. Data migration handles the migration of data from an existing application to a new replacement application without compromising the quality and integrity of data. Data Governance ensures that there is proper structure, management system, and ownership to manage data.

For proper usage of data, Data Architecture breaks down the data subject into three key levels:

- Conceptual Data – This represents all business entities at the highest level.
- Logical Data – Represents the logic of how data entities are related. It describes data in much details such as all attributes of the data, the primary and foreign key, and normalization level.
- Physical Data – The actual realization of data entities for specific use. It explains how data will be physically implemented in the database. A physical database model shows all table structures, including column name, column data type, column constraints, primary key, foreign key, and relationships between tables.

This is explained better with an example.

Conceptual	Logical	Physical
Product	Product ID	PRODUCT_ID: INTEGAR
	Product Name	PRODUCT_NAME: VARCHAR (50)
	Product Description	PRODUCT_DESC: VARCHAR (200)
	Product Category	PRODUCT_CATEGORY: VARCHAR (50)
	Product Price	PRODUCT_PRICE: FLOAT

According to TOGAF, Data Architecture usually consists of the following components:

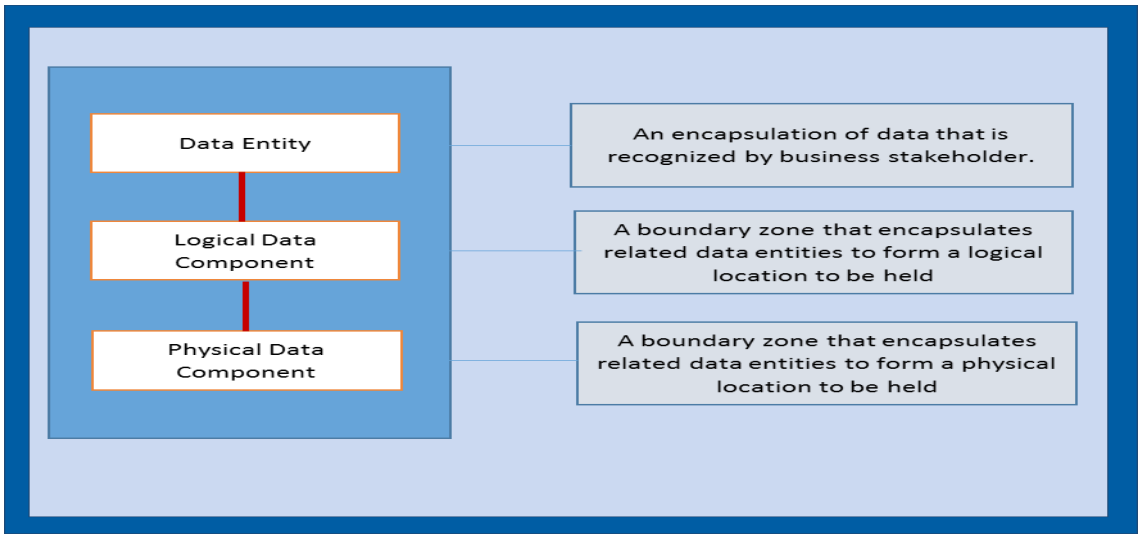

Figure 5: Data Architecture and its Components

Some of the key Data Architecture deliverables/viewpoints recommended by TOGAF (we will discuss more about this framework later) are:

Data Entity/Business Function Matrix	The purpose of the Data Entity/Business Function matrix is to depict the relationship between data entities and business functions within the enterprise.
Application/Data Matrix	Application/Data matrix depicts the relationship between applications (i.e., application components) and the data entities that are accessed and updated by them.
Conceptual Data Diagram	This depicts the relationships between critical data entities within the enterprise. This diagram is developed to address the concerns of business stakeholders.
Logical Data Diagram	This shows logical views of the relationships between critical data entities within the enterprise. This diagram is especially meant for database designers, and application developers.
Data Dissemination Diagram	This diagram shows the relationship between data entity, business service, and application components.

8 TECHNOLOGY ARCHITECTURE

Technology Architecture details the underlying IT infrastructure that supports the physical application and data components, which in turn enable the business components. It is a description of the structure and interaction of the platform services, and logical and physical technology components.

According to TOGAF, Technology Architecture usually consists of the following components:

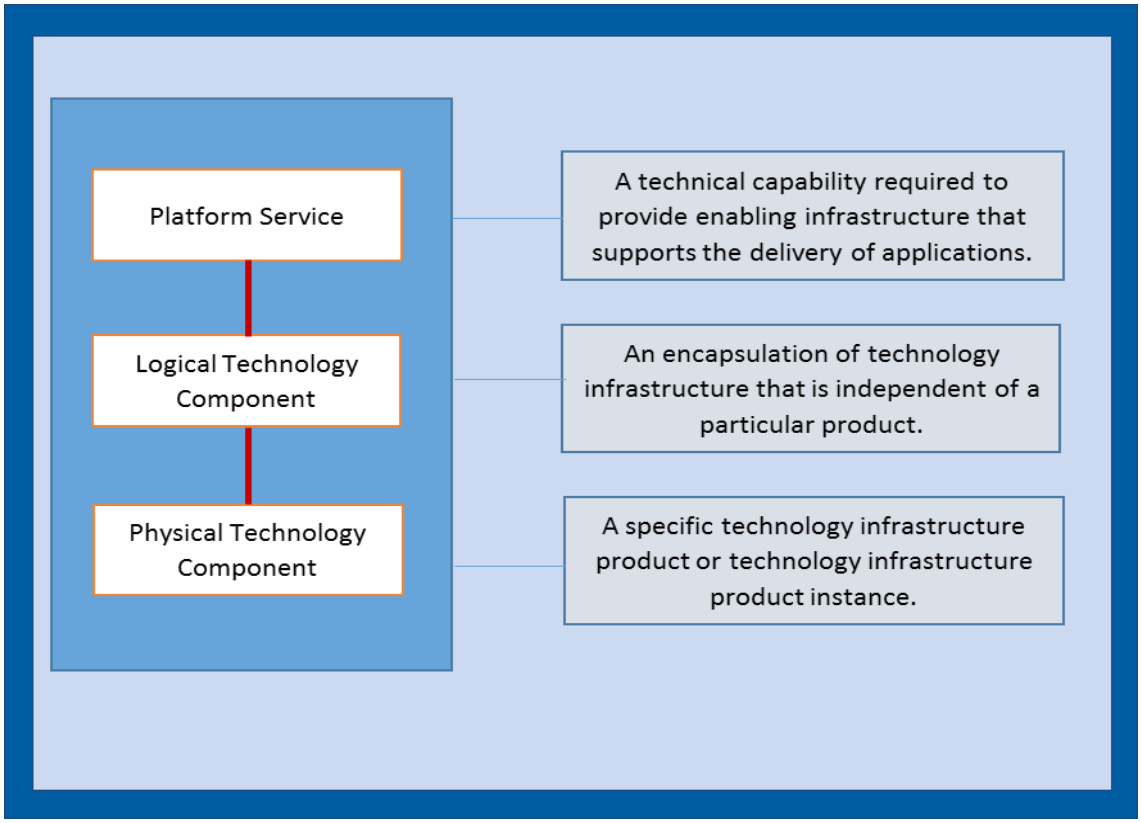

Figure 6: Technology Architecture and its Components

It could be bit confusing for people to understand what exactly the Technology Architecture layer contains. For simplicity some people equate Technology Architecture to elements of Data Center. This is partly correct because Data Centers manage almost all infrastructure components (such as servers, storage, computing power, etc.), and infrastructure layer does come under Technology Architecture. However Technology Architecture is slightly bigger than this. The following figure shows all components with Technology Architecture layer.

Infrastructure Component	•Physical or virtual technology platform on which applications are deployed. •E.g. servers, network devices, etc.
Technology Component	• Includes a class of technology product that commonly exists in marketplace, and which organizations procure. • E.g. Windows, Java, Mainframe
Application Programming Interface (API)	• Specifies a common interface between application software and the underlying Application Platform across which all services are deployed • E.g. Google API
Network Services	•Network services are provided to support distributed applications requiring data access and applications interoperability in heterogeneous or homogeneous networked environments. •E.g. Email, data communications, etc.
Operating System Services	•Provide services for managing platform resources such as processor, memory files, input and output. •E.g. Batch processing
Communication Infrastructure	•Provides basic services to connect systems and mechanism to transfer data. It contains the hardware & software elements that make up networking and physical communication links. •E.g. network, switches, transmission media, etc.
Communication Infrastructure Interfaces	•The interface between Application Platform and Communications Infrastructure. •Internet (HTTP/HTTPS protocol), TCP/IP protocol, etc.

NOW THAT WE ARE FAMILIAR WITH THE 'WHAT' PART OF ENTERPRISE ARCHITECTURE, LET'S GET TO THE 'HOW' PART OF ENTERPRISE ARCHITECTURE.

9 HOW TO EXECUTE ENTERPRISE ARCHITECTURE

To initiate and operationalize Enterprise Architecture practice in the organization, SIX key things are recommended.

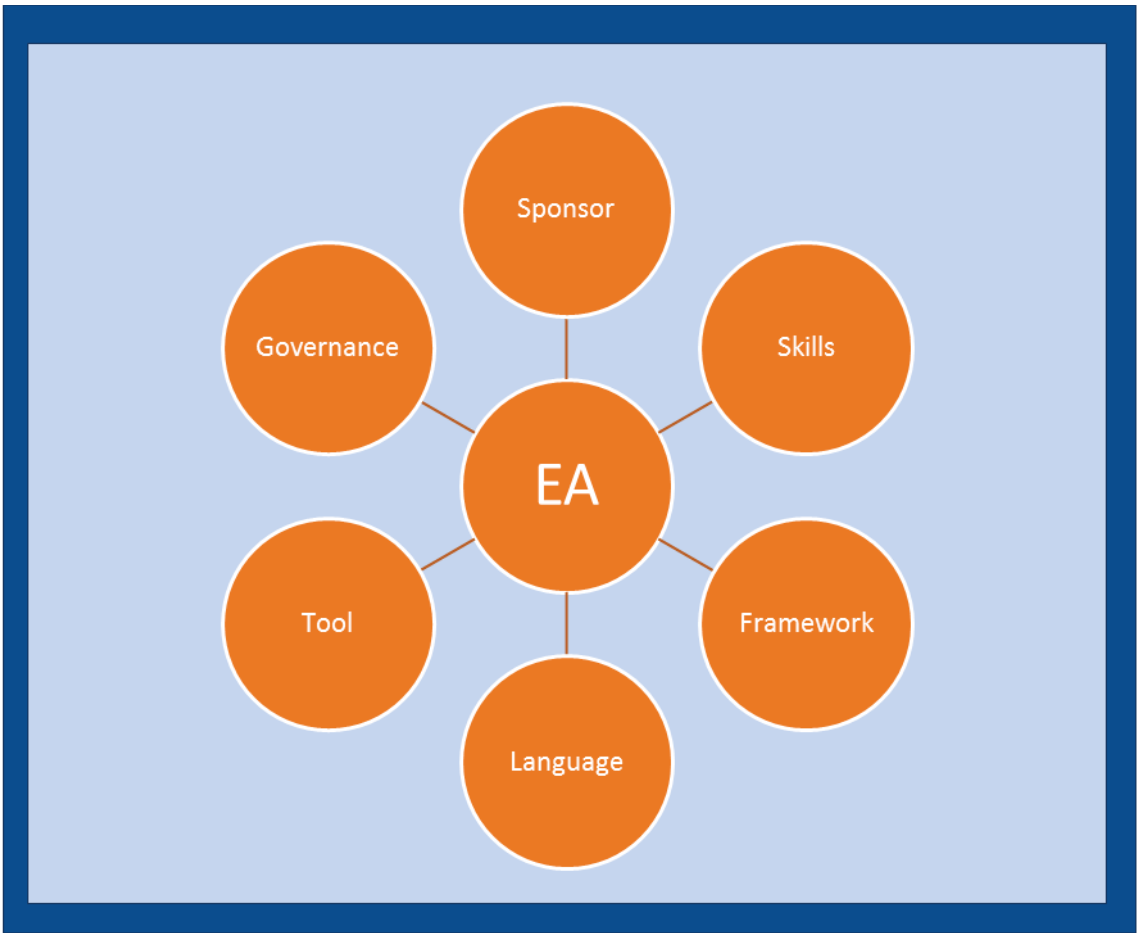

Figure 7: Enabling Enterprise Architecture – Six Key Areas

- **Sponsor**: Who will own and fund the Enterprise Architecture program?
- **Skills**: Do we have the right set of role, skills, people and experience for undertaking Enterprise Architecture work?
- **Framework**: Which EA framework is right for your organization?
- **Language**: Do we have standard taxonomy and rules to define Enterprise Architecture consistently across the organization? This is also called metamodel.
- **Tool**: Which Enterprise Architecture can best aid in the Enterprise Architecture work?
- **Governance**: Do we have right governance structure to manage and drive Enterprise Architecture at enterprise-wide level?

Let us look at each of this key factors.

9.1 EXECUTIVE SPONSORSHIP

In the context of Enterprise Architecture, sponsorship means whether there is an executive backing to the Enterprise Architecture program. In frequent cases in the past, Enterprise Architecture programs used to originate in the IT departments. While this may have served its purpose to some extent in the initial days of EA, it has been realized that having IT own EA is counterproductive in the long run. EA ends up being perceived as an IT initiative, and therefore receives the same level of (limited) support and enthusiasm as IT does.

Having the business organization own Enterprise Architecture is the ideal way to implement EA in the organization. This is primarily because of two main factors:

1. Enterprise Architecture, by definition, has Business Architecture at its top layer. EA should be top-down driven i.e. driven by business.
2. EA program can sustain itself in the long run if it continues to deliver business value. It can deliver business value only when it aligns itself closely with business.

Enterprise Architecture can get real traction if top senior management sponsor it. Making EA come under COO's or CEO's purview is the best scenario. If this option is not feasible, it is advised to give EA mandate to any other business organization such as Business Transformation office, Business Architecture Group, etc. The executive in charge of EA must be influential within the organization, someone whose voice is respected widely. Embarking on an EA program needs some tough decisions (e.g. pushing the whole enterprise to a common set of standards, policies, governance), and decisions are best implemented if driven top-down.

Another advantage of having senior executive own EA is that it will create imperative for EA to continually deliver tangible business value to the organization. If EA does not provide value-add to business, what chances does it have of its survival? Successful EA organizations derived the value out of EA by making EA an integral part of key transformation initiatives spanning the organization.

With right management support, EA can work wonders for an organization.

9.2 SKILLS

Having the right set of people and skills is one of the most important ingredient in undertaking fruitful Enterprise Architecture work. Enterprise Architecture requires multi-dimensional skills as the nature of EA is so multi-faceted. Since EA's mandate can extend across the enterprise, may entail dealing with stakeholders of diverse background, may get involved in projects that requires different expertise and skills, it is therefore important to ensure that the Enterprise Architecture team is staffed with right people.

It is an irony that the word 'architecture' in 'Enterprise Architecture' has mislead so many organizations. They tend to wrongly perceive that Enterprise Architecture team should be staffed primarily with architects. However to be fair to them, it is because "Enterprise Architecture" and "Enterprise Architect" are still not well defined in the industry.

An Enterprise Architect, broadly speaking, needs two set of skills – Generic and Specialized skills. Generic skills constitute the 'breadth' and specialized skills constitute the 'depth' of ones skills.

Generic skills comprise of the following:

- Leadership
- Team work
- Inter-personal
- Program or Project Management
- Communication
- Conflict management
- Understanding of business and organization dynamics
- Stakeholder management
- Understanding of regulatory environment

Specialized skills mainly refers to the following:

- Expertise in one or more of these areas:
  - Business Architecture
  - Application Architecture
  - Data Architecture
  - Technology Architecture
- Industry domain expertise

The table below shows the various EA skill definitions.

Generic Skills	Business Skills	Architecture Skills	Program/Project Management Skills	General IT Skills	Technical IT Skills	Regulatory Skills
Leadership	Business Case	Business Modeling	Program Management	IT Application Development Methodologies & Tools	Software Engineering	Contract Law
Teamwork	Business Scenario	Business Process Design	Project Management	Programming Languages	Security	Data Protection Law
Inter-personal	Organization	Role Design	Managing Business Change	Brokering Applications	Systems & Network Management	Fraud
Oral Communications	Business Process	Organization Design	Change Management	Applications & Systems	Transaction Processing	Commercial Law
Written Communications	Strategic Planning	Data Design	Value Management	Storage Management	Location & Directory	
Logical Analysis	Budget Management	Application Design		Networks	User Interface	
Problem Solving	Visioning	Systems Integration		Web Services	International Operations	
Stakeholder Management	Business Metrics	IT Industry Standards		IT Infrastructure	Data Interchange	
Conflict Management	Business Culture	Services Design		Asset Management	Data Management	
Risk Management	Legacy Investments	Architecture Principles Design		Service Level Agreements	Graphics & Image	
Sales Mindset	Business Functions	Architecture Views & Viewpoints Design		Systems Engineering	Operating System Services	
Coaching		Building Block Design		COTS	Network Services	
Industry Experts		Solutions Modeling		Enterprise Continuum	Communication Infrastructure	
Innovation Mindset		Benefits Analysis		Migration Planning		
Big Thinking		Business Interworking		Management Utilities		
Negotiation		Systems Behavior		Infrastructure		
		Architecture Patterns				

An Enterprise Architect profile is not a single role. There are various sub-roles that apply in Enterprise Architecture. The roles may also vary based on the nature of engagements and how the EA organization is structured.

Broadly speaking, the following comprise Enterprise Architecture roles:

- Architecture Board Member (s)
- Architecture Sponsor (s)
- Chief Enterprise Architect
- Business Architect (s)
- Application Architect (s)
- Data/Information Architect (s)
- Technology Architect (s)
- Domain Architect
- Security Architect
- Project Architect
- Program/Project Manager
- IT Developer/Designer

All said and done, the most important skills an Enterprise Architect should have is the ability to take bold organizational decisions, steer the organization to a vision, communicate the changes, convince the stakeholders of the value of EA and its output, deal with political situations, and drive consensus. Think of an Enterprise Architect as the Head of a country (President, Prime Minister, etc.). While he/she may have its own core skills (such as law, business, medicine, etc.), what is most needed as the Head is to take bold decisions, derive consensus, and guide the country to an articulated vision.

9.3 HOW ENTERPRISE ARCHITECTS ARE DIFFERENT FROM OTHER ARCHITECTS

It is worthwhile to mention how Enterprise Architects are different from other architects. Unfortunately people unfamiliar with Enterprise Architect tend to perceive all 'Architect' as same. But it is indeed different. Just like a Building Architect is different from a City Planner/ Architect, similar Enterprise Architect is different from other types of IT architect roles.

The difference mainly lies in the breadth and depth of the role. 'Depth' refers to level of expertise in one or more areas. 'Breadth' refers to the level of understanding and span of responsibilities across the organization.

- The role of an Enterprise Architect spans across Line of Business, departments and, in some cases, across multiple organizations.
- Solution Architects are mostly concerned with a specific solution to a business problem. The problem could be uni-dimensional (e.g. IT project) or multi-dimensional (cross-functional transformation program).
- Domain Architects focus on specific domain and have deep expertise in that area. Examples are Business Architect, Security Architect, Infrastructure Architect, and so on.
- IT Architects are generally the technical lead of a project. They have a broad understanding of non-functional requirements of a project, and ensure that they are met by technical design and decisions.
- Software Architects usually make design choices around technical standards, architecture patterns, coding standards, tools, and platforms.
- Developers are mainly programmers who have expertise in software development.

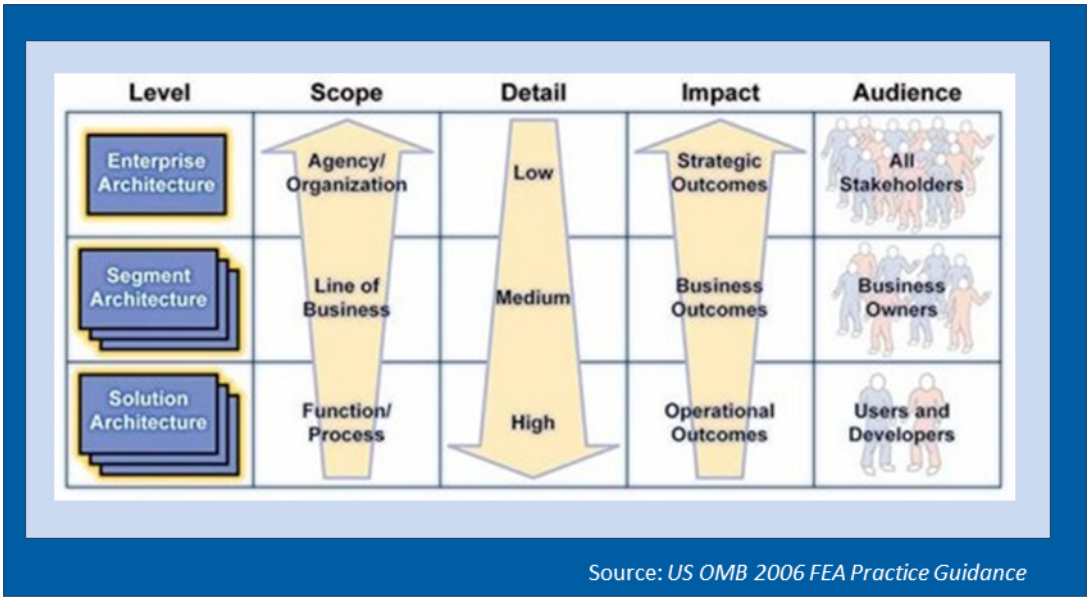

Figure 8: Architectural Levels and Attributes

9.4 FRAMEWORK

A framework is a structure for content or process that can be used as a tool to structure thinking, ensuring completeness, consistency and correctness. In the context of architecture, an architecture framework is a conceptual structure used to develop, implement, and sustain an architecture.

IEEE-1471-2000 [01] defines architectural framework as "*a skeletal structure that defines suggested architectural artifacts, describes how those artifacts are related to each other, and provides generic definitions for what those artifacts might look like*."

Just as we have Balanced Scorecard framework that recommends a set of measurements for key strategic perspective, or a policy framework used in government domain, so too we need architectural framework to organize and relate architectural artifacts to each other.

A framework is incomplete without a supporting taxonomy and methodology. A **taxonomy** is a methodology for organizing and categorizing architectural artifacts. A **methodology** provides an approach or a process to define and create architecture for solving problems related to architecture.

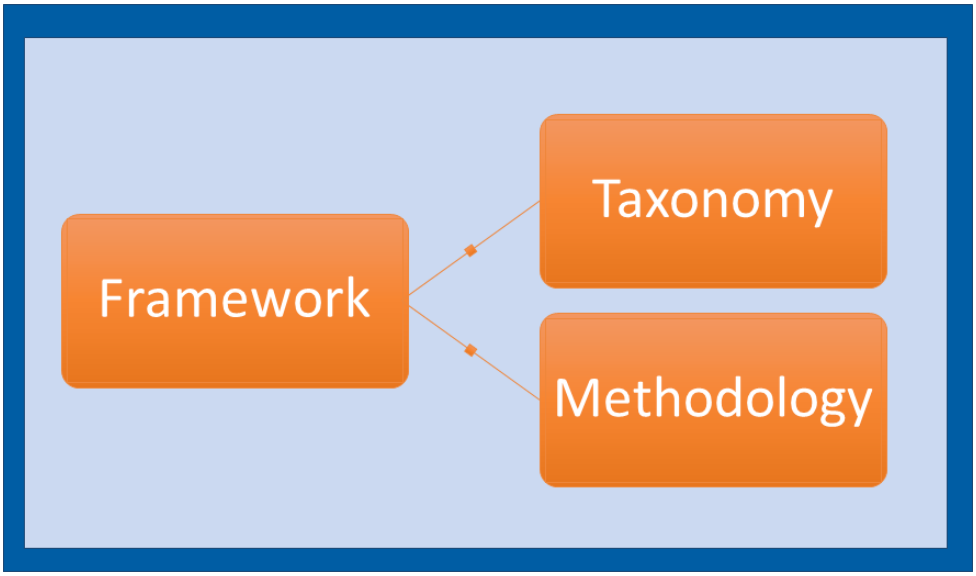

Figure 9: Framework – Taxonomy – Methodology

A taxonomy is kind of knowledge organization system. The word "taxonomy" is sometimes used synonymously with "classification". An example of taxonomy is the periodic system or periodic table in chemistry. Another example is biological taxonomy that classifies all living organisms in a hierarchy such as Domain, Kingdom, Phylum, Class, Order, Family, Genus, and Species.

Similarly an Enterprise Architecture needs a taxonomy to define terminology, and to provide a coherent description of the components and conceptual structure of an information system.

A methodology guides us on what steps to take in creating our architecture, in what order, what inputs and outputs are needed, and particularly what output to produce from these steps.

Taken together, taxonomy and methodology constitute the Architecture Framework that provides an abstraction through which we can define and connect a range of concepts, models, techniques, viewpoints, etc.

In order to define Enterprise Architecture, an enterprise architect or the organization must be able to select the right architecture framework to accomplish the architectural objectives. There are a number of well-proven and effective Enterprise Architecture Frameworks are available in the industry. The top ones are:

- The Open Group Architecture Framework (TOGAF)
- The Zachman Framework™ for Enterprise Architecture
- Federal Enterprise Architecture Framework (FEAF)
- Pragmatic Enterprise Architecture Framework (PEAF)

A list of other Enterprise Architecture frameworks is provided in Appendix A.

Let us take a summary look at the frameworks mentioned above.

The Zachman Framework™ for Enterprise Architecture

The Zachman Framework™ is less of a conventional Enterprise Architecture Framework and more of a taxonomy. It provides a logical structure for classifying and organizing the descriptive elements (or artifacts) of an Enterprise that are significant to the management of the Enterprise, as well as to the development of the Enterprise's systems. This framework is an intersection of two key dimensions. One dimension is the various **audience** associated with architectural artifacts. The other dimension is the communication interrogatives – the descriptive **focus** of the artifact: the WHAT, HOW, WHERE, WHO, WHEN, and WHY of the project.

In addition to this, the framework has six audience perspectives (Executive, Business Management, Architect, Engineer, Technician, and Enterprise), six enterprise names (Inventor Sets, Process Flows, Distribution Networks, Responsibility Assignments, Timing Cycles, and Motivation Intentions).

An image of **The Zachman Framework™** is shown below:

Figure 10: The Zachman Framework for Enterprise Architecture

The way to read the framework is to traverse through the 36 intersecting cells in the grid. Each cell is an intersection of an audience perspective and enterprise names. So as we move horizontally in the grid, we see different descriptions of the system – all from the same audience's perspective. For example, from a Business Management Perspective, he moves from Business Entity to Business Transform to Business Location to Business Role to Business Interval to Business End. Basically he moves from one intent to another – What, How, Where, Who, When and Why. If we move vertically through the grid, we see a single view (e.g. Process Identification), but change the audience from whose viewpoint/perspective we are viewing.

The Zachman Framework™ suggests that every architectural artifact must reside in one and only one cell in the grid. There should not be no ambiguity about which artifact goes to which cell. Secondly, an architecture is considered complete only when every cell in that grid is filled. The third suggestion is that cell in the columns must be related to each other. Data is information for business, but Data Entity to an architect.

While the above suggestions sounds good theoretically, problems abound in the practical real word. Seldom is it clear to the organization who are all the audience whose perspective needs to be addressed. Nor is the understanding of an artifact is clear to one and all. It is also seen that due to the lack of clear definition of an artifact, confusion arise as to which artifact can go to which cell; it is also possible that location of an artifact an overlap in multiple cells in the grid.

Therefore **The Zachman Framework™** is not a complete framework as it lacks a clear methodology of defining the architecture. It also does not allow us to define future (or Target State) architecture; the framework is good for describing the current state enterprise.

John Zachman – the founder of the framework – himself says that "*The **Zachman Framework™ IS NOT a methodology** for creating the implementation (an instantiation) of the object. The 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.*"

In summary, the **Zachman Framework™** is a good taxonomical model to define current state enterprise by organization the artifacts according the various dimensions in the grid. However it lacks a methodology that shows how to transition from current state to future state architecture.

The Open Group Architecture Framework (TOGAF)

The Open Group Architecture Framework is popularly known as TOGAF, and is considered the de facto global standard for Enterprise Architecture. The forum, comprised of more than 200 enterprises, develops and maintains the TOGAF standard and publishes successive versions at regular intervals.

TOGAF: *"The TOGAF framework enables organizations to effectively address critical business needs by:*

- *Ensuring that everyone speaks the same language*
- *Avoiding lock-in to proprietary solutions by standardizing on open methods for Enterprise Architecture*
- *Saving time and money, and utilize resources more effectively*
- *Achieving demonstrable ROI"*

TOGAF divides an enterprise architecture into four categories, as follows:

1. **Business Architecture**: Describes the capabilities, functions, and processes the business uses to meet its goals
2. **Application Architecture**: Describes how applications support business processes, how they are designed, and how they interact with each other
3. **Data Architecture**: Describes how enterprise data is organized, stored and accessed
4. **Technology Architecture**: Describes the hardware and software architecture that support applications and their interactions.

TOGAF consists of the following key components and concepts:

- The Architecture Development Method (ADM)
- ADM Guidelines and Techniques
- Architecture Content Framework
  - Deliverables, Artifacts, Building Blocks
- The Enterprise Continuum
  - The Architecture Repository
- TOGAF Reference Models
- The Architecture Capability Framework
  - Establishing an EA Capability

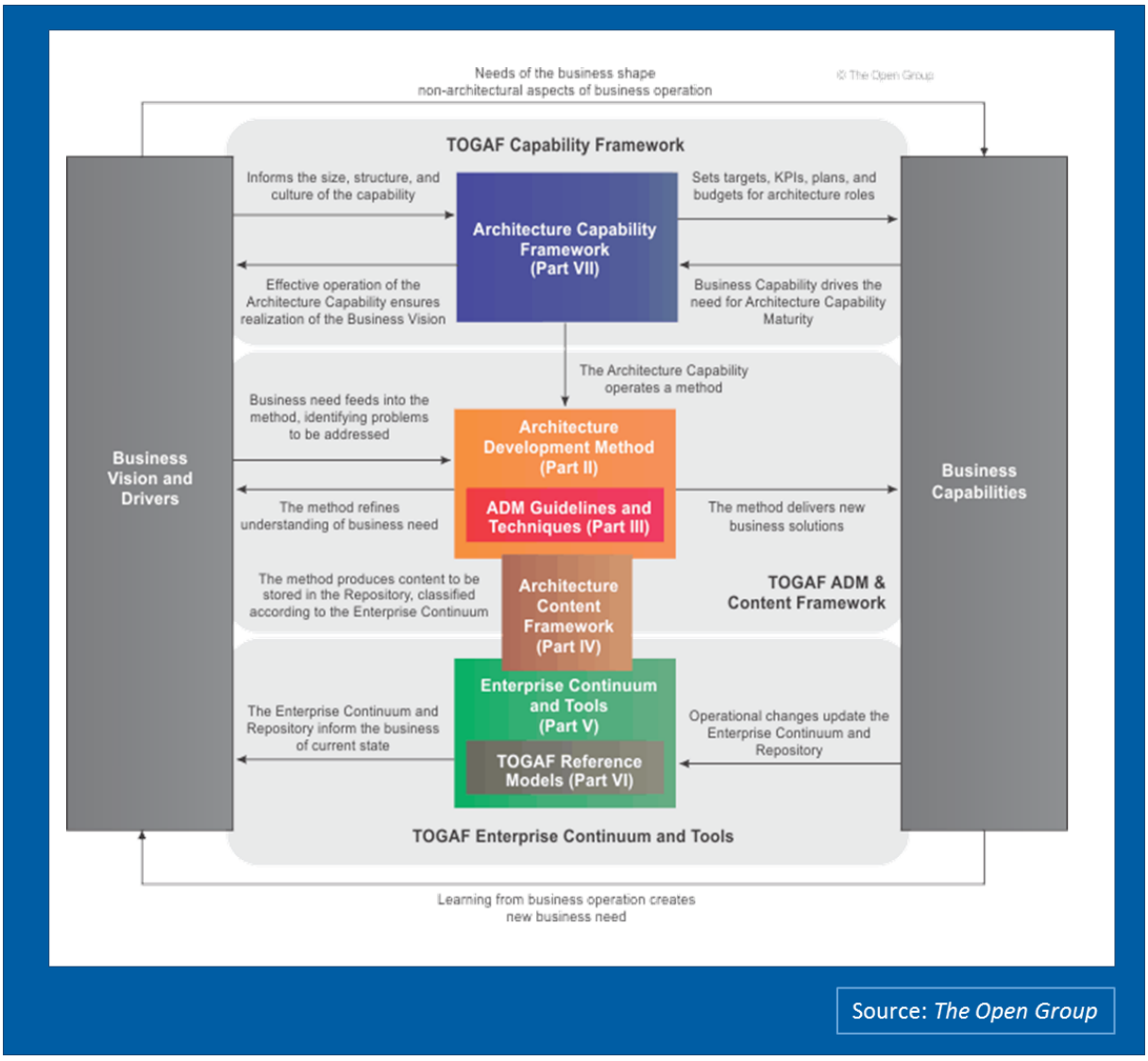

Figure 11: Structure of the TOGAF Document

The Architecture Development Method (ADM)

TOGAF: *"The Architecture Development Method (ADM) is the core of TOGAF. It is a proven way of developing an architecture. It could very aptly be also called as architectural process or methodology. The other key features of ADM are:*

- *It consists of eight phases that can be cycled iteratively. Each phase consists of objectives, approach, inputs, steps and outputs*
- *It is an iterative method. Iterations can be done over the whole process, within phases and between phases*
- *It integrates all the elements within TOGAF*
- *It is designed to address enterprise business and IT needs by providing:*
  - *A set of architectural views (business, data, application, technology)*
  - *A set of recommended deliverables*
  - *A method for managing requirements*
  - *Guidelines on tools for architecture development"*

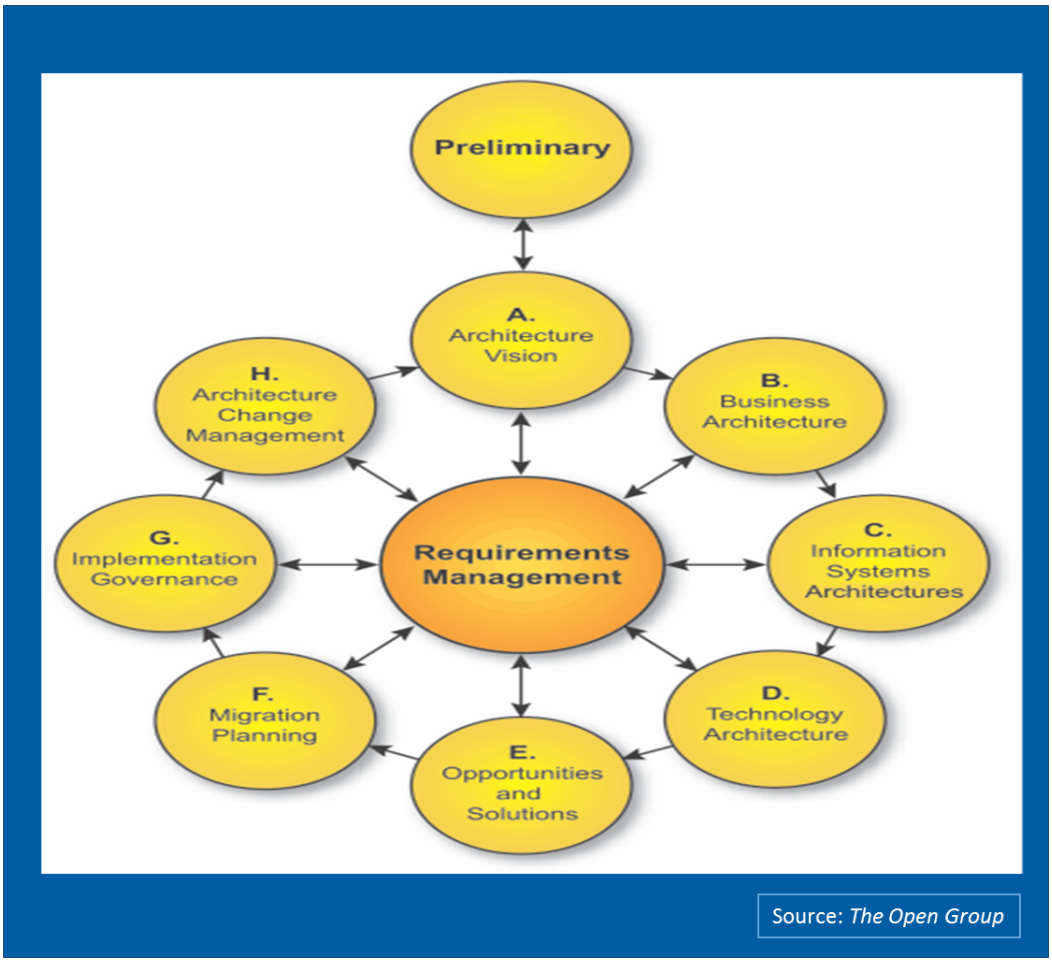

Figure 12: TOGAF Architecture Development Method (ADM) Cycle

The phases of TOGAF ADM are:

1. ***Preliminary Phase****: Prepare the organization for a successful architecture project*
2. ***Phase A – Architecture Vision****: Set the scope, constraints, and expectations for a TOGAF project; create the Architecture Vision; validate the business context, create the Statement of Architecture Work*
3. ***Phase B – Business Architecture****: Develop Business Architecture; Develop baseline and target architectures and analyze the gaps*
4. ***Phase C – Information Systems Architectures****: Develop Information Systems Architectures; Develop baseline and target architecture and analyze the gaps*
5. ***Phase D – Technology Architecture****: Develop Technology Architecture; Develop baseline and target architecture and analyze the gaps*
6. ***Phase E – Opportunities and Solutions****: Perform initial implementation planning; identify major implementation projects*
7. ***Phase F – Migration Planning****: Analyze costs, benefits, and risks; develop detailed Implementation and Migration Plan*
8. ***Phase G – Implementation Governance****: Provide architectural oversight for the implementation; ensure that the implementation project conforms to the architecture*
9. ***Phase H – Architecture Change Management****: Provide continual monitoring and a change management process to ensure that the architecture responds to the needs of the enterprise*
10. ***Requirements Management****: Ensure that every stage of a TOGAF project is based on and validates business requirements*

In each ADM phase, the following steps are performed to create the desired architecture.

1. Select reference models, viewpoints, and tools
2. Develop Baseline Business Architecture* Description
3. Develop Target Business Architecture Description
4. Perform gap analysis
5. Define candidate roadmap components
6. Resolve impacts across the Architecture Landscape
7. Conduct formal stakeholder review
8. Finalize the Business Architecture
9. Create Architecture Definition Document

* Above steps are representative of Business Architecture Phase. They can also be applied to other ADM phases.

TOGAF defines a number of input and output deliverables for each phase.

Adapting the Architecture Development Method (ADM)

TOGAF: "*Because TOGAF ADM is a generic method, it can be adapted to a variety of situations, needs, frameworks, and organization types. It can be designed to deal with most system and organizational requirements. Specific components of ADM can be tailored to meet the appropriate needs of an enterprise.*

The ADM can be integrated with a host of other architectural frameworks such as Zachman framework, DoDAF, PEAF, and so on. It is also supportive of other standard framework such as program management processes, ITIL, CMMI, COBIT, PRINCE2, PMBOK, and MSP. TOGAF may be used either in its own right, with the generic deliverables that it describes; or else these deliverables may be replaced or extended by a more specific set, defined in any other framework that the architect considers relevant."

Governing the Architecture Development Method (ADM)

TOGAF: "*The ADM, whether adapted or used as is, is a key process to be managed and governed in the same manner as other architecture artifacts. The Architecture Board should be satisfied that the method is being applied correctly across all phases of an architecture development iteration. Compliance with the ADM is fundamental to the governance of the architecture, to ensure that all considerations are made and all required deliverables are produced.*

The management of all architectural artifacts, governance, and related processes should be supported by a controlled environment.

The major information areas managed by a governance repository should contain the following types of information:

- ***Reference Data**: Used for guidance and instruction during project implementation. This includes the details of information outlined above. The reference data includes a description of the governance procedures themselves.*
- ***Process Status**: All information regarding the state of any governance processes will be managed; examples of this include outstanding compliance requests, dispensation requests, and compliance assessments investigations.*
- ***Audit Information**: This will record all completed governance process actions and will be used to support: Key decisions and responsible personnel for any architecture project that has been sanctioned by the governance process; A reference for future architectural and supporting process developments, guidance, and precedence.*"

Partitioning/Scoping the Architecture

TOGAF: "*There are times when the scope of architectural activity needs to be constrained mainly due to:*

- *The organization authority of the team producing the architecture*
- *The objectives and stakeholder concerns to be addressed within the architecture*
- *The availability of people, finance, and other resources*

The scope of any architectural work chosen must allow different architects to be able to work independently or in collaboration without creating any duplicate or conflicting activities. This therefore calls for the right "partitioning" of architecture.

According to TOGAF, four dimensions can be typically used to define and limit the scope of an architecture.

- ***Breadth**: What extent or part of the enterprise will be involved in the architectural work?*
- ***Depth**: To what level of detail will the architectural work involve?*
- ***Time Period**: How much of architectural work can be "fit in" within a stipulated time period? Alternatively what is the time period defined for the Architectural Vision, and other architectural activities (such as Transition Architecture)?*
- ***Architectural Domains**: What domains should be considered within the architecture scope? Is it just Business, Data, Application, and Technology or should it be all-inclusive architecture?"*

Architecture Integration

TOGAF: "*If the above dimensions (Breadth, Depth, Time Period, and Architectural Domains) can be used to scope/partition a single architecture, can these same dimensions be used to integrate many architecture? Fortunately the answer is "Yes." The figure below shows the framework for integration of architectural artifacts.*"

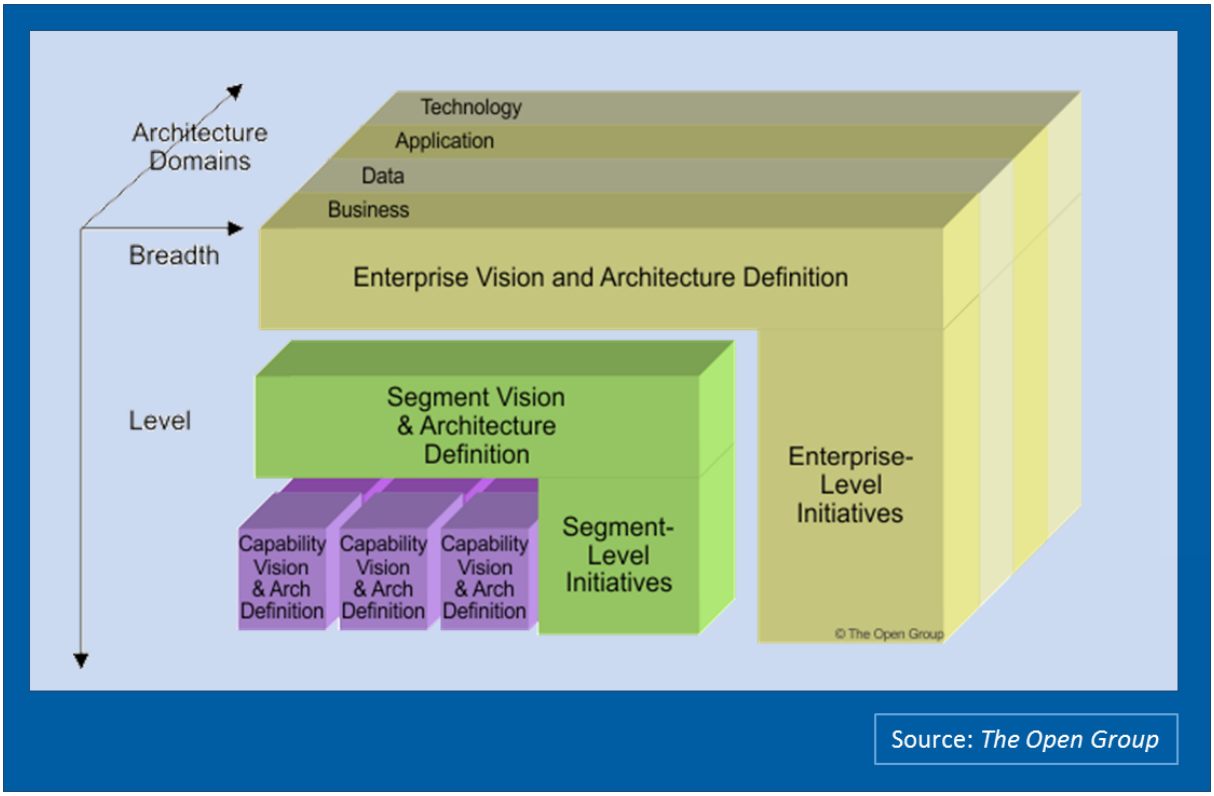

Figure 13: TOGAF Architecture Development Method (ADM) Cycle

According to the latest update from TOGAF, *"at the present time, the state of the art is such that architecture integration can be accomplished only at the lower end of the integration spectrum. Key factors to consider are the granularity and level of detail in each artifact, and the maturity of standards for the interchange of architectural descriptions. As organizations address common themes (such as Service Oriented Architecture (SOA), and integrated information infrastructure), and universal data models and standard data structures emerge, integration toward the high end of the spectrum will be facilitated."*

ADM Guidelines and Techniques

TOGAF has provided "*a set of guidelines and techniques to support the application of ADM. The **guidelines** help to adapt the ADM with different scenarios, including different process styles and specific requirements. The **techniques** support specific tasks within the ADM (e.g. defining principles, business scenarios, gap analysis, risk management, etc.).*"

Architecture Content Framework

TOGAF: *"The Architecture Content Framework provides a detailed model of architectural work products, including **Deliverables**, **Artifacts** within the deliverables, and **Architecture Building Blocks** that deliverables represent.*

*A **deliverable** is an architectural work product that is contractually specified and formally reviewed, agreed, and signed off by the stakeholders. Deliverables represent the output of projects.*

*An **artifact** is an architectural work product that describes an aspect of an architecture. There are three classes of artifact as follows:*

- *Catalogs (or Catalogues) are list of building blocks.*
- *Matrices show relationship between building blocks of specific types*
- *Diagrams present building blocks in a graphical way.*

***Building blocks** represent re-usable component of business, IT, or architectural capability that can be combined with other building blocks to deliver architectures and solutions."*

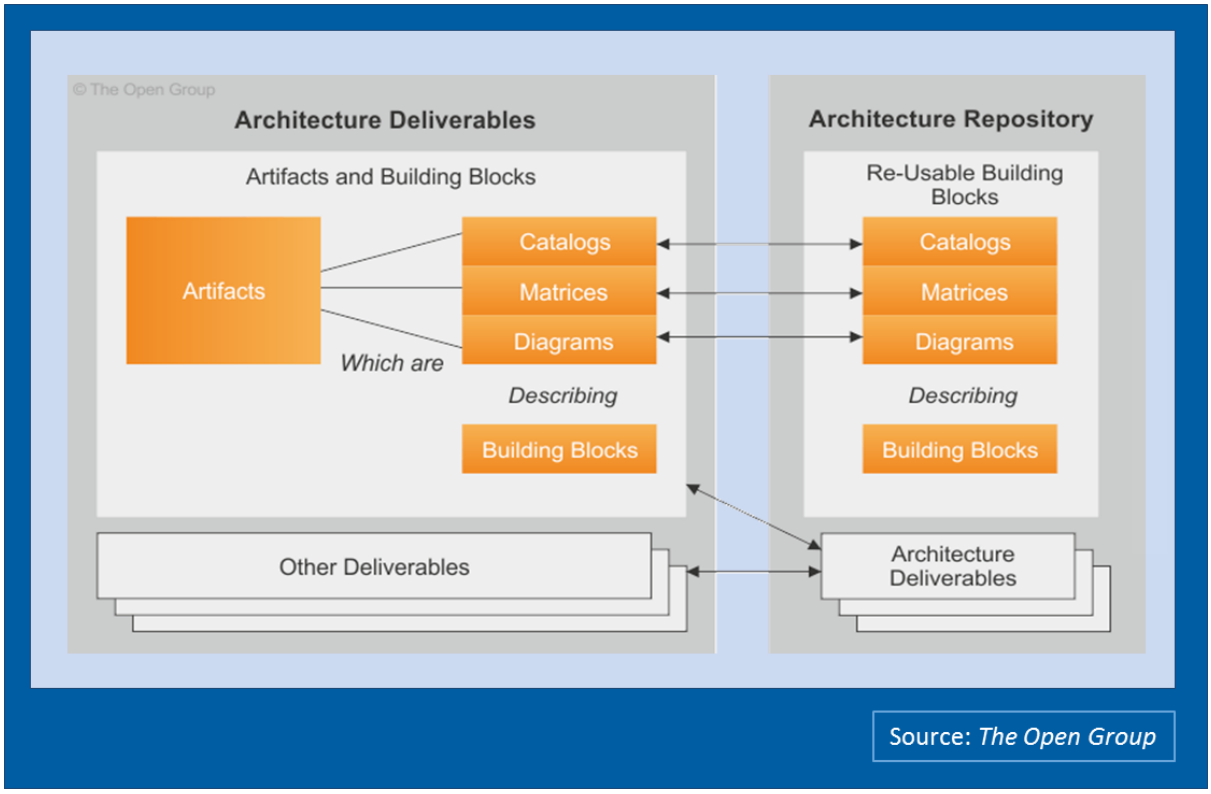

Figure 14: Relationships between Deliverables, Artifacts, and Building Blocks

TOGAF Content Metamodel

One of the major differentiation factor of TOGAF is its underlying content metamodel. TOGAF defines metamodel as a model that describes how and with what the architecture will be described in a structured way.

At a basic level, a metamodel provides structure and language to define Enterprise Architecture. It can be used to define objects, and relationships between them. Almost all Enterprise Architecture tools come with its own embedded metamodel that makes it easier to map objects in the tool.

TOGAF core content metamodel is structured into **Core** and **Extension** content. This partition allows to support many scenarios. The **core** provides a minimum set of architectural content to support traceability across artifacts. The **extension** content allows for more specific or more in-depth modeling.

Let us look at core metamodel entities and their relationships:

***Actor**: A person, organization, or system that is outside the consideration of the architecture model, but interacts with it.*

***Application Component**: An encapsulation of application functionality that is aligned to implementation structuring.*

***Business Service**: Supports business capabilities through an explicitly defined interface and is explicitly governed by an organization.*

***Data Entity**: An encapsulation of data that is recognized by a business domain expert as a discrete concept. Data entities can be tied to applications, repositories, and services and may be structured according to implementation considerations.*

***Function**: Delivers business capabilities closely aligned to an organization, but not explicitly governed by the organization.*

***Information System Service**: The automated elements of a business service. An information system service may deliver or support all of one or more business services.*

***Organization Unit**: A self-contained unit of resources with line management responsibility, goals, objectives, and measures. Organization units may include external parties and business partner organizations.*

***Platform Service**: A technical capability required to provide enabling infrastructure that supports the delivery of applications.*

***Role**: An actor assumes a role to perform a task.*

***Technology Component**: An encapsulation of technology infrastructure that represents a class of technology product or specific technology product.*

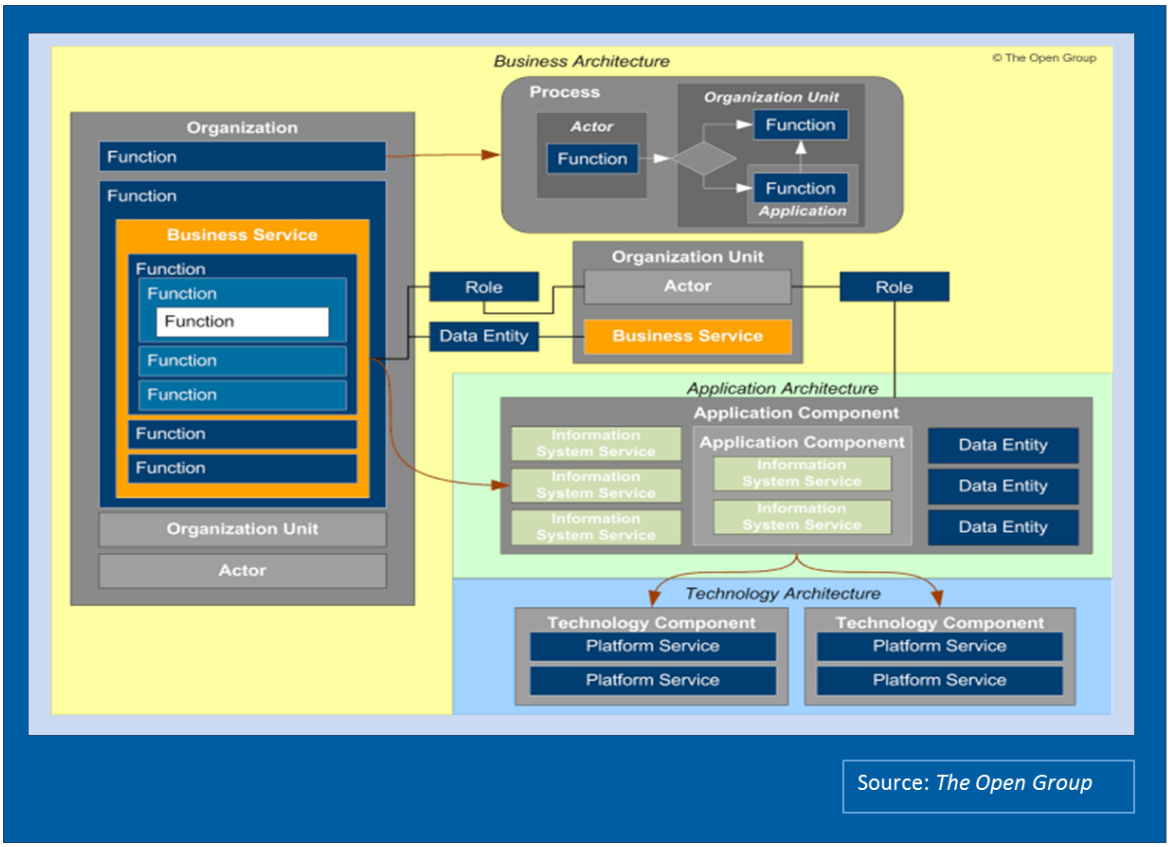

Figure 15: Content Metamodel – Core Entities and their Relationships

The content metamodel provides definitions of all the types of building blocks that may exist, showing how they can be described and related to one another.

- *When creating and managing architectures, it is necessary to consider concerns such as business services, actors, applications, data entities, and technology.*
- *The metamodel highlights these concerns, shows their relationships and identifies artifacts that can be used to represent them in a consistent way.*
- *The metamodel can also be used to provide guidance to organizations that wish to implement their architecture using an architecture tool.*

At the highest level, the content framework is divided up in line with the TOGAF ADM phases as shown below.

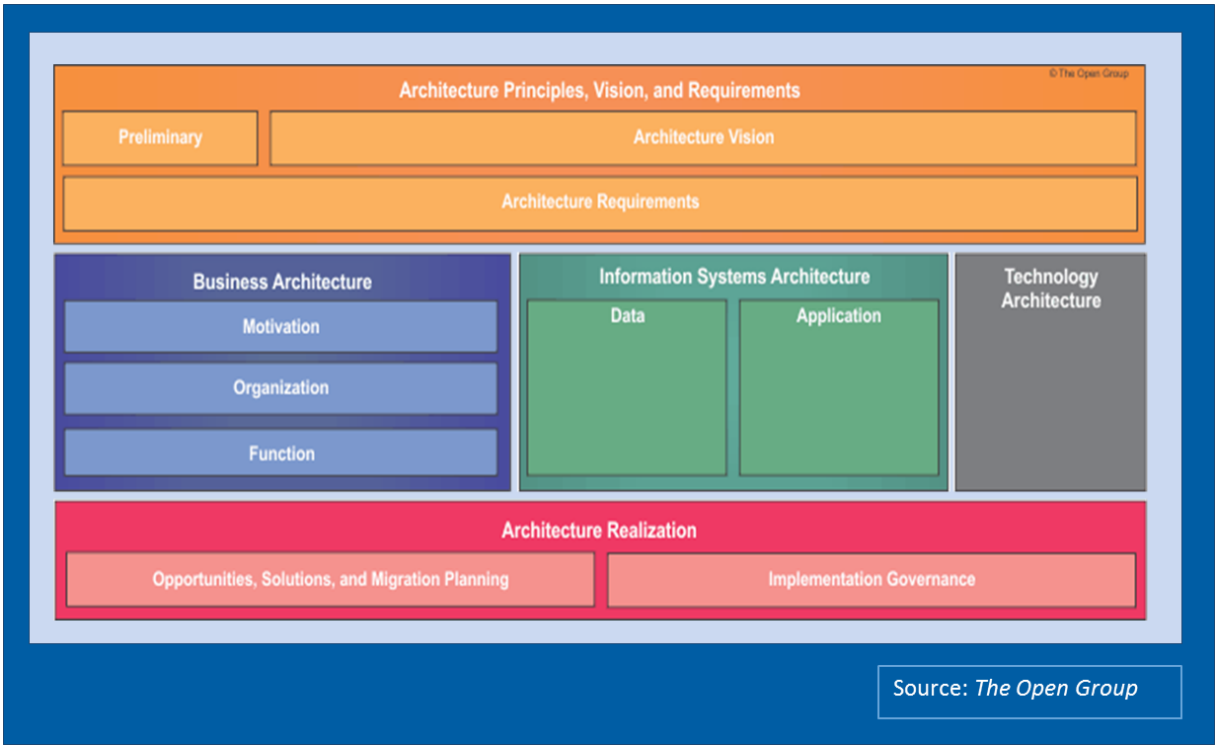

Figure 16: Content Framework by ADM Phases

Detailed representation of the content metamodel is shown below:

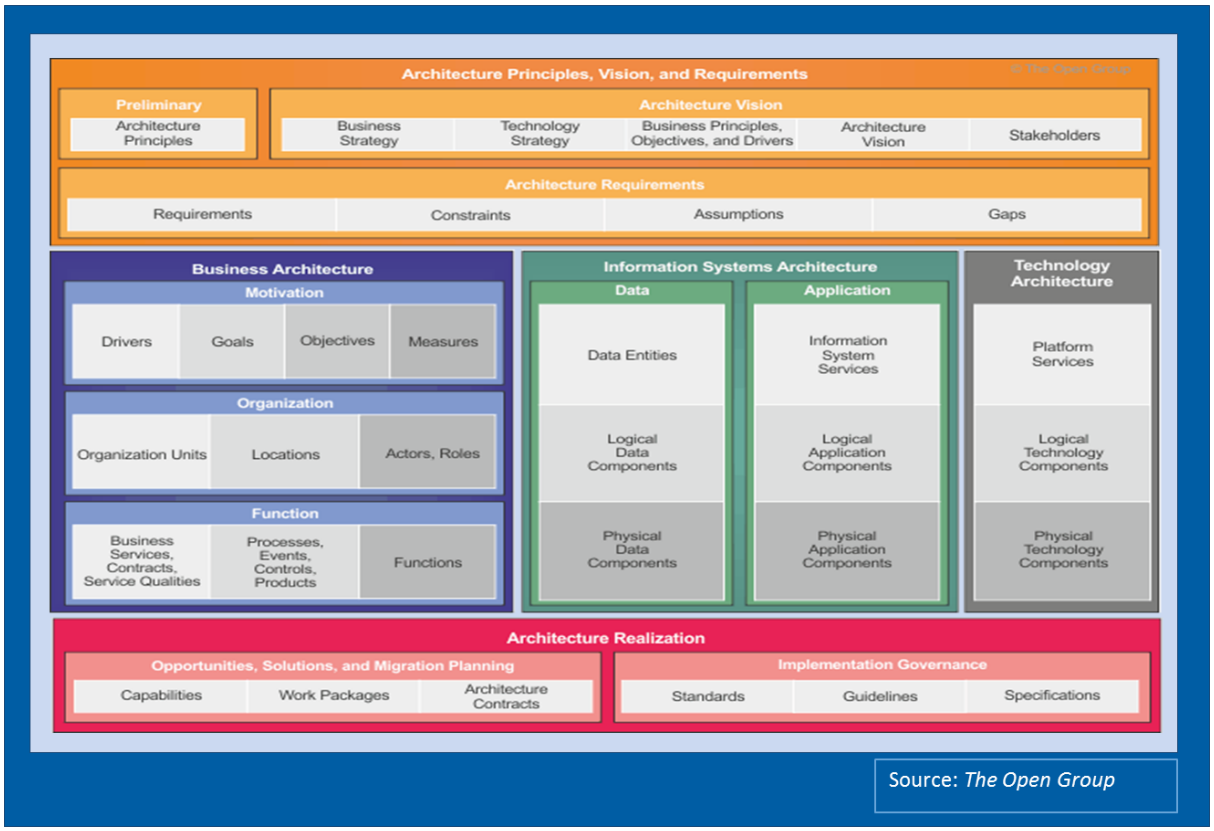

Figure 17: Detailed Representation of the Content Metamodel

The metamodel entities and relationships that are present within the core content metamodel is shown below:

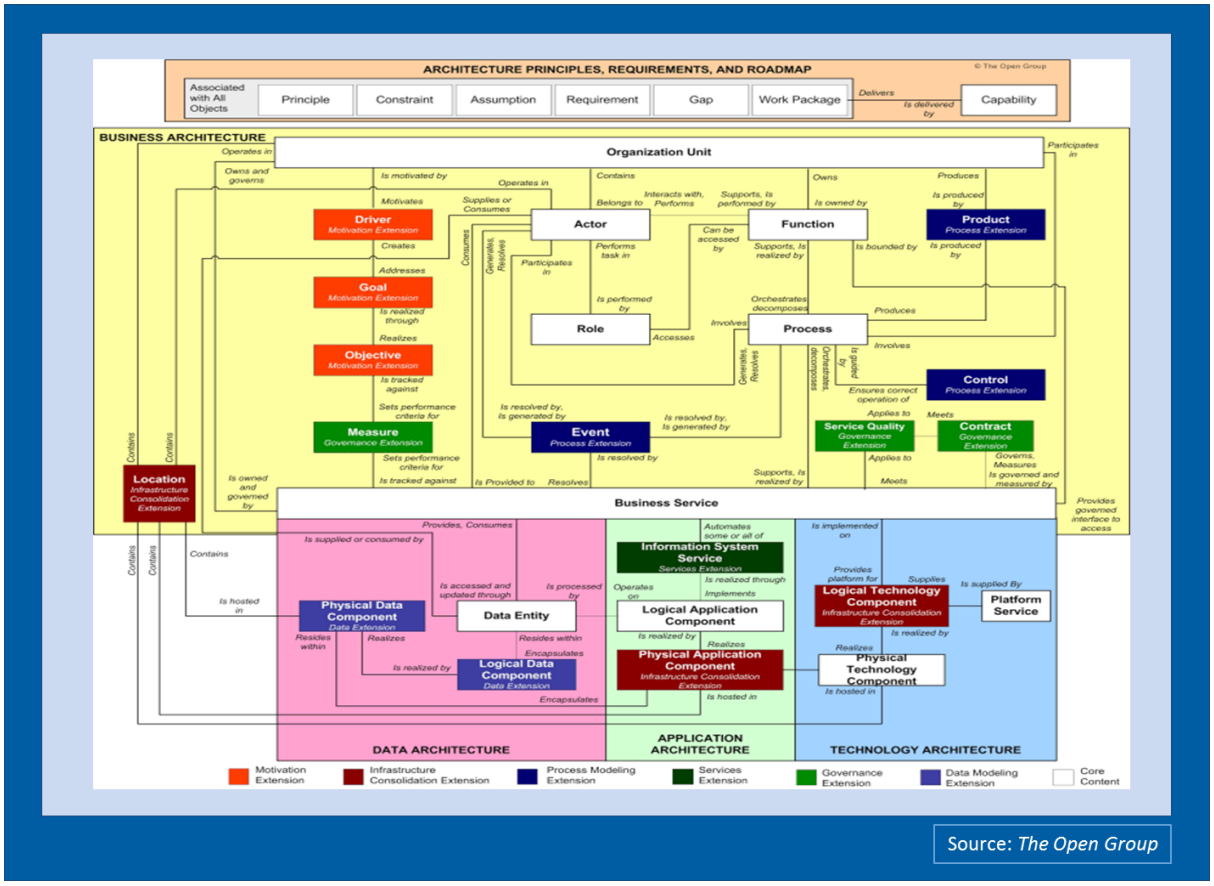

Figure 18: Relationships between Entities in the Full Metamodel

As discussed above, the TOGAF content metamodel supports a number of extension modules that allow more in-depth consideration of particular architecture concerns. The figure below shows the core content metamodel and predefined extension modules.

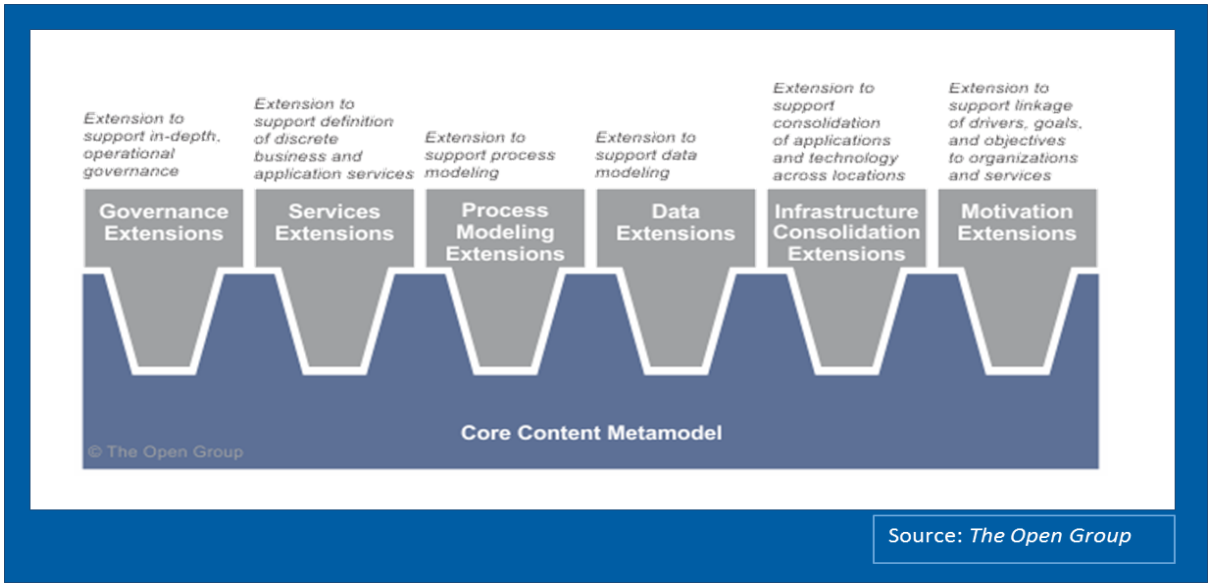

Figure 19: Core Content Metamodel and Predefined Extension Modules

The Enterprise Continuum

TOGAF: *"The Enterprise Continuum provides methods for classifying architecture and solution artifacts, both internal and external to the Architecture Repository, as they evolve from generic Foundation Architectures to Organization-Specific Architectures.*

The Enterprise Continuum enables the architect to articulate the broad perspective of what, why, and how the enterprise architecture has been designed with the factors and drivers considered. The Enterprise Continuum is an important aid to communication and understanding, both within individual enterprises, and between customer enterprises and vendor organizations. Without an understanding of "where in the continuum you are", people discussing architecture can often talk at cross-purposes because they are referencing different points in the continuum at the same time, without realizing it.

Any architecture is context-specific; for example, there are architectures that are specific to individual customers, industries, subsystems, products, and services. Architects, on both the buy side and supply side, must have at their disposal a consistent language to effectively communicate the differences between architectures. Such a language will enable engineering efficiency and the effective leveraging of Commercial Off-The-Shelf (COTS) product functionality. The Enterprise Continuum provides that consistent language.

The Enterprise Continuum enables the organization of re-usable architecture artifacts and solution assets to maximize the enterprise architecture investment opportunities."

An overview of the context and constituents of the Enterprise Continuum is shown below.

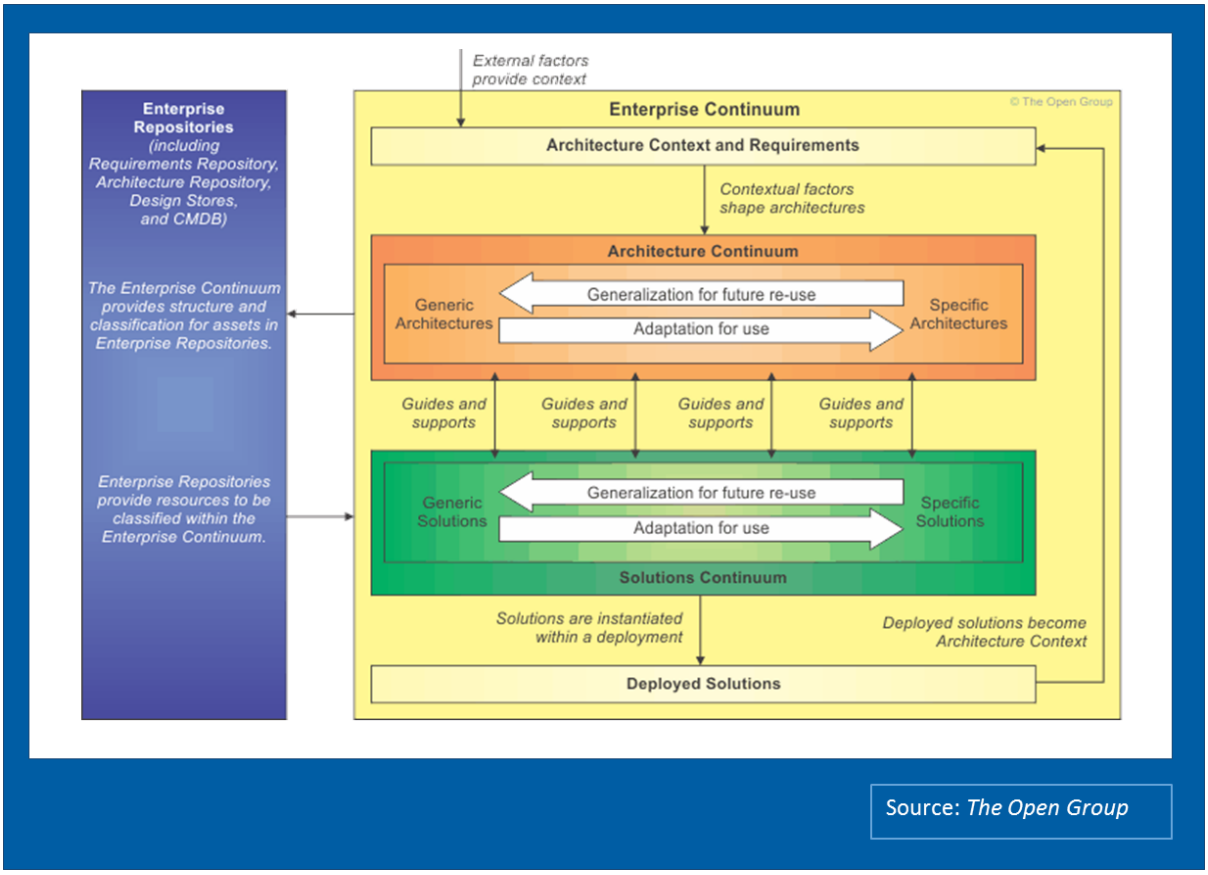

Figure 20: Core Content Metamodel and Predefined Extension Modules

"*The Enterprise Continuum is the outermost continuum and classifies assets related to the context of the overall enterprise architecture.*

The Architecture Continuum offers a consistent way to define and understand the generic rules, representations, and relationships in an architecture, including traceability and derivation relationships (e.g., to show that an Organization-Specific Architecture is based on an industry or generic standard).

The Solutions Continuum provides a consistent way to describe and understand the implementation of the assets defined in the Architecture Continuum.

The Architecture Continuum illustrates how architectures are developed and evolved across a continuum ranging from Foundation Architectures, such as the one provided by TOGAF, through Common Systems Architectures, and Industry Architectures, and to an enterprise's own Organization-Specific Architectures."

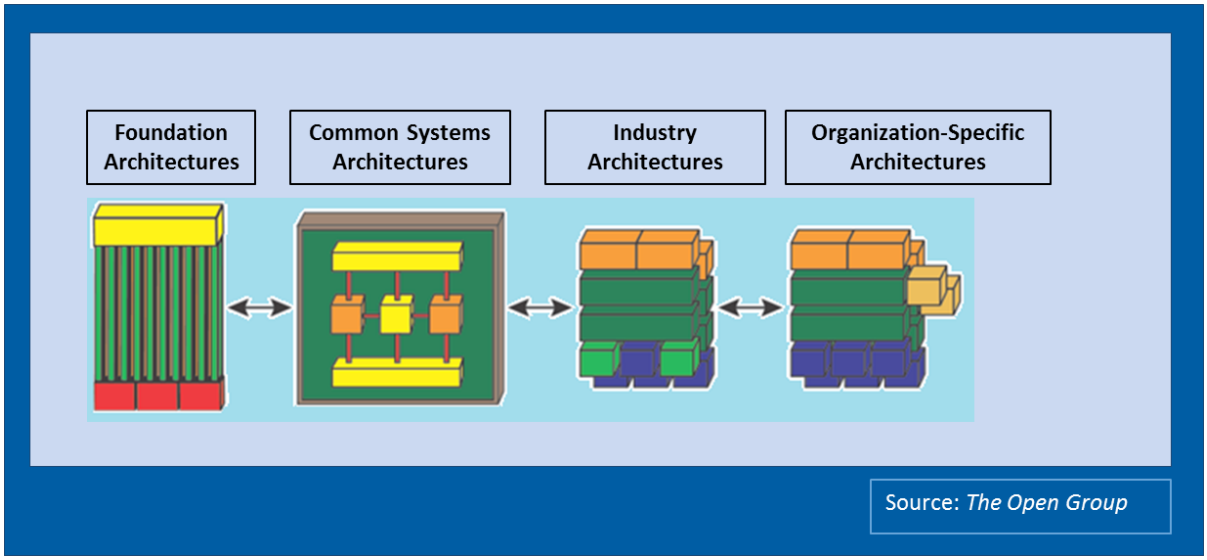

Figure 21: Architecture Continuum

- *A Foundation Architecture consists of generic components, inter-relationships, principles, and guidelines that provide a foundation on which more specific architectures can be built. The TOGAF ADM is a process that would support specialization of such Foundation Architectures in order to create organization-specific models.*
- *Common Systems Architectures guide the selection and integration of specific services from the Foundation Architecture to create an architecture useful for building common (i.e., highly re-usable) solutions across a wide number of relevant domains.*
- *Industry Architectures guide the integration of common systems components with industry-specific components, and guide the creation of industry solutions for targeted customer problems within a particular industry.*
- *Organization-Specific Architectures describe and guide the final deployment of solution components for a particular enterprise or extended network of connected enterprises.*

The Solutions Continuum represents the detailed specification and construction of the architectures at the corresponding levels of the Architecture Continuum. At each level, the Solutions Continuum is a population of the architecture with reference building blocks – either purchased products or built components – that represent a solution to the enterprise's business need expressed at that level. A populated repository based on the Solutions Continuum can be regarded as a solutions inventory or re-use library, which can add significant value to the task of managing and implementing improvements to the enterprise."

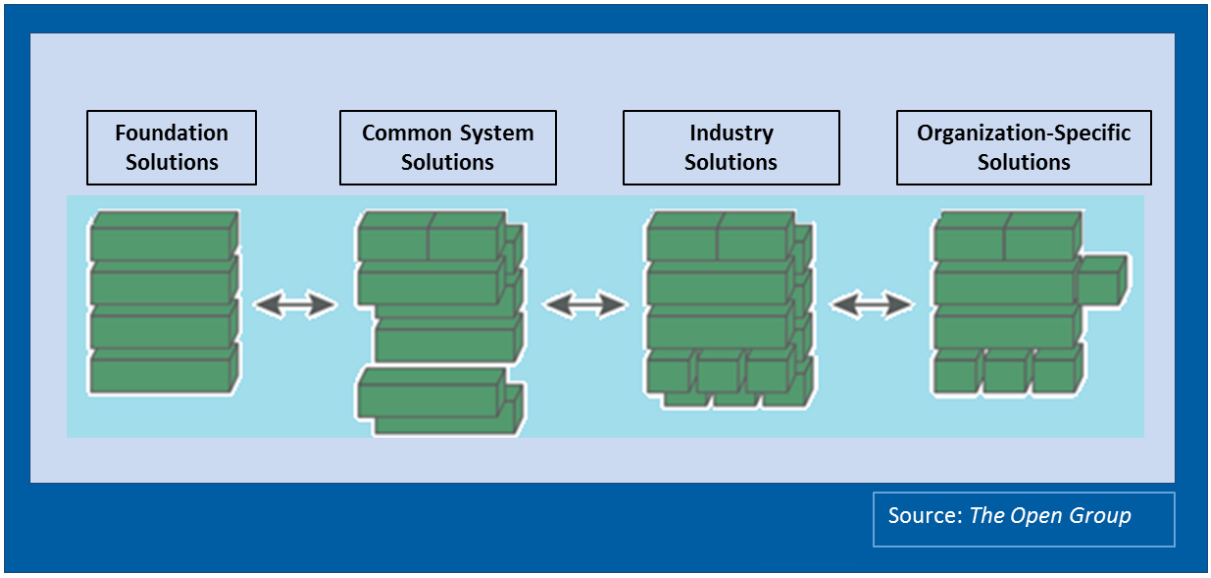

Figure 22: Solutions Continuum

- *Foundation Solutions are highly generic concepts, tools, products, services, and solution components that are the fundamental providers of capabilities.*
- *A Common Systems Solution is an implementation of a Common Systems Architecture comprised of a set of products and services, which may be certified or branded. It represents the highest common denominator for one or more solutions in the industry segments that the Common Systems Solution supports.*
- *An Industry Solution is an implementation of an Industry Architecture, which provides re-usable packages of common components and services specific to an industry.*
- *An Organization-Specific Solution is an implementation of the Organization-Specific Architecture that provides the required business functions. Because solutions are designed for specific business operations, they contain the highest amount of unique content in order to accommodate the varying people and processes of specific organizations.*

The following shows the relationship between each of the three continua and how these relationships should be applied within an organization.

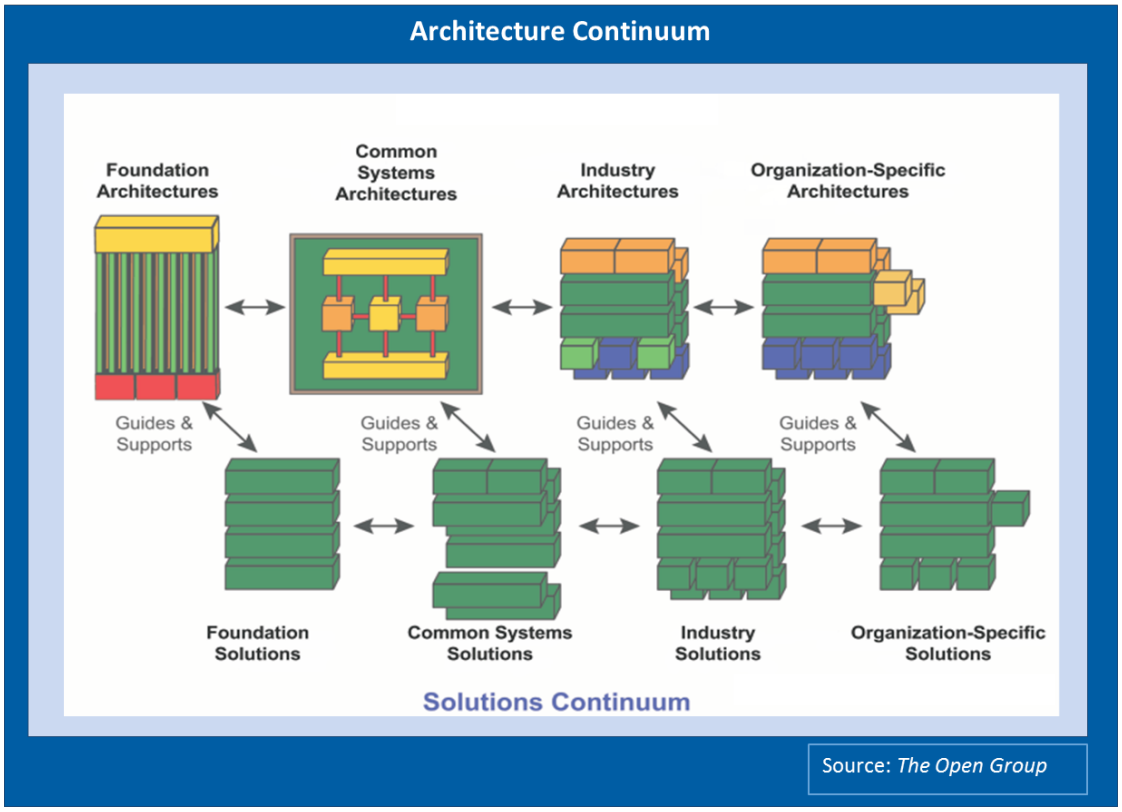

Figure 23: Solutions Continuum

"*The relationship between the Architecture Continuum and the Solutions Continuum is one of guidance, direction, and support. For example, Foundation Architectures guide the creation or selection of Foundation Solutions. Foundation Solutions support the Foundation Architecture by helping to realize the architecture defined in the Architecture Continuum. The Foundation Architecture also guides development of Foundation Solutions, by providing architectural direction, requirements and principles that guide selection, and realization of appropriate solutions. A similar relationship exists between the other elements of the Enterprise Continuum.*"

Architecture Repository

TOGAF: *"Architecture Repository within TOGAF allows an organization to distinguish between different types of architectural assets that exist at different levels of abstraction in the organization.*

At a high level, six classes of architectural information are held within an Architecture Repository:

- *The Architecture Metamodel describes the organizationally tailored application of an architecture framework, including a method for architecture development and a metamodel for architecture content.*
- *The Architecture Capability defines the parameters, structures, and processes that support governance of the Architecture Repository.*

- *The Architecture Landscape presents an architectural representation of assets in use, or planned, by the enterprise at particular points in time.*
- *The Standards Information Base captures the standards with which new architectures must comply, which may include industry standards, selected products and services from suppliers, or shared services already deployed within the organization.*
- *The Reference Library provides guidelines, templates, patterns, and other forms of reference material that can be leveraged in order to accelerate the creation of new architectures for the enterprise.*
- *The Governance Log provides a record of governance activity across the enterprise."*

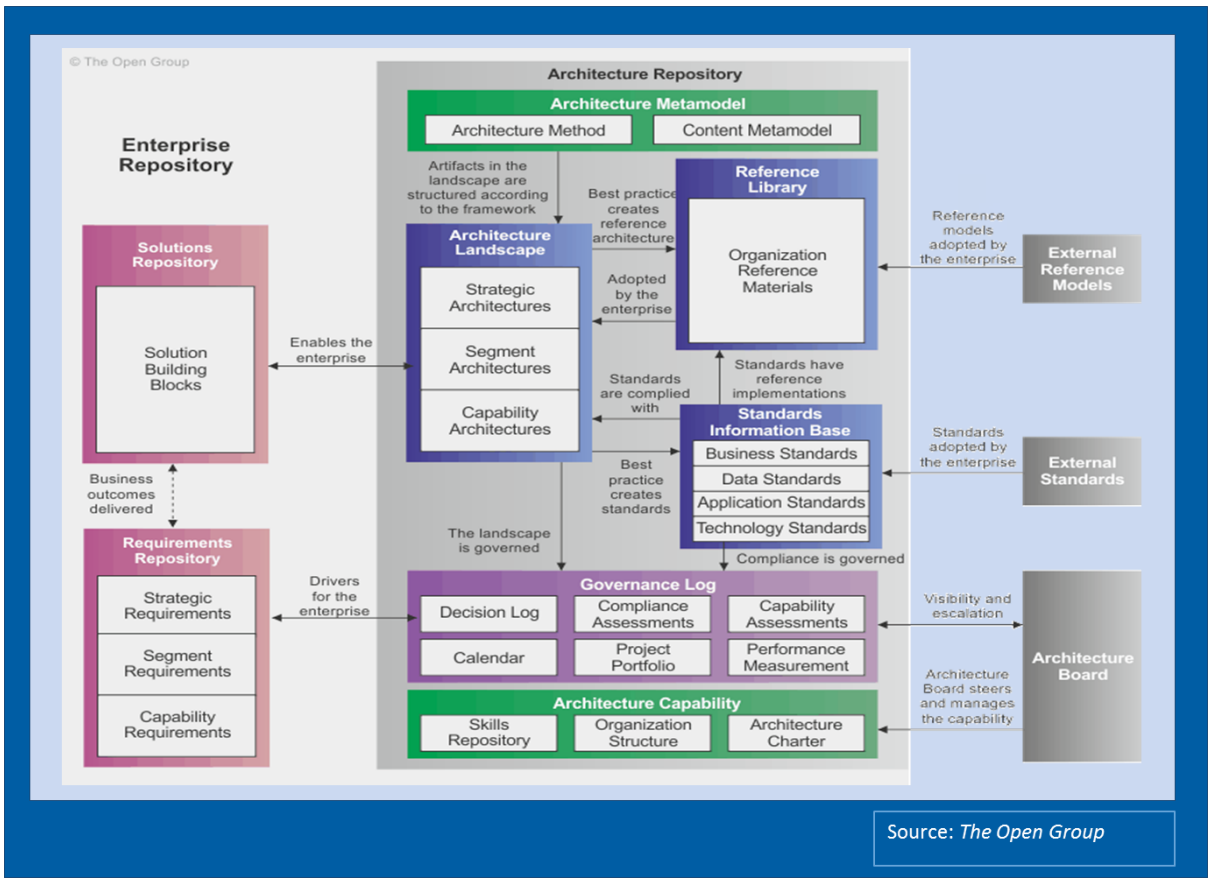

Figure 24: Overview of Architecture Repository

Architecture Capability Framework

TOGAF: *"The Architecture Capability Framework provides guidance on establishing an operational enterprise architecture within an enterprise. An overall structure for the Architecture Capability Framework is provided below. The structure consists of:*

- *Establishing an Architecture Capability*
- *Establishing Architecture Board*
- *Ensuring Architecture Compliance*

- *Defining and Using Architecture Contracts*
- *Defining framework and guideline for Architecture Governance*
- *Evaluating and Quantifying Architecture Maturity in an organization*
- *Establishing Architecture Skills Framework that provides a set of role, skills, and experience levels for people performing Enterprise Architecture work."*

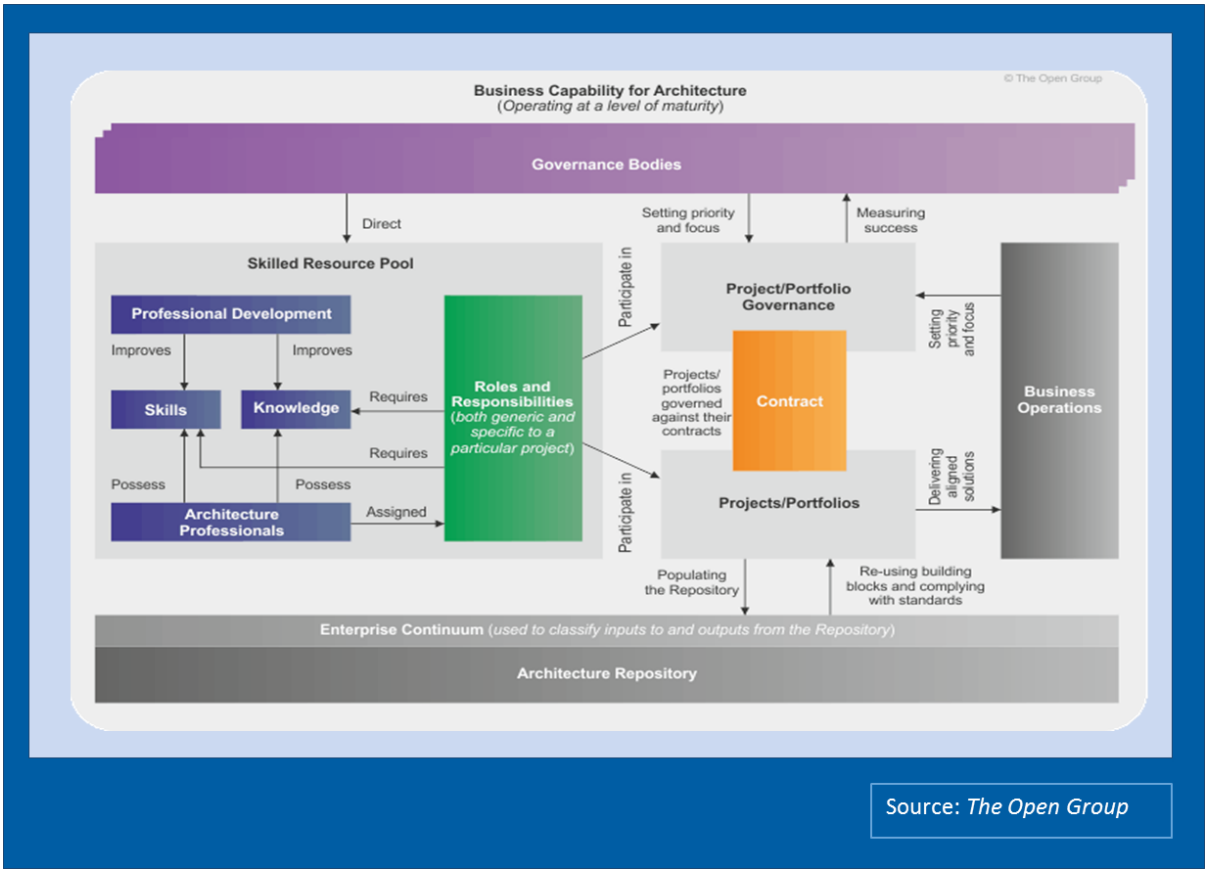

Figure 25: Architecture Capability Framework

Federal Enterprise Architecture Framework

Federal Enterprise Architecture Framework (FEAF) provides "*an overall approach to developing and using Enterprise Architecture in the Federal Government.*"

FEAF is considered the most complete of all the Enterprise Architecture Frameworks because it has both a comprehensive taxonomy (like The Zachman Framework), and architectural process (like TOGAF).

The Common Approach to FEAF promotes increased levels of mission effectiveness by standardizing the development and use of architectures within and between Federal Agencies. This includes principles for using EA to help agencies eliminate waste and duplication, increase shared services, close performance gaps, and promote engagement among government, industry, and citizens.

FEAF provides a suite of tools to help federal agencies implement the Common Approach. At its core is the Consolidated Reference Model (CRM), which equips OMB and Federal agencies with a common language and framework to describe and analyze investments. It consists of a set of interrelated "reference models" that describe the six sub-architecture domains in the framework:

- Strategy
- Business
- Data
- Applications
- Infrastructure
- Security

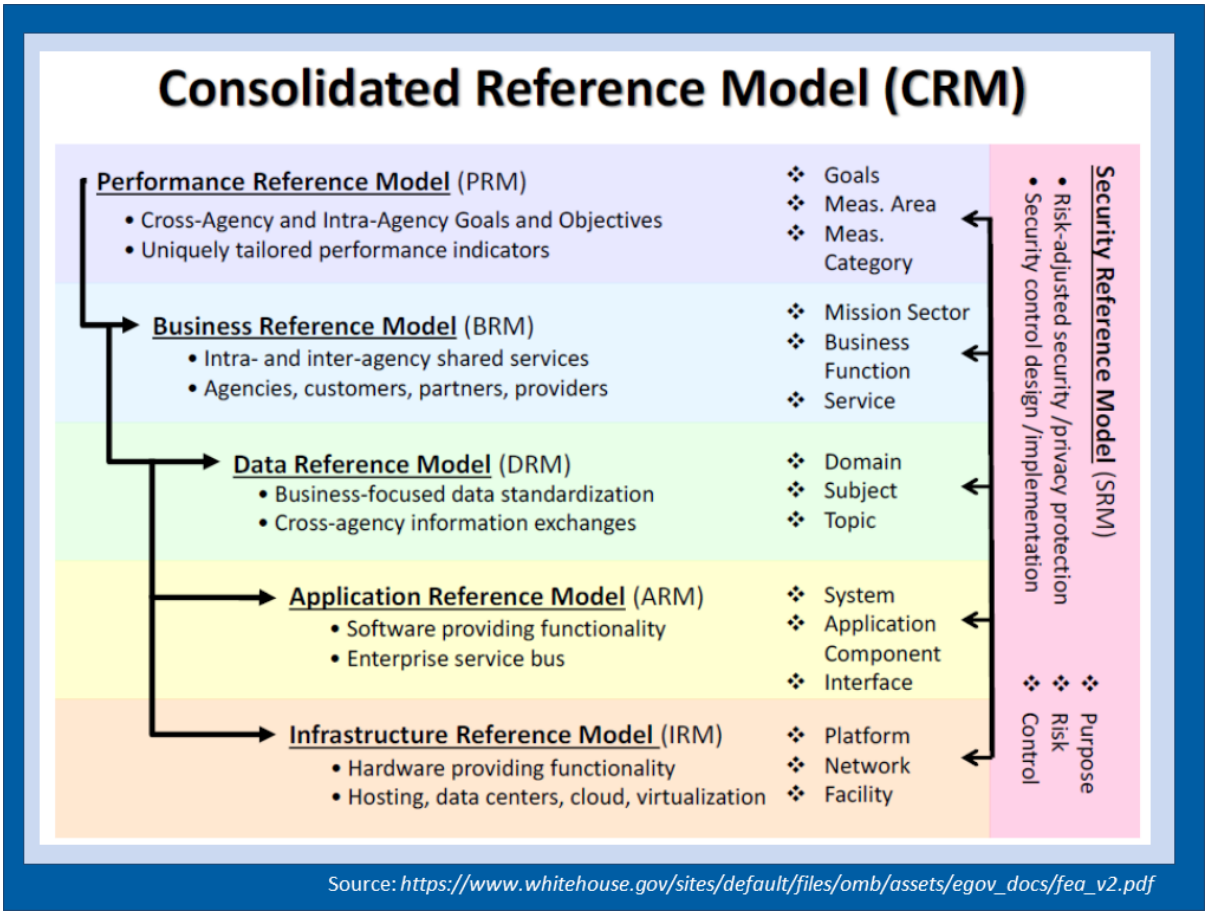

Figure 26: FEA Consolidated Reference Model

The **Performance Reference Model (PRM)** links agency strategy, internal business components, and investments, providing a means to measure the impact of those investments on strategic outcomes.

The **Business Reference Model (BRM)** describes an organization through a taxonomy of common mission and support service areas instead of through a stove-piped organizational view, thereby promoting intra- and inter-agency collaboration.

The **Data Reference Model (DRM)** facilitates discovery of existing data holdings residing in "silos" and enables understanding the meaning of the data, how to access it, and how to leverage it to support performance results.

The **Application Reference Model (ARM)** categorizes the system- and application-related standards and technologies that support the delivery of service capabilities, allowing agencies to share and reuse common solutions and benefit from economies of scale.

The **Infrastructure Reference Model (IRM)** categorizes the network/cloud related standards and technologies to support and enable the delivery of voice, data, video, and mobile service components and capabilities.

The **Security Reference Model (SRM)** provides a common language and methodology for discussing security and privacy in the context of federal agencies' business and performance goals.

Pragmatic Enterprise Architecture Framework (PEAF)

Pragmatic Enterprise Architecture Framework (PEAF) was launched in 2008 after many years of development. It has been developed with the vision that there needs to be a quick start toolkit to begin and sustain Enterprise Architecture initiative. Therefore PEAF basically markets it at "Cuts EA to the Bone."

PEAF says, "*The pragmatic ethos and culture, focuses on being pragmatic about everything we do. This ethos is evident and pervasive within the Pragmatic EA Framework (PEAF) which reduces and distills what is needed out of the general EA background noise and hype, and provide the results in an easy to understand and utilize form. Pragmatic EA are committed to ensuring that anyone attaining certified status not only understands, but also can apply the Pragmatic Ethos as well as the Pragmatic EA Framework.*"

PEAF is based on Pragmatic's assertion that every enterprise consists of four distinct conceptual parts. They are:

Direction

Direction is that part which exists solely to provide direction and leadership to the rest of the Enterprise. This is where the C-Suite, Partners and Exec Management team generally sit working on things like Vision, Mission, Goals, Objectives, Strategies, Tactics, Business Models and Operating Models.

Operation

Operation is that part which exists solely to fulfil that Enterprises Mission and thereby helping it to fulfil its Vision.

Transformation

Transformation is that part which exists solely to transform the Enterprise. If the Enterprise never needed to change, this area would simply not exist.

Support

Support is that part which exists solely for the purposes of dealing with problems and issues from the rest of the Enterprise.

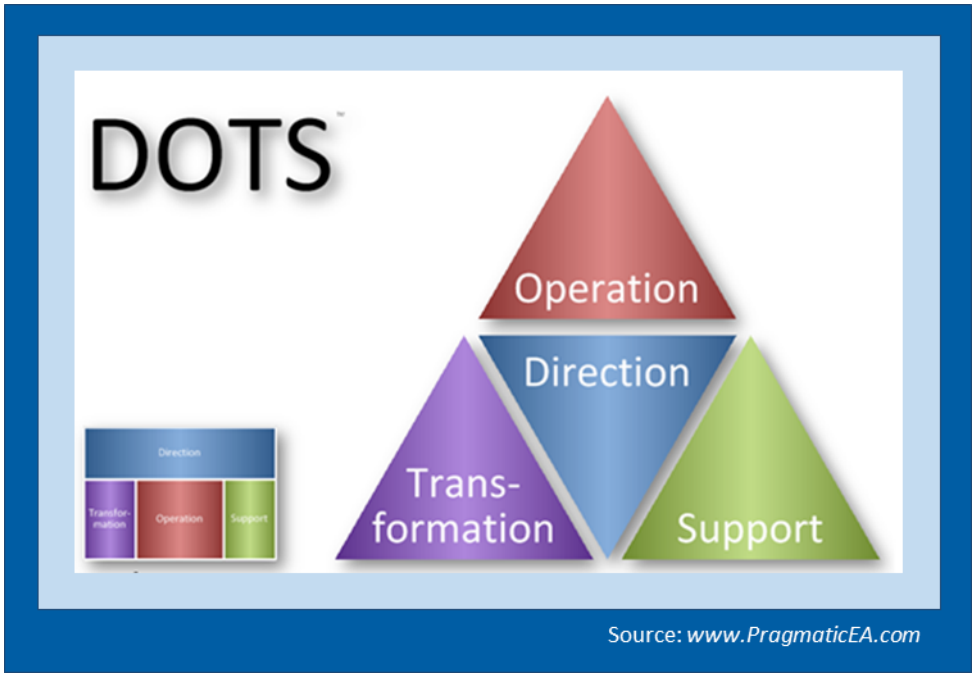

Figure 27: PEAF Ontologies – Enterprise DOTS

Secondly PEAF has an ontology called MACE that is used to categorize information relating to the ***OPERATIONAL*** structure of something:

Methods	Information about what is being done and how it is being done. E.g. Functions, Processes, Practices, Activities, Phases, Disciplines.
Artefacts	Information about the things that are being consumed and produced by the methods. E.g. Products, Services, Materials, Information.
Culture	Information about the People that are being used to perform the Methods. E.g. People, Values, Ethics, Trust, Psychology.
Environment	Information about the things that are used to performed the Methods. E.g. Tools, Frameworks, Locations.

It is important to note that culture sits at the center because it is the core of everything.

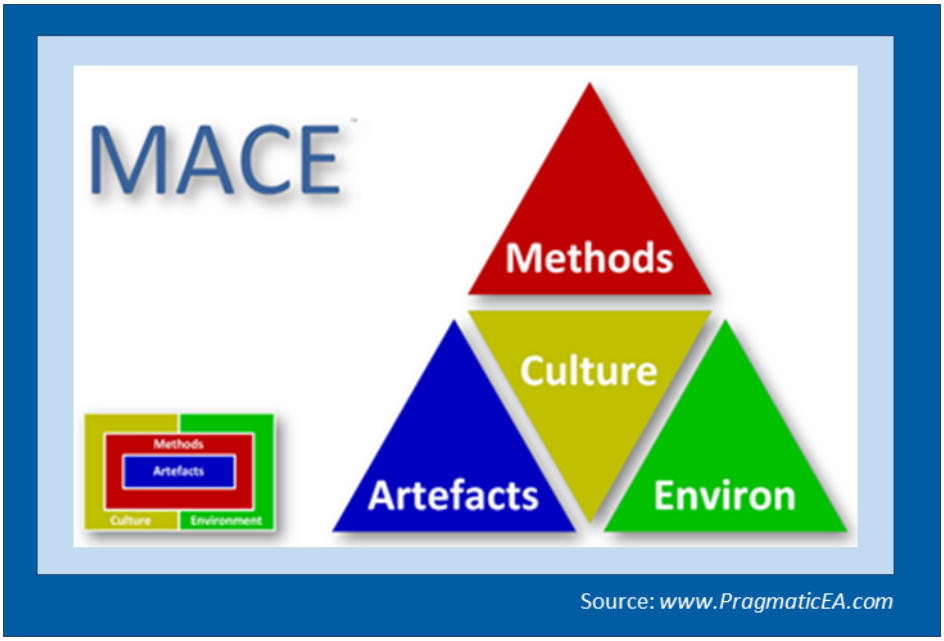

Figure 28: PEAF Ontologies – Structural MACE

The ontology to categorize information relating to **TRANSFORMATION** is called MAGMA. It has five key categories – Motivation, Actions, Guidance, Measures, and Assessment.

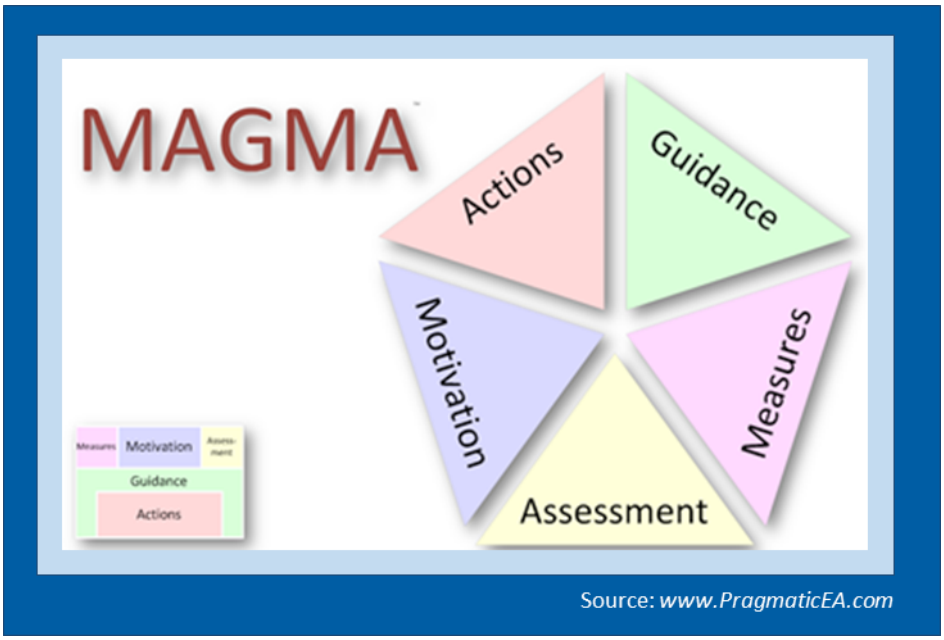

Figure 29: PEAF Ontologies – Transformational MAGMA

Motivation	Information about the reasons why we are transforming. E.g. Visions, Goals, Objectives, Requirements.
Actions	Information about the things we need to do in order to achieve those goals and satisfy those requirements. E.g. Mission, Strategies, Tactics, Roadmaps, Plans, Tasks.
Guidance	Information about the things that will guide others as the Actions are executed. E.g. Principles, Polices, Standards, Rules, Values, Frameworks (MACE)
Measures	Information about the things that will allow us to know if we have achieved our goals and satisfied our requirements. E.g. Metrics, KPIs, CSFs,
Assessment	Information about the things that led to us to choose: • the target and intermediate structural models (as defined by MACE) • The Actions (as defined by MAGMA) that will effect the changes between them. E.g. Strengths, Weaknesses, Opportunities, Threats, Pro's, Cons, Issues, Risks.

The next ontology for categorizing information and methods related to MATURING something is called EMMA. Its key aspects are explained below:

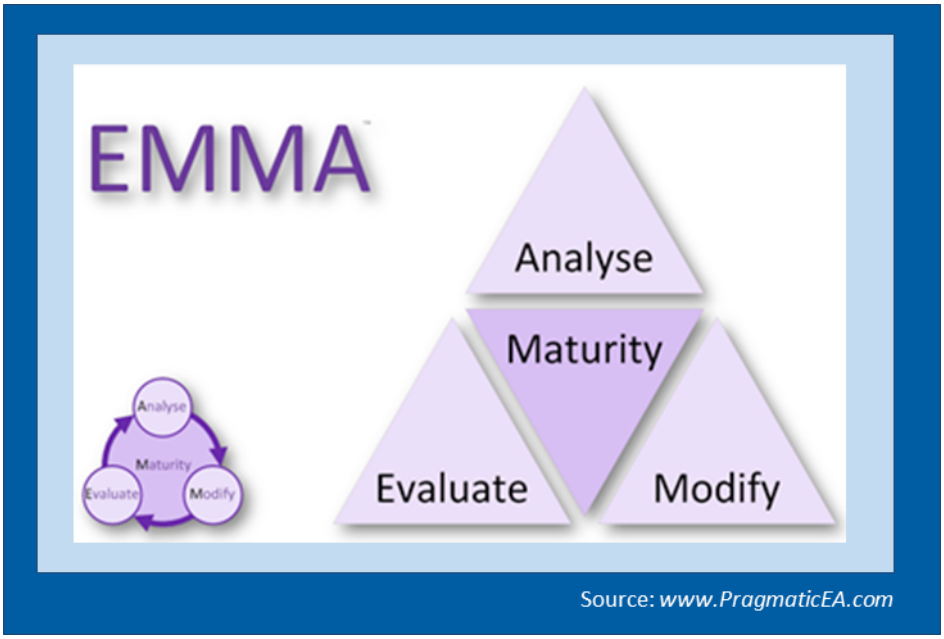

Figure 30: PEAF Ontologies – Framework EMMA

Evaluate	Measure how mature we are and if we should investigate increasing our maturity.
Analyze	Determine how to change, and to secure the mandate and budget required to do so.
Modify	Make the changes identified to increase our maturity.
Maturity	A model which provides the Motivation, Actions, Guidance, Measures and Assessment to allow an increase in maturity.

All of the above three ontologies are brought together to compose the Pragmatic framework.

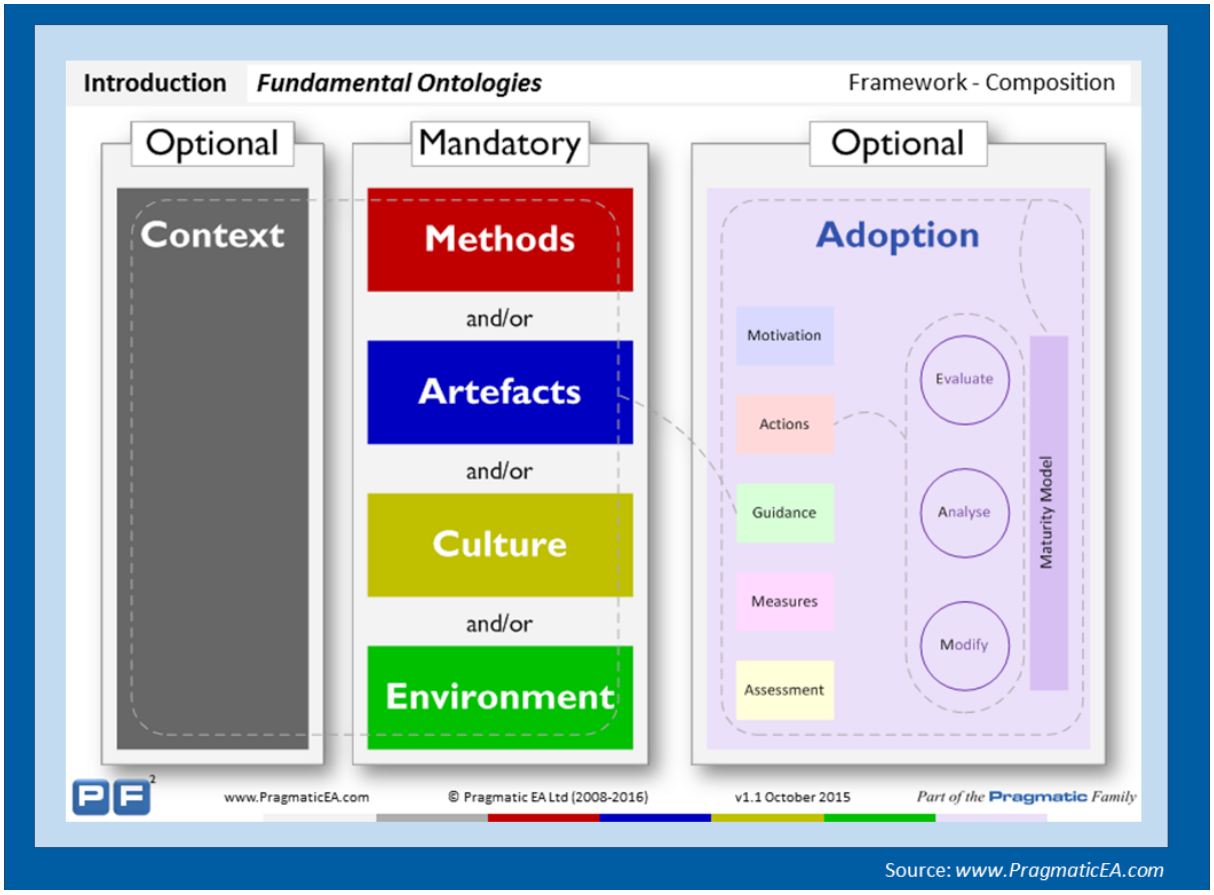

Figure 31: PEAF Framework Composition

It must be noted that Pragmatic framework is not a framework by itself. It consists of a family of frameworks (called PF²).

"PF² consists of a coherent and holistic set of Ontologies and Frameworks designed to help improve the maturity of how Enterprises carry out their business.

The relationships between the frameworks are not one of decomposition but are one of inheritance. Therefore to adopt any lower level framework, the ontology that it inherits from must be understood first."

Each framework is designed to be:

Pragmatic	Provide 80% of the benefits for only 20% of the effort.
Well-defined	Deal with a well-defined domain.
Complete	Be complete in scope with no overlaps and no gaps (not the same as complete in terms of detail. Detail is provided by Frameworks to the right).
Interlocking	Connect to and interface with frameworks at the same level.
Inheritable	Each framework inherits and builds on the content and guidance from Frameworks to the left and provides content and guidance to frameworks to the right.
Extensible	Helps Enterprises create their own frameworks (marked with a red X) by inheriting as much or as little as they deem appropriate from whatever level they deem appropriate.

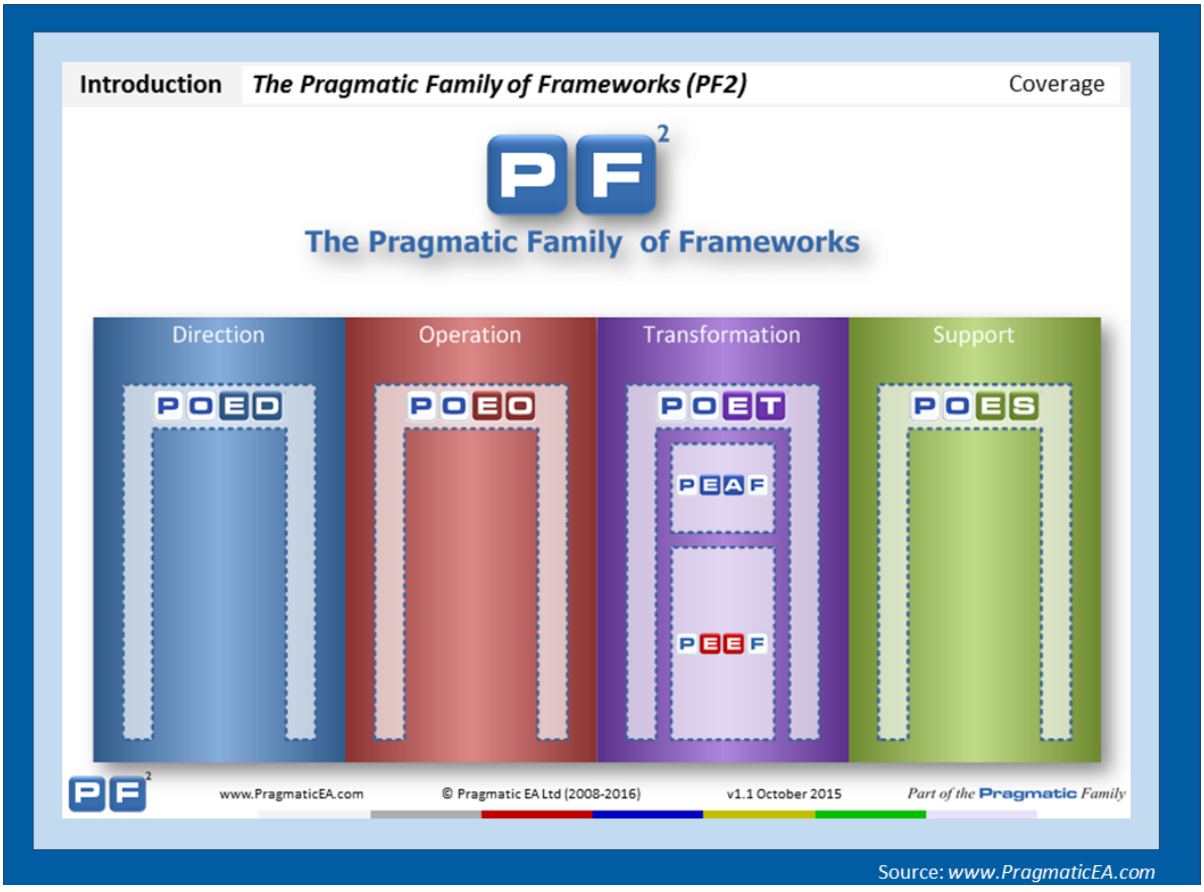

Figure 32: The Pragmatic Family of Frameworks

- The **Pragmatic Ontology for Enterprise Transformation** sets the context for the Transformation part of the Enterprise. It defines Methods, Artefacts, Cultural and Environmental things that apply to all parts of Transformation, that serve to set the context to increase the maturity of its individual parts (Strategizing, Road mapping, Initiation, Elaboration, Construction and Transitioning and Governance).

- The **Pragmatic Enterprise Architecture Framework** sets the context for the Strategizing and Road mapping parts of Transformation (Enterprise Architecture). It defines Methods, Artefacts, Cultural and Environmental things that serve to set the context to increase their maturity.

  PEAF is based on and inherits from POET and therefore POET is a pre-requisite for understanding and adopting PEAF.

- The **Pragmatic Enterprise Engineering Framework** sets the context for the Initiation, Elaboration, Construction and Transitioning parts of Transformation (Enterprise Engineering). It defines Methods, Artefacts, Cultural and Environmental things that serve to set the context to increase their maturity.

  PEEF is based on and inherits from POET and therefore POET is a pre-requisite for understanding and adopting PEEF.

- The **Pragmatic Ontology for Enterprise Direction** sets the context for the Direction part of the Enterprise. It defines Methods, Artefacts, Cultural and Environmental things that apply to all parts of Direction, that serve to set the context to increase the maturity of its individual parts.

- The **Pragmatic Ontology for Enterprise Operation** sets the context for the Operations part of the Enterprise. It defines Methods, Artefacts, Cultural and Environmental things that apply to all parts of Operations that serve to set the context to increase the maturity of its individual parts.

- The **Pragmatic Ontology for Enterprise Support** sets the context for the Support part of the Enterprise. It defines Methods, Artefacts, Cultural and Environmental things that apply to all parts of Support, that serve to set the context to increase the maturity of its individual parts.

One of the best advantage of Pragmatic Framework is its guidance on how to adopt and leverage the framework for specific needs of the enterprise. Pragmatic Frameworks makes it easier for enterprises to use them as a basis to create their own Enterprise specific frameworks (X-Framework) by taking a Pragmatic Framework (or Ontology) and making the necessary changes required, in terms of content, branding, naming etc.

According to PEAF, most other frameworks provide minimum help to tailor and adopt them. However PEAF claims to take a distinctly different view by being committed to providing as much collateral and guidance as possible

In terms of a way to start using the Pragmatic frameworks, Pragmatic provides two basic approaches:

- By using it as a reference material and adopt things as you go that is applicable and relevant to the specific needs of the enterprise.
- By adopting a more systematic approach and start at the beginning.

9.5 WHICH FRAMEWORK IS RIGHT FOR MY ORGANIZATION?

Having gone through a host of Enterprise Architecture frameworks, the next logical question is which framework is right for your organization. The answer is "There's no simple answer." What framework is best-fit for an organization depends on the needs, time factor and circumstances of the organization. Federal organizations have found FEAF quite effective whereas most other organizations have found TOGAF to be useful. There is no framework that can be directly adopted straightaway. Every framework would need some amount of tailoring to meet the requirements of the organization.

A good approach to select a right framework is to follow the **Choose** – **Evaluate** – **Select** process. Choose a group of frameworks that you would like to evaluate, evaluate them based on certain criteria, and finally select the right one. The below table provides a good set of evaluation criteria to assess and evaluate the right framework.

Taxonomy	Is the taxonomy comprehensive and complete to classify the various architectural artifacts?
Process	Does the framework provide step-by-step process for creating an enterprise architecture?
Reference-model	Does the framework provide tools and techniques to build a relevant set of reference model?
Practice Establishment	Does the framework provide tools and techniques to help in establishing EA practice and culture within the organization?
Maturity Model	Does the framework provide a maturity model that helps in assessing the effectiveness and maturity of different organizations within an enterprise in using EA?
Business Value	Is the framework capable enough to drive business value?
Governance	Does the framework have an effective governance model to manage and govern the EA program?
Complexity	Does the framework provide enough guidance to manage complexity within an organization? For example, can it be used to scope out the boundaries/partitions within an enterprise so that EA can be managed better?
Reusability	Are the artifacts of the frameworks re-usable for future needs?
Skillsets	Are enough skillsets available in the industry that is well-versed in the framework?

Training & Certification	Does the framework provider provide training & certification program to uplift the capability of the architects?
Time to Implement to Value	How much time does it take to implement the framework before we see the business value derived out of it?
Information Availability	Is enough information and user experience about the framework available the framework?

9.6 ENTERPRISE ARCHITECTURE TOOLS

The Enterprise Architecture profession has come a long way since its beginning. So much so that there are now excellent tools available to execute and manage Enterprise Architecture programs. Mature organizations have started to show great interest in adopting such tools for their EA programs. In fact the fight for market dominance in EA tool space is so strong that even Gartner publishes Magic Quadrant reports annually ranking the tools in various leadership quadrants. The report can be accessed at this link: https://www.gartner.com/doc/3162324/magic-quadrant-enterprise-architecture-tools

It is beyond the scope of this paper to suggest which EA tool is the best for your enterprise. However the paper can gladly provide a list of criteria that you can use to shop for right EA tool. The criteria is mostly derived from a report "***Enterprise Architecture Tool Selection Guide***" published by *Institute for Enterprise Architecture Developments.*

There are three main dimensions based on which the evaluation criteria is based on:

1. Functional Dimension – the basic functionality of the tool. Basically it evaluates how well the tool performs the core functions needed to run the EA activity.
2. Non-Functional Dimension
3. People Dimension – the utility of the tool to different stakeholders

Functional Dimension	
Methodologies and Models	How well, and how completely, does the tool support the methodologies and modeling approaches it claims to support? Also if the tool supports multiple methodologies and modeling approaches, how well does it integrate the different approaches? How well the data can be moved between the different perspectives offering by these different approaches?
Model Development Interface	How well does the tool interface support to design, build, maintain the architecture models? Does the tool support visual diagram-based modeling? Is the interface user-friendly, structured well, navigation easy, has comprehensive diagramming capability, and follow graphical user interface convention and guidelines?
Tool Automation	Does the tool support automation capability to automate key EA development activities? Does the tool support creation of macros or scripts to automate common functions or actions together?
Reporting	Does the tool provide robust reporting capability to generate models and reports based on data in the repository?
Extensibility and Customization	How well can the tool be modified (extended, customized) to meet the unique EA requirements of an organization? For example, can the underlying metamodel be modified, or new meta-model added? Can it support modification by a programming interface such as VBA? Can the tool be integrated with other software products?
Analysis and Manipulation	Does the tool provide support for analysis and manipulation of developed models? For example, does the tool provide the ability to compare Baseline and Target architecture models?
Repository	Does the tool support data repository such as relational database systems to hold the repository data? Does the tool provide support for version control of architecture models, ability to roll back to previous versions, ability to pick and choose which changes to commit/check-in, ability to provide managed user access?

Deployment Architecture	What deployment architecture does the tool support? Example: single user/single client structure, or two-tier client/server architecture?
Costs and Vendor Support	How affordable is the tool cost and after sales support provided by the vendor? How is the licensing agreement structure? Is it a named license or floating user license?
Architecture Results	Does the tool support essential and supporting results? Essential results are graphics, models, and/or narratives that every enterprise architecture description must include, to support the scope and characteristics of the EA. Supporting results are the graphics, models, and /or narratives that may be needed to further elaborate on essential products or to address particular domain.
People Dimension	
Enterprise Architects	Enterprise Architects investigate all aspects of enterprise architectural approaches and methodologies. This can involve researching different representations and enterprise architectural structures, including the development and investigation of alternative modeling approaches. Therefore the tool must support these requirements.
Solution Architects	Solution Architects are focused at the Solution level and working with the developing vendor to design and implement the Solution.
Strategic Planners/ Management	Strategic planners, including executive management and innovating staff, use the enterprise architectures results for strategic decision making. They need to be assembled and modified quickly, and should be based on current (or planned) future capability
Enterprise Program Managers	Enterprise Program Managers as well as domain program managers and often project managers supports the enterprise architecture program in order to support the implementation and transformation phase. The enterprise architecture tools should be able to capture current and future resources (such as platforms, assets and components), organizations, people, information exchanges, tasks or activities, and processes and their relationships as well as program planning facilities.

Software Architects	A Software Architecture relates requirements, fixed system hardware, and infrastructure (i.e., COTS or GOTS) to software structures in order to demonstrate software effectiveness, therefore their needs for tooling support are different from the Enterprise and Solution Architect.
External Partners	Solution Architects and Software Architects often work together with Vendors / Partners. Hence their demands from the tool can be quite different.
Non-Functional Dimension	
Scalability	Is the tool scalable to meet the demands of multiple concurrent users?
Performance	Is the tool high on performance?
Usability	Is the tool friendly and easy to use?
Accessibility	Is the tool accessible to users with diverse needs such as visually impaired, etc.?
Maintainability	Is the tool simple to maintain?

A detailed checklist of EA Tool requirements and specifications can be found in the "***Enterprise Architecture Tool Selection Guide***" mentioned above.

10 ESTABLISHING ARCHITECTURE CAPABILITY IN AN ENTERPRISE

Having gone through the basics of Enterprise Architecture, the next logical question is how to establish Enterprise Architecture capability in an enterprise? What organization structure, governance process, people skills, roles and responsibilities are needed to effective operate EA function?

Again extending the TOGAF guidelines, establishing EA capability needs the following broad framework.

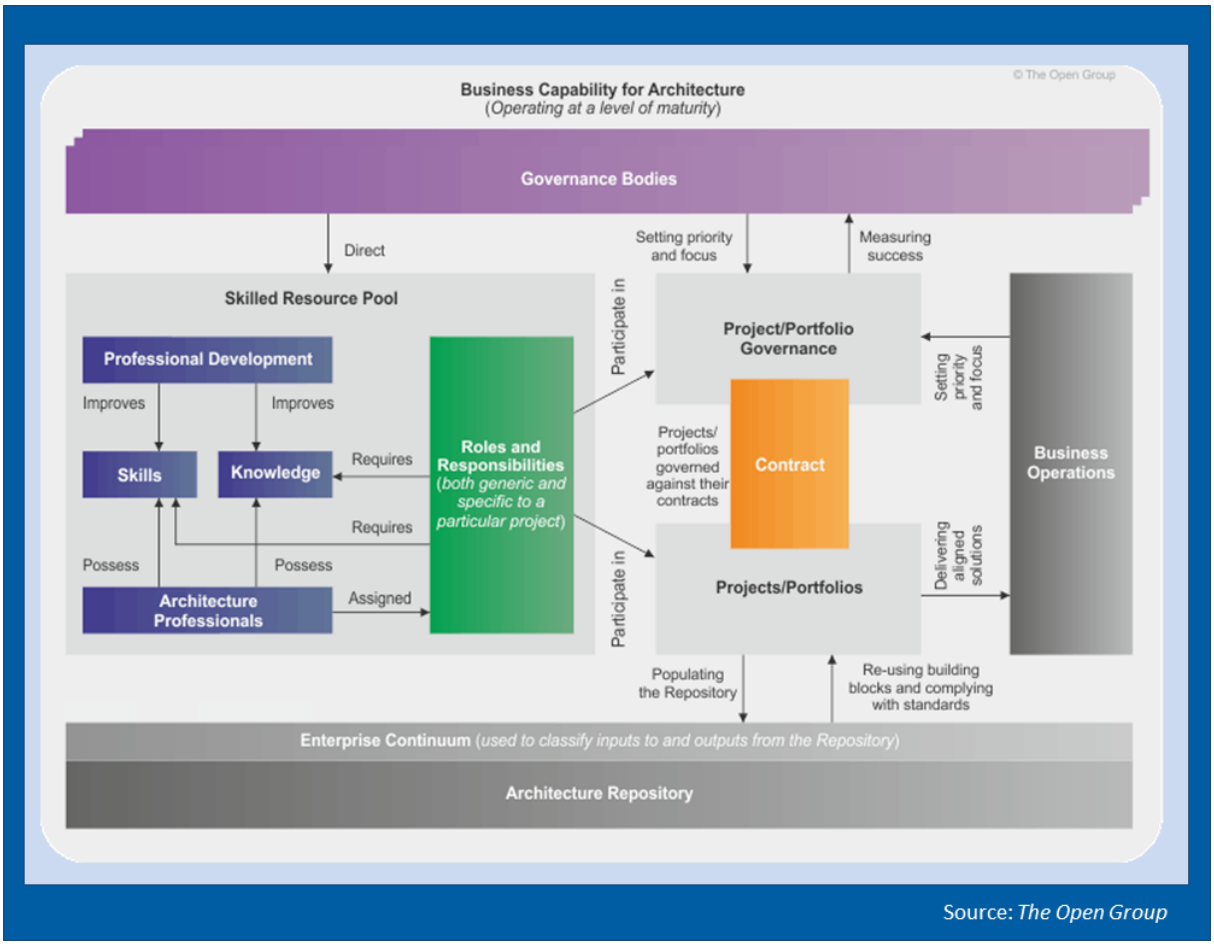

Figure 33: Architecture Capability Framework

10.1 ARCHITECTURE CAPABILITY

One good way to start to use TOGAF Architecture Development Method (ADM) to support setting up the architecture capability. Implementing any architecture capability within an organization requires the design of four domain architectures – Business, Data, Application, and Technology. It is advised to the implementer to refer the relevant ADM phase to pick out the required steps in establishing the EA function. Note that ADM is generic, and therefore it needs to be tailored to the specific needs of the organization.

A quick overview of the steps from key ADM phases required to set up architecture function is shown in the table below:

ADM Phase	Steps
Phase A: Architecture Vision	• Establish the Project • Identify Stakeholders and Concerns, Business Requirements, and Architecture Vision • Identify Business Goals and Business Drivers • Define Scope • Define Constraints • Review Architecture Principles, including Business Principles • Develop Statement of Architecture Work and Secure Approval • Conduct Architecture Maturity Assessment (Section 11.6)
Phase B: Business Architecture	• Define Architecture Ontology (define architectural terms and definitions) • Setup Architecture Process • Create list of Architecture Viewpoints and Views • Define Architecture Framework including Architecture Deliverables • Create Architecture Accountability Matrix • Define Architecture Performance Metrics • Define Architecture Governance Framework

The above steps will help you get started. The other ADM phases can be adopted as you go along later in the journey.

10.2 ARCHITECTURE BOARD

Setting up an Architecture Board is absolutely critical to oversee the implementation and governance of EA function. The Board should constitute key (and influential) stakeholders across various departments.

Architecture Board is typically responsible for: Providing architecture-related decision making, ensuring adherence to architecture guidelines and standards, ensuring consistency between architectures, ensuring architectural flexibility to meet changing business needs, ensuring business – IT alignment, improving architectural maturity in the enterprise, encouraging architecture-based development, and encouraging re-use of architecture components.

The size of the Architecture Board should be optimal – not too large that it hampers decision-making and not too small that it fails to represent key stakeholders for key departments.

10.3 ARCHITECTURE COMPLIANCE

Architecture Compliance is an element of Architecture Governance that ensures the compliance of individual projects and programs with enterprise architecture. Setting up Architecture Compliance process typically should include the following:

- Defining the terminology of Architecture Compliance terms. For example, what is the definition of 'Compliant' vs. 'Non-conformant'? The idea is to remove ambiguity as much as possible from the definitions.
- Defining Architecture Compliance Review process. An example of a review process is given below:

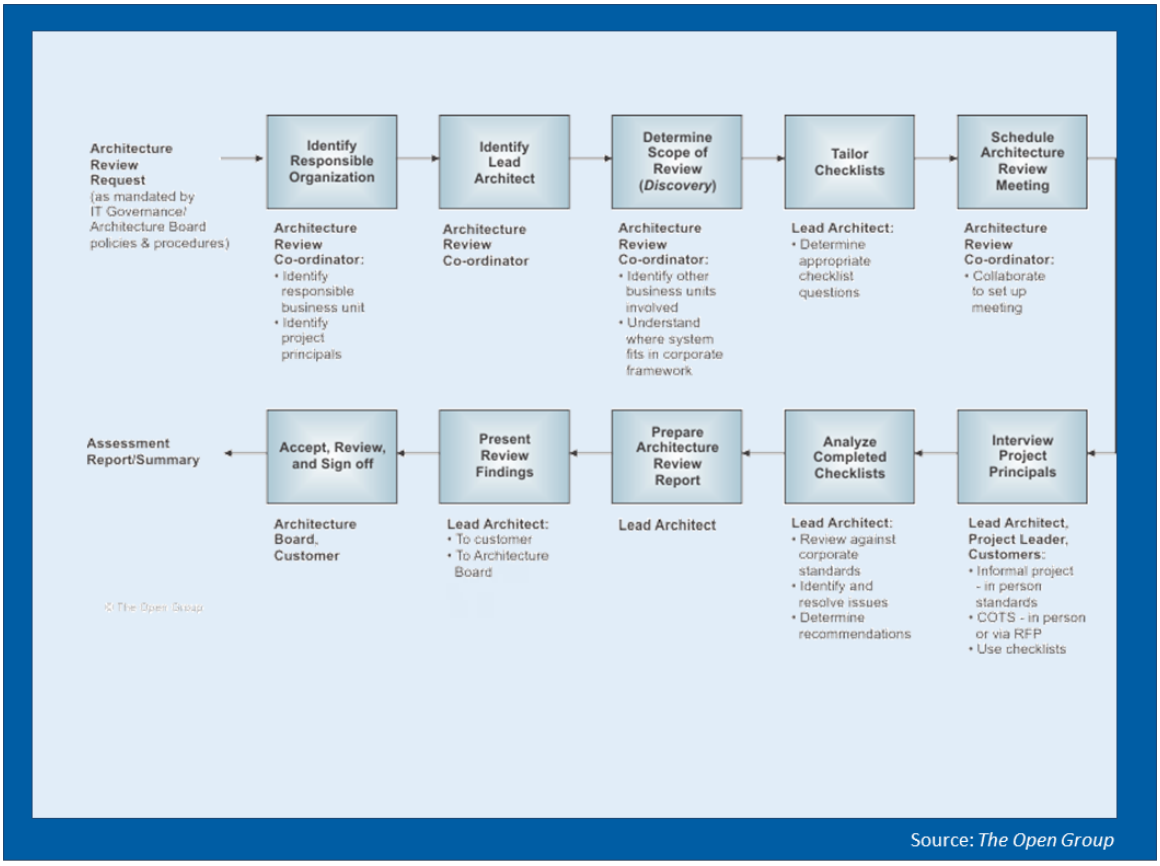

Figure 34: Architecture Compliance Review Process

- Defining the timing/frequency of compliance review process. Should the process be done at specific project milestones, or on an adhoc basis? The best practice is that the Architecture Compliance review is typically targeted for a point in time when business requirements and the enterprise architecture are reasonably firm, and the project architecture is taking shape, well before its completion.
- Identifying the Compliance Review team.
- Preparing Architecture Compliance Review Checklists and communicating the same to the enterprise.
- Creating Architecture Compliance Review guidelines.

10.4 ARCHITECTURE CONTRACTS

Architecture Contracts are the joint agreements between development partners and sponsors on the deliverables, quality, and fitness-for-purpose of an architecture. Successful implementation of these agreements will be delivered through effective architecture governance. Architecture Contracts may occur at various stages of the Architecture Development Method (ADM). Typical examples of Architecture Contracts are: Statement of Architecture Work, Contract between Architecture Design and Development Partners, Contract between Architecting Functions and Business Users.

10.5 ARCHITECTURE GOVERNANCE

Architecture governance is the practice and orientation by which enterprise architectures and other architectures are managed and controlled at an enterprise-wide level. Architecture Governance does not happen in isolation. It could fall under the purview of other governance structures such as corporate governance, Technology governance, IT governance, Architecture governance, etc. Architecture Governance may also contain sub-governance team at multiple geographic levels – global, regional, and local.

Characteristics of Architecture Governance include:

- Implementing a system of controls over the creation and monitoring of all architectural components and activities, to ensure the effective introduction, implementation, and evolution of architectures within the organization
- Implementing a system to ensure compliance with internal and external standards and regulatory obligations
- Establishing processes that support effective management of the above processes within agreed parameters
- Developing practices that ensure accountability to a clearly identified stakeholder community, both inside and outside the organization

10.6 ARCHITECTURE MATURITY MODEL

It is very crucial that we adopt a mechanism to evaluate and measure our level of progress in the architecture journey. As they say, we can manage things better if we can measure it. Same applies to Enterprise Architecture. There is a need to understand the level of architecture maturity reached at regular intervals. It is this very need that Architecture Maturity Model fulfills. It provides a set of techniques for evaluating and quantifying an organization's maturity in Enterprise Architecture.

The concept of Maturity Model originated from Carnegie Mellon University's The Software Engineering Institute (SEI). SEI developed the original Capability Maturity Model (commonly called CMM) for Software (SWCMM) in early 1990s. Since then CMM has been adopted as a framework and template by various agencies and organizations for coming up with its own maturity models. Once such organization is the US Department of Commerce (DoC) who applied the CMM techniques to develop an Enterprise Architecture Capability Maturity Model (ACMM). The ACMM provides a framework that represents the key components of a productive enterprise architecture process. The goal is to enhance the overall odds for success of enterprise architecture by identifying weak areas and providing a defined evolutionary path to improving the overall architecture process.

The ACMM comprises three sections:

- The enterprise architecture maturity model
- Enterprise architecture characteristics of operating units' processes at different maturity levels
- The enterprise architecture CMM scorecard

The DoC ACMM consists of six maturity levels and nine architecture elements. The six levels are:

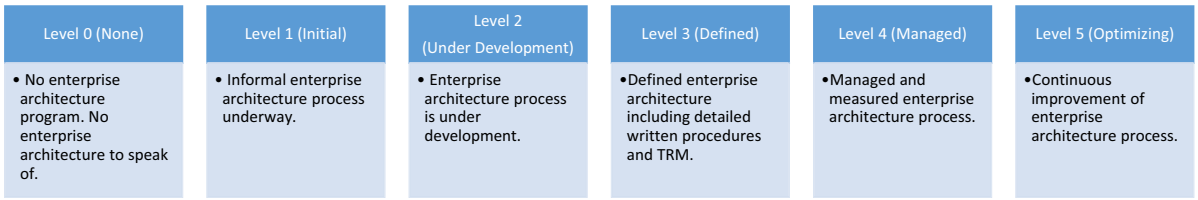

Figure 35: Enterprise Architecture Process Maturity Levels

The nine enterprise architecture elements are:

1. Architecture process
2. Architecture development
3. Business linkage
4. Senior management involvement
5. Operating unit participation
6. Architecture communication
7. IT security
8. Architecture governance
9. IT investment and acquisition strategy

Phase	Initial	Under Development	Defined	Managed	Optimizing
Description	**Informal EA Process Underway**	**EA Process is under Development**	**Defined EA including detailed Written Procedures and Technical Reference Model**	**Managed and Measured EA Process**	**Continuous Improvement of EA**
Architecture Process	Processes are adhoc and localized. Some EA processes are defined. There is no unified architecture process across technologies or business processes. Success depends on individual efforts.	Basic IT architecture process is documented based on OMB Circular A-130 and Department of Commerce IT Architecture Guidance. The architecture process has developed clear roles and responsibilities.	The architecture is well defined and communicated to IT staff and business management with operating unit IT responsibilities. The process is largely followed.	IT architecture process is part of the culture. Quality metrics associated with the architecture process are captured.	Concerted efforts to optimize and continuously improve architecture process.
Architecture Development	EA processes, documentation, and standards are established by a variety of ad hoc means and are localized or informal.	IT vision, principles, business linkages, baseline, and Target Architecture are identified. Architecture standards exist, but not necessarily linked to Target Architecture. Technical Reference Model (TRM) and	Gap analysis and migration plan are completed. Fully developed TRM and Standards Profile. IT goals and methods are identified.	IT architecture documentation is updated on a regular cycle to reflect the updated IT architecture. Business, Data, Applications, and Technology Architectures defined by appropriate de jure and de facto standards.	A standards and waivers process is used to improve architecture development process.

Phase	Initial	Under Development	Defined	Managed	Optimizing
Description	**Informal EA Process Underway**	**EA Process is under Development**	**Defined EA including detailed Written Procedures and Technical Reference Model**	**Managed and Measured EA Process**	**Continuous Improvement of EA**
		Standards Profile framework established.			
Business Linkage	Minimal or implicit linkage to business strategies or business drivers.	Explicit linkage to business strategies.	IT architecture is integrated with capital planning and investment control.	Capital planning and investment control are adjusted based on the feedback received and lessons learned from updated IT architecture. Periodic re-examination of business drivers.	Architecture process metrics are used to optimize and drive business linkages. Business involved in the continuous process improvements of IT architecture.
Senior Management Involvement	Limited management team awareness or involvement in the architecture process.	Management awareness of architecture effort.	Senior management team aware of and supportive of the enterprise-wide architecture process. Management actively supports architectural standards.	Senior management team directly involved in the architecture review process.	Senior management involvement in optimizing process improvements in architecture development and governance.
Operating Unit Participation	Limited Operating Unit acceptance of the EA process	Responsibilities are assigned and work is underway.	Most elements of operating unit show acceptance of or are actively participating	The entire operating unit accepts and actively participates in the IT architecture process.	Feedback on architecture process from all operating unit elements is used to

Phase	Initial	Under Development	Defined	Managed	Optimizing
Description	**Informal EA Process Underway**	**EA Process is under Development**	**Defined EA including detailed Written Procedures and Technical Reference Model**	**Managed and Measured EA Process**	**Continuous Improvement of EA**
			in the IT architecture process.		drive architecture process improvements.
Architecture Communication	The latest version of the operating unit's IT architecture documentation is on the web. Little communication exists about the EA process and possible process improvements.	The DoC and operating unit IT architecture web pages are updated periodically and are used to document architecture deliverables.	Architecture documents updated regularly on DoC IT architecture web page.	Architecture documents are updated regularly, and frequently reviewed for latest architecture developments/standards.	Architecture documents are used by every decision-maker in the organization for every IT-related business decision.
IT Security	IT security considerations are adhoc and localized.	IT security architecture has defined clear roles and responsibilities.	IT security architecture Standards Profile is fully developed and is integrated with IT architecture.	Performance metrics associated with IT security architecture are captured.	Feedback from IT security architecture metrics are used to drive architecture process improvements.
Governance	No explicit governance of architectural standards	Governance of a few architectural standards and some adherence to existing Standards Profile.	Explicit documented governance of majority of IT investments.	Explicit governance of all IT investments. Formal processes for managing variances	Explicit governance of all IT investments. A standards and waivers process is used to

Phase	Initial	Under Development	Defined	Managed	Optimizing
Description	**Informal EA Process Underway**	**EA Process is under Development**	**Defined EA including detailed Written Procedures and Technical Reference Model**	**Managed and Measured EA Process**	**Continuous Improvement of EA**
				feed back into IT architecture.	make governance-process improvements.
IT Investment and Acquisition Strategy	Little or no involvement of strategic planning and acquisition personnel in EA process. Little or no adherence to existing Standards Profile.	Little or no formal governance of IT investment and acquisition strategy. Operating unit demonstrates some adherence to existing Standards Profile.	IT acquisition strategy exists and includes compliance measures to IT enterprise architecture. Cost benefits are considered in identifying projects.	All planned IT acquisitions and purchases are guided and governed by the IT architecture.	No unplanned IT investment or acquisition activity.

Based on the above Architecture Maturity Model, regular maturity evaluations can be conducted to measure the maturity level. The best practice is to carry out the assessments at least once a year. Assessments can be done for the current state and the target (Desired state) so that the gap is clearly visible. The results can be compiled in the form of a scorecard that can then be reported to the concerned stakeholders and teams. An example of Enterprise Architecture CMM scorecard is shown below:

Figure 36: Example of EA Maturity Level Assessment Result

10.7 ARCHITECTURE SKILLS FRAMEWORK

Having the right architecture skills in the team is the most important element in establishing and sustaining the enterprise architecture practice. The word 'architecture' is so misunderstood that its effect spilled over to the roles associated with architecture. It is not at all uncommon to find people confusing Enterprise Architecture with Solution Architecture, IT Architecture, Project Architecture, and so on. Take a look at a job description of an Enterprise Architecture job opening and you will not be surprised to see that the job description has very little to do with enterprise architecture. Hence it is very critical that 'architecture' as a concept and the distinctions between various architecture roles and skills are well understood. In order to set up Enterprise Architecture practice rightly, it is important to have the right Architecture Skills Framework to be able to onboard staff with right skills, experience, and roles. TOGAF's Architecture Skills Framework (ASF) provides a set of role, skill, and experience norms for staff undertaking enterprise architecture work.

Architecture Skills Framework helps in defining:

- The roles within a work area
- The skills required by each role
- The depth of knowledge required to fulfill the role successfully.

There are three aspects of TOGAF's Architecture Skills Framework:

- Roles (also called TOGAF Roles)
- Categories of Skills
- Proficiency Levels.

The key **TOGAF roles** are:

- Architecture Board Members
- Architecture Sponsors
- Architecture Manager or Chief Enterprise Architect
- Architects for:
    - Overall Enterprise Architecture
    - Business Architecture
    - Data Architecture
    - Application Architecture
    - Technology Architecture
- Program/Project Managers
- IT Architects and/or Designer

The Categories of Architecture Skills are:

Roles	Skills
Generic Skills	• Leadership • Teamwork • Inter-personal • Oral Communications • Written Communications • Logical Analysis • Stakeholder Management • Risk Management
Business Skills & Methods	• Business Case • Business Scenario • Organization • Business Process • Strategic Planning • Budget Management • Visioning • Business Metrics • Business Culture • Legacy Investments • Business Functions
Enterprise Architecture Skills	• Business Modeling • Business Process Design • Role Design • Organization Design • Data Design • Application Design • Systems Integration • IT Industry Standards • Services Design • Architecture Principles Design • Architecture Views & Viewpoints Design • Building Block Design • Solutions Modeling • Benefit Analysis • Business Interworking • Systems Behavior • Project Management

Program or Project Management Skills	• Program Management • Project Management • Managing Business Change • Change Management • Value Management
IT General Knowledge Skills	• IT Application Development Methodologies & Tools • Programming Languages • Brokering Applications • Information Consumer Applications • Information Provider Applications • Storage Management • Networks • Web-based Services • IT Infrastructure • Asset Management • Service Level Agreements • Systems • Commercial off-the-Shelf (COTS) Applications • Enterprise Continuums • Migration Planning • Management Utilities • Infrastructure
Technical IT Skills	• Software Engineering • Security • Systems & Network Management • Transaction Processing • Location & Directory • User Interface • International Operations • Data Interchange • Data Management • Graphics & Image • Operating System Services • Network Services • Communications Infrastructure
Legal Environment	• Contract Law • Data Protection Law • Procurement Law • Fraud • Commercial Law

Proficiency Levels

Level	Achievement	Description
1	Background	Not a required skill, though should be able to define and manage skill if required
2	Awareness	Understands the background, issues, and implications sufficiently to be able to understand how to proceed further and advise client accordingly
3	Knowledge	Detailed knowledge of subject area and capable of providing professional advise and guidance. Ability to integrate capability into architecture design.
4	Expert	Extensive and substantial practical experience and applied knowledge on the subject.

Of all the roles mentioned above, the role of an Enterprise Architect is undoubtedly most important and challenging. The role of an Enterprise Architect is more of a city planner than that of a building architect. The Enterprise Architect does not necessarily create the technical vision of an enterprise; rather he or she works with a large number of stakeholders in the organization to gather and articulate the technical vision, and helps in producing the strategic plan to realize it. An Enterprise Architect is someone who has the ability to bring the various domains of architecture together – Strategic Architecture, Business Architecture, Application Architecture, Data Architecture, and Technology Architecture. The Enterprise Architect need not get into the details of everything. He should keep things at a level of abstraction necessary to work on issues effectively as well as communicate the same to all stakeholders. He or she should focus on understanding the client requirements, develop well-formulated models of the components of the solution, validate and refine the model as necessary, and manage the architecture in the long run.

In a nutshell, "An Enterprise Architect has a responsibility for ensuring the completeness (fitness-for-purpose) of the architecture, in terms of adequately addressing all the pertinent concerns of its stakeholders; and the integrity of the architecture, in terms of connecting all the various views to each other, satisfactorily reconciling the conflicting concerns of different stakeholders, and showing the trade-offs made in so doing."

Therefore it is recommended that Enterprise Architects should be on-boarded to the team working in large transformation projects and programs so that they can bring "enterprise-as-a-whole" perspective in the solutions being envisioned. They should be entrusted with the often difficult tasks of "connecting the dots" and provide "enterprise context" to things. Provided with right information, support and authority, Enterprise Architects can bring out the business value of the organizational initiatives.

11 ENTERPRISE ARCHITECTURE SUCCESS STORIES

Enterprise Architecture discipline has convincingly proven its worth and business value over the past few years by solving specific business problems and enabling transformation across enterprises. It has been widely adopted across all organization types – government, private organizations, educational institutions, industry sectors, etc. The following are some of the success stories spread across organization types, countries, and industry types.

- The United States' Federal Enterprise Architecture Program Management Office (FEAPMO) highlights the various agencies that have successfully applied Enterprise Architecture to solve specific business problems. For instance, Department of Defense (DoD)'s High Performance Computing Modernization Program (HPCMP) used Enterprise Architecture to provide the user community with protocol-rich, high-availability, high-capacity, low-latency, secure connectivity. Food and Drug Administration (FDA) used Enterprise Architecture to standardize business processes and achieve considerable cost savings for their IT Consolidation initiative. The U.S. Customs and Boarder Protection (CBP) uses EA to improve system support at lower cost to more than 20 agencies with missions tied to Internal Trade and Transportation. Several banking oversight agencies used Enterprise Architecture to implement a streamlined data collection process that reduced costs, increased productivity, and improved oversight of financial institutions.
- Country-level Enterprise Architecture: Several countries have used Enterprise Architecture for achieving country-wide transformation and improving citizen-centric services. The government of Singapore established Singapore Government Enterprise Architecture (SGEA) programme to support and enable the business strategies, objectives, and a vision of a 'Networked Government'. It adopted a federated architecture approach similar to the United States government. The programme facilitated the identification of opportunities for collaboration among agencies, encouraging greater sharing of data, systems and processes across agencies. Similar model has been adopted by other countries such as Australia, Bahrain, Denmark, Saudi Arabia, Oman, etc. The Australian Government Architecture (AGA) adopted Enterprise Architecture to assist in the delivery of more consistent and cohesive service to citizens and support the more cost-effective delivery of ICT services by government. The Kingdom of Bahrain has adopted TOGAF to define its own Enterprise Architecture framework. Called National Enterprise Architecture Framework (NEAF), it provides Enterprise Architecture guidelines and best practices for Bahrain government entities across multiple areas, including citizen-centric eservices, mobile applications, websites and technologies.

- There are host of other organizations (public and private) spread across industry sectors and geographies that have adopted Enterprise Architecture to address their business problems. Dairy Farm Group in Hong Kong used TOGAF as the basis of an enterprise-wide IT architecture to integrate many disparate business units. Westpac – a major Australian bank – used Enterprise Architecture to manage the technology components of a major outsourcing relationship.
- The following link provides some popular case studies of organizations that have applied TOGAF and Enterprise Architecture principles for a variety of situations. http://www.opengroup.org/public/arch/p4/cases/case_intro.htm
- There are several agencies/forum that award organizations for excellence in Enterprise Architecture. iCMG has constituted Enterprise & IT Architecture Awards "*to honor architects & enterprises whose work demonstrates a combination of talent, vision & workmanship, which are creating successful and enduring systems & enterprises.*" Similarly Forrester and InfoWorld has its own categories of Architecture awards.

12 FURTHER EDUCATION ON ENTERPRISE ARCHITECTURE

I hope this eBook has intrigued your interest in Enterprise Architecture. If you want to learn more about this subject, here are few recommended options:

1. **Self-Learning**: The obvious first option is to go through self-learning mode. There are plenty of materials available on the web. Most organizations that have adopted Enterprise Architecture have published their frameworks. For example, The US government websites are good sources of Enterprise Architecture materials. Additionally sites such as Wikipedia are useful resources too.
2. **Online Courses**: There are varieties of Enterprise Architecture courses available on the internet. The courses are available at various levels of difficulty and catered to diverse target audience. Some of the good online courses to get started are:
    a. Introduction to Enterprise Architecture by Open2Study
    b. Introductory videos on YouTube
3. **Certifications**: Certifications is usually recommended if you are keen on becoming an Enterprise Architecture practitioner (or Enterprise Architect). Almost all the major organizations that have their own EA framework have their own certifications. Some of the most popular ones:
    a. **TOGAF 9.0 Certification** from The Open Group. Certification is available at Level 1 and 2, and recommended for beginners. More experienced practitioners can go for the advanced T**he Open Group Certified Architect** (Open CA) programs (available at 3 levels). By far, TOGAF 9 certification is the most popular certification in the industry.
    b. **Zachman Certified Enterprise Architect (Level 1, 2 and 3)**
    c. **Pragmatic Enterprise Architecture Framework (PEAF)** certification
    d. **Certified Enterprise Architect and Associate Certified Enterprise Architect** provided by the FEAC Institute.
4. **Graduate Degree**: If you're interested to obtain a formal graduate degree in Enterprise Architecture from a good university, there is one available from Pennsylvania State University (Penn State) in USA. There are two courses available:
    a. **Graduate Certificate in Enterprise Architecture** (9 credits course)
    b. **Master of Professional Studies in Enterprise Architecture** (33 credits course)

13 CONCLUSION

In today's uncertain economic conditions and dynamic market changes, organizations can survive in this chaos if they are able to manage complexity better and stay focused on long-term value. One of the capabilities that can enable them to be ready for tomorrow is through the Enterprise Architecture capability. If used effectively with right senior management support and sponsorship, Enterprise Architecture can help in managing change better through smart design & mapping of the organization, aligning the operations with business strategy and goals, and putting a clear focus on long-term business value derived from Enterprise Architecture. Any Enterprise Architecture program is a long-term program; organizations need to have the right appetite, patience, and maturity to sustain the EA program. Eventually the EA program can bear significant positive returns on business value such as decreased operating costs, improved speed-to-market, reduction of complexity and risk, and greater overall technology effectiveness. In summary, Enterprise Architecture is a continuous discipline to design enterprises & business better into a cohesive unit so that business values are delivered better and faster. Enterprise Architecture will help you build a better enterprise, and more cohesive enterprise.

14 APPENDIX A – ENTERPRISE ARCHITECTURE FRAMEWORKS

Type of Framework	Framework Name
Consortia-developed Frameworks	ARCON – A Reference Architecture for Collaborative Networks
	Generalised Enterprise Reference Architecture and Methodology (GERAM)
	RM-ODP – the Reference Model of Open Distributed Processing
	IDEAS Group – a four-nation effort to develop a common ontology for architecture interoperability
	ISO 19439 Framework for enterprise modelling
	TOGAF – The Open Group Architecture Framework
Defense Industry Frameworks	AGATE – the France DGA Architecture Framework
	DNDAF – the DND/CF Architecture Framework (CAN)
	DoDAF – the US Department of Defense Architecture Framework
	MODAF – the UK Ministry of Defence Architecture Framework
	NAF – the NATO Architecture Framework
Government Frameworks	European Space Agency Architectural Framework (ESAAF)
	Government Enterprise Architecture (GEA)
	FDIC Enterprise Architecture Framework
	Federal Enterprise Architecture Framework (FEAF)
	Nederlandse Overheid Referentie Architectuur (NORA)
	NIST Enterprise Architecture Model
	Treasury Enterprise Architecture Framework (TEAF)

Open-source Frameworks	MEGAF – an infrastructure for realizing architecture frameworks that conform to the definition of architecture framework provided in ISO/IEC/IEEE 42010
	Praxeme – an open enterprise methodology, contains an enterprise architecture framework called the Enterprise System Topology (EST)
	TRAK – a general systems-oriented framework based on MODAF 1.2 and released under GPL/GFDL
	SABSA – an open framework and methodology for Enterprise Security Architecture and Service Management
Proprietary Frameworks	ASSIMPLER Framework
	Avancier Methods (AM)
	BRM (Build-Run-Manage) Framework
	Capgemini Integrated Architecture Framework (IAF)
	Dragon1 – An open Visual Enterprise Architecture Method recently recognized by The Open Group as Architecture Framework
	DYA framework developed by Sogeti since 2004
	Dynamic Enterprise Architecture
	Extended Enterprise Architecture Framework
	EACOE Framework
	IBM Information FrameWork (IFW)
	OBASHI – the OBASHI Business & IT methodology and framework Pragmatic Enterprise Architecture Framework (PEAF)
	Purdue Enterprise Reference Architecture
	SAP Enterprise Architecture Framework
	Service-oriented modeling framework (SOMF)
	Solution Architecting Mechanism (SAM)
	Zachman Framework

15 REFERENCES

1. The Open Group – The Open Group Architecture Framework (TOGAF)
2. Pragmatic EA Ltd. – Pragmatic Enterprise Architecture Framework (PEAF_
3. Federal Enterprise Architecture Framework v2.0 (FEAF)
4. Zachman International Enterprise Architecture – The Zachman Framework
5. ARIS Community by Software AG (2009). 10 Definitions of Enterprise Architecture. Which Corresponds to Yours?
6. Grigoriu, Adrian. (2011). ebiz – Enterprise Architecture Matters – Enterprise Architecture is the science of anatomy and physiology of an Enterprise.
7. Sessions, Roger. (2006). Msdn.microsoft.com – A Better Path to Enterprise Architectures
8. Walker, Mike. (2007). Msdn.microsoft.com – A Day in the life of an Enterprise Architect
9. www.wikipedia.org – Enterprise Architecture
10. www.wikipedia.org – Enterprise Architecture Framework
11. www.wikipedia.org – Singapore Government Enterprise Architecture
12. National Human Genome Research Institute – All About the Human Genome Project (HGP)
13. United States Department of Commerce. (2007). Enterprise Architecture Capability Maturity Model (ACMM) Version 1.2
14. www.whitehouse.gov. Office of Management and Budget – EA Success
15. Australian Government – Department of Finance. Australian Government Architecture (AGA).
16. Kingdom of Bahrain – eGovernment. National Enterprise Architecture.
17. The Open Group – Case Studies.
18. The Open Group – Case Studies. Westpac (Australia)
19. InfoWorld. The 2014 Enterprise Architecture Awards
20. InfoWorld. The 2015 Enterprise Architecture Awards
21. iCMG. Global Enterprise & IT Architecture Excellence Awards 2015
22. Kraft, Debra. Chron. Federal Enterprise Architect Certification
23. Penn State University
24. www.zachman.com – FEAF Certification and Training
25. PricewaterhouseCoopers (PwC). (2009). Building Value through Enterprise Architecture – A Global Study.
26. http://www.iso-architecture.org/42010/defining-architecture.html