

A FRAMEWORK FOR DEVELOPING AND IMPLEMENTING THE ENTERPRISE TECHNICAL ARCHITECTURE

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Abstract

Organizations build, buy and reuse different types of technology with the intention to addressing their organizational needs, challenges and for competitive advantage. Unfortunately, the means is not the end. Instead, it some add to complications and complexities, and more consume more resources. Some organizations have adopted the technical architecture approach to address the challenges of posed by technology deployment.

The technical architecture is intended to address aspects, from strategic planning to implementation of technology infrastructures. This is to consistently effect significant technological change within the environment. The technical architecture approach facilitates and enables prioritization of analysis, development and implementation, which are based on value add business requirements and vision. It therefore allows the organization to proceed at its own pace while progressing at the same time.

The paper present Model which reflects the consistent approach that adaptive enterprises could employ to build, maintain, and apply technical architecture in the computing environment. The model emphasizes a holistic approach to technical architecture deployment in the organization.

Keywords: *Technical Architecture, Operating model, Development, Implementation*

INTRODUCTION

In the last two decades, effort to improve on information technology (IT) strategies and operations has increased. This includes bridging the gap between IT and the business, pragmatics assessment and accessibility of technologies in to addressing needs, semiotics of technology deployment, and how the technology strategy impact the vision of the organization. Some studies including Kilpeläinen (2007) argue that the role of technical solutions is to support business objectives and operations. However, there has been improvement in some areas such as systems development, project management and technology deployment (Zachman, 1996). Despite these improvements and efforts, organizations still find it difficult to realize and comprehend returns on their IT investments. This means that it is unfortunately, that none of these efforts seem to have completely resolved the challenges to meet the organization's needs, timely, and ensures the value is achieved from investments on IT infrastructures. These challenges could be attributed to complexities of deployment, duplications of technologies and how they intend to enable business needs (Armour et al, 2007). As a result, many organizations have sought solutions through the deployment of technical architecture. What is even more important in achieving the technical architecture objectives is the semiotics, the understanding between human and technical actors in the deployment of technologies. This includes the process, how the requirements are derived, the architecture development and implementation. According to Ross et al (2006), "*operating model is the necessary level of business process integration and standardization for delivery goods and*

services". Otherwise, the challenges could possibly be increased and prohibitive. Many organizations have developed technical architecture, but were never implemented [5].

Technical architecture is a prevailing paradigm, which questions the goals, scope, processes and roles that are considered on technological deployment and introduction of new technology infrastructure potentialities. In Patel's [6] argument, there are many challenges which need to be addressed by IT functions; this includes planning, rapid business and environmental change. In an attempt to answer the questions (how could IT infrastructure be used to achieve business needs, as well as gain return on investment?) which the technical architecture poses, the Business and IT units of the organization engages in an intensive *learning* experience. The former develops a thorough understanding of a model which reflects on current practices and to acquire an understanding of the potential of technical architecture to transform how and what work is done. Thus, standard and principles are employed. Iyamu (2009) defines principles as guiding statements of positions that communicate fundamental elements, truths, rules, or qualities that must be exhibited by the organization during implementation.

The technical architecture is intended to provide the means to maintain an adaptive infrastructure through sets of principles, standards, configurations, process and governance. Patel (2002) further posit that IT governance is affected by an organization's unique culture and working practice, and should reflect its own goals and ambitions. The architecture also drives the introduction of new technology by focusing on function and scalability, compatibility and interoperability.

The paper introduces and puts into context the model of operandi of the technical architecture as could be deployed within an organization as architecture framework. The experience on which this work is based comes from the author's work as an architect, and from working closely with other architects who have designed systems for large corporate and government departments. This will give clarity and an understanding of some of the words, elements and components that are involved. A four phase approach is adopted. Like many other frameworks, it is not a definitive guide to technical architecture modeling. It could be customized within environmental and technological context and over time.

The model begins by presenting overview of the technical architecture deployment including a diagrammatical (Figure 1).

The rest of the paper is structured into four sections - in accordance to the phases of technical architecture deployed. The first section highlights the primary objectives of the architecture. The second section covers the business strategy. The third and fourth sections discuss how technical architecture is developed the implementation, respectively. Finally conclude with the highlights of the contribution of the paper.

OVERVIEW: TECHNICAL ARCHITECTURE DEPLOYMENT

This paper presents a methodological approach (model) for the deployment of technical architecture. As depicted in Figure 1 below. The deployment is a four-phase approach. The model starts by identifying the business-driven requirements for the technical architecture. Based on the business vision and requirements, technical architecture focuses on deriving high-level requirements to give direction and priority to its domains (Burke, 2007; Cook, 1996). While there is a suggested dependency among the requirements, not all requirements are necessarily identified in earlier paths through the model. For instance, while focusing on technical architecture, an architecture team could concentrate on deriving technical architecture requirements directly from environmental or technology trend relating to business strategy. Others could find the need to develop a more robust and intuitive set of technical architecture requirements after first deriving business requirements. It is important to remember and understand that requirements directs the

architecture in what they are to provide in support of the business, not how they will provide it (Gibson, xxx; Spewak, 1992).

Figure 1 above illustrates the four logical phases (Objectives, Business Strategy, Development and Implementation) involved in the deployment of technical architecture. In the context of this paper, technical architecture is defined as a logically consistent set of principles, standards and models that are derived from business strategy (business vision, requirements and contextualization) in order to guide the engineering of the organization's information systems and technology infrastructure across the various domain architectures (1999).

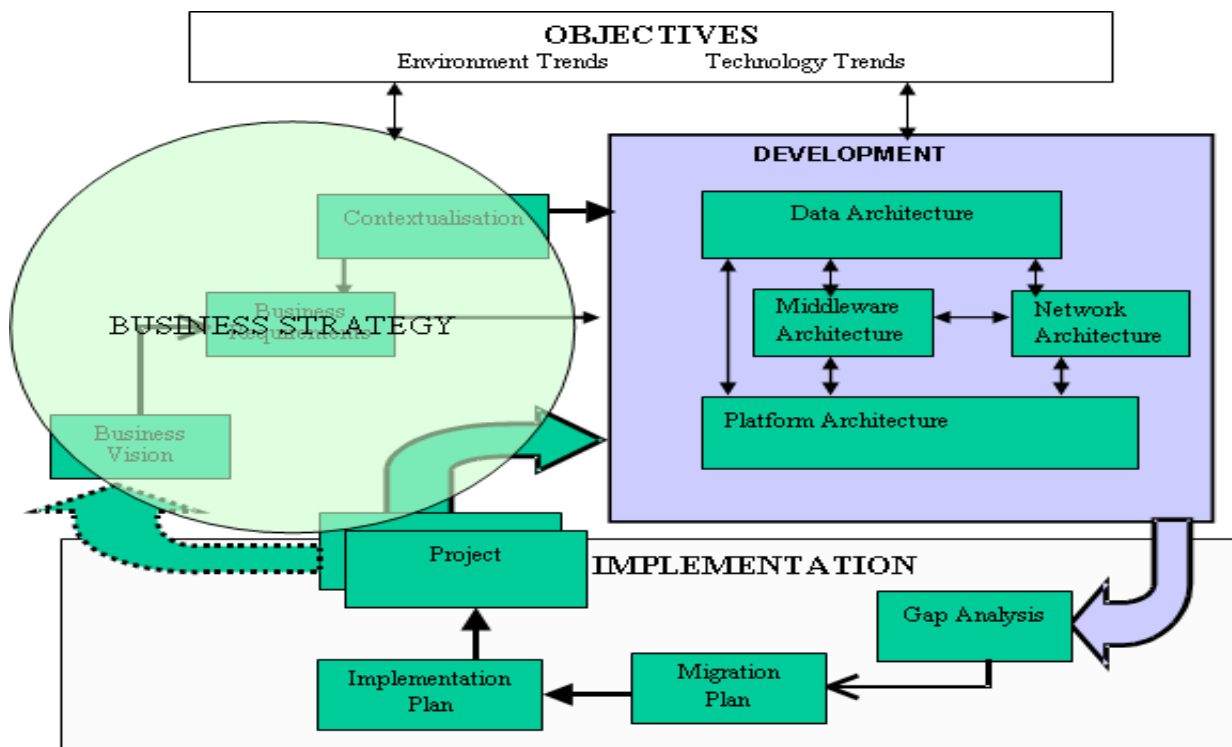


FIGURE 1: TECHNICAL ARCHITECTURE DEPLOYMENT

PHASE ONE: OBJECTIVES

The main objective of the technical architecture model is twofold. They include, providing a baseline of the current state of an organization's technology environment. One of the biggest challenges in managing change is gaining an accurate view of the current state; and to facilitate assessment of the impact of technology change on the current organizational environment and the conception of strategic alternatives for consideration. This led to the main aim of the paper, which provide guide for enterprise architect, particularly technical architects.

Conceptually, the primary objectives of the technical architecture:

- i. To effectively remove hardware obsolescence or vendor dependency as a requirement; and re-engineering of technology artefacts.
- ii. To enable information systems; and to periodically review the systems in support of the organisation' needs.
- iii. To ensure that the rapidly changing external and environmental trends are enforced to significantly change the business and technical environments within organisations.

The technical architecture requires ongoing evaluation and iterative processes to protect the major investment in information technology and systems by keeping them current with the changing environment. The section that follows explains the development of technical architecture, begins with requirements.

PHASE TWO: REQUIREMENTS

The business units or divisions often have different requirements, often far apart. As a result poses challenge in attempt to map the requirements for the organisation's common goal. Also, some of the stakeholders are actors in many units or divisions, thereby, causing conflict of interests. On another hand, technical actors also pose challenge of shared services and infrastructure.

As depicted in Figure 1, the second phase, business strategy is the primary driver for the development and implementation of the technical architecture. It consists of business vision, business requirements and contextualization. This phase is primarily influenced by factors which include organisational processes and activities, and environmental trends (Youngs, et al, 1999). The trends relate to the business of the organization as well as relevant technologies that enables them.

The outcome of phase 1 (Visioning and Business strategy) as described above is articulated and translated to address business and technological challenges in the organization. At this phase, the business strategy layer, the technical architecture is developed to the engineering of information systems and technology infrastructure in the organization. This is to enable and support processes, business logic and activities.

The components of the business strategy phase are discussed as follows:

Business Vision

As illustrated in Figure 1, this business vision is the first component of the second phase in the deployment and implementation of the technical architecture. The primarily purpose is to provide a clear vision of "business futures" by capturing the most important enterprise business strategies being pursued at the time (Watson, 2002). It focuses mainly on strategic thinking about the future.

For the purpose of business visioning, the project team gathers strategic planning documentation from the business and extract the relevant business drivers as well as high level information and application needs. Environmental trends are considered in the process and a business vision document is prepared and verified with senior management and other stakeholders.

Business Strategy

The business requirements are high-level requirements derived from business vision and expressed as functional statements, which give direction and priority to, among other activities, technical architecture.

Generically, they include:

- Enable the organization to implement its strategies over time with minimal impact to ongoing service delivery and processes.
- Enable business scalability - be able to respond and operate at the same rates in which business process and activities occur.
- Enable the organization to compete in the economy according to technology and environmental trends.
- Deliver flexibly packaged and priced services through multiple channels at multiple geographic locations.
- Enable governance in the computing environment.

Contextualization

At this stage of the deployment, articulation of the organization's system into technical architecture context is performed. The context consists of the business vision and requirements of the organization, as captured at the time. The requirements are extracted into set of needs which are then used to develop the subsequent architectural products, a set of blueprints and views of the organization. Each view is expressed in terms of components, connections and constraints, which are governed by architectural model. A key feature of the approach is the conceptual mechanism that provides traceability between views.

Once the gathering of information, requirements from the business strategy is completed, the architects begin the development of the technical architecture.

PHASE THREE: DEVELOPMENT

The development of technical architecture is in four stages, they include requirements; classification of domains; documentation; and governance principles. Technical architecture is developed for purpose, which is relative to organizational strategy. The development of the technical architecture includes four main sequential steps:

- Technical requirements.
- Definition of the domains
- Documentation of technologies into current-to-strategic forms
- Formulation of governance principles

Technical Architecture Requirement

Technical architecture requirements are derived from the architectural requirements contained in the business strategy phase as they relate to the technical architecture. The requirements for technical architecture are derived from the overall business strategy as identified in the business vision, requirements and contextualized. They describe the basic functions required of the technical architecture in enabling the business drivers specified by the organization in the business strategy.

The development phase describes the components of technical architecture and their relationships. It also gives a view of the sequence involved in developing technical architecture. The above introductory paragraphs demonstrate how technical architecture could be developed and implemented, based on the empirical evidence that comes from experience. This section focuses on development.

The technical architecture is defined as a logically consistent set of principles, standards and models that:

- Are derived from business requirements;
- Guide the engineering of the organisation's information systems and technology infrastructure across the various domain architectures;
- Are understood and supported by senior management and lines of business of the organisation;
- Take into account the "full context" in which the domains of technical architecture will be applied; and
- Enable rapid change in the organisation's business processes and the applications that enable them.

In the development, implementation and practice of technical architecture, definition is key, it is importantly emphasized, so to understand the different entities, components, scope and boundaries of the domains of the architecture. The definition guides the integrations, collaborations and the changes the technical architecture engineer through its development. The next subsection addresses the domain architecture including its definitions.

Technical Architecture Domains

Each domain of technical architecture consists of both technical and non-technical (such as process and people) factors. Technical architecture enables change by bridging the gap between strategic planning and implementation efforts through a strategy process that is holistic in scope. Technical architecture comprised of different types of domains, Data, Middleware, Network, Platform and Distributed architectures. Each domain has unique and specific deliverables, analysis methods, processes and participants. Table I below provides definition (domain, description and category) of the domains. The domain architectures are created to provide principles and standards for using technologies as they are related, and to enable specific business objectives.

As expressed in the abstract and introduction sections, the technical architecture provides the means to maintain an adaptive infrastructure through sets of principles, standards, configurations, process and governance. It also drives the introduction of new technology by focusing on function and scalability, compatibility and interoperability to fulfill business and technical needs. Individual templates (Tables I, II, III, and IV) are used to achieve the objectives of the technical architecture within the context of the organization needs. The templates could be manual or automated; they are used for information capturing, validation and processing of the architecture activities and deliverables.

Domain-level technical architectures contain the prescriptive elements of the technical architecture that guide the IT engineering activities within the organization. This includes the analysis, design, and implementation and operations management. They provide the organization with a means to categorize related technologies for the purpose of identifying reusable technology and they consist of sets of principles and standards (industry, product, and configuration) that govern the selection and use of related technologies in specifically defined logical domains. The development phase, domains of technical architecture (Data, Middleware, Network, Platform and Distributed) are inter-dependent as they each evolve iteratively. They are defined as in Table I.

Actors' enrolment in the different domains is based on skill and area of specialization. However, personal interest is a strong influencing factor as well. There are three main steps involved in creating the technical domain architectures are:

- Create a domain architecture that represents the logical technical domains and their relationships to each other, referring to existing frameworks and modifying accordingly, rather than creating from scratch.
- Define domain-level principles, categorise technologies into appropriate domains, then document technology, product and configuration standards as appropriate groups complete technology research, product evaluations, and configuration designs.
- Relate standards to appropriate and supported infrastructure patterns within the organisation.

Each of the technical architecture domains provides a unique capability view of the computing environment. The Data and Network domains provide the tools, models, techniques, and participants to manage the impact of change on business processes and partners. Middleware and Distributed domains enable the management of change on business system logics and applications; and the Platform domain enables the management of change on technology infrastructure.

The domain architectures represented in Table I above have been identified as the most appropriate groupings of technologies that are required to enable and support the business drivers. These domain architectures evolve in an iterative manner as both technical and business requirements dictate. Primarily, the role of each of the domain architectures is intended to organize technologies and their usage rules to assist architects in identifying common uses of technologies, and to eliminate as much redundancy as possible.

TABLE I: TECHNICAL ARCHITECTURE DOMAINS

Technology Domains	Description	Technology Categories	Process/ Procedural
Data Architecture	Defines the mechanics for managing, securing and maintaining the integrity of the organization's significant logical entities. These entities are recorded and accounted for in the business information environment. The architecture provides standards for accessing data, as well as business objects if appropriate.	Data and Object Repositories and Encyclopedia, Data Modeling, Replication and Administration Tools, Object-Oriented Databases.	
Middleware Architecture	Defines the components that create an integration environment between user workstations and legacy and server environments to improve the overall usability of the distributed infrastructure. It creates uniform mechanisms for application integration independent of network and platform technologies.	Remote Procedure Calls (RPC), Messaging-Oriented Middleware (MOM), Object Request Brokers (ORBs), Transaction Processing (TP) Database (DB) Gateways.	
Network Architecture	Provides the communication infrastructure for the distributed computing environment. It consists of logical elements, physical hardware components, carrier services, and protocols.	Network Hardware, Network Operating Systems, Security, Carrier and Internet Services.	
Platform Architecture	Defines the components of technology infrastructure, including the client and server hardware platforms; the operating systems executing on those platforms; and the database environments and interfaces supported.	Hardware (Workstations, Servers), Operating Systems, Database Management systems.	
Distributed Architecture	Defines how the hardware and software components of the environment will be managed. It focuses on issues of configuration management, fault detection and isolation, testing, performance measurement, problem reporting, and software upgrades and controls.	Network Systems, Configuration, Storage Management and, Security, Performance Management, Capacity Planning.	

Classification

All technologies are grouped into domains (Table I), which defines their strategic or non-strategic terms. A consensus among the key stakeholders is reached on the following: employees' involvement; authenticity of technologies; where the technologies resides; in what forms and their

use. Technical requirements are then defined in a technical architecture product catalogue, which contains information about the products. The rules pertaining to the individual technologies are reflected in a Table II below, per domain architecture. Table II is an example of a populated template of the technical architecture.

Table II: The columns may be defined as follows:

- A. **Technology category** refers to each of the broad logical groupings of technologies within the domain *e.g. data warehouse*.
- B. **Technology** refers to the actual technology involved *e.g. ETL (extract, transform, load) tools*.
- C. **Standards** are the (local and international) standards with which the products complies *e.g. "ODBC"*.
- D. **Products** are the named vendor products (hardware, software, etc.) *e.g. Oracle Warehouse Builder*.
- E. **Current / Future** indicates whether the product is currently in use or planned for use in the future.
- F. **Architectural Status** is the formal status given to each product as agreed by the Architects and directly impacted stakeholder, and it is indicated as follows:
 - S - Strategic** (*all new development will utilise this product according to the configuration standards, and existing solutions are to migrate to or be replaced by this product where feasible*);
 - M - Maintain** (*do not proliferate, maintain for as long as the product is required - there should be a replacement strategy in the 3 to 5 year timeframe*);
 - O - Outdated** (*must be upgraded or replaced*) or **Obsolete** (*must be removed*);
 - N - Not supported** or **Not approved** (*any products evaluated and rejected*);
 - T - Tactical** (*interim, short-term solution for up to 3 years, to be replaced by a strategic choice*);
 - E - Evaluating** (*being researched, in proof of concept phase and or being piloted - if successful, will be given tactical or strategic status - if not successful, will be given "not approved" status with supporting documentation*).

Configuration standards are used to describe how the product will be used in the organisation. Software configuration standards include the release or version number to be used, installation options and configuration settings, upgrade paths and maintenance procedures. Hardware configurations should include the model name and number, configuration settings, installation procedures and any related peripheral standards. References to diagrams used to position the product, procedures, and or guidelines may be used where necessary. The positions are indicated as follows: **S**ingle user, **G**roup users, **D**epartmental, **F**ew Department and **E**ntire Organisation.

The domains of the technical architecture are standardised to ensure uniformity, assessment, evaluation and reduce complexity.

TABLE II: TECHNICAL ARCHITECTURAL GROUPING

Technology Category (A)	Technology (B)	Standards (C)	Products (D)	Current / Future (E)	Architectural Status (F)	Configuration (G)
A1	B1	C1	D1	C	S	O
		C2	D2	F	E	S
	B2	C3	D3	F	S	D
		C4	D4	C	M	G
		C5	D5	C	N	F

The key for the content of Table II above are as follows:

- **A** – Consists of one or more **Bs**;
- **B** – Each **B** could have more than one **C**; and **D**, depend on the organization;
- **E** – Its either a **C** or an **F**;
- If **E** is equal to **C**, then **F** is equal to **S/N/E** and
- If **E** is equal to **F**, then **F** is equal to **S/M/O/N/T**

The last stage of the technical architecture development is the formulation of the principles. This is covered in the following section.

Domain Principles

Principles, as defined by [6], are guiding statements of position that communicate fundamental elements, truths, rules, or qualities that must be exhibited by the organization. Principles are formulated from the business strategy as they pertain to the technical architecture and are further broken down into rationale, process and guidelines. This applies to all the domains of technical architecture.

The primary purpose of principles is to enable the organization to take an incremental and iterative approach to transitioning to formal modeling, while allowing it to influence decision making immediately and consistently. In the technical architecture context, principles are used as evaluation criteria in the absence of detailed models that direct decision making more discretely and comprehensively. For example, one type of architecture model is a technology domain configuration standard that details technology products and the way they are configured together to deliver a reusable building block of technical infrastructure (e.g., an application server). In the absence of a defined configuration standard, an application development team's technical design for an application should be evaluated for its consistency with the principles dealing with applications, information, and technical infrastructure.

TABLE III: PRINCIPLE FORMULATION

Principle	Rationale	Process	Guideline

The principles lead to policies and procedures and are used to give guidance to the designers, developers and implementers of the technical architecture (Data, Middleware, Network, Platform

and Distributed). The rationale for the principle is documented along with any process or procedure and guideline, which could be used when applying the principle.

The principles impact the selection, design, and implementation of software packages, application components, infrastructure deployment and business objects.

PHASE FOUR: IMPLEMENTATION

The implementation phase consists of four stages: Gap analysis; Migration planning; Implementation planning; and Project – each of these stages is briefly described below. The technical architecture is expected to enable rapid technology-related change in the organization's business processes and the applications that enable them. The technical architecture is dependent on:

- The business vision of the organisation, which captures the most important business strategies being pursued at the time;
- The organisational Requirements which consists of high-level architectural requirements, derived from business strategies, to give direction and priority; and
- The architecture which contains sets of principles, derived mainly from best practices and trends that are relative to, and consistent across each domain architectures area within the business strategy of the organisation.

Gap Analysis

The final phase of the deployment consists of conducting gap analyses across the domain architecture areas to determine corrective action, develop prioritized migration plans and finally draw up implementation plans. Carrying out the projects in the implementation plans transition the organization from the current state to future state as defined during the project.

The purpose of the gap analysis is to assess the current state of the technical architecture against the desired state as reflected by the drivers, which is covered during phase two (Business Strategy). This assessment is an iterative and ongoing process and is reflected by a checklist (objectives and business strategy) and an accompanying action plan. These assessments are stored in the technical architecture repository and made accessible to the architects and other stakeholders.

TABLE IV: IMPLEMENTATION

Requirement (Future State)	Action	Deliverable	Responsibility	Status	Target Date
Principles					
The entity that defines the rationale and motivation for the task. This entity provides guidance for the scope.	Defines the individual tasks including the deliverables.	Tasks to be carried out.	Who carries out the tasks – architect, business units, etc.	Have options: (1) Not started (2) In Progress (3) Completed	Date agreed to by the primary stakeholders including the architect.

Migration Planning

Positioning strategy and movement from one architectural phase to another is a very complex issue. It is much more complex than simply bringing in a new vendor or new technology.

The current trends in technology architectural direction are toward higher levels of connectivity and functionality. True, the current movement in the industry is toward more "open"

strategies, but if this ever occurs in reality, the building block approach to implementation will be a viable strategy.

Certainly, one of the key decision processes involved with architectural planning is the need to have a future target. Shorter-term goals can then be defined as stepping-stones to the strategic goal. Of course the problem here, again, is that historically, information technologists have not been all that accurate in predicting product directions and timing. For example, who had in the 80s predicted the impact that PCs have on the industry, today? Or who would have predicted the explosion of the Internet?

Implementation Planning

Once the current inventory is defined, the first step in planning is to assess the strategic and technical fit of the current technologies. Strategic fit is assessed based on the technology's contribution to business value, as defined by the business strategy. Technical fit is assessed based on the technology's adherence to the technical architecture design principles and technology standards. This assessment enables the applications to be placed in one of four categories as shown in Table IV.

Project

The development and implementation project passes through this cycle multiple times. There are continuous interactions between the project implementers and the architecture.

Each technical architect project is required to model the technology environment, including infrastructure configuration standards and guidelines for using standard products and configurations. The models provide both views of the recommended technology and the bases for assessing the impact of new and replacement of technologies within the context of the whole enterprise-wide technology infrastructure (rather than just within the context of the specific technology being considered).

The technical architecture is not a project, but an iterative process. The process phase ensures the operationalisation of technologies in an architected approach.

CONCLUSION

The modeling provides guidance concerning the information technology assets to knowledge workers, information processors, IT application developers, infrastructure managers, and executives. The model helps organizations to explore the factors leading to the success or failure of technical architecture in their computing environment. The paper presents a new paradigm for building technical architecture that improves the effectiveness of functional operations to include their efficiency and use of technology throughout the organization.

The main contribution of the paper is methodological, through which we gain better understanding of the procedural deployment and use of technical architecture in the computing environment.

The paper constitutes a learning curve, and is expected to benefit the computing industry, IS researchers on the capabilities of the technical architecture involving change and through it, contributes to the body of knowledge in this sub-field. Based on the practicality, it is an aggregation of ideas and experience to which many architects would subscribe to.

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