

Position Paper

An Enterprise Architecture Process Model

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Abstract—This paper describes work in progress towards the elaboration of a Enterprise Architecture Process Model. This model is being developed as part of a comprehensive enterprise IT Capability Model (eIT-CM). The Enterprise Architecture Model comprises nine (9) processes and is compatible with the ISO/IEC 15504 standard.

Key Words - Modeling, Enterprise Architecture, Capability Models, Enterprise IT

I. INTRODUCTION

The information system infrastructure of a modern enterprise is very complex and has to be agile enough to provide the business with the means to adapt to changing market conditions. Architecting this information system infrastructure is the responsibility of the enterprise architects and the senior manager to whom they are ultimately reporting: the Chief Operating Officer (CIO). Enterprise Architecture (EA) is thus a systems engineering discipline that is an important component of the governance and management of enterprise information systems.

The work in progress described in this article is part of an attempt to develop an Enterprise IT Capability Model. The EA model we propose in this paper is thus fully integrated into a comprehensive set of processes covering the entire range of processes required to manage, develop and operate an enterprise IT infrastructure.

II. ENTERPRISE ARCHITECTURE AND ENTERPRISE IT

Nowadays, IT is part of the fabric of most enterprise and government organizations. This means that organizations cannot operate without their IT infrastructure, but furthermore their present and future competitiveness is dependant on this IT infrastructure.

The *Enterprise IT Capability Model* (eIT-CM) has been developed to provide as succinctly as possible to

the IT professionals and their managers an integrated view of the practices that are necessary to manage, develop and operate a modern IT infrastructure. Also nicknamed the *Egg Model* because of its conceptual representation, the eIT-CM is a capstone model built around the most popular and recognized IT practices frameworks, namely the CMMI [1] and the IT Infrastructure Library (ITIL), and compatible with recognized international standards, namely ISO/IEC 15504. The CMMI and ITIL were chosen as base models of the eIT-CM because of their wide market acceptance.

Being a capstone model, the eIT-CM does not aim to replace these well documented and maintained frameworks. The eIT-CM is rather an integrator model that merges these and other frameworks and provides the missing processes and practices that are required to adequately cover the field of enterprise IT practices. CMMI processes are integrated in the eIT-CM verbatim while the ITIL processes are all recognisable but had to be adapted to be compatible with ISO/IEC 15504.

The structure of the eIT-CM is illustrated in figure 1. Processes in this model are classified being part of process groups, like EA, that are in turn part of three practice domains:

- Governance, whose goal is *to support the organization's strategic directions, to define the IT vision, strategies, tactics and implementation plans, and to manage the implementation of these plans and ensure the delivery of required services.*
- Delivery, whose goal is *to deliver to the organization in a predictable, efficient and timely manner the business processes, applications and IT infrastructure that are planned for as well as any modifications to these elements.*
- Operations, whose goal is *to introduce new and/or modified systems and processes into the organization and the IT environment in an efficient manner.*

These three practice domains reflect the various nature of enterprise IT practices. Governance processes are mostly managerial and principally involve senior managers and architects. Delivery processes are

instantiated when a project is created and terminate when the project complete or is cancelled. Operations processes are product like.

EA is part of the Governance practice domain. EA processes interact not only with the Leadership and Portfolio Management process groups, but also with processes in Delivery and Operations. While the delivery and operations practice domains are essentially coming from respectively the CMMI and ITIL, the governance practice domain had to be elaborated from many sources, including the industrial experience of one of the authors in this area. The Malcom Balridge award criteria [2] were an important source of inspiration for the Leadership process area.

III. THE PROPOSED MODEL

The goals of the EA processes are 1) to proactively engineer the organization business and IT components, including their organization and their interfaces, required to fulfil the organization vision and 2) to engineer the strategies that will evolve the organization's enterprise architecture from its current state to its desired state.

The eIT-CM enterprise architecture processes were inspired from the Accenture model [3] as well as other work such as [4] and [5]. The current version of these processes is in annex.

EA in this model comprises four main components:

- Business Architecture, whose purpose is to *provide the organization with the business processes that are required to fulfill its business objective in the most optimal fashion.*
- Technical Architecture, whose purpose is to *provide to the IT organization the infrastructure required for the IT services to its end users and to its applications in the most effective and optimal manner.*
- Information Architecture, whose purpose is to *provide the organization with an architecture of its information assets that is optimally tuned to its usage and strategic requirements.*
- Application Architecture, whose purpose is to *provide the organization with a strategy for the evolution of its IT applications that is optimally tuned to its strategic requirements.*

An integrator process, named Enterprise Architecture, and whose purpose is to assist the organization in coming with business objectives and strategies that are doable from an IT perspective, to provide the organization with the IT roadmaps required to meet the organization's business objectives and to assist in the implementation of these roadmaps, integrates these components.

The Technical Architecture process has an associated process: Technology Management. Its purpose is to ensure that the organization is using IT technologies in the most effective and optimal manner.

Application Architecture is a major component of what is referred to in the literature as applications management. Other components of application management are found in the Portfolio Management process group as well as in Delivery and Operations practices areas. The Engineering Reuse Program Management process is associated to Application Architecture. The purpose of this process is *to plan, establish, manage, control and monitor an organization's reuse program and to systematically exploit reuse opportunities.* This process, taken verbatim from ISO/IEC 15504-5 [6], has been deemed part of Enterprise Architecture given its technical governance nature.

A Security Architecting Process, whose goal is to *provide the organization's IT infrastructure with the security required to meet its business objectives,* was added to reflect the importance of IT security in a modern IT information systems architecture. Inspired from ISO/IEC 17799 [7] and the industrial experience of one of the authors, this process is only one of the security elements of the eIT-CM. Security related practices are also found in the Leadership process group, as well as in the Delivery and Operations practice areas.

IV. CONCLUSIONS AND FUTURE WORK

We believe that our work should help better understand what enterprise architecture is and how it fits into enterprise IT. By documenting the EA processes in a fashion that is compatible with process standards in software and systems engineering, we are facilitating their use by the professional community in these areas.

Initial validation of the eIT-CM has been done through the reviews of twelve experts from industry and academia. The review was done through a written questionnaire. 141 comments were collected from this initial review. To further validate our work, we intend to go through additional review cycles and perform on-site assessments with industrial partners.

We expect that the eIT-CM initial publication will be done this fall.

V. REFERENCES

[1] *Capability Maturity Model Integration (CMMI) - Continuous Representation; version 1.1, CMMISM for Systems Engineering, Software Engineering, Integrated Product and Process Development, and Supplier Sourcing*: CMU/SEI, 2002.

[2] "Baldrige National Quality Program - Criteria for Performance Excellence," National Institute of Standards and Technology, Technology Administration, Department of Commerce 2003.

[3] Accenture, "Architecture Frameworks for Client/Server and Netcentric Computing," in *Enterprise Systems Integration, Second Edition, The Auerbach Best Practices Series*, J. M. Myerson, Ed.: Auerbach, A CRC Press Company, 2002, pp. 39-78.

[4] F. J. Armour, S. H. Kaisler, and S. Y. Liu, "A Big-Picture Look at Enterprise Architecture," *IT Pro*, vol. 1, pp. 35-42, 1999.

[5] *IT Architecture Maturity Model*: US Department of Commerce, 2003.

[6] *ISO/IEC FDIS 15504-5, Information technology -- Process Assessment -- Part 5: An exemplar Process Assessment Model*: ISO/IEC, 2005.

[7] "ISO/IEC 17799:2005, Information technology -- Security techniques -- Code of practice for information security management," ISO/IEC 2005.

[8] *Best Practice for ICT Infrastructure Management*: OGC, 2002.

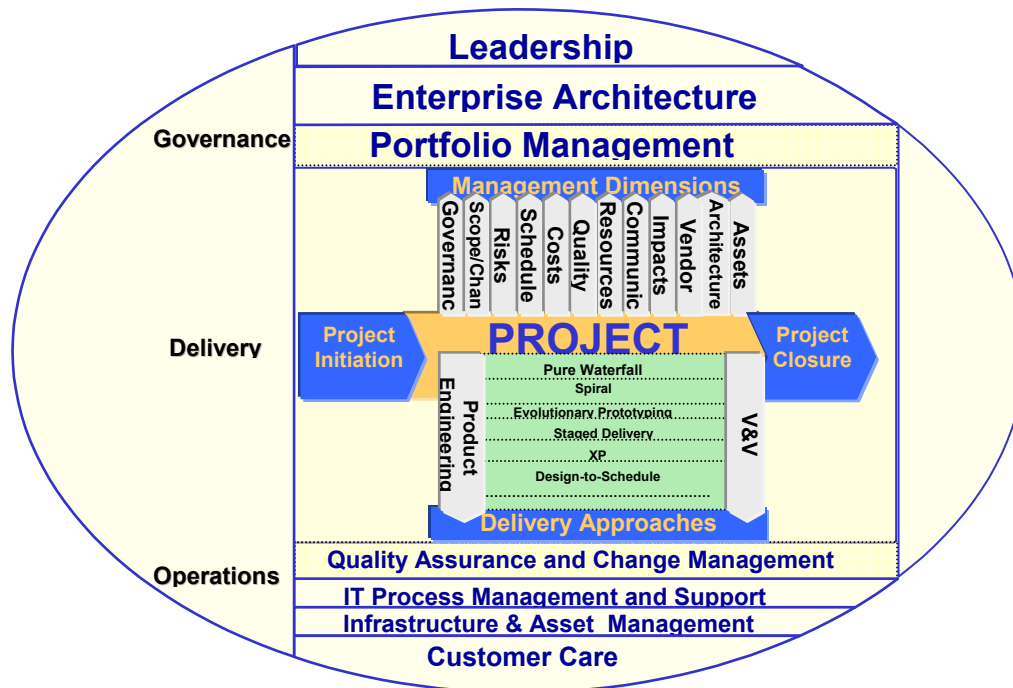


Figure 1: The eIT-CM

ANNEX: ENTERPRISE ARCHITECTURE PROCESSES

Enterprise Architecture

Process ID	EA1
Process Name	Enterprise Architecture
Process Purpose	The purpose of the Enterprise Architecture process is to assist the organization in coming up with business objectives and strategies that are doable from an IT perspective, to provide the organization with the IT roadmaps required to meet the organization's business objectives and to assist in the implementation of these roadmaps.
Process Outcomes	As a result of successful implementation of this process: <ol style="list-style-type: none"> 1. the organization's objectives and strategies are achievable from an IT perspective 2. the organization's objectives and strategies optimally exploit the organization's IT assets and resources

	<ol style="list-style-type: none"> 3. the current enterprise architecture is understood and documented 4. a target enterprise architecture that is consistent with the organization's business objective is defined 5. a roadmap from the current to the target architecture that is consistent with the organization business objectives and IT investment strategy is defined 6. the organization's infrastructure and application projects are conformant to its enterprise architecture
Base Practices	<p>EA1.BP1. Document current enterprise architecture. Get inventory and document current enterprise architecture to the degree necessary for planning activities. This documentation should include, for IT services and architecture components, attributes such as availability, security, performance, capacity and scalability. [Outcome: 3]¹</p> <p>EA1. BP2. Assess current enterprise architecture. Assess current enterprise architecture from an operational and strategic perspective. [Outcome: 1, 2, 3, 4, 5]</p> <p>EA1. BP3. Provide inputs to the organization's planning activities. Participate in the organization's planning activities by providing inputs on the current IT infrastructure ability to support contemplated strategies and the costs, resources and schedule requirements of the IT configurations associated with these strategies. [Outcome: 1, 2]</p> <p>EA1. BP4. Define the target enterprise architecture. Define and document the target architecture that optimally fits the organization's strategic objectives from a time, resources, production and technology evolution perspective. This documentation should include, for IT services and architecture components, attributes such as availability, security, performance, capacity and scalability. [Outcome: 2, 4, 5]</p> <p>EA1. BP5. Design an optimal roadmap. Design and document a roadmap that specifies how to evolve the enterprise architecture from its current to target state taking into account time, resources, production and technology evolution requirements and constraints. [Outcome: 2, 5]</p> <p>EA1. BP6. Implement architectural principles. Elaborate and implement infrastructure and application architectural principles that are consistent with the organization's enterprise architecture roadmap. [Outcome: 6]</p>
References	BK², ITIL [8]

Business Architecture

Process ID	BA1
Process Name	Business Architecture
Process Purpose	The purpose of the Business Architecture process is to provide the organization with the business processes that are required to fulfill its business objective in the most optimal fashion.
Process Outcomes	<p>As a result of successful implementation of this process:</p> <ol style="list-style-type: none"> 1. the organization's core and infrastructure business processes are well documented and understood 2. the organization has the business processes required to fulfill its business objectives 3. the organization's core and infrastructure processes are optimally tuned
Base Practices	<p>BA1.BP1. Document current core and infrastructure processes. Document the processes that are strategic to the business objectives of the organization (core) and the key infrastructure processes that support these core processes. These processes are aggregated in functional domains. [Outcome: 1]</p> <p>BA1.BP2. Assess current core and infrastructure processes. Assess the performance of the core and key infrastructure processes. These assessments can be done either in a context of continuous improvement (Kaizen), or re-engineering to fulfill the organization's objectives. [Outcome: 1]</p> <p>BA1.BP3. Engineer and/or re-engineer business processes. Engineer or re-engineer as required business processes to fulfill the organization's objectives taking into account IT constraints. Assess scenarios and select the optimal solution in light of the given constraints. [Outcome: 2 and 3]</p>
References	BK,

¹ This is a mapping of the base practice to one of the aforementioned outcome.

² BK = Body of Knowledge

Technical Architecture

Process ID	TA1
Process Name	Technical Architecture
Process Purpose	The purpose of the Technical Architecture process is to provide to the IT organization the infrastructure required for the IT services to its end users and to its applications in the most effective and optimal manner.
Process Outcomes	As a result of successful implementation of this process: <ol style="list-style-type: none"> 1. the organization has the networking, communication, computing and collaboration services required by its end users 2. the organization's IT applications have the networking, computing, storage, middleware, directory and security services they require 3. the infrastructure services are provided in a cost effective manner 4. the infrastructure services are provided with the required level of availability and performance
Base Practices	<p>TA1.BP1. Assess IT infrastructure needs. Assess and document present and future (near- and mid-terms) infrastructure needs taking into account current operations as well as the enterprise architecture roadmap. This documentation should include attributes such as availability, security, performance, capacity and scalability. [Outcome: 1, 2, 4]</p> <p>TA1.BP2. Assess current IT infrastructure performance. Assess current IT infrastructure performance from an availability perspective. Availability in this context means conformant to functional and quality (ref. ISO/IEC 9126) requirements. [Outcome: 1, 2, 4]</p> <p>TA1.BP3. Assess IT infrastructure operation costs. Assess current IT infrastructure performance from an operational and financial perspective. [Outcome: 3]</p> <p>TA1.BP4. Engineer the IT infrastructure. Engineer (or re-engineer) the current IT infrastructure to meet current and planned needs in a fashion that is optimal from a performance, availability, operational and financial perspective. [Outcome: 1, 2, 3, 4]</p>
References	BK, ITIL [8]

Technology Management

Process ID	TA2
Process Name	Technology Management
Process Purpose	The purpose of the Technology Management process is to ensure that the organization is using IT technologies in the most effective and optimal manner.
Process Outcomes	As a result of successful implementation of this process: <ol style="list-style-type: none"> 1. the organization is proactively aware of the evolution of IT technologies and their associated market 2. the organization's usage of IT technologies is managed to balance issues such as engineering benefits as well as operational, maintenance and financial impacts
Base Practices	<p>TA2.BP1. Maintain an inventory of current technologies. Put in place and maintain an inventory of all current technologies used in the IT infrastructure and applications of the organizations. Document associated procurements issues. [Outcome: 1, 2]</p> <p>TA2.BP2. Implement a technology watch process. Implement a technology watch process to proactively assess the current state and probable short and middle term evolution of IT technologies that are pertinent to the organization. This assessment shall consider both technical and market issues. [Outcome: 1]</p> <p>TA2.BP3. Maintain an IT technology standards register. Maintain an IT technology standards register that documents legacy, current, special usage and emerging technologies. [Outcome: 2]</p> <p>TA2.BP4. Implement a technology approval process. Implement and operate a process to manage usage of non-current technologies in infrastructure and application projects. This process should involve senior IT management and take into account strategic, financial and human resources issues. [Outcome: 2]</p>
References	BK, ITIL [8]

Information Architecture

Process ID	IA1
Process Name	Information Architecture
Process Purpose	The purpose of the Information Architecture process is to provide the organization with an architecture of its information assets that is optimally tuned to its usage and strategic requirements.
Process Outcomes	As a result of successful implementation of this process: <ol style="list-style-type: none"> 1. the organization's current information assets and their usage patterns are understood 2. the organization's current information assets have a clear ownership structure that contributes to ensure its integrity 3. the organization's current information assets are organized, logically and physically, optimally from both an operational and an engineering perspective 4. the organization's current information assets have the required level of safety and security from a logical and physical perspective 5. confidentiality and privacy requirements of the information assets are understood and implemented 6. the organization's information assets are used optimally
Base Practices	<p>IA1.BP1. Assess current information assets. Assess current information assets (InfA) to understand their logical and physical organization as well as the ownership structure, usage patterns and security/privacy attributes. The Pareto principle should be applied. [Outcome: 1, 2]</p> <p>IA1.BP2. Clarify InfA ownership. Ensure that data ownership in the organization is clear, that no data duplication exists and that data replication is properly synchronized. [Outcome: 2]</p> <p>IA1.BP3. Engineer the InfA architecture. Engineer (or re-engineer) the InfA architecture (logical and physical) to meet current and planned needs in a fashion that is optimal from a performance, availability, operational, integrity, and financial perspective. [Outcome: 1, 2, 3, 6]</p> <p>IA1.BP4. Engineer InfA security architecture. Engineer (or re-engineer) the InfA security architecture to meet security, business continuity and privacy requirements. [Outcome: 4, 5]</p>
References	BK

Application Architecture

Process ID	AA1
Process Name	Application Architecture
Process Purpose	The purpose of the Application Architecture process is to provide the organization with a strategy for the evolution of its IT applications that is optimally tuned to its strategic requirements.
Process Outcomes	As a result of successful implementation of this process: <ol style="list-style-type: none"> 1. an updated inventory of all the organization's applications and their relationships/dependencies is maintained 2. a mapping of the applications to key business processes/services and business domains is maintained 3. applications that are core to the business are identified 4. services quality attributes (availability, performance,...) are allocated to the applications that enable them 5. the evolvability of applications and their maintainability are assessed and documented 6. a middleware strategy is elaborated and implemented 7. reuse considerations are taken into account when the target architecture is defined 8. an optimal strategy for the evolution of the enterprise applications in response to business needs is elaborated
Base Practices	<p>AA1.BP1. Maintain an Application Inventory. Maintain an inventory of all software applications that capture key size, technology, maintainability, COTS usage, history and relationship information. Include also which domain they are related to and to which service they contribute. [Outcome: 1, 2, 5]</p> <p>AA1.BP2. Model Services Dependencies. Model IT services mutual dependencies. Identify core applications. [Outcome: 2, 3]</p> <p>AA1.BP3. Allocate Quality Attributes. Allocate quality attributes to applications and their underlying infrastructure to meet service requirements. [Outcome: 4]</p> <p>AA1.BP4. Elaborate and Implement Middleware Strategy. Elaborate a middleware strategy to facilitate</p>

	<p>application integration, including the integration of legacy applications, and minimize delivery costs and cycle. [Outcome: 6]</p> <p>AA1.BP5. Optimize reuse. Optimize reuse when defining the target architecture in conjunction with the reuse process. [Outcome: 7]</p> <p>AA1.BP6. Elaborate Application Evolution Strategy. Elaborate an application evolution strategy that is optimal to meet the organization business objectives. [Outcome: 6]</p>
References	BK, ITIL [8], ISO/IEC 15504-5 REU.3 [6]

Engineering Reuse Program Management (ISO/IEC 15504-5)

Note: this is the REU.2 process of ISO/IEC 15504-5

Process ID	AA2
Process Name	Engineering Reuse Program Management
Process Purpose	The purpose of Engineering Reuse Program Management is to plan, establish, manage, control and monitor an organization's reuse program and to systematically exploit reuse opportunities.
References	ISO/IEC 15504-5 REU.2 [6]

Security Architecting

Process ID	SA1
Process Name	Security Architecting
Process Purpose	The purpose of the Security Architecting Process is to provide the organization's IT infrastructure with the security required to meet its business objectives.
Process Outcomes	<p>As a result of successful implementation of this process:</p> <ol style="list-style-type: none"> 1. the organization's IT security risks and exposure are within acceptable ranges 2. the organization's IT security risks and IT security costs are balanced 3. the organization's IT infrastructure meets stated requirements
Base Practices	<p>SA1.BP1. Assess organizational IT risks. Assess present and future (near, middle and longer terms) organizational IT security risks and their potential impacts. Scope should include human factors, mobile computing, convergent IP telephony services and teleworking. [Outcome: 1]</p> <p>SA1.BP2. Assess organizational IT security. Assess the effectiveness and operational (TCO: Total cost of ownership) impacts of current IT security architecture and the policies it is supporting. [Outcome: 1, 2]</p> <p>SA1.BP3. Validate acceptable risks with senior management. Communicate to senior management assessment results and validate acceptable risks level. A proper risk/impact and cost/benefits analysis should be presented. The study should include a TCO analysis of proposed security measures (include policies, process and infrastructure). [Outcome: 1, 2]</p> <p>SA1.BP5. Design and implement security infrastructure. Design the organization's IT security infrastructure and supervise and validate its implementation. [Outcome: 1, 3]</p> <p>SA1.BP6. Specify security requirements of IT infrastructure elements. Provide security requirements to delivery projects. [Outcome: 3]</p>
References	ISO/IEC 17799 [7], BK