Architectural Representations for Describing Enterprise Information and Data

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Abstract: - Enterprise Architecture is a generalised term, which refers to a number of architectural representations each based on a different viewpoint. The core representations being: the Business, the Information, the Application and the Technology architectures. Since the seminal work on Enterprise Architecture by John Zachman, first published in 1987, a number of architectural frameworks have been suggested e.g. TOGAF, RM-ODP, C4ISR, TEAF and FEAF. In the current study, this paper discusses the various architectural representations from various perspectives, and presents a basic model for the development of an enterprise architecture. Zachman framework is discussed in some detail and a brief overview of several other enterprise models is given. The emphasis is on information and data architectures. The objective is to promote understanding of enterprise architectures and to present enough appropriate background information so that it serves as a useful guidance for the large enterprises who wish to embark on the process of developing enterprise-wide information architectures.

Key-Words: - Enterprise Architecture, Architectural Representations, Information Architecture, Technology Architecture, Zachman Framework

1. Introduction
Large enterprises are complex entities operating in a fast-moving environment facing ever-increasing demands for better quality and higher values. To ensure that a firm’s IT structure and knowledge base is effectively developed and managed, it is necessary that a rigorously defined architectural framework is developed to capture the long term vision of the enterprise in all its dimensions and complexity. Enterprise Architecture (EA) is such a framework, which acts as a coordinating and integrating force between various aspects of an organisation including:

- Business planning - which refers to goals, visions, strategies and governance principles
- Business operations - which refers to processes, functions and data
- Automation - which refers to information systems and databases
- Technological infrastructure - which refers to computers, software and networks.

The purpose of an EA is to provide a high level corporate view of the enterprise that is understood by everyone in the organisation as well as other stakeholders and interested parties including, in some cases, the government agencies. Essentially, the development of an organisation’s EA is a key to bridging the communication gap between the business strategy level (that needs information for strategic planning) and the technical level (that needs to continually ensure that the organisation keeps functioning in the correct way) [1]. In simple terms, EA provides a link between the business mission and its strategy/processes to its IT and information strategy. Thus, EA can be seen as a key enabler for achieving alignment between the business and the IT.

A well-documented EA provides numerous benefits to an organisation – enabling it to address the important enterprise-wide concerns such as:

- Meeting stakeholders needs
- Aligning IT with the business
- Seamless integration of applications
- Data and information sharing
- Security and dependability
- Data integrity and consistency
- Reducing duplication
- Efficiency of services and better governance.

In the rest of this paper, we first discuss the core elements of an EA and propose a generic model for building EA. Then, in sections 3 and 4, we introduce the Zachman Framework and briefly discuss various frameworks that are currently available. Section 5 provides a scheme for implementing an EA and the last section presents a summary.
2. Architectural Representations for an EA

Enterprise Architecture provides a high level corporate view of an enterprise. It is the capture of all behaviour that goes on in an organisation: the data that is processed, the information that is kept, who does what and why etc. In essence, it is the what, how, who and why of the business at every level of the organisation. We can refer to these elements as the way the various architectural representations can be described. Some of these descriptions refer to the business mission and the goals of the organisation; some refer to the business and governance processes and the rest to the information and application systems.

This suggests that the EA should be based on the strategic vision of the enterprise. It also suggests that an EA is an enterprise-wide framework incorporating a number of architectures, which provide or represent different perspectives of the organisation. In this context, Malhotra [2] identifies the following core components of an EA:

- Strategic Capabilities Architecture - a guiding architecture based on the strategic vision
- Business Architecture – based on the long term strategy, goals and objectives
- Information Architecture – based on the Business Architecture to define the IS strategy that implements the business strategy
- Data, Systems and Computer Architectures – to determine the Information Architecture consisting of:
  - Data Architecture - relates to and aligns the firm’s data related aspects with the business applications
  - Systems Architecture - refers to the specific information and data systems
  - Computer Architecture - refers to the specific hardware and software.

From the above, it follows that an EA is a logical organisation of information pertaining to the following corporate level enterprise-wide elements:

- Strategic vision, goals and objectives
- Business rules and measures
- Information and data requirements
- Application and information systems
- Technology infrastructure

Zachman [3] suggests three fundamental architecture to be the Business model, the IS model and the Technology model from the perspectives of the owner, the designer and the builder, respectively.

Based on the above and following the ideas presented by other researchers [e.g. 4-6], we suggest the following components as the minimum set of core architectural representations, from various perspectives of the organisation, for a generalised EA (refer also to Fig 1):

- Business Architecture – to address the business mission, strategy, governance, business process models and business functions
- Application (or Solution or Software or Functional) Architecture – to focus on the information systems to support the business mission and information requirements
- Data (or Information) Architecture – to define the data and information that needs to be made available to accomplish the mission and to provide to other agencies
- Technical (or IT or Infrastructure) Architecture – to define the technology infrastructure needed to support the Data and Application architectures and to document the required technical standards.

Fig 1: Architectural Representations of an EA

Since an EA is the what, how, who and why of the business at every level of the organisation, it makes sense if each architectural representation is viewed in terms of these elements (or descriptions, as we referred to them earlier):

- What – to determine business objects, data and materials
- How – to determine control flows and business functions and procedures
- Who – to refer to staff, stakeholders and their responsibilities
- Why – to refer to mission and objectives of the enterprise.

Thus, an EA becomes a two-dimensional model representing architectural representations on one axis and descriptions of representations on the other axis.

Refer to Fig 2, which presents the core architectural representations and the minimum set of descriptions.
for each representation. Depending on the business domain, it may be necessary to add more representations and descriptions.

<table>
<thead>
<tr>
<th>Descriptions</th>
<th>What</th>
<th>how</th>
<th>who</th>
<th>why</th>
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<tbody>
<tr>
<td>Arch. Representations</td>
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<tr>
<td>Business Architecture</td>
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<td>Application Architecture</td>
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<td>Data Architecture</td>
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Fig 2: A generalised basic model of EA

Once a skeleton matrix has been organised, the next step is to fill each cell of the matrix with a particular description with respect to the associated representation. As an example, the intersection of ‘who’ and ‘technical architecture’ can be the ‘user interface’. Similarly, the intersection of ‘why’ and ‘business architecture’ can be the ‘business charter’.

The next section discusses a well-known framework, to further clarify the theory mentioned above.

3. Zachman Framework for EA

Numerous frameworks and models exist for designing and implementing EAs. One such framework, developed in 1987, is due to John Zachman [3, 7]. According to Zachman: To keep the business from disintegrating, the concept of IS architecture is becoming less of an option and more of a necessity.

This framework [3, 7-9] has become the model around which major organisations view and communicate their enterprise information architectures. It has set the standard on how an organisation should develop, implement and maintain an EA. This framework provides structure and definition of a complete set of views, which describe an enterprise. It describes and provides a classification of all the elements an EA should contain. Instead of representing the architectural process as a series of steps, Zachman organises the processes around the points of view, known as perspectives (or architectural representations) taken by the various players, known as aspects (or descriptions). The model consists of 30 views arranged in a two-dimensional matrix of five rows providing representations and six columns providing aspects or descriptions. Refer to Fig 3.

The architectural representations (which provide perspectives for different roles) refer to the following:

- Scope and objectives – represented by the Strategic Planner – corresponds to an executive summary where estimates of size, cost and functionality are required.
- Business model – represented by the Business Owner – shows business entities and processes as well as their interactions.
- IS or System model – represented by the Designer – corresponds to software functions that represent the Business model.
- Technology model – represented by the Builder/analysis/developer) – considers tools and technologies.
- Detailed representation – by the Sub-contractor (coder) – represents individual modules and the final operational system.

The six aspects (or descriptions), shown as columns, are the following:

- What – refers to business data – describes entities involved in each perspective e.g. business objects, system data, relational tables
- How – refers to control flows – describes functions within each perspective e.g. business processes, software and hardware functions
- Where – refers to locations and interconnections – e.g. location of network nodes
- Who – refers to staff, departments and people relationships and responsibilities
- When – refers to duration of business processes and time-event relationships
- Why – refers to motivation with respect to business mission and objectives.

Note that Zachman introduces an additional perspective and two new descriptions (when and where).
The complete matrix provides the highest-level view of a generalised architecture. Each cell is filled with a particular view with respect to an associated representation. The vertical axis provides a source of potential viewpoints and the horizontal axis provides a generic taxonomy of concerns. Zachman does not explicitly cover ‘rules’ or ‘product standards’ or prescribe any methods - the focus is on ensuring that all aspects of an enterprise are well organised and exhibit clear relationships to ensure a complete system, regardless of the order in which they are established. The framework is concerned with content rather than the process.

4. Choosing an EA Framework
The primary concerns in choosing a framework are the stakeholders and the business domain. A fundamental use of an architectural description is to communicate with stakeholders and be effective in the provision of services and goods. Different architectural views must provide information that stakeholders need in a way that they can assimilate and use. Different models address different concerns. Although different frameworks share many objectives and approaches, they are directed at different communities. Zachman framework is a generic reference model, which serves as the basis for numerous other models eg RM-ODP, TOGAF, C4ISR, FEAF and TEAF. The following paragraphs present a brief description of these frameworks - for a fuller review of the models, refer to Mahmood [10].

### 4.1 RM-ODP (Reference Model for Open Distributed Processing)
The RM-ODP [11-14], is a joint effort by the International Standards Organisation and ITU (International Telecommunications Unit). It provides support for the development of standards to support distributed processing in heterogeneous environments and describes the following viewpoints [15]: enterprise, information, computational, engineering and technology. The RM-ODP consists of a Business model which is based upon four architectural representations viz: Application, Software, Technical and operational. RM-ODP is influenced by the Zachman Framework and formal methods. It uses the object modelling technique (OMT) for defining viewpoints.

### 4.2 TOGAF (The Open Group Architecture Framework)
TOGAF, developed by the Open Group [16] in mid 1990s and first released in 1995, provides a practical industry standard method of designing an EA. Focusing on mission-critical business applications, it defines an EA to comprise the following architectures: Business, applications, data and technology, which are the same as shown in figure 1. However, the model also provide two additional components:

- Architecture Development Method (ADM) - which explains how to derive an architecture that addresses the business requirements and
- Resource Base - that provides resources for the application of ADM.
The latest release, TOGAF 8.1 [18-19], which appeared in December 2003 is freely available.

### 4.3 C4ISR (Command/Control/Communication/Computers, Intelligence, Surveillance and Reconnaissance) Architecture Framework

The C4ISR version 2 [5, 6], published in 1997, is intended to ensure that the architectural descriptions developed by the C4 agencies are comparable and integrate-able across joint and combine organisational boundaries. It defines the following views (represented as rows in a 2-dimensional matrix): Organisational (requirements, capabilities, interoperability), System (existing and future systems and interconnections), Technical and Overall. Each view is further divided into products (static models). The column of the matrix represent the 6 aspects similar to Zachman’s what, how, where, who, when and why. Its current reincarnation known as DoDAF (US DoD Architecture Framework) was released in late 2003 [5].

### 4.4 US-FEAF (Federal Enterprise Architecture Framework)

This framework, developed in 1999 by the US Federal Chief Information Officers Council [20-22] in response to the Clinger-Cohen Act of 1996 (also known as ITMRA – IT Management Reform Act) [23-24], promotes shared development for US federal processes and sharing of information among US federal and other government agencies. It partitions a given architecture in the same way as in figure 1 and suggests building a framework from the viewpoints of the Planner, the Owner, the Designer, the Builder and the Subcontractor. These viewpoints correspond to the Zachman Framework. The framework is essentially a guide for collecting common architectural information and building a repository to store this information for subsequent use and sharing. The model also provides guidance on who to accomplish transition from the current architecture to the future architecture.

### 4.5 US-TEAF (Treasury Enterprise Architecture Framework)

The TEAF [17], which provides guidance to US Treasury bureaus concerning the development and evolution of IS architecture, supports Treasury’s business processes in terms of work products. It describes the following architectural views: functional (how), information (what), organisational (who) and infrastructure (where). It suggests four viewpoints: those of the planner, the owner, the designer and the builder. Note that it consists of four descriptions: how, what, who and where. This model separates EA information into the following components: EA direction (the drivers, policies), EA description (the matrix with representations and descriptions) and EA accomplishment (the transition strategy).

### 5. Implementation of an EA

Typically, an EA will include a baseline (or current) architecture, a target architecture and a transition plan for moving from the baseline to the target. In this respect, the essential steps can be identified as follows:

- Identification, validation and clarification of the enterprise needs in terms of business functions, measures and controls based on long-term vision, strategic mission and principles
- Clarification of strategic direction, long-term vision and principles
- Creation of current architecture based on required architectural representations and relevant descriptions - data models in terms of the existing data and information based on the current strategies ensuring that any data conflicts are resolved
- Determination of target architecture based on future directions and business vision
- Formulation and implementation of the transition methodology to map the as is to the to be architecture
- Documentation and review of the process

Transition process is not easy and requires the development of a strategy to first transform the key performance data and then the operating systems. This forms the basis of an accompanying paper, currently being prepared.

### 6. Conclusions

In this study, we have discussed the core architectural representations, with respect to various viewpoints and aspects, for the modelling of enterprise information and data. A basic model has also been developed. Zachman Framework has been discussed and a number of currently available models briefly explained. Hints on the implementations have also been presented. It is suggested that the first step that an organisation needs to take, with a view to developing an EA, is to define the required EA based on its long-term mission and strategy. The next step is to create a roadmap, which will enable the enterprise to move from its current state to the intended future state. It is hoped that large enterprises who wish to embark on the process of developing enterprise-wide information architectures will find the information useful.
References


