Main Aspects of Enterprise Architecture Concept

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Abstract: Business today is facing the challenge of surviving in an increasingly dynamic environment which requires the management to be flexible and to have a clear view over the organization as a whole as well as over its particular components and their interrelations. The significant importance of IT for the successful development of the business is a generally recognized fact. The present article discusses the concept of enterprise architecture defined as (an approach for developing) a generalized conceptual plan which describes the enterprise structure with all its components and the relations between them; formulates principles and rules for designing and functioning of the organizational structure, the processes and the IT in the enterprise; and aligns the enterprise's IT with its business goals and processes. Described are the structural elements of the enterprise architecture. A cycle for enterprise architecture development is presented as well as the Zachman framework as a popular approach for enterprise architecture description.

Key words: business economics, business management, enterprise architecture, information technologies.

Introduction

"There is no big difference whether an object is real, for example an airplane, or conceptual, for example, an enterprise. The challenges are the same – how to design and build this object, element by element, in such a way as to achieve its purpose."
John Zachman[1]

The increasingly dynamic environment, in which business operates nowadays, confronts the contemporary enterprise with the challenge of finding a fast and adequate way of reacting to changes – which, on its turn, requires an adequate set of tools for flexible management. The enterprise architecture concept, which is gaining popularity at the world scale, is considered to be such a set of tools. It is based on the idea that management needs a wide "view from above" on the organization as a whole, providing a vision on its different components, the way they work together and synchronize each other. Moreover, the essential role of information technologies (IT) for increasing the adaptive ability of the enterprise and the successful achievement of its goals is a widely accepted fact. However, management is often confronted with situations, where existing IT turn out not being synchronized with the organization goals and "information islands" are created. The achievement of synchronism between business processes and IT is increasingly being placed into "focus" as it influences directly the organization flexibility and adaptivity to the quickly changing environment.

[1] Zachman, J. A., The Challenge is Change, on-line resource, http://www.ies.aust.com/PDF-papers/zachman2.pdf

The **purpose** of the present article is to present the concept of enterprise architecture (EA) as a set of tools for flexible management in the conditions of dynamic business environment through the synchronization of business processes and business goals of the enterprise with IT. To reach this purpose, the following **tasks** are fulfilled within the framework of the article: (1) The essence of the notion of EA is presented, the main definitions for EA are summarized and its structural elements are described; (2) EA is positioned in the context of enterprise management, as well as the management of the overall organization structure; (3) The article examines EA building cycle and presents a conceptual framework for the description of EA.

1. Emergence of enterprise architecture and importance of the concept

The emergence of the *enterprise architecture* topic is associated with the name of the American scientist John Zachman[2]. In 1987, he published an article with the title "A Framework for Information Systems Architecture"[3]. The term *architecture* was used for many years by information systems specialists, but in the environment of the 1990s, managers and specialists, involved mainly in enterprise planning and in reengineering of business processes, started to use this term in the sense of overall and general view on the business. Nowadays, business and IT managers speak about enterprise architecture (EA) as "*a detailed description of all key elements in the organization and the взаимовръзките interrelations between them*"[4].

The wider implementation of the EA concept in practice is associated with the Information Technology Management Reform Act[5] adopted in the USA in 1996, which requires Federal agencies to apply holistic approach in synchronizing IT with their business goals, and to document their existing and target EAs. The growing popularity of the EA concept was confirmed by a study on 79 companies performed by the Institute For Enterprise Architecture Developments in 2003 / 2004 comprising[6]. The results demonstrate that EA is applied in more and more organizations in the world, and their numbers grow in countries like South Korea, Japan, China, India, Iran, Russia. EA is implemented mostly by big companies[7], but there is a trend towards increasing numbers of small and medium enterprises reacting positively to the concept. The study also shows that EA is applied mainly by government agencies and enterprises in the field of industry, energy and municipal services, transport, financial services, as well as healthcare. A formal framework for EA was set by the standard ISO 15704:2000 Industrial automation systems – Requirements for enterprise-reference architectures and methodologies, introduced in 2000[8]. It includes a standard EA model, known under the name GERAM[9].

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[2] A detailed analysis of Zachman framework can be found in Dankova, P., Zachman framework as an approach to description of the enterprise architecture (in Bulgarian), in: Actual problems of the economy and business management, Collection of papers, Economic University, Varna, 2008, pp. 165-171.
[3] Zachman, J. A., A Framework for Information Systems Architecture, IBM Systems Journal, vol. 26, No 3, 1987.
[4] Harmon, P., Developing an Enterprise Architecture, Business Process Trends, 2003.
[5] Information Technology Management Reform Act / Clinger-Cohen Act
[6] Trends in Enterprise Architecture: How are Organizations Progressing?, Institute For Enterprise Architecture Developments, 2004.
[7] With more than 1000 persons staff.
[8] ISO 15704:2000 Industrial automation systems – Requirements for enterprise-reference architectures and methodologies.
[9] Generalized Enterprise Reference Architecture and Methodology.

2. Significance of enterprise architecture

The review of existing definitions of the term *enterprise architecture* in the literature shows that the authors place the emphasis on a few key fields, which complement each other and expand the scope of the term:

The **first** group of definitions[10] are clustered around the view that EA represents a summarized conceptual plan, describing the structure of an organization with its separate components and interrelations between them. The main goal of EA is considered finding the most efficient way, in which the enterprise can reach its goals.

A regulative emphasis can be noticed in the **second** group of definitions[11]. EA is treated as a set of principles, rules, and models, upon which the development and implementation of organization structure, business processes, information systems, applications, and technical structure in an organization, are based.

The prestigious Institute of Electrical and Electronics Engineers (IEEE)[12] and the Institute for Enterprise Architecture Developments[13] are unified around the **third** group of definitions[14]

with an emphasis on system approach to organization, according to which EA deals with understanding and explanation of the different components of the enterprise, the interrelation between them, and the principles of their design and development.

The **fourth** group of definitions[15] presents EA as an approach to the achievement of business goals through the best possible application of IT. They use the expression "synchronizing business goals and processes with IT" and consider EA as a sort of framework, which is used to document existing information systems, their interrelations, and the way in which they interact to fulfill the enterprise mission.

On the basis of these definitions, we propose the following summarized definition of the term: *Enterprise architecture represents (an approach to developing) a general conceptual plan, which describes the structure of the enterprise with its separate components and links between them; it defines the principles and rules for the design and operation of the organization structure, the processes and information systems in the enterprise, and it synchronizes information technologies in the enterprise with its business goals and processes.*

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[10] Lillehagen, F. and D. Karlsen, Enterprise Architectures – Survey of Practices and Initiatives, http://interop-esa05.unige.ch/INTEROP/Proceedings/Industrial/IND1_Lillehagen.pdf; Wagter, R., M. van den Berg, J. Luijpers and M. van Steenbergen, Dynamic Enterprise Architecture: How to Make It Work, John Wiley & Sons, 2005.

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[12] Institute of Electrical and Electronics Engineers, http://www.iso-architecture.org/ieee-1471/ieee-1471-faq.html

[13] Institute for Enterprise Architecture Developments, http://www.enterprise-architecture.info/Images/Extended%20 Enterprise/Extended%20Enterprise%20Architecture.htm

[14] Std 1471-2000, IEEE Recommended Practice for Architectural Description of Software-Intensive Systems, 2000; Bredemeyer, D., What it Takes to be Great in the Role of Enterprise Architect, http://www.bredemeyer.com

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A few main emphasis points are outlined in the definition proposed by us:

First, EA can be considered as a process of definition of the different components of the enterprise and of developing a plan for building the enterprise system. The analogy with the construction industry is obvious. Like the construction contractor, who would not start any building construction without a precise and clear architectural project comprising a combination of plans, in the same way, building an enterprise should be based on a combination of descriptive models.

Second, EA provides a holistic view on the enterprise and gives the opportunity of visualizing the different structural units in it, the ways, in which they are related to each other, and in which they interact. This view allows to determine how, for example, a change in business goals would influence the different business processes, the organization structure, IT, etc. *Lillehagen and Karlsen*[16] consider EA as a specific "skeleton" outlining the main components of the enterprise and providing the opportunity of easier identification and analysis of the problems in them. *Bredemeyer*[17] emphasizes that the architecture determines "the building blocks" of the system, their characteristics, their mutual links, the relations between them and the environment, and it is designed with a view of achieving integrity of the system and support to the realization of its main functions. In this way, EA provides the management with a set of tools for analysis and decision-making.

Third, EA "fills the gap" between business and IT[18]. The main goal of EA is to outline the interrelations between the business and IT in such a way as to describe the key interactions between them and to support the business decision-making process. EA determines how information and technologies support business operations and bring benefit to the business. A well designed EA in the organization may become the most efficient set of tools in proving the right information to the right person in the right format in the right moment.

3. Structural elements in the enterprise architecture

Understanding the essence and feasibility of EA requires a more detailed explanation of its structural elements. EA can be treated as consisting of four interrelated elements, namely: technology architecture, information architecture, architecture of applications, and business architecture (Figure 1). Each of these architectural structures contributes to the improvement of activities in the different units in the enterprise, as well as of the enterprise as a whole. Moreover, the ideas with respect to the main points of emphasis for EA undergo a certain evolution, which is seen in Figure 1.

At the initial stage of introduction, EA is considered as equivalent to the **architecture of technology.** It is directed most of all to the establishment of technological standards and principles, including the description of the existing technologies in the enterprise. The convergence of ITs resulting in their lower cost, in easier training of employees and their increased mobility within the organization, is considered to be the main benefit of the implementation of EA.

The information architecture and the architecture of applications is gradually included in EA scope.

16 Lillehagen, F. and D. Karlsen, Enterprise Architectures – Survey of Practices and Initiatives, Online source http://interop-esa05.unige.ch/INTEROP/Proceedings/Industrial/IND1_Lillehagen.pdf
17 Bredemeyer, D., What it Takes to be Great in the Role of Enterprise Architect, http://www.bredemeyer.com
18 Bailey, I., A Simple Guide to Enterprise Architecture, Model Futures, 2006.
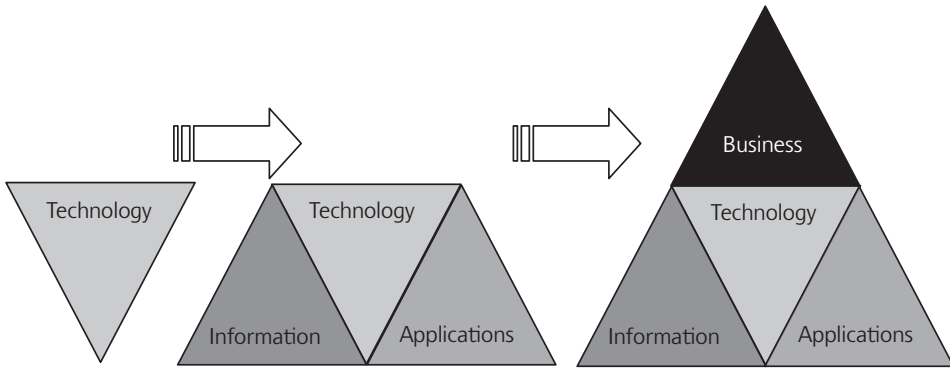
Figure 1. Evolution of views on the content of enterprise architecture[19]

The **architecture of information** describes all information sets, used by different customers in the enterprise. In this way, a common database is created to avoid doubling of information and tasks. Databases and data storage units are parts of this architecture together with systems for the management of databases, rules and tools of limiting data access.

The **architecture of applications** describes the systems which ensure the realization of business processes in the enterprise and channels information storage and use. The software, internet, intranet, are all parts of this architecture. At this stage of EA development,

expansion contributes to shared access to information within the enterprise as a whole, including outside information from customers, suppliers, partners, even competitors; and also helps avoid doubling of activities. The architecture of applications, the information architecture, and the technology architecture are unified by *Kalianov*[20] in the term **system architecture**.

We should consider **business architecture** as a natural superposed structural element within the EA, which – based on the system architecture – binds the enterprise into an entire system, directed towards maintaining dynamic balance and rational realization of goals. Business

Level 1	Corporate mission and strategy		
Level 2	Business architecture		
	Business processes	Organization structure	Documents processing system
Level 3	System architecture		
	Applications	Information (data)	Technologies

Figure 2. Enterprise architecture levels

[19] Bredemeyer, D., What it Takes to be Great in the Role of Enterprise Architect, http://www.bredemeyer.com
[20] Kalianov, G. N., Enterprise architecture and the instruments of its modelling (in Russian), Automation in industry, № 7, 2004.

architecture defines business strategies, goals, processes, the organization structure, roles and responsibilities, as well as the relations between them. It represents a basis for the definition of requirements to information systems and technologies, necessary for the performance of business activities.

Through constant interaction between its structural elements, EA provides the enterprise with the opportunity of successfully realizing the corporate mission and strategy, and increasing its flexibility. Therefore, in order to more comprehensively present EA in a structural aspect, we adopt the view of *Kalianov* about three EA levels (Figure 2): The **first level** includes the corporate mission and strategy, which determine the main direction of development for the enterprise and define the long-term goals and tasks. On this basis, the business architecture (**second level**) is built in the enterprise, describing the necessary business processes, information and physical flows, as well as the organization structure. The **third level** hosts the system architecture, which unifies the information architecture, the architecture of applications and the technological architecture. According to *Kalianov*, this level "determines the group of methodological, technological and technical solutions ensuring the information support of the enterprise activity determined by its business architecture".

4. Place of enterprise architecture in management of the enterprise

The role of EA, outlined so far with respect to the realization of the corporate mission and strategy, provides us with grounds to look for its place in the management process. Structurally, the management of the enterprise can be presented as a pyramid with the mission of the enterprise situated on top, giving an
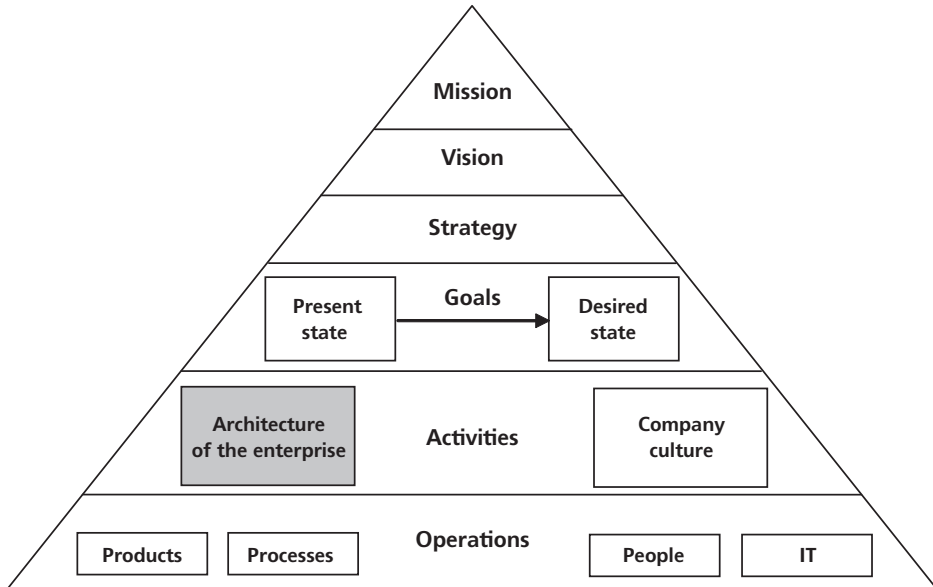
Figure 3. Enterprise architecture as a management tool [21]

[21] Lankhorst, M. et al., Enterprise Architecture at Work: Modelling, Communication, and Analysis, Springer-Verlag Berlin Heidelberg, p. 8, 2005.

answer to the question why the enterprise really exists (Figure 3). The vision presents the way, in which the enterprise sees its future, as well as the values it shares. Lower in the pyramid, there is strategy defining the way or path of attaining the mission and vision of the enterprise. The strategy, on its turn, is transformed into specific goals. The place of the enterprise architecture is on the next level – it gives an overall picture of present and future operations, as well as the actions, which should be undertaken in order to reach the goals of the enterprise. In parallel with the EA, an important role for reaching the goals is also played by the company culture, formed by the people and the management of the enterprise. The everyday operations carried out in the enterprise are at the basis of the pyramid.

We should underline that in the last years, EA is increasingly treated as an inseparable part of the **overall strategy** of the enterprise[22].

According to the study quoted above, carried out by the Institute for Enterprise Architecture

Developments in 79 companies[23] in 2003 / 2004, the number of organizations perceiving EA as an element of their strategic management is on the rise. In 2003, these were 60 % of the interviewed, while in 2004 this percentage reached 67 %.

In the context of enterprise management, EA can be considered as **a tool for organization development and change**. It can be said that the principles of organization of activities in the enterprise undergo a three-stage evolution: functional specialization – reengineering of the business processes – enterprise architecture[24] (Figure 4).

The vertical organization structure implies *functional specialization* of the different structural units in the enterprise. In this way, a specific level
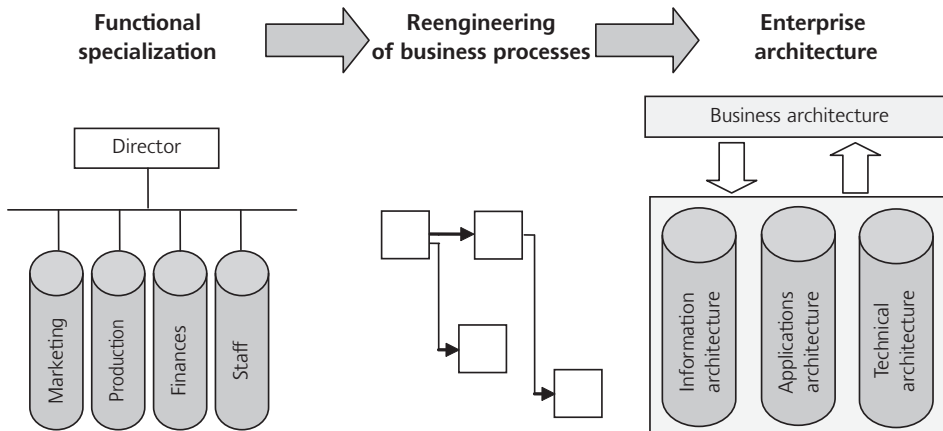
Figure 4. Evolution of organization principles[25]

[22] Vaidyanathan, S., Enterprise Architecture in the Context of Organizational Strategy, Business Process Trends, Nov. 2005.
[23] Trends in Enterprise Architecture: How are Organizations Progressing?, Institute For Enterprise Architecture Developments, 2004.
[24] Danilin, A. and A. Sljusarenko, Enterprise architecture (in Russian), online source, http://www.citforum.ru/consulting/articles/enterprise_arch/; Bredemeyer, D., R. Malan, R. Krishnan and A. LaFrenz, Enterprise Architecture as Business Capabilities Architecture, 2003, http://www.bredemeyer.com
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of efficiency in the performance of functions and processes, in which these units are specialized, is reached. Even though this structure is widely applied, it is already acknowledged from a long time that it results in weaknesses in the interaction between the different functional units and information exchange is a frequent problem.

The *reengineering* of business processes is based on the idea that the processes in the enterprise cross the lines of functional separation. This concept is associated with the name of Michael Hammer, who defines reengineering as a "fundamental revision and radical re-design of the company business processes with a view of achieving essential improvements in the existing efficiency indicators like costs, quality, services, and speed"[26]. For some companies, this approach

brings very good results. However, many failure cases are also registered and the inadequate information technologies and applied systems are considered to be the main reason for those failures.

The *enterprise architecture* concept examines the organization from the position of the system approach and places the emphasis on the role of IT for the realization of its goals. This makes it necessary to take into consideration the specific character of the business and business processes in the choice of technological solutions, not ignoring technologies in designing business processes, at the same time. EA provides an overall views on the way different systems contribute for the performance of activities in the enterprise.
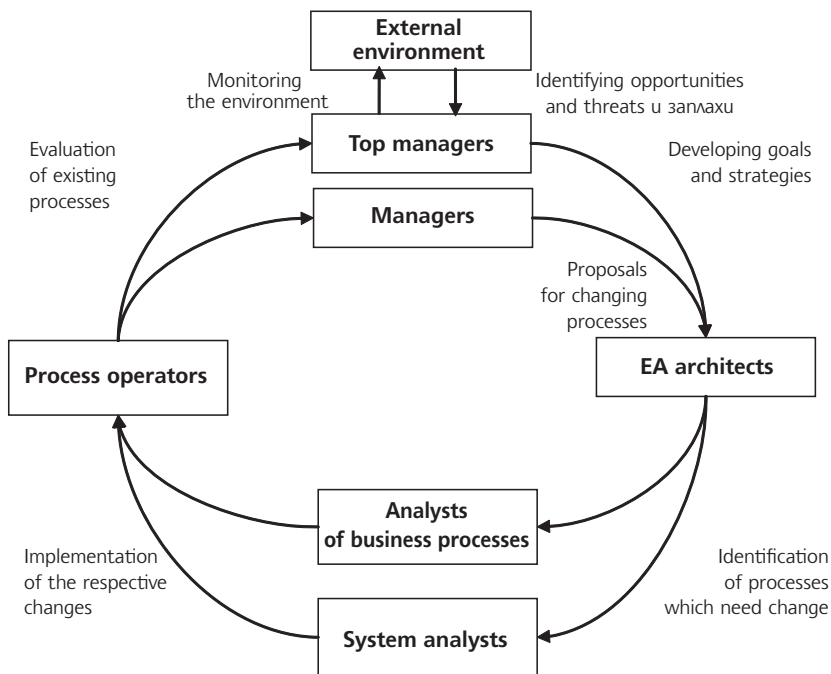
Figure 5. Cycle of building enterprise architecture[27]

[26] Hammer, M., Reengineering Work: Don't Automate, Obliterate, Harvard Business Review, July/August, pp. 104-112, 1990.
[27] Kalianov , G. N., Enterprise architecture and the instruments of its modelling (in Russian), Automation in industry, № 7, p. 3, 2004.

5. Building enterprise architecture

In practice, building EA can be considered as a sort of cyclical process with the contribution of several main participants (Figure 5).

As the successful achievement of the organization goals requires the system architecture to be based upon the business enterprise architecture, managers at different levels play a key role in the process of EA building. Through constant monitoring of the business environment and the identification of respective opportunities and threats, the top management of the enterprise develops the organization goals and strategies. Based on these goals and strategies, as well as on the proposals of the middle management, EA architects identify the processes which need change. The implementation of changes is done by system analysts and the analysts of business processes in the enterprise. Existing processes are evaluated by those, who execute them and they also present proposals for change, if needed. It should be underlined that a key condition for the introduction and maintaining of a successful EA is the following: *the starting point for EA building should be the vision, goal, and priorities of the business, not technology.*

Different methods are applied in practice for the description of enterprise architecture[28]. We consider that **Zachman** framework (Figure 6), published by John Zachman in 1987[29], can be presented as the clearest an most accessible method for EA description. Zachman framework is not only the first, but also the most preferred approach for EA description, which is confirmed by the above-mentioned study of the Institute For Enterprise Architecture Developments[30].

In the construction of his framework, Zachman used the notion **architecture** as a metaphor. He states that if we apply architectural approach to an enterprise, we will discover that developing and designing of an enterprise are not too different and is in no case easier than developing and changing the design of a building or airplane. Zachman considers that in the same way as a real object – a building or an airplane – can be designed through a series of different descriptive models, this approach can be applied to a conceptual object as, for example, an enterprise. The structural ordering of these models would provide the opportunity of identifying the logical relations between them. It is what Zachman achieves through the EA framework developed by him. Under the matrix form, he summarizes the descriptive models of the different structural levels in the enterprise, based on the principles of the system approach.

Zachman framework is made of six columns and five rows, constituting thirty cells. The obtained matrix describes the place of the different elements of the enterprise and their synchronization with each other, the links between them. The columns in the framework are defined by Zachman on the basis of six fundamental questions, which according to him, people have always asked in order to be able to understand and describe clearly and in details each object, no matter what the specific object is. These are the questions What – How – Where – Who – When – Why. On the other hand, the rows describe what is "seen" through the eyes of the users of the models and descriptions, contained in the cells of the respective row. While the upper row represents the widest prospective, the most general view on the enterprise, each subsequent lower level becomes more concrete and detailed.

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28 For example, The Open Group Architecture Framework (TOGAF); Extended Enterprise Architecture Framework (E2AF); US Federal Enterprise Architecture Framework (FEAF); Department of Defense Architecture Framework (DoDAF); Capgemini's Integrated Architecture Framework (IAF), etc.
29 Zachman, J. A., A Framework for Information Systems Architecture, IBM Systems Journal, Vol. 26, No 3, 1987.
30 Trends in Enterprise Architecture: How are Organizations Progressing?, Institute For Enterprise Architecture Developments, 2004.

	WHAT / DATA	HOW / FUNCTIONS	WHERE / LOCATION	WHO / PEOPLE	WHEN / TIME	WHY/MOTIVATION
SCOPE / Contextual prospective	List of things important to the enterprise / Text description	List of business processes / Text description	List of locations in which the business operates / Text description	List of the main participants / Text description	List of significant events. Periods and deadlines. / Text description	Mission. Goals. Strategies. Critical factors of success. / Text description
BUSINESS MODEL / Conceptual prospective	Defining essences, relations and rules / Diagram "essences – links"	Model of business processes / Functional diagram of flows.	Network model of the enterprise / Business locations and their links	Roles and responsibilities in each process / Organization diagram	Sequence of processes	Business plan
SYSTEM MODEL / Logical prospective	Logical data model / Diagram "essences – links"	Architecture of the application / Data flows diagram	Logical representation of the system architecture in the different locations	Architecture of the interface according to the role of different participants	Logical structure of processes	Business rules model
TECHNOLOGY MODEL / Physical prospective	Physical data model limited by the chosen technology	Description of technologies necessary for the implementation of processes	Physical network architecture / Link points, communication lines, etc.	Architecture of the interface according to the customers and tasks	Control structure Performance time	Developing business rules
DETAILED REPRESENTATION / Structural prospective	Data definitions	Programs and modules	Network components	Security architecture. Access permits / control	Time definition. Setting time for the events	Specification of rules

Figure 6. Zachman framework for enterprise architecture

The main advantage of the presented Zachman framework can be summarized using the words of the author himself: *"to enable focused concentration on selected aspects of an object without losing a sense of the contextual, or holistic, perspective"*[31]. We believe that it is exactly Zachman's holistic approach to the enterprise as a combination of many logically linked components that makes Zachman framework so successful and preferred by the business.

Conclusion

The EA concept is not popular in our business circles yet. In our country, as in the countries where this concept has already gained recognition, business organizations are not the pioneers in this field. For example, the Information strategy of the judicial system for the period 2006 – 2009, adopted by the Ministry of Justice of the Republic of Bulgaria, includes the implementation of the EA concept, presented in this article, as a way of synchronizing the introduced IT improvements with the strategic goals of this structure, of achieving flexibility and internal coherence of the components[32].

Enterprise architecture has one main purpose: to ensure the successful execution of all processes in the enterprise and, in this way, to increase its efficiency. Therefore, a key principle in EA design is the synchronization of IT with the mission, vision and goals of the organization. In this process, the hierarchical structure within EA should be strictly observed: strategic goals determine business processes, which determine information needs, which determine applications, which determine the infrastructure and technological solutions. Adopting EA by the enterprise would have a significant contribution for its successful development and survival in the conditions of the exceptionally dynamic from information point of view contemporary business environment.

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