The Information Architecture Framework For Enterprise Integration

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Abstract
The concepts of the Enterprise architecture and Enterprise information architecture (EIA) are discussed, and the framework of Enterprise information architecture is presented. The architecture-driven integration of Enterprisewide information systems on the basis of the EIA models is discussed.

Keywords: Enterprise information architecture, conceptual modelling, components of Enterprise architecture, basic domains, basic transactions.

1. Introduction
An architecture-driven approach to Information Systems development provides the consistent vision to Enterprise - as to IT based business processes integration. One of the key issues in improving the effectiveness of business-driven applications development is enhancement of Enterprise Information Architecture (EIA) [1,2]. Developments of Frameworks for EIA are directed to build a responsive IT, to support business process reengineering and to build business-driven applications. Enterprise Information Architecture is one of the components of Enterprise Architecture (EA), so concept “Enterprise Architecture” must be discussed also as one of the key issues in the area of Enterprise modelling.

2. The Universe of Discourse for Enterprise modelling
The Enterprise activities and interactions with environment are structured and described in the Universe of Discourse (UoD). The interpretation of dimensions of the Universe of Discourse in the different approaches (GERAM, D. Stevenson, J. Zachman, MSF MS [3, 5-11]) to the architecture-driven Enterprise modelling varies, but the common basic components (dimensions of the UoD) could be refined. This approach to the EIA modelling is based on the UoD with dimensions as follows [4]:
- (a) The Levels of Description of Enterprise activities;
- (b) The Domains of Enterprise activities;
- (c) The Life Cycle phases of the activities.

2.1 The Levels of Description
The dimension (or view) "The Levels of Description" of the UoD includes the levels of generalisation of Enterprise models as follows [4]:
- General level – specifies an Enterprise Architecture meta-model, dimensions of the Universe of Discourse (the UoD) for modelling of Enterprise activities and transactions are defined.
- Conceptual level (or architecture level) – this is a content level, conceptual models identifies business content of the Enterprise, describes functions and cross-function activities.
- Method level - specifies methods and techniques whereby the components of Enterprise are created and maintained (detailed design level).
- Infrastructure level – this level specifies the technology support of the components of Enterprise models (Deployment level).
2.2 The Domains of Enterprise activities

The dimension (or view) "The Domains of Enterprise activities" of the UoD includes the domains as follows [4]:

- the business domain (BD) - includes business processes (activities and facilities), critical to Enterprise functionality and development; for instance marketing, long-term forecasts, operations strategy, capacity planning, human resource management and other processes.
- the information domain (ID) - includes activities and facilities aimed to organise data and knowledge, necessary for Enterprise management and product development; for instance manufacturing standards, quality control standards, products and processes definitions, inventory files, and other activities.
- the domain of information processes (IPD) or application domain - identifies the major information processing activities the Enterprise performs to produce business driven decisions and products, for instance quality process and facility planning, scheduling, materials planning and control, and other processes.
- the product technology domain (PTD)- includes processes and facilities for development of the Enterprise products and services; for instance product design, materials processing, testing, materials handling, and other processes.
- the domain of workplaces (WPD) is defined as a set of different work locations, together with requirements for various functions at these workplaces.

Figure 1 depicts the Enterprise model on the General level of the UoD. Enterprise is considered as the set of basic domains BD, ID, IPD, PTD and basic transactions -internal transactions TR1 – TR6 between these domains, and external transactions TR7 – TR10 between Enterprise domains and environment.

The domain of workplaces (WPD) is assumes as the distributed one - it is mapped onto all other basic domains (the Figure 2) and transactions. For that reason WPD is hidden on the Figure 1. The interactions between WPD and items of Enterprise model (basic domains and transactions) could be conceptualised as a type of transactions too.
The types of workplaces correspond with the type of basic domains and with the type of basic transactions they are mapped to. For instance, the business workplaces, the information domain workplaces, the information processing workplaces and the product technology workplaces are identified.

The internal interfaces (TR1 -TR6) of the manufacturing companies includes all types of information flow supporting strategic, managerial and operational internal activities, for instance, material requirement planning, inventory management, facility planning and location, other. The external interfaces (TR7 -TR10) for manufacturing companies includes manufacturing standards, quality control standards, safety programs, customers, vendors and other types of external information transferring.

![Image](image.png)

Figure 2. The domain of workplaces is distributed one and is mapped onto the basic domains

2.3 The Life Cycle phases

The dimension (or view) "The Life Cycle phases of Enterprise activities" of the UoD is abstracted on the basis of the framework GERAM [3] and MSF LC [7], and includes the LC phases as follows:
1. Identification phase – includes the definition of general activities and items to be investigated.
2. Concepts phase – provides for the presentation and definition of the operational and structural concepts.
3. Requirements phase – allows the description of functional, informational, behavioural and capability requirements.
4. System design phase – is for specification of the system and all its components satisfying the above requirements.
5. Detailed design phase - is for specification of all components of system satisfying the above requirements.
6. Implementation phase – support the physical implementation of the designed system.
7. Managing (operation) phase – employs the released processes and the provided resources to support the functionality of the implemented system.
8. Reengineering (decommission) phase – this is system change phase, allows to re-engineer the processes and structures according to newly specified requirements.
9. End of life cycle phase supports the recycling of the system at the ending of its use.

The content of LC phases depends on the particularities of the domains and activity or process to be investigated. The content of LC phases depends on the level of description (conceptual, methods, infrastructure) as well.
3. The Enterprise Architecture Framework

The Enterprise model on the Architecture (Conceptual) level is named Enterprise Architecture Framework (or Conceptual Model of Enterprise). The Enterprise Architecture Framework (Figure 3) includes the conceptual models (or architectures) of all domains: the architecture of business domain (ABD), the architecture of information domain (AID), the architecture of information processes domain (AIPD), the architecture of product technology domain (APTD), and the architecture of workplaces of domains (AWP).

The Enterprise Architecture Framework also includes the conceptual models of domain's transactions - the domains interface architecture (DIA).

The conceptual model of business domain (BD) defines the architecture of BD (ABD). The ABD includes conceptual models required by the top managers for supporting Enterprise functionality and existence. These models provide executives with objectives and knowledge (methods) as well as with actual data for strategic planning, finance management, marketing, manufacturing management and human resources management. The ABD could be abstracted as the hierarchical structure of business activities.

The conceptual model of information domain (ID) defines the architecture of ID (AID). The AID includes conceptual models of the data and knowledge necessary to provide the Enterprise management and product development. The AID is deployed as a Repository, which involves data bases for providing actual data for production level (operators, line managers, middle managers, and data warehouses for providing data and knowledge for top and middle managers. The AID could be abstracted as the conceptual structures of data, knowledge and goals (objectives).

The conceptual model of information processes domain (IPD) defines the architecture of IPD (AIPD). The AIPD identifies conceptual models of the information processing activities (applications) an Enterprise performs to produce business driven decisions and products. The AIPD could be assumed as the hierarchy of Enterprise functions.

The conceptual model of the product technology domain (PTD) defines the architecture of PTD (APTD). The APTD includes conceptual models of the processes providing development of the Enterprise products and services. The APTD could be assumed as the hierarchy of Enterprise processes.
The conceptual model of the domain of workplaces (WPD) is the architecture of WPD (AWPD). The AWPD is defined as a set of conceptual models of the different workplaces, aimed to specify requirements for various functions at these workplaces.

The conceptual models of transactions TR1 - TR10 define the domain's interface architectures (DIA1 - DIA10) for definite pairs of domains (or domain and environment). Each of these DIA is particular one, and specifies the interaction (integration) of two different domains. Specification provides transferring of messages or objects between these domains.

4. Conceptual modelling of Enterprise domains

The conceptual model of any domain is assumed as a structure of the same components, namely:

- The conceptual data model of domain (DDM);
- The conceptual process model of domain (DPM);
- The conceptual interface models (DIMi, DIMj,...) of domain.

Figure 4 depicts a conceptual model (architecture) of domain. The content of components DDM, DPM and DIM for the particular domain depends on the type of the domain - these components are domain-dependent. For instance the conceptual data model of the business domain is quite different from DDM of the product technology domain; as well as conceptual process models (DPM) of domains are very specific too.

A conceptual data model (DDM) of the information domain is assumed as the conceptual model of repository for information, and includes data, knowledge and goals for supporting all Enterprise activities.

A conceptual data model of the business domain consists of specifications of business entities (objects and processes) critical to Enterprise external activities and top management: definitions of business rules, top management functions and information structures.

A conceptual data model of the information processes domain is assumed as the conceptual model of repository for information processing specifications (application logic repository).

A conceptual data model of the product technology domain (PTD) consists of specifications of PTD entities (objects and processes) aimed to provide the manufacturing of the Enterprise products and services.

A conceptual data model of the domain of workplaces (WPD is assumed as a specification of functional and structural requirements for definite IT-based place of work.

The conceptual process models of domains (DPM) are domain-dependent. They include models of both material flow and information flow (transformation processes) providing the domain-specific activities.

For instance, a conceptual process model (DPM) of business domain is the structural model of top management functions of enterprise including business interactions with market.

The conceptual interface model of domain (DIM) specifies models of interaction with definite domains, specifying the transferring (input and output) of data (messages) or objects.

For instance a conceptual interface model of information domain specifies transactions with all domains, directly - connection with interface architectures DIA1, DIA4, DIA5 and DIA9.
The conceptual interface models of domain (DIM)

The conceptual process model of domain (DPM)

The conceptual data model of domain (DDM)

Figure 4. The architecture (conceptual model) of domain

5. Conceptual modeling of domain’s transactions

The conceptual models of domain’s transactions (TR1 – TR10) integrates the activities of two different domains, and reasonably includes the components as follows:

- The conceptual interface model of the transaction TRx for the domain i (TIMi),
- The conceptual interface model of the transaction TRx for the domain j (TIMj),
- The conceptual data model of the transaction TRx (TDM),
- The conceptual information-processing model of the transaction TRx (TPM).

A conceptual model of domain’s transaction is also named “an architecture of domains interface” (DIA). A set of the conceptual models of domain’s transactions is assumed as the conceptual integrity model of the Enterprise domains.

The conceptual interface model of transaction for the domain i (TIMi)

The conceptual process model of transaction (TPM)

The conceptual data model of transaction (TDM)

The conceptual interface model of transaction for the domain j (TIMj)

Figure 5. The conceptual models of transactions or architecture of domains interface (DIA)

The architecture of domains interface (DIA) is domain-dependent because defines an interaction of two particular domains.

- A conceptual data model of the transaction TRx (TDM) is assumed as a set of definitions of objects (or entities) for providing data or object transferring between definite two basic domains.
- A conceptual information-processing model of the transaction TRx (TPM) is assumed as a set of specifications of procedures (or actions) aimed to provide data or object transferring between the same two domains.
- A conceptual interface model of the transaction (TIMj) is a specification of the link of particular DIAx with definite basic domain j. Each DIAx includes two interface models of the transaction (TIMi, TIMj). The TIMj specifies a link with a conceptual interface model (DIMj) of the definite domain j.

6. Enterprise Architecture and Enterprise Information Architecture

The concepts “Enterprise Architecture” (EA) and “Enterprise Information Architecture” (EIA) could be structured and defined on the basis of the Enterprise Architecture framework (Figure 3).
The Enterprise Architecture is the Enterprise model on the conceptual (or architectural) level, namely includes the structure of the domain’s architectures (ABD, AID, AIPD, APTD, AWPD), and domain’s interface architectures (DIA1 – DIA10) depicted on the Figure 3.

The Enterprise Information Architecture is considered as a part of the Enterprise Architecture, which serves for co-ordination of domain (internal) activities and integration of external activities of domains (co-ordination of interactions between domains). The EIA includes only information flows and transformations. The domains IA and the IA of domain’s transactions are refined in this approach. So, the IA of business domain, the IA of product technology, the IA of information domain, the IA of information processing, and the IA of workplaces are identified.

Figure 6. The types of Enterprise information architecture

The IA of domains interaction is the part of domains interface (DIA); it includes only information flows and transformations of the interaction.

The EIA could be classified on the basis of the functional view to the Enterprise activities, and some important types of the EIA are refined. The integration of business domain and product technology domain is important issue. This point of view identifies the management information architecture as the basis for MIS – management information system (Figure 6). The development of ERP (Enterprise Resource Planning) systems requires more wide interpretation of EIA – the integrated information architecture for ERP systems is depicted on the Figure 6.

Thus, the particular type of Enterprise information systems (ERPS, MIS, EIS – Executive IS, DSS – Decision Support Systems) requires a definite type of information architecture. The EA framework (Figure 3) is assumed as the basic structure for development of the detailed architectures of all types as depicts the Figure 6.
7. Conclusions

Modelling of Enterprise integration is considered as a multi-dimensional problem of investigation of the enterprise activity domains, description levels and life cycle phases of activities. The structure of the Universe of Discourse is defined and used for the development of the Enterprise Architecture Framework (EAF). This EAF is aimed for IT based integration of Enterprise activities - business processes, management processes, production design, manufacturing control processes. The EAF is considered as a top-level framework for component based application development [12].

The Enterprise Architecture Framework refines the basic Enterprise domains and transactions. The decomposition of the Enterprise in the UoD refines the scope of the problem “Enterprise integration”. That includes development of the models of Domains as well as models of Domain’s transactions at all levels of description - from the general to infrastructure level. The development of each component is considered to follow the life cycle phases listed above.

The paper deals only with the conceptual or architectural modelling of these domains and transactions. The detailed development of these conceptual models is predefined as decomposition at the lower levels of description in the UoD: at the method level and at the infrastructure level.

Also, the approach to the identification of the Enterprise Information Architecture and types of the EIA on the basis of the functional view is developed.

8. References


