Genres and Ontologies in Enterprise Architecture – A Short Introduction to GOBIAF

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Abstract

This paper introduces Genre and Ontology-based Business Information Architecture Framework (GOBIAF). The aim of Business Information Architecture (BIA) is to support the development of holistic information management principles in geographically dispersed environments. Communication genres and information need interviews are used as a domain analysis method. Ontologies are used as a business infrormation architecture representation mechanism to explicate the results of domain analysis.

1 Introduction

Distributed organisations face challenges in trying to holistically manage information that is scattered to geographically distributed and culturally heterogeneous business units. A significant part of business critical information flowing in business processes is based on actual data originating from production processes. The use of process-related information should be supported and developed to support business objectives and requirements. The problem is, however, twofold. First, due to the high-level specialisation of business units, the domain-specific issues require specialised knowledge to allow one to interpret and take appropriate actions. Second, the vocabularies used in various business units may overlap or be incompatible. The fundamental need is to manage complex and distributed entities as an entirety.

To overcome these problems, the Genre and Ontology based Business Information Architecture Framework (GOBIAF) was developed, aiming to support business critical information management based strategic and operational thinking, forcing dispersed business units to define, evaluate, and manage local business information in a collective and harmonised way. Business information architecture (BIA) descriptions are achieved through an iterative development process: from genres and information need interviews to ontologies and from genre-based ontologies to BIA descriptions. The focus is in domain analysis method and ontology develoment, excluding the actual architecture implementation in an operational environment.

This paper provides a general overview to GOBIA framework (see Figure 1), including a novel arcitecture taxonomy, genre-based domain analysis method and ontology-based architecure representation and management mechanism. For more detailed discussion on the subject, the reader is referred to [11] or [13]. Section 2 reviews theoretical background related to genres, ontologies and enterprise architecture. Section 3 introduces the general structure of GOBIAF. Finally, section 4 concludes the paper.

2 Theoretical Background

In this section, we provide a brief review of the theories and terminology related to genres, ontologies and enterprise architecture. Our goal is on the ways to interconnect the concepts.

2.1 Data, Metadata and Ontologies

An ontology is an explicit specification of a conceptualisation [8]. Because ontological analysis clarifies the structure of knowledge [3] within a specific domain, ontologies can be used in an integration task to describe the semantics of the information sources and to make the content explicit [21]. While the formality and specificity of ontologies varies, they are used to model real-world knowledge in a machine-readable way. However, it is important to clearly distinguish between ontology (classes and persistent instances), metadata (instances that are used to describe the actual data), and data. Together, ontology and

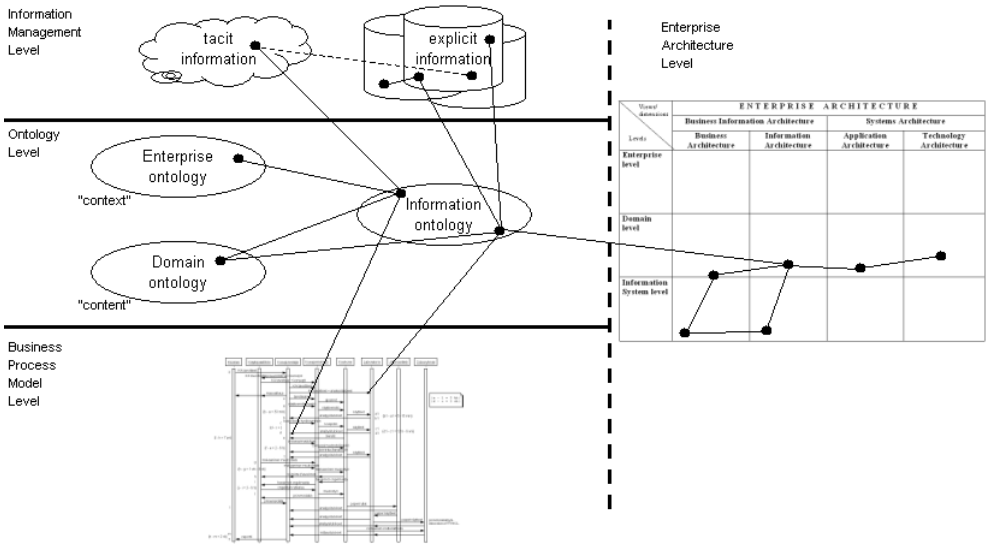

Figure 1: GOBIA Framework.

metadata descriptions constitute a knowledge base.

RDF (Resource Description Framework) is a language for representing information about resources [14] addressable by URI. RDF is not just a syntax, but a graph-based data model usable for complex metadata descriptions. This flexibility and its increasing usage in the semantic web make RDF an adequate base for general-purpose ontology descriptions. For definition of classes and property types, OWL (Web Ontology Language) [15] was developed on top of RDF. Thus, OWL ontologies are valid RDF graphs as such, allowing detailed specifications and constraints of the classes. From the OWL sub-language family, OWL DL (description logic) provides moderate expressibility and guaranteed computability for ontology descriptions and was selected as the ontology language used in this paper.

2.2 Communication Genres

Genres are prototypical models for communication [19]. Genres of organisational communication represent a typified piece of information, responding to a recurrent communicative situation, carrying an identified name, serving specific purposes, and enacting social substance(s) and form(s) [22]. Thereby, genre instances usually include domain specific information concept(s) expressed as part of organisational communication [11]. We define information concepts to be anything that can be addressed and manipulated by a human or a system as a discrete entity. These information concepts derive from organisational culture and its permanent vocabulary, and are used in everyday tasks. Information concepts aggregate related data and knowledge to form packages describing real-life entities.

Genres are typified social actions, implying high domain knowledge whose explication is the target of ontology development. Ontology development suffers from its comprehensive, low abstraction level nature, requiring large amounts of resources to be attained from scratch. The traditional, unstructured data collection techniques such as observations, document analysis, and discussions [24] seem to be inadequate. Genres and ontologies complement each other as genres provide means to model communication taking place in business processes. Genres highlight business critical information concepts that are the classes to be modelled in domain ontology. Open and semi-structured information need interviews [7] seem to provide a practical way to acquire this knowledge from key interest groups. The results of genre analysis are extended to represent not only existing resources but also organisational requirements.

2.3 Enterprise Architecture

EAs are tools to evaluate the current and future business objectives through examining the key business, information, application, and technology issues and their impact

on business functions [17]. As an EA is the glue integrating these distinct issues into a cohesive framework, an EA may establish an enterprise's mission through optimal performance of its core business processes within an IT environment [5]. Architectural descriptions provide a way to map the information needs of an organization, to relate them to specific business functions, and to document their interrelationships to guide software development and to facilitate integration and sharing of data [2]. This is why architectural descriptions aim to act as a bridge between the hard and soft sides [23] within organizations.

Because architectural descriptions are exactly as good and valuable as the underlying (source) data, methods used in domain analysis as well as tools for representing the results have to be rich and extensive enough (Kaisler and Armour 2005). Further, state transition diagrams and use cases that are traditionally used in architecture development [5] are valuable tools as such but their interconnection is weak, i.e., in alteration situations where changes in one model should be mapped to all the related models. Even if there have been attempts to provide coherent architecture descriptions [10] there still exists a need for a single model type and notation for modeling the semantics between entities in EA models [6].

3 GOBIAF

Theoretical examination of the concepts of EA, ontologies, and genres seems to establish some major similarities to make them feasible candidates for integration to complement each other. Ontologies, for one, traditionally suffer from an information acquisition bottleneck [16] to reach essential, domain-specific conceptualization for what the genre-based analysis method is designed for. Moreover, recent architectural approaches seem to lack consistent information representation mechanisms that ontologies provide. Altogether, the concepts form the basis for four levels that together compose GOBIAF: the business process model, information management, ontology, and enterprise architecture levels (see Figure 1.

The problem in recent EA taxonomies (e.g. [18]) has been how to position informational

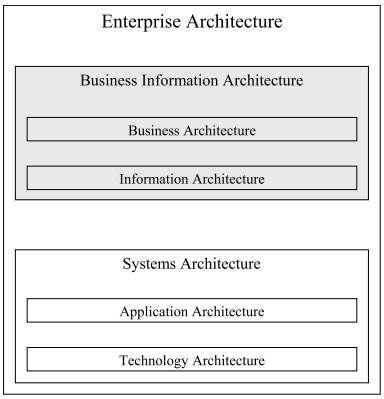

Figure 2: BIA in architecture taxonomy.

issues when reflecting the dual nature of contemporary organizations. That is, all technical aspects of an organization, which are managed in application and technology architectures, are perceived to belong to the hard side of an organization. The soft side, in turn, consists of business perspectives and sociotechnical aspects that are discussed in business architecture. Instead of placing information (architecture) on the hard side with applications and technologies, it may be placed on the soft side with business architecture. This kind of architecture taxonomy (see Figure 2) implies that there are whole bulks of business information (requirements) that are not necessarily expressed in explicit formats, i.e. in digital documents. This highlights the role of applications and technologies as supportive elements of business operations [12].

The aim of GOBIAF is to express an in-depth state of the most important aspects of key business processes and related information as well as their management, so that extensive horizontal and vertical communication of business information can be assured in the organizational scale. Therefore, the direction of emphasis is, first, on business (processes), second, on information necessary to operate the business, and, third, applications and technologies necessary to support business operations. Even if the overall setting sounds hierarchical, we do not want to present it that way because of the genuine need for iterative development in practice. Thus, the issues in the framework are mentally approached top-down (architecture principles set guidelines and constraints for the development process) but the actual EA definition process takes place in a bottom-up fashion (genre analyses

provide knowledge for ontologies and genre-based ontologies provide knowledge for architecture descriptions). As a result, architecture descriptions are acquired through an iterative development process that is twofold: from genres (business process model level) and information need interviews (information management level) to ontologies (ontology level) and from genre-based ontologies to BIA descriptions (enterprise architecture level).

3.1 Business process and information management levels

The first step in the BIA development process is genre analysis [20] and information needs elicitation [12]. Within GOBIAF, the main target of the genre analysis is to accomplish an extensive process model from the organizational communication point of view. Thus, the original diagonal matrix contrived in genre sessions is elaborated to a process model (e.g. a sequence diagram) where genre instances represent activities related to specific sequence of events. In contrast to mere information flows, genres emphasize the social aspects of communication, implying human comprehension and impact to the particular communicative situation. Through this characteristic, genres provide a way to reach deep, domain-specific knowledge of informational issues that is of special interest in GOBIAF. Thus, we do not necessarily need any rigid business process modeling language, such as BPEL, the use of which would be a prerequisite when focusing on business process harmonization (cf. [4]).

Genre analysis reveals the existence and utilization of contemporary information systems and applications but it is not capable of, or even intended for, describing the systems in detail. Furthermore, the genre-based analysis method does not reveal the usage needs, i.e., how different interest groups are likely to use the managed information or even what that information is, or should be. Open and semi-structured information need interviews (at the information management level) are, thus, seen as prerequisites for deepening the knowledge of the existing systems. Thus, all the relevant interest groups are interviewed to get an overall understanding of the actual organization-wide daily information needs. The participants are encouraged to evaluate and rethink their operations and routines. Once the needs of individual groups are identified, they are summarized and presented in a meeting where all the interest groups are present. This facilitates a lot of interesting discussion that is crucial for the development process as a whole. Thus, the interviews are seen as a mechanism for elaborating the needs in order to enhance the overall organizational information management.

3.2 Ontology level

Once extensive domain analyses in both business process and information management levels are conducted, ontology construction begins to bind these distinct sources of information together. In short, the role of ontologies in our case is to define business unit-specific information concepts related to cross-organizational value-chains in pre-defined periods of time, i.e., a specific communicative action (genre), in a business process.

As already stated, this means that the results of genre analyses give overall knowledge about the present state of operational activities. It also hints of the state of organizational information management related to the information concepts, occurring in business processes. The information management level, in turn, complements the genre analysis by providing extensive information about the state of information management and related (future) requirements, as well as the knowledge of the usage of contemporary information systems, applications, and technologies underneath. Both of these aspects are modeled in further detail on the ontology level.

The ontology level complies with the division presented in [1] where knowledge of the information creation context is linked to information content through generic information characteristics (Figure 3). Thereby, the ontology level consists of three ontologies that together aim at describing different kinds of information sources with their respective structure, access, and format properties. The enterprise ontology is aimed to provide information about business process specifications on different abstraction levels. The process models derived from genre analysis are obtained into enterprise ontology descriptions. The domain ontology, for one, presents the content of information concepts and their semantics as well as the relation to the overall organizational information resource. The information

Table 1: Data layers in GOBIAF ontology level (domain ontology adapted from process industries).

	Enterprise ontology	*Information ontology*	*Domain ontology*
Ontology layer (classes)	Metamodel for business process models	Metamodel for information categories in organisational communication	Domain concepts for a given domain
Metadata layer (instances)	Business process models	Genres as well as information creation and utilisation contexts	Equipment configurations and measurement property information
Data layer	Execution logs from a workflow system	Document and metadata contents related to genre instances	Measurements and other context specific data

ontology, in turn, provides links between the enterprise and domain ontologies, addressing generic concepts and attributes that apply to all kinds of information within an enterprise.

Table 1 shows the role of ontologies in relation to data elements described earlier in the context of process industries (see [12]). Ontology and metadata descriptions, i.e. RDF graphs constrained with OWL ontologies (see [14]) to specify the concepts and/or properties (the ontology) used in metadata descriptions, together constitute a knowledge base, but with some differences compared to a traditional knowledge-based system. URIs are used as a reference mechanism so that metadata descriptions can be distributed and the annotation of a multitude of resources becomes possible. Thus, it is possible to enforce consistent ontologies and practices for metadata annotations within an organization, alleviating the challenges of logical contradictions in ontology descriptions.

3.3 Enterprise architecture level

The enterprise architecture level is represented as a 3*4 matrix (Figure 4) with architecture views (business, information, application, and technology architectures) on the x-axis, and levels (enterprise, domain, and information system/operative levels) on the y-axis in line with FEA [5] and EA Management Grid [9]. Further, architecture dimensions presented on the z-axis provide different abstraction levels, viewing the total architecture description grid. In contrast to FEA and EA Management Grid, the level of abstraction of the architecture dimensions can be altered from the so-called traditional dimension (business, information, application, and technology architectures) to the BIA dimension where business and information architectures are mapped together. The total EA contains BIA and systems architecture (SA), which consists of application and technology architectures. The traditional dimension is perceived as a starting point in formulating the scope of the total BIA/EA development process. The organizational levels (y-axis) are included in all the dimensions to support decision-making taking place in different hierarchical levels in an organization.

Information presented in the BIA dimension is obtained from ontology descriptions, reflecting all the relevant aspects of the domain at hand (e.g. semantic queries, inference-based classification, links and pointers to existing documentation, guidelines and strategies). To be specific, information provided in ontology descriptions describes the relation between activities and actors in business processes (enterprise ontology) and significant information concepts (domain ontology). As the ontology level describes different kinds of information sources with their respective structure, access, and format properties, ontologies can be taken as an architecture description language in BIA. Thereby, a knowledge base of RDF graphs constrained with OWL ontologies provides a coherent information representation mechanism that seems to be missing in the domain of EA.

Ontology descriptions are described on the Information System/Operative Level in the form of knowledge base (1). To provide BIA information on the Domain Level, the abstraction level of presented information is increased to provide more holisticity in the descriptions. That is, where Information System/Operative Level was intended to provide detailed information about, for example, the activity level operations in business

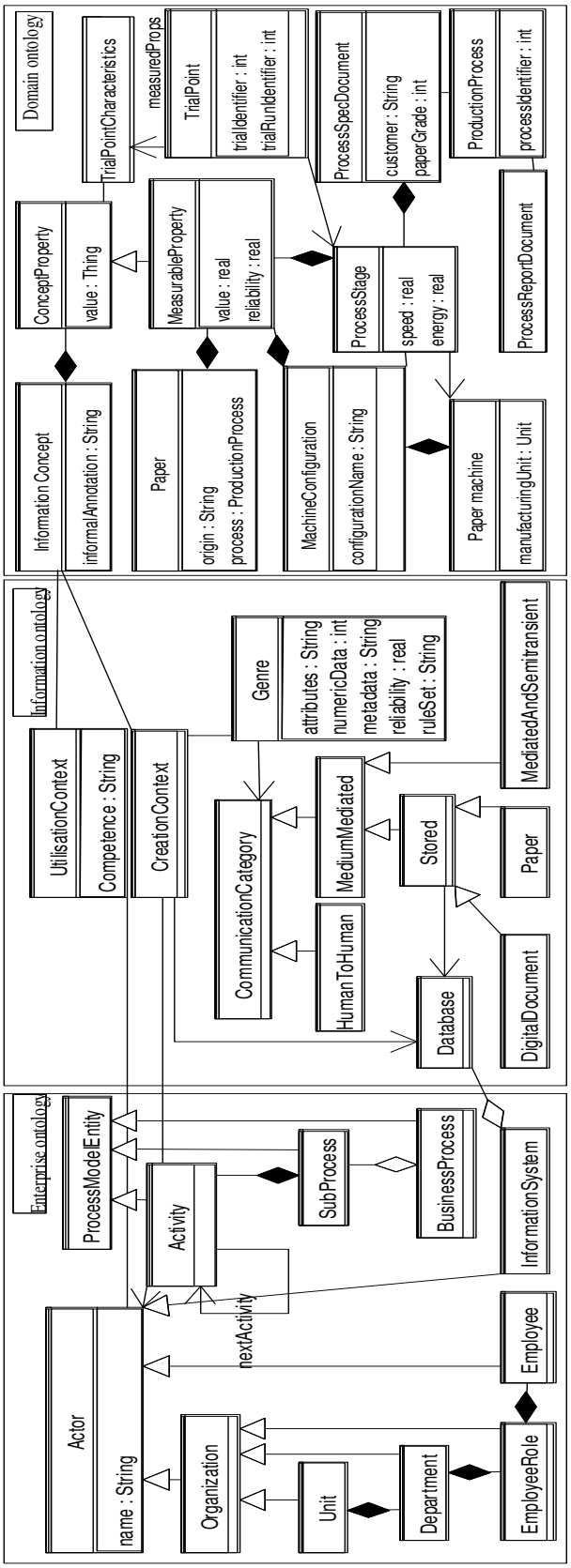

Figure 3: A sketch of the GOBIAF ontology level (domain ontology adapted from process industries).

Views/ dimensions / Levels	ENTERPRISE ARCHITECTURE			
	Business Information Architecture		**Systems Architecture**	
	Business Architecture	**Information Architecture**	**Application Architecture**	**Technology Architecture**
Enterprise level	- Aggregated business requirements from corporate and enterprise perspectives - Requirements for strategic, enterprise-level ICT usage - List of main business processes, functions, and actions that the enterprise performs	- A list of aggregated business assets in which the enterprise is interested - Strategic information management decisions - Common information structures	- *Strategic application portfolio of the whole organization* - *High-level application architecture, application – process summary*	- *Strategic technology portfolio* - *EAI architecture roadmap principles* - *Technology principles* - *Technology/solution alternatives and choices* - *Core technology selection and maturity analysis*
Domain level	- A model of the actual business processes that the enterprise performs, independent of any system or implementation considerations and organizational constraints. - Presented as sequential diagrams that are derived from genre analysis - Targeted business requirements (needs) from BU perspective	- The relation (information ontology) between business processes (enterprise ontology) and significant informational assets (domain ontology) presented in ontology level descriptions (semantic model based on genre and information management level analysis)	- *Application map per each application domain* - *Applications and their relations (interoperability etc. requirements) based on overlaps in the semantic model*	- *Domain-level technology decisions* - *Integration architecture* - *Technology & application architecture* - *Product line architecture* - *Technology alternatives and choices*
Information System/operative level	- A model of the logical state of business operations and their relation to the operational requirements (development proposals in genre analysis) - Information need interviews	- A model of the logical representation of the business assets about which it records information (data storages) - A model may include aspects that should be digitally managed (tacit knowledge)	- *A model of the logical systems implementation supporting the business processes*	- *Systems-level technology platform* - *Application architecture principles and patterns*

Figure 4: GOBIAF Architecture Level.

processes, the Domain Level focuses on operations described in the business unit level. In other words, only the ontology layer is presented on the Domain Level. Further, the Enterprise Level is achieved by further increasing the level of abstraction, aiming to produce aggregated business and information requirements in which an enterprise is interested especially in a strategic sense. The Enterprise Level integrates the unit-specific descriptions, showing the semantics between unit-specific information concepts through which the possibilities for data level integration can be evaluated. Architectural descriptions on this level need declarative explanations that can be augmented afterwards to the traditional dimension to show the semantics between the architectural dimensions that, in turn, increase the readability of the descriptions.

4 Conclusion

In this paper, we build on findings derived from recent literature and from practical experiences, addressing the importance and usefulness of the soft side of organizations to act as a baseline in EA development. A business information driven approach is, however, remained somewhat unexplored because most of the contemporary EA models are focusing on evaluation and development of technical aspects of total EA. The technical orientation may, however, be problematic because business is supposed to be accommodated to constraints IT poses. Further, contemporary EA models seem to focus on representing existing resources and information already managed in digital formats.

When business information is used as the baseline for EA development a few issues have to be taken into consideration. The first one is how to differentiate business information from its initial contexts in an efficient, extensive, and standard way. The second problem is how the semantics between the derived information set can be presented and, third, mapped to EA descriptions. The paper demonstrates how not just communication

genres complement ontologies but also how genre-based ontologies complement EA descriptions, providing synergy between them to address the issues mentioned above. The core concepts and the generic steps of development process, defining the GOBIAF are presented in the paper.

The main reason for using ontologies instead of traditional enterprise architecture description mechanisms derives from the assumption that most contemporary enterprises do not develop information systems internally anymore. Instead, they acquire and integrate enterprise application packages to form a desired backbone for their enterprise. Thereby, without a formal and abstract method to describe organization-wide business information requirements, enterprises may not have control over their architectural descriptions because they have to adopt information and process models embedded in the software packages. Thus, the usage of ontologies as an information system independent enterprise architecture description language brings several advantages especially when an organization is planning to alter its actual structure and processes reported in the baseline EA.

In addition to advantages in describing semantics between information concepts, ontologies also provide a shared vocabulary and point of reuse when collaborative information systems are developed based on derived architecture descriptions. This stems from the fact that formal ontologies are, in contrast to EA, executable entities, describing EA from different points of view. Thereby, the use of ontologies in EA descriptions makes them truly valuable, not just as general blueprints of reference after completing the architecture but also in actual implementation of solutions to achieve greater efficiency. In practice, ontologies in architecture descriptions seem to bind the soft and hard sides of an organization closer together and, consequently, to decrease the possibility of the traditional business/IT alignment problem.

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