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Applying Genre-Based Ontologies to Enterprise Architecture

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Abstract

This paper elaborates the approach of using ontologies as a conceptual base for enterprise architecture (EA) descriptions. The method focuses on recognising and modelling business critical information concepts, their content, and semantics used to operate the business. Communication genres and open and semi-structured information need interviews are used as a domain analysis method. Ontologies aim to explicate the results of domain analysis and to provide a common reference model for Business Information Architecture (BIA) descriptions. The results are generalised to model further aspects of EA.

Keywords

Enterprise architecture, business information architecture, ontology, genre, systems integration

Introduction

Distributed manufacturing organisations face significant challenges in trying to holistically manage information that is scattered to geographically dispersed and culturally heterogeneous business units. A significant part of business critical information flowing in business processes is based on actual data and knowledge originating from production processes. Equipment manufacturers use statistical data to indicate the functional and economical properties of the production machinery to be sold. Business analysts use knowledge acquired from domain analysis to develop high-level organisational strategic objectives. In both cases, the fundamental need is to manage complex and distributed entities as an entirety. Enterprise Architectures (EA) can be used as overall blueprints for applying information technology (IT) to achieve business objectives (van den Hoven 2003) and to provide a holistic view of the enterprise.

Contemporary EA frameworks, such as the classical Zachman's Framework (1987) or Federal Enterprise Architecture Framework (FEAF, CIO Council 1999) either lack a holistic information representation mechanism, or are technology-driven, providing negative impacts on the overall perception and outcome of an EA from a business perspective. The Genre and Ontology based Business Information Architecture Framework (GOBIAF) (Kilpeläinen 2006) 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 (i.e., GOBIAF levels): from genres (business process model level) and information need interviews (information management level) to ontologies and from genre-based ontologies (ontology level) to BIA descriptions (architecture level).

There have been some attempts to provide coherent architecture descriptions (e.g. Jonkers et al. 2003), and to integrate ontologies and architectures. Kyaruzi & van Katwijk (1999) have applied an ontology-based approach to software architecture. The UK Ministry of Defence Architecture Framework (MODAF, Bailey 2006) utilises a common terminology and library of standard elements, ensuring that each instance of an architectural element uses a commonly agreed and shared definition for its name. However, none of the mentioned frameworks use genres and business information as a base for architecture development. In general, there still exists a need for a single model type and notation for modelling the semantics between entities in EA models (Ekstedt 2004).

This paper covers the architecture level of GOBIAF, elaborating the overview described in (Kilpeläinen 2006). The BIA development process is briefly reviewed along with theoretical background on genres and ontologies. The relation between ontologies and architecture descriptions is explicated and directions for systems implementation are outlined. The results are generalised to account further aspects of enterprise architecture.

Theoretical Background

In this section, a general background to genres and ontologies is provided. Domain analysis and ontology construction phases of GOBIAF are reviewed using a distributed production process line (PPL) in the process industries as an example. For details, see (Kilpeläinen, Tyrväinen & Kärkkäinen 2006; Kilpeläinen 2007).

Genre-Based Ontologies

An ontology is an explicit specification of a conceptualisation (Gruber 1993). In GOBIAF, classes and persistent instances are perceived to belong to ontology whereas instances that are used to describe the actual data should be perceived as metadata. Together, ontology and metadata constitute a knowledge base. Because ontological analysis clarifies the structure of knowledge (Chandrasekaran 1999) 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 (Wache et al. 2001). While the formality and specificity of ontologies varies, they are used to model real-world entities in a machine-readable way. RDF (Resource Description Framework) -based (Manola & Miller 2004) OWL (Web Ontology language) can be used to model ontologies (McGuinness & van Harmelen 2004).

Genres are prototypical models for communication (Swales 1990). 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) (Yates & Orlikowski 1992). Thereby, genre instances usually include domain specific information concept(s) expressed as part of communication (Kilpeläinen 2006). We define information concepts to be anything that can be addressed and manipulated by a human or a system as a discrete entity. 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.

Ontology development has traditionally suffered from its comprehensive, low abstraction level nature, requiring large amounts of resources to be attained from scratch. The traditional data collection techniques such as observations, document analysis, and discussions (Zhou & Dieng-Kuntz 2004) seem to be inadequate. Genres and ontologies complement each other as genres provide means to model communication taking place in business processes, implying high domain knowledge. Genres highlight business critical information concepts whose explication is the target of domain-based ontology development. Open and semi-structured information need interviews (Fontana & Frey 2000) 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 which can be further utilised in EA descriptions. Mapping between the data the genre-based analysis method (e.g., Tyrväinen, Kilpeläinen & Järvenpää 2005) provides for ontology development will be presented elsewhere in a more extensive manner.

Domain Analysis

The business process (production process line) in the case organisation (e.g., Kilpeläinen, Tyrväinen & Kärkkäinen 2006) was modelled in detail from the organisational communication point of view and enhanced with genre metadata. Sequence diagrams were used as a business process description mechanism in which genre instances represent communicative activities related to specific periods of time. The sequence diagram is an example of flow of activities, not a normative definition of the process. This is because the goal was to obtain the business critical information concepts rather than analysing the actual order of events in the flow of the process. Thus, the usage of a complex business process modelling language, such as Business Process Execution Language (BPEL), is not required.

The modelled business process can be divided to three sub-processes (Figure 1) that flow through distinct business units in the same format: preparation and specification (SP1), production (SP2), and reporting (SP3). SP2 roughly consists of pulping, base paper production, and finishing stages during all of which customers are involved. The unit-specific operations and resources are allocated with the aid of production process specification document which is done by a master unit, administering the production process. The three business units involved specify their internal operations, run the actual production, and report the results as autonomous entities. After agreeing on business critical information concepts, which have importance through the whole process, and on metadata describing them, we decided to focus on a single but essential information concept, namely the trial point to aid data level integration throughout the geographically dispersed PPL. Trial points represent a state of a production process within a specific timeframe by measuring characteristic properties of quality measurements and process indicators. Multiple trial points can be taken along a production process.

The request, or the genre instance of a communication genre named "trial point request" describes a situation where an actor (i.e., roles, groups, departments, and processes of the organisation exchanging information) requests another actor to measure characteristic properties of a process substance associated with a trial point. The genre instance includes one or more domain-specific information concepts (e.g., a trial point) and documents that relate the communicative activity, being a part of a business process, to information representing it. Thereby, the information concept acts as a bridge by providing a common denominator between the process and data in heterogeneous databases. The information concept itself includes knowledge that is not communicated because it is tacit for both parties, and it is not necessary in terms of successful outcome of the action. Notwithstanding, the concept is related to the total organisational knowledge.

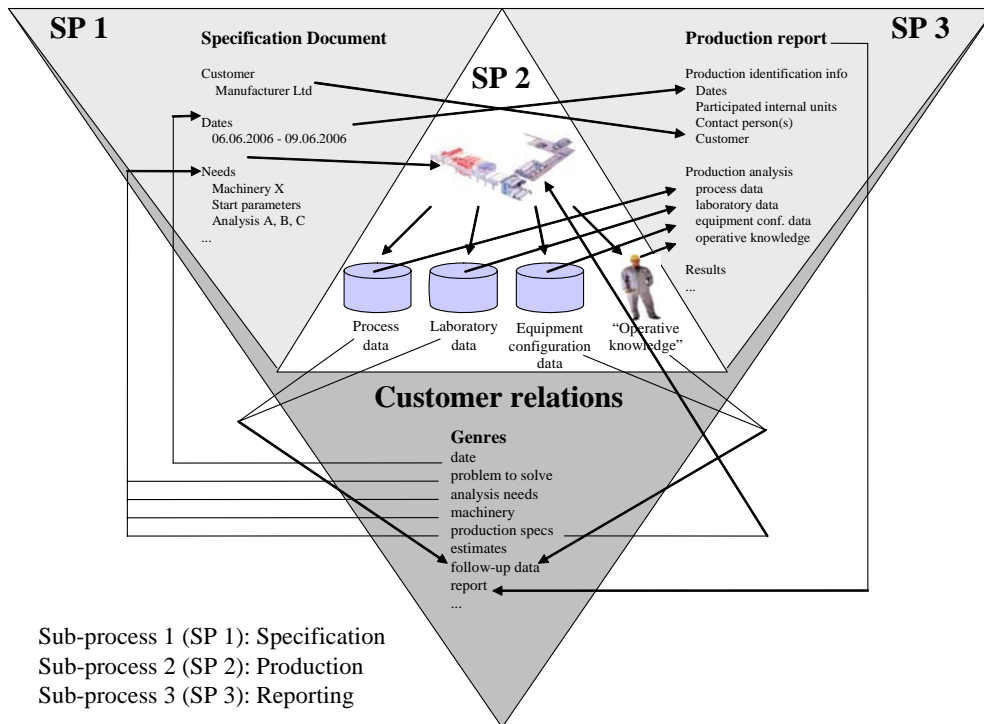


Figure 1: Coarse outline of a business process and its sub-processes

As a general outcome of the domain analysis, we found out that the correlation between process, laboratory analysis, equipment configuration, and other data as well as operative knowledge (Figure 1) was unsubstantial, or required hard work to attain. Further, the naming practices used were also incompatible. In addition, it turned out that most of the information concepts needed for data management already exist but their exploitation in information systems level as a means for data integration took place only occasionally. The overall state of the management of business critical information did not provide basis for an efficient customer service, e.g., in providing timely and PPL-wide follow-up data.

Ontology Construction

The GOBIAF ontology level describes different kinds of information sources with their structure, access, and format properties. The aim of the ontology is to describe all the business critical information concepts (that are derived from the domain analysis phase of BIA development process described above) within business processes and model the semantics between them regardless of the physical business unit boundaries. Ontologies should also reflect the current and future state of the information management (e.g., tacit information to be explicated) and business processes (e.g., PPL-wide reporting in addition to business unit specific reporting). The division of the ontologies is adopted from (Abecker et al. 1998) where three ontologies span the dimensions of information modelling. Table 1 summarises the structure of the knowledge base containing ontology descriptions with a domain ontology, being specific to process industries.

Table 1: Data layers in the ontology level in GOBIAF

		Enterprise ontology	Information ontology	Domain ontology
Know- ledge base	Ontology layer (classes)	Metamodel for business process models	Metamodel for information categories in organisational communication	Domain concepts for a given domain (e.g., process industries)
	Metadata layer (instances)	Business process models (i.e., process specifications)	Genres as well as information creation and utilisation contexts	Equipment configurations and process measurement property information
Data layer		Execution logs from a workflow management system	Document and metadata contents, transactions related to genre instances	Measurements and other context specific data

- *The enterprise ontology* provides information about business process specifications on different abstraction levels. The ontology layer contains a generic metamodel of the process models (e.g., definition of a business process and organisational units), metadata layer contains business process models and organisational relations, and the data layer consists of activity logs from a workflow

management system (if available). The business process models (sequence diagrams) derived from genre analysis are transformed into metadata layer of the enterprise ontology, consisting of successive and parallel communicative activities that indicate the flow of activities performed by actors communicating.

- *The domain ontology* presents the content of domain-specific information concepts and their semantics as well as their relation to the overall organisational information resources. In the process industries example, the ontology layer contains a partial domain model related to trial points, paper machines, and related documents. The metadata layer contains links and specifications for particular paper machine configurations, properties to be measured, and pointers to databases containing the actual measurements. The data layer contains the databases and other repositories (e.g., paper files) where measurement information and machine configurations (e.g., construction drawings) are stored.
- *The information ontology* provides links between the enterprise and domain ontologies, addressing generic concepts and attributes that apply to all kinds of information within an enterprise. The ontology layer is derived from the categories of communication forms (Tyrväinen 2003) (see CommunicationCategory in Information ontology in Figure 2) used in the genre-based analysis method. Metadata layer, in turn, contains genres, as well as creation and utilisation contexts connecting the information concepts to organisation units and work roles of interest. Communication categories are used to classify genre instances along with other genre-related metadata. The actual document contents and database transactions related to a given genre instance form the data layer.

While the development of enterprise and information ontologies is relatively straightforward to the extent that class data can be reused in different domains, domain ontology must generally be developed from scratch based on data acquired from the case organisation. The development of a complete domain model for process industries was out of scope for this example. Instead, only the ontology layer (classes) of the three ontologies was implemented. The sample ontology was developed using Protégé knowledge base framework (<http://protege.stanford.edu/>) connected to description logic reasoner Pellet (<http://pellet.owldl.com/>). OWL DL was used as a modelling language. Partial results of the ontology construction are illustrated as a UML diagram in Figure 2. OWL classes are informally mapped to UML classes, properties are mapped to UML attributes and associations – constraints, rules and other assertions are omitted for simplicity.

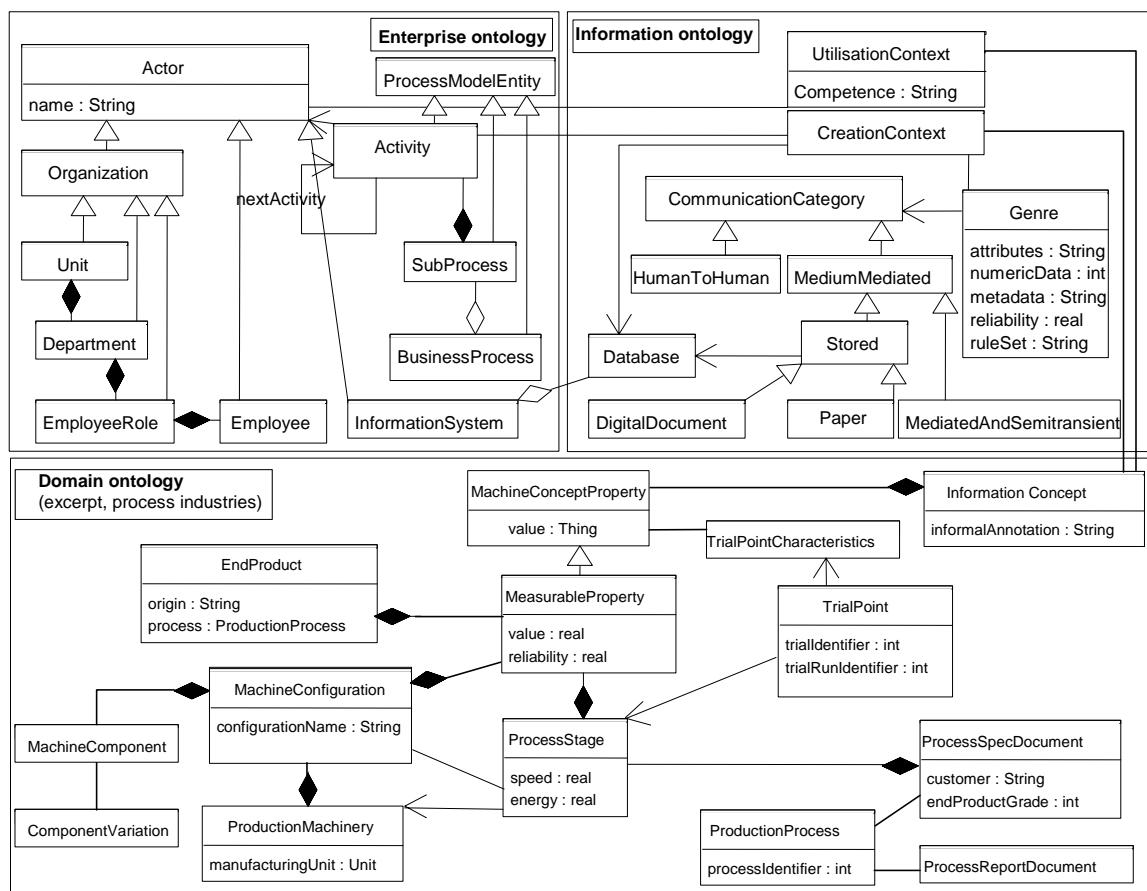


Figure 2: A sketch of the GOBIAF ontology level (domain ontology adapted from process industries)

The population of metadata level in enterprise and information ontologies can be regarded as “traditional” business process or information modelling. However, the ontology is used to harmonize the concepts used in different modelling notations, providing a consistent base for architecture descriptions. The population of domain ontology may require implementing custom – potentially complex - adapters to data sources. For example, the domain concepts include product data about production machinery along with all configuration-specific parameters (e.g., what components or component variations are used during the various phases of the production process), as well as real-time process and laboratory measurement data – both measurable and categorical characteristic properties. Domain concepts may also include concepts that are related to other ontologies but are essential to the modelled domain, such as process specification and report documents. However, the knowledge base itself does not contain the data related to concepts or measurements – only pointers and annotations to actual data sources or information systems (i.e., the data layer) are provided.

Ontologies as Enterprise Architecture Descriptions

The architecture level in GOBIAF can be represented as a 3*4 matrix with architecture views on the x-axis, and decision scope levels (enterprise, domain, and system/operative levels) on the y-axis in line with FEA (CIO Council 1999) and EA Management Grid (Hirvonen & Pulkkinen 2004). The grid is presented in Table 2.

Table 2: GOBIAF architecture level as an extension to EA Grid (adapted from Hirvonen and Pulkkinen 2004).

Aggregation/ Architecture Views Decision Scope	ENTERPRISE ARCHITECTURE			
	Business Information Architecture		Systems Architecture	
	Business Architecture	Information Architecture	Application Architecture	Technology Architecture
Enterprise level	<ul style="list-style-type: none"> - 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 	<ul style="list-style-type: none"> - A list of aggregated business assets in which the enterprise is interested - Strategic information management decisions - Common information structures 	<ul style="list-style-type: none"> - <i>Strategic application portfolio of the whole organisation</i> - <i>High-level application architecture, application – process summary</i> 	<ul style="list-style-type: none"> - <i>Strategic technology portfolio</i> - <i>EAI architecture roadmap principles</i> - <i>Technology principles</i> - <i>Technology/solution alternatives and choices</i> - <i>Core technology selection and maturity analysis</i>
Domain level	<ul style="list-style-type: none"> - A model of the actual business processes that the enterprise performs, independent of any system or implementation considerations and organisational constraints. - Presented as sequential diagrams that are derived from genre analysis - Targeted business requirements from BU perspective 	<ul style="list-style-type: none"> - 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) 	<ul style="list-style-type: none"> - <i>Application map per each application domain</i> - <i>Applications and their relations (interoperability etc. requirements) based on overlaps in the semantic model</i> 	<ul style="list-style-type: none"> - <i>Domain-level technology decisions</i> - <i>Integration architecture</i> - <i>Technology & application architecture</i> - <i>Product line architecture</i> - <i>Technology alternatives and choices</i>
Information System/operative level	<ul style="list-style-type: none"> - A model of the logical state of business operations and their relation to the operational requirements (development proposals in genre analysis) - Information need interviews 	<ul style="list-style-type: none"> - 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) 	<ul style="list-style-type: none"> - <i>A model of the logical systems implementation supporting the business processes</i> - <i>Application architecture principles and patterns</i> 	<ul style="list-style-type: none"> - <i>Systems-level technology platform</i> - <i>Infrastructure platforms, networks, data communication</i>

In contrast to FEA and EA Management Grid, the level of abstraction of the architecture dimensions can be altered from the so-called traditional view level (business, information, application, technology) to the BIA dimension where business and information architectures are mapped together. The total EA contains BIA and systems architecture (SA), which consists of aggregated application and technology architectures. The traditional view level is perceived as a starting point in formulating the scope of the total BIA/EA development process. The organisational levels (y-axis) are included in all the aggregation levels to support decision-making taking place in different hierarchical levels in an organisation. Aggregation levels reflect the architecture taxonomy proposed by Kilpeläinen (2006), based on the mutual and reported (Teng, Kettinger & Guha 1992) high cohesion of the business (processes) and information needed to operate the business.

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). Ontology descriptions are described on the Information System/Operative Level in the form of a knowledge base.

From Ontologies to Enterprise Architecture

The numerous concepts related to GOBIAF architecture level can be summarised using a three-dimensional “knowledge cube” (Figure 3). Knowledge cube can be used to quickly review and scope the architecture development needs in a high-level view. Navigating the cells in the cube reflects the relations that need to be taken to account when producing architecture descriptions.

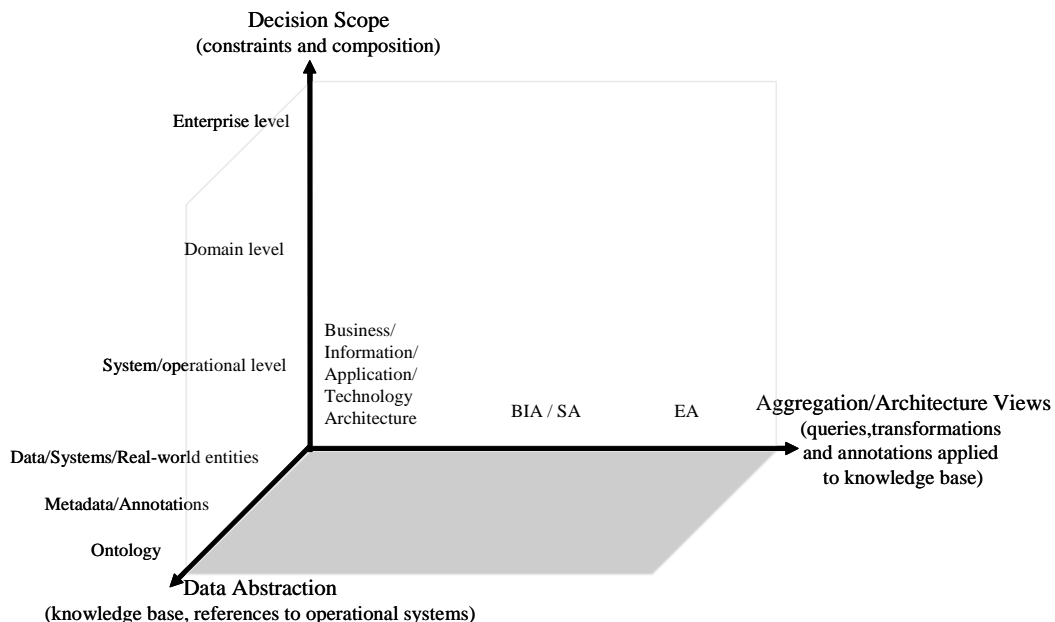


Figure 3: A “knowledge cube” view to GOBIAF components

- Vertical dimension (z-axis) corresponds to the organisational level used in EA Grid. Decision scope poses constraints when higher-level descriptions (e.g., enterprise-wide policies) are applied to lower levels. When navigated to higher level, descriptions are composed together. That is, where Operative Level was intended to provide detailed information about, for example, the activity level operations in business processes, the Domain Level focuses on operations described in the business unit level. 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 various business unit specific descriptions, showing the semantics between unit-specific information concepts through which the possibilities for data level integration can be evaluated. In many cases, architectural descriptions on this level need declarative explanations that can be augmented afterwards to lower levels to show the semantics between the decision scopes that, in turn, increase the readability of the descriptions.
- Horizontal dimension (x-axis) specifies the detail level and views for the architecture description. The lowest level provides the traditional division to business, information, application and technology architectures, aggregated together in the higher levels. Explicit transformation rules must be defined

to systematically generate higher-level descriptions. New data from the knowledge base, specific only to a given aggregation level can also be added (e.g., information creation and utilisation contexts specified in ontology level are specific to BIA-level descriptions, since they combine information from both enterprise and information ontologies). Annotations, textual notes, documentation, or other data that cannot be readily represented in a knowledge base may also be needed to clarify the descriptions.

- Y-axis provides the data abstraction level where data layers in the GOBIAF ontology level are linked to architecture views and decision scopes. Y-axis can be used to define the relation of specific aspects of the architecture to the modelled knowledge base and, eventually, to the real-world entities, systems, documents, and data that is described. For example, the concepts in enterprise ontology are related to business architecture in the same way as information ontology is related to information architecture. However, domain ontology spans the entire enterprise or a business unit where the concepts are modelled. Finally, classes that represent interconnections between ontologies can be mapped to a higher aggregation level, as mentioned in case of creation and utilisation contexts.

The knowledge base, while containing a large amount of semantically rich information, is not alone sufficient for EA management. On one hand, in order to keep the ontology consistent, interfaces to operational systems must be constructed based on the prioritisation of business activities that must be monitored real-time. On the other hand, sophisticated tools to facilitate browsing, querying, and updating the ontology must be provided to users. Similarly, condensed information to aid decision making should be provided. Finally, access and transformation rules to specific classes of the ontology with regard to decision and aggregation view levels must be defined. The general mechanism for retrieving RDF data from knowledge base is SPARQL (Prud'hommeaux & Seaborne 2007), combined with data retrieved from respective operational systems, if necessary.

Semantic relationships expressed in ontology facilitate querying the knowledge base. For example, if a list of all employees in a business unit is required, the containment relationship (“unit consists of departments”) can be used to expand the search to all departments in the unit. Generalisation is another useful semantic relationship: to retrieve all *MediumMediated* document types, communication categories in information ontology specifies that *Stored* and *SemiTransient* genres to be retrieved as well. The most interesting and useful descriptions are retrieved when combined with concepts in domain ontology, such as the creation and utilisation contexts in the case organisation. Although our modelling scope and development method is focused only to business, information, and BIA architectures, it seems feasible to generalise the relation of ontologies and architecture views also to system and technology architectures but also to total EA. Application and technology ontologies, possibly consisting of concepts like *user*, *application*, *computer*, *device*, *network*, *operation system* etc. could be defined. As in enterprise and information ontologies, it should be possible to model these ontologies in a relatively standard way and provide standardised queries and transformations to derive application, technology, and systems architecture. However, the precise definition of the content and development methodology for these extensions needs further work. Genre analysis and information need interviews work well applied to BIA development but for other aspects of EA, other development methods are needed. It could even be argued that a suitable development method could be selected depending on the scope of the architecture development needs considering all dimensions specified in the knowledge cube, as well as the organisational and technical context.

Implementation Outline

The GOBIAF architecture management system itself is basically a knowledge warehouse based on semantic web technology (Figure 4). The system is structured as a three-tier architecture including user interface, application logic, and data storage layers. External application interfaces are separated from the rest of the system and should be implemented as plug-ins. GOBIAF Core implements the application logic for the system and works as a central hub, communicating with rest of the components. Data storage layer is separated using a semantic framework (RDF platform, description logic based inference engine and SPARQL query processor, e.g., Jena, Pellet, ARQ) for RDF data (classes and instances in knowledge base) and a general-purpose storage handler for other internal data sources (e.g., queries, transformation rules, annotations, internal documents). GOBIAF interface produces EA descriptions but also enables semantic search, retrieval of documents, processes, and role information based on ontological relationships.

The implementation of external application interfaces depend on the level of detail, timing, and control requirements related to particular application. Usually it is much simpler to just retrieve data for reports compared to data modifications (e.g., tuning production process parameters) or general application integration (should a specific functionality in another system need to be executed from the GOBIAF system). Also the type of external application affects the implementation. For example, high-level process-aware systems such as a workflow management system or ERP may contain a great deal of information useful to architecture descriptions (e.g., one might want to import business process models from a workflow system), but interfacing with it may be laborious. On a smaller scale, specific business applications could be communicated using

standard enterprise application integration (Linthicum 1999) tools, such as messaging systems or transaction processing monitors, as well as web services. Direct connections to operational databases should be implemented using ODBC or JDBC based wrappers or other generic database integration tools. Existing information systems could be left largely untouched, provided that a low-level interface is established. In most cases, a one-way (i.e., for retrieval of data) interface should be sufficient.

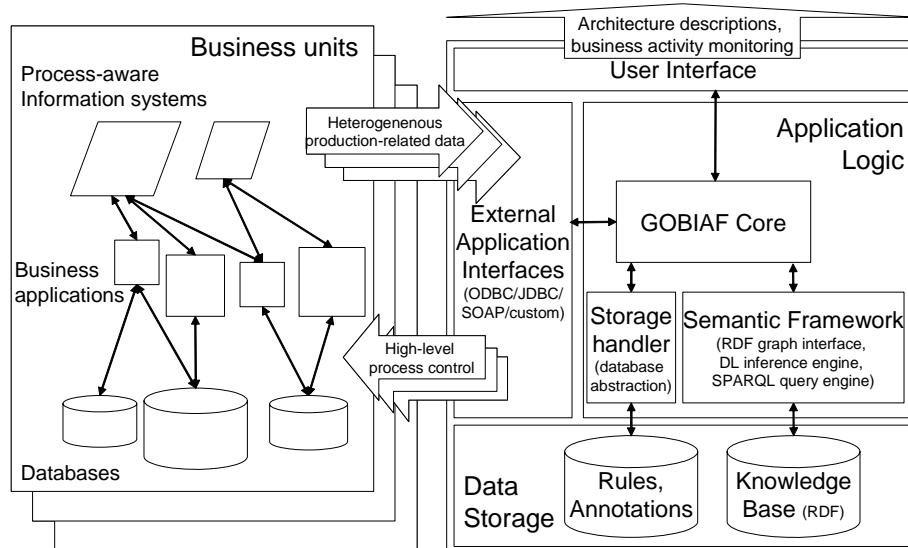


Figure 4: Preliminary software architecture for GOBIAF implementation

Eventually, GOBIAF could be used as a business activity monitoring system, but accomplishing this in a maintainable way would require considerable resources. In practice, many business processes are based on “human activities” outside a workflow management system (even if existent) and a notable part of communication in the business takes place in analogue of face-to-face form (e.g., Kilpeläinen & Tyrväinen 2004). Enterprise architecture should not be perceived as a “magical” solution to all problems in the enterprise, but instead a careful consideration is needed to focus the development efforts to critical parts of the architecture and integration needs, perhaps only in specified units or processes. GOBIAF system does not intend to replace other management systems, application integration technology (e.g., SOA) or practices (e.g., process modelling). Instead, GOBIAF system merely retrieves, integrates, and analyses the data to support decision-making. The earlier phases of GOBIAF development help this prioritization. In any case, the knowledge base should be regarded as a “living entity” because developing and managing the architecture is a continuous process. Architecture descriptions should be kept up to date, adapting to and specifying organisational and technical changes. The relevancy and accuracy of the architecture models should always be assured.

Conclusion

We demonstrated the applicability of ontologies as a description mechanism and a common reference model to business information architecture descriptions, and enterprise architecture in general. Ontology enables presenting the information concepts, their content, and semantics in a coherent and harmonised way. Three sample ontologies were developed to demonstrate the capabilities of GOBIAF ontology level. Since the ontology was not populated and the system was not implemented in operational environment, our results remain inconclusive. However, we believe that our lightweight approach for data integration (in contrast to an ERP project, providing the same kind of functionality) and enterprise architecture development, linking management directly to production processes has potential for further development.

Defining the fundamental information concepts and the data describing them provides several advantages. First, increased knowledge of vocabulary used in distinct business units where mutual understanding is crucial for successful collaboration. Second, the knowledge of contemporary data level management principles and naming practices provide a baseline when new information systems are developed for the same purposes (i.e., to manage information related to trial points). The knowledge of data level interconnections through information concepts provide knowledge through which the need to adjust data management capacity (i.e., hardware) can be evaluated and rationalised. Identification of information concepts builds up knowledge of overlaps in contemporary application portfolio and duplicated information. Solving these issues would decrease maintenance costs along with supporting, integration of business critical communication throughout an enterprise. The domain concepts provide the glue that facilitates relating other enterprise architecture concepts to each other, information systems and operational work.

The main reason for using ontologies instead of traditional architecture description mechanisms derives from the assumption that most contemporary enterprises do not develop information systems internally anymore. Instead, they acquire and integrate application packages to form a desired backbone for their enterprise. Thereby, without a formal and abstract method to describe organisation-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 architecture description language brings several advantages especially when an organisation 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 a 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 organisation closer together and, consequently, to decrease the possibility of the traditional business/IT alignment problem. Ontologies provide a coherent information representation mechanism that seems to be missing in the domain of EA.

The prospect of defining each view of the enterprise architecture grid using a formal ontology facilitates explicit, incremental enterprise architecture development effort focused to specific parts of the organisation. Future research includes generalising the GOBIAF development method to other aspects of EA, as well as the implementation of the architecture management system. Using ontologies as a common reference model makes them not only application-independent, but also adaptable to different enterprise architecture frameworks, assumed that the general basic views of EA Grid of FEAF are roughly followed. If sufficient mappings across different frameworks are defined, it could be possible to achieve interoperability across different enterprise architecture tools and eventually merge existing architecture descriptions.

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