ERP-CONTROL*: A REA-BASED ENTERPRISE RESOURCE PLANNING APPLICATION


Abstract

The conceptual characteristic of Enterprise Resource Planning (ERP) systems is the transactional recording of business information that relates to the execution of the different business processes within the enterprise value chain. The REA ontology introduced by McCarthy (1982) and extended by Geerts and McCarthy (2002) provides a solid theoretical foundation for ERP systems. In this article the REA-based ERP application named “ERP-Control” is presented to demonstrate how the REA ontology can be used for the semantic design of an ERP system and its implementation in a web-based information technology.

In ERP-Control the business processes in form of exchange and conversion processes (see Hruby 2006) are designed and implemented according to the REA ontology. The exchange processes obey the duality restriction commanded by the REA ontology by having equally valued resource flows between the involved agents. In the conversion processes the underlying production technology is integrated according to the IEC standard on Enterprise Control System Integration (IEC-ECSI 2008). The duality restriction relates to the resources in the conversion process that are consumed and used as input and the resources that are produced as output.

The semantic data model of ERP-Control is constructed for the exchange and conversion processes according to the REA ontology and it is implemented in a mysql database. The double entry booking functionality for collecting the transactional business information is implemented as IT service which is invoked during the confirmation task within the business process execution. The IT services of ERP-Control are implemented in the business logic layer of a 3-tier IT architecture. The different IT services composing the processes are orchestrated in the Java Process Definition Language (jPDL) within the business process context and they are executed in the Java Business Process Manager (jBPM) engine. For the integration of the graphical user interface, the business logic and the persistence layer of the 3-tier IT architecture the JBoss Seam application framework is used.

Keywords: REA ontology, semantic ERP design, semantic ERP implementation, JBoss Seam application framework.

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ERP-Control is a prototypical ERP application that was developed at the Institute of Management Science of the Vienna University of Technology by Abmayer, Achleitner, Czerny, Dural, Fellner, Findeis, Nasufi, Ranzi, Rodler, Schwaiger and Sporer.
Extended Abstract

SAP ERP 6.0 and MS Dynamics AX are market leading ERP applications. As such they are used in enterprises to collect the transactional business data over time according to the double-entry bookkeeping logic and for the resource-based business planning. For that purpose these applications are built upon an accounting and a policy infrastructure. These applications were developed over many years so that a mixture of data and process models are applied. Instead of a single clear cut conceptual foundation of the accounting and policy infrastructure the applications use quite different concepts that are often difficult to understand and to combine. Parallel to the development of the ERP systems there were business economic models developed in academia. This development started with the seminal paper of McCarthy (1982) who introduced the REA-based accounting model. The REA model was extended by Geerts and McCarthy (2002) to the REA business ontology in order to cover not only the accounting domain but also the policy domain. The REA ontology has the advantage of providing a theoretical sound and consistent framework. Consequently it seems worthwhile to clarify if the REA ontology can be made available for a more streamlined development of the existing ERP applications.

In this paper an ERP system is designed and prototypically implemented in modern IT as a web-based application. The prototypical implementation is called “ERP-Control”. Due to the explicit reference to the REA ontology its underlying process and data models are semantically specified (see Izza 2009). The REA semantic process and data models and their implementation in ERP Control show how the REA ontology and the ERP application domains can be reconciled. Furthermore the semantic models and their implementation provide a benchmark that should be beneficial for the REA ontological analysis of existing ERP applications.

ERP-Control is based upon the REA ontology which includes the REA accounting ontology developed by McCarthy (1982) and the REA business ontology which was developed by Geerts and McCarthy (2002). The REA accounting ontology provides the accounting infrastructure which allows the recording of the business information related to the execution of the different business processes. The REA business ontology includes next to the accounting infrastructure also a policy infrastructure. The two infrastructures are shown in Figure 1 in the lower and upper part. The ontology in the figure which underlies the ERP-Control application is the REA management ontology that was introduced by Abmayer and Schwaiger (2013). It combines the REA business ontology with the cybernetic management framework (Schwaiger 2012). In contrast to the REA business ontology it contains probabilistic event types that are essential for the design and the implementation of management processes in an uncertain business environment. This extension is not needed for the focus of this article which lies on the business process execution and the collection of the related information flows according to the double-entry bookkeeping rationale.
The execution of exchange processes is modeled in the REA ontology by economic events between economic agents in which economic resources are exchanged. In the data model the three involved REA entities are modeled in form of the resource, event and agent class and they are shown at the top of Figure 2. The duality relationship is indicated by the reflexive association connected to the event class. This REA representation is a generic one. For specific applications the three classes are categorized and concretized with additional attributes. In the ERP-Control application the resource classes are specified according to the IEC-ECSI standard (2008) which uses the three resource categories in form of material, personnel and equipment. These three categories are integrated in the data model as specializations of the general classifier in form of the resource. Next to the resource categories specified in the IEC-ECSI standard also financial resources are included so that in the ERP-Control application not only real resources but all kind of resources can be exchanged in the business processes. For the material resources and the financial resources additional flow classes are included. This allows a parsimonious recording of these resource categories which are flowing in many business transactions.

The duality restriction in the execution of the conversion processes relates to the resources that are consumed and used in the process as well as the resources that are produced. The consumed and used resources are the input and the produced resources are the output of the conversion process. The input and output resources that are involved in a specific conversion process are specified in the segment response class. The resource-specific classes associated to the segment response class contain the quantities of the input and output resources. The associated resources themselves are defined in the process segment class and they are specified in two steps, i.e. in the classes for the resource-related segment specifications and the classes for the segment specification properties.

The process segment class in the IEC-ECSI standard translates the production technology underlying the conversion processes into a data model for the three generic resource categories that are used (i.e. personnel and equipment) and consumed (i.e. material) in the process. The product specific properties of the input and output resources are specified in the specification property classes so that they can be identified in the resource classes for the material, the personnel and the equipment.

Figure 1: Probabilistic REA management ontology
In ERP-Control the duality restriction for the exchange and the conversion processes is implemented in the booking()-function. The function is invoked in the execution of the exchange and conversion processes after all needed business information related to the involved events, resources and agents are specified.

![Data model in ERP-Control for exchange and conversion processes](image)

**Figure 2:** Data model in ERP-Control for exchange and conversion processes

![Implementation of ERP-Control in 3-tier architecture](image)

**Figure 3:** Implementation of ERP-Control in 3-tier architecture
The booking()-function is implemented in the business logic layer of the 3-tier architecture as method within the booking class. It is provided to the web-based application via its interface. In the Java EE technology the booking class is a session bean. The booking bean is invoked in the confirmation-task which is the last task in the execution of the business process. The implementation of the booking()-function at the business layer in the 3-tier architecture is conceptually shown in Figure 3. The business processes are jBPM-executable processes which are provided to the application users in a graphical user interface via Java Serve Faces (JSF). By executing the booking()-function the business information is persisted via Hibernate into the database.

Figure 4: Implementation of sales processes in ERP-Control

Figure 4 and Figure 5 show the confirmation-task as the last tasks in the execution of the exchange process and the conversion process. In the exchange process execution the elements of the REA model in form of the customer (agent), product and quantity (resource) as well as the payment selection (dual event) are specified. In the execution of the conversion process the quarterly and monthly plans (commitments) and the production output quantity are specified before executing the confirmation task. In the confirmation task the input resources for the produced output are specified according to the production technology of the conversion process so that all input and output resources can be persisted in the database according to the duality restriction.

Figure 5: Implementation of production processes in ERP-Control

The transactional business information persisted in the database can be used for reporting purposes. Figure 6 shows e.g. the balance sheet resulting within the International Financial Reporting System.
(IFRS). Next to the balance sheet also the income statement, the cash flow statement and the changes in equity statement can be queried from the database with just “one click” in the reporting section of the ERP-Control application.

![IFRS Report](image)

**Figure 6**: Implementation of financial reporting processes in ERP-Control

### References


