Semantically Modeled Enterprise Databases

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INTRODUCTION

A semantically modeled enterprise database is a reflection of the reality of the activities in which an enterprise engages and the people and resources involved in those activities. Many organizations have invested immense sums of money in enterprise resource planning systems (ERP) and associated “bolt-on” applications such as customer relationship management (CRM) and advanced planning systems (APS). A significant portion of the value of these systems is in the integrated database and associated data warehouse. To maximize value, the database should serve as a semantic representation of the organization. Otherwise, relevant information needed to reflect the organization’s activities may be omitted or may be stored in such a way that the underlying reality is hidden or disguised and is therefore of no use to decision makers.

Semantically modeled enterprise databases require their component objects to correspond closely to real-world phenomena and preclude the use of artifacts as system primitives (Dunn & McCarthy, 1997). Semantically modeled enterprise information systems allow for full integration of all system components centered on a single integrated database and facilitate joint use of information by decision makers. Researchers have advocated semantically designed information systems because they provide benefits to individual decision makers (Dunn & Grabski, 1998, 2000) and because they facilitate organizational productivity and interorganizational communication (Cherrington, Denna, & Andros, 1996; David, 1995; Geerts & McCarthy, 2001a).

Ontologically based systems with common semantics are necessary to facilitate interorganizational information systems (Dunn, Cherrington, & Hollander, 2005; Geerts & McCarthy, 2001b, 2003). Such systems are increasingly necessary as business-to-business e-commerce becomes a major component of the economy. Presently, most interorganizational data is sent via electronic data interchange (EDI), which requires very strict specifications as to how the data are sequenced and requires some investment by adopting organizations. Knowledge inherent in these systems is limited at best. Trading partners who implement systems based on the same underlying semantic model may eliminate many of the current problems.

ERP systems have been defined as “designed to process an organization’s transactions and facilitate integrated real-time planning, production and customer response” (O’Leary, 2000, p. 27). David, Dunn, and McCarthy (1999) propose the use of the resources-events-agents (REA) enterprise ontology as a basis for comparison among systems and ERP packages. We agree REA is a robust candidate to which ERP systems may be compared because of its strong semantic, microeconomic, transaction and accounting heritage. More importantly, semantic models must be used as a basis for the information system because of the information contained within the semantics.

The REA framework as an enterprise ontology provides a high-level definition and categorization of business concepts and rules, enterprise logic, and accounting conventions of independent and related organizations (Geerts & McCarthy, 2001b, 2003). The REA ontology includes three levels: the value chain level, the process level, and the task level. The value chain level models an enterprise’s “script” for doing business. That is, it identifies the high-level business processes or cycles (e.g., revenue, acquisition, conversion, financing, etc.) in the enterprise’s value chain and the resource flows between those processes. The process level represents the semantic components of each business process. The task (or workflow) level of the REA ontology is the most detailed level and includes a breakdown of all steps necessary for the enterprise to accomplish the business events that were included at the process level.

The robust nature of the basic REA model has been demonstrated in research using various notations and implementation tools (Geerts & McCarthy, 1991; Nakamura & Johnson, 1998). What began as a simple model to capture semantics of accounting transactions more effectively than traditional double-entry techniques progressed to become an enterprise ontology (Geerts & McCarthy, 2001, 2003) and has contributed to inter-enterprise integration attempts such as the development of ebXML standards (e.g., RosettaNet, UNEDIFACT).
BACKGROUND

The core REA model for each transaction cycle consists of the following components, presented in list form for brevity’s sake. Readers are encouraged to read McCarthy (1982) for more detail.

- Two or more economic events that represent alternative sides of an economic exchange (at least one increment event and at least one decrement event).
- Two or more resources that represent what is received and given up in the economic exchange.
- Internal agents that represent the company’s personnel that are responsible for each of the economic events (at least one agent for each event).
- One external agent that represents the person or company with whom the company is engaging “at arms’ length” in the exchange.
- Duality relationship between the increment and decrement economic events.
- Stock-flow relationships between the events and the associated resources, representing the inflows or outflows of the resources resulting from the events.
- Responsibility relationships between the events and the internal agents.
- Participation relationships between the events and the external agents.

The following components were added in the progression from accounting model to enterprise ontology, again presented in list form. Readers are encouraged to read all of the Geerts and McCarthy articles listed in the references; David, Gerard, and McCarthy (2002); and Dunn et al. (2005) for more detail.

- Separation of the ontology into operational and knowledge (planning and control) levels to facilitate budgeting and management.
- Integration of transaction cycle models into an enterprise-wide value chain model.
- Expansion of transaction cycle models into workflow or task level models.
- Separation of components into continuants (enduring objects with stable attributes that allow them to be recognized on different occasions throughout a period of time) and occurrences (processes or events that are in a state of flux).
- Type images that represent category-level abstractions of similar components.
- Commitment images that represent agreements to engage in future economic events.
- Assignment relationships between agents that represent the designation of an agent category to work with another agent category (e.g., salesperson assigned to customer).
- Custody relationships between agents and resources that represent the agents that are accountable for various resources.
- Fulfillment relationships between commitment images and the resulting economic events.
- Partner relationships between commitment images and the participating agents.
- Reservation relationships between commitment images and the resources that are the proposed subject of the future exchange.
- Typification description relationships between continuant components and the categories to which they belong, e.g., resource-resource type and agent-agent type relationships.
- Characterization description relationships between continuant type images, e.g., agent type-agent type and agent type–resource type relationships.
- Typification history relationships between physical occurrences and their types, indicating that the occurrences share the same script, e.g., event-event type.
- Scenario history relationships between abstract occurrences and other abstractions, e.g., event–resource type.
- Business process as a description of the interaction between resources, agents, and dual events.
- Partnering as the purpose of the interaction between resources, agents, and commitments.
- Segmentation as a description of the grouping of physical categories into abstract continuant categories.
- Policy or standard as a description of the expression of knowledge-level rules between abstract types (e.g., scripts and scenarios).
- Plan as a description of the application of a script to physical occurrences.
- Strategy as a description of rules for the execution of a business process or partnering.

REA ONTOLOGY RESEARCH

Much attention has been given to the REA ontology in the literature. Published research papers have included design science and empirical methodologies. Textbooks include extensive coverage of the REA ontology. In this section we provide brief overviews of each of these categories and identify sources for interested readers.

Design science research associated with semantically modeled enterprise databases began before the advent of the REA ontology, in both computer science and account-