

Revised Classification of the Enterprise Information Architecture Elements

Pavel Hruby, Jesper Kiehn

Microsoft Development Center Copenhagen, Frydenlunds Allé 6, 2950 Vedbaek, Denmark
phruby@acm.org, jkiehn@microsoft.com

Abstract

REA (resources, events, agents) is an emerging mainstream ontology for the enterprise information architectures. However, the REA ontology is underspecified, which opens for the possibility of various interpretations of the concepts and for various incompatible modeling styles. This paper shows that introducing the concepts of ownership and other rights into the REA ontology enables creation of semantically precise application models.

Keywords: *enterprise information systems; ontology; REA*

1. Introduction

REA (resources, events, agents) is an ontology for describing business systems. The core REA model describes a business system as a set of economic resources, economic events, and economic agents. *Economic agents* are individuals or organizations capable of having control over economic resources, and transferring or receiving the control to or from other individuals or organizations. *Economic resources* are things that are scarce, that have utility, and that users of business applications want to plan, monitor, and control. *Economic events* represent either an increment or a decrement in the value of economic resources. The core REA model is illustrated in Figure 1.

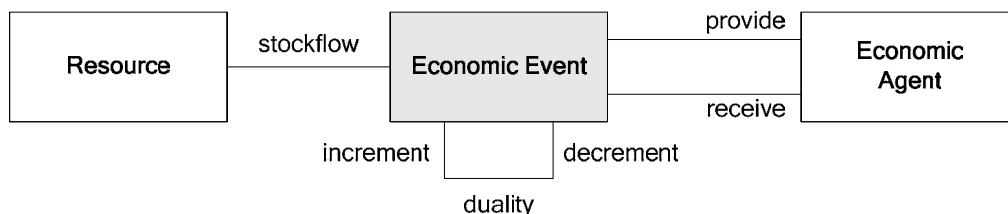


Figure 1. Core REA model (adapted from Hruby 2006)

Understanding REA fundamentally enhances the potential of application designers to configure business solutions without omissions. REA defines a set of domain rules (axioms) that assure consistency of the enterprise information architecture:

- At least one increment event and one decrement event exist for each economic resource. Likewise, every economic event must be related to an economic resource.
- Every increment economic event must eventually be related by duality relationship to a decrement economic event, and vice versa.
- Every economic event must be related to both provider and recipient economic agents.

REA was originally proposed as a generalized accounting model (McCarthy, 1982). Since then, it has been extended by McCarthy and Guido Geerts to a framework for enterprise information architectures and ontology for business systems (Geerts GL, McCarthy WE 2000a, 2002). REA became the foundation for several electronic interchange standards, such as ebXML and Open-edi.

The objective of this paper is to show that introducing the concept of rights, and especially the ownership rights into the semantics of the REA stockflows leads to precise modeling rules for REA application models.

The rest of this paper is structured as follows. The next section illustrates several REA modeling problems, which originate in the underspecification of the REA ontological categories. The next two sections discuss the original and the revised categories of stockflow relationships with the concept of rights. The last two sections illustrate how the concept of rights influences other REA modeling elements than stockflow, and how it helps to solve the REA modeling problems illustrated in the section 2.

2. REA Modeling Problems

REA as an ontology is underspecified, which (a) makes REA hard to understand, as some of the modeling questions are not answered by the ontology and are open for free interpretation, (b) allows for creating models that formally satisfy the REA axioms, but are incorrect from the business perspective. As an example, we'll describe several problems, which we repeatedly came across when trying to apply REA, and when explaining it to people with software background.

2.1 Are Economic Events Moments or Time Intervals?

Are the REA economic events instantaneous or do they last over a period of time? Answer to this question has the fundamental impact on the REA models such as rental; e.g. should a rental of a car be modeled as a single economic event with the start and end in different points in time, or as two instantaneous economic events: the start of the rental, and the end of the rental? Likewise, should a transport of an item be modeled as a single economic event with the start and the end in different points in time, or as two instantaneous events: the load and the unload event? The current REA ontology does not give an

answer, as both options satisfy the REA axioms. However, this ambiguity contributes to possible misinterpretation of the REA models.

2.2 What Does “Produce” Mean?

Does the REA concept of “produce” (Geerts GL, McCarthy WE 2000a) mean “create” a resource, or can it also mean “modify” a resource? E.g. should transport (changing a location of a resource) be modeled as a consumption of the resource in the original location and a creation of a new resource in the destination? Or, should it rather be modeled as modifying a location property a resource but not its existence? Likewise, should “TV Marketing” be modeled as a consumption of the original resource and producing a new resource with a new feature called “Known from TV”? Or, should it rather be modeled as an event modifying the “Known from TV” feature, but not changing the existence of the resource? Both options are valid with respect to the REA axioms, but the semantic of the models is different, which opens space for ambiguity.

2.3 What Does “Inside” and “Outside” Agents Mean?

The concepts of inside and outside agents were well-defined in the original REA paper (McCarthy 1982), but with the introduction of the conversion processes into REA (Geerts, McCarthy 2000a), the meaning of the inside and outside agents became unclear, because the economic events in the conversion processes no longer transfer the resources between the inside and outside agents.

3. Classification of REA Stockflows

Stockflow is a relationship between an economic event and an economic resource, see Figure 1. There are several categories of stockflow relationships in REA. The *Inflow* and *Outflow* are the categories of stockflows in the original REA model (McCarthy 1982), which focused on exchange processes (transfers of economic resources). The *Produce*, *Use* and *Consume* are the categories of stockflows in the REA model describing conversion processes (transformations of resources) (Geerts, McCarthy 2000a). This classification scheme is outlined in Table 1.

Event Category	Stockflows in Conversion Process	Stockflows in Exchange Process
<i>Increment</i>	<i>Produce</i>	<i>Inflow</i>
<i>Decrement</i>	<i>Use</i> <i>Consume</i>	<i>Outflow</i>

Table 1. Classification of REA stockflow relationships

In this paper we use the terms Use and Consume as they are used in English: a resource ceases to exist after the Consume event, and still exists after the use event (i.e. what is consumed is eaten). The Produce in Table 1 means both create a new resource and modify an existing resource. The Inflow, and Outflow mean transfer of some rights to a resource from the provider to the recipient economic agent.

4. Revised Classification of REA Stockflows

In this section we'll show that adding a new criterion to the classification of stockflow relationship resolves the problems related to the ambiguity mentioned in section 2. The new criterion classifies stockflow relationships according to the rights associated with the economic resource that are influenced by the related economic event. The new classification scheme is outlined in Table 2.

One category of stockflows changes (i.e. creates, transfers or destroys) ownership rights. An enterprise establishes the ownership rights to a resource either by taking (buying) it or by creating it. An enterprise loses the ownership rights to a resource either by giving (selling) it or by consuming it. Therefore, the new categories of stockflows are Create and Take (related to the increment events), and Consume and Give (related to the decrement events).

The other category encompasses the stockflows that do not influence the ownership rights. The stockflows Produce (now with the precise meaning of modifying an existing resource) and Use do not change any rights. The stockflows Borrow and Lend do not change ownership, but transfer other rights, such as the right to use the resource. The terms Take and Give should be understood as generalized terms for transferring some rights to a resource, but not the ownership right.

Event	Ownership	Stockflows in Conversion Process	Stockflows in Exchange Process
<i>Increment</i>	<i>Changed</i>	<i>Create</i>	<i>Take</i>
<i>Increment</i>	<i>Unchanged</i>	<i>Produce</i>	<i>Borrow</i>
<i>Decrement</i>	<i>Changed</i>	<i>Consume</i>	<i>Give</i>
<i>Decrement</i>	<i>Unchanged</i>	<i>Use</i>	<i>Lend</i>

Table 2. Revised classification of REA stockflow relationships

The original Inflow relationship is now represented by the Take and Borrow, and the original Outflow by the Give and Lend relationships. Take and Give transfer ownership, Borrow and Lend transfer all other rights except of ownership.

The original Produce relationship is now represented by Create, which creates a new resource, and Produce with redefined semantics to mean the change some features of an existing resource. The semantics of Use and

Consume is unchanged (Consume destroys the resource, while after Use the resource still exists).

The stockflows Create, Take, Produce and Borrow are related to the increment economic events, the stockflows Consume, Give, Use and Lend are related to the decrement events.

5. Revised Semantics of the REA Elements

The classification scheme for stockflow also determines the semantics of the economic events and agents. The new semantics of economic events is illustrated in Table 3.

	Events in Conversion Process	Events in Exchange Process
Ownership		
<i>Changed</i>	<i>Create or terminate ownership Change resource existence Last over a period of time</i>	<i>Transfer ownership Do not affect resource features Are instantaneous or last over period of time</i>
<i>Unchanged</i>	<i>Do not influence rights Do not change existence Last over a period of time</i>	<i>Transfer rights but not ownership Do not affect resource features Last over a period of time</i>

Table 3. Revised semantics of economic events

The events related to Take and Give stockflows might be instantaneous or last over period of time. All other events last over a period of time.

The revised classification scheme does not require the concepts of the increment and decrement events, and therefore can be used both in the REA models in the trading partner view, and the independent view. Distinguishing between an increment and a decrement is necessary in the trading partner view. In the independent view, the concepts of increment and decrement are redundant, therefore, the Take and Give will be replaced by the Transfer Ownership event, and the Borrow and Lend will be replaced by the Transfer Rights event.

The concept of the *Participation* relationship (Geerts, McCarthy 2000a, 2000b, 2002) between an economic event and an agent can be replaced by the *Provide* relationship and the *Receive* relationship (Hruby 2006), see also Figure 1. These relationships have different semantics in the exchange and in conversion processes. For the lack of better terminology we call the *Participation* in the exchange process the *Provide Rights* and *Receive Rights* relationships; and the *Participation* in the conversion the *Provide Control* and *Receive Control* relationships.

The *Provide Rights* and the *Receive Rights* relationships link the economic agents, who are legal entities capable of holding ownership rights to economic resources, and transferring them to other agents, with the events *Take*, *Give*, *Borrow* and *Lend*. The *Provide Control* and the *Receive Control* relationships link the economic agents, which are actual people capable of controlling economic resources, but not having ownership rights to them, with the economic events *Create*, *Consume*, *Produce* and *Use*.

There is still a single concept for the *Economic Resource*, because an economic resource can be related to every stockflow in the scheme. However, the resources expose a different interface to the conversion and to the exchange stockflows (and consequently, to the economic events). The stockflows in the conversion processes view a resource as a portfolio of features. The stockflows in the exchange process view a resource as a portfolio of rights.

The new classification scheme allows for more precise formulation of the domain rules (axioms) as follows.

- Every economic resource must be related by a *Create* or *Take* relationship to an increment economic event, and by a *Consume* or *Give* relationship to a decrement economic event
- Every economic event must be related to an economic resource.
- Every economic event with the *Create* or *Produce* stockflow must be related via a *Conversion Duality* to an economic event related to the *Use* or *Consume* stockflow.
- Every economic event with the *Take* or *Borrow* stockflow must be related via an *Exchange Duality* to an economic event related to the *Give* or *Lend* stockflow.
- Every economic event with the *Create*, *Consume*, *Produce* and *Use* stockflow must be related by a *Provide Control* and *Receive Control* relationships to economic agents.
- Every economic event with the *Take*, *Give*, *Borrow* and *Lend* stockflow must be related by a *Provide Rights* and *Receive Rights* relationships to economic agents, which represent parties with different economic interests.

6. Modeling Problems Resolved

The new classification scheme gives a more specific answer on which economic events are instantaneous and which last over a period or time. Therefore, a rent of a car will be modeled as a *Borrow* or *Lend*, depending on whether the model represents the renter's or owner's viewpoint. Therefore, the rent of a car is an economic event that lasts over a period of time. The transport of an item will be modeled as a *Produce* relationship, and the economic event lasts over a period of time as well.

The problem of the inside and outside agents is solved by removing these concepts from the ontology (there is now just one category of economic agents), and by refining the concept of the Participation relationship into the Provide Rights, Receive Rights, Provide Control and Receive Control relationships.

Representing the Produce stockflow either as the Create and or the Produce relationships solves the problem of modeling the marketing process, The "TV Marketing" can now be modeled by using the Produce relationship (with the meaning of "modify") between an increment event and the resource, as the redefined Produce relationship (with the meaning of "modify") does not change the existence of the resource.

7. Conclusions

The revised classification scheme of the enterprise information architecture elements can be seen as a refinement of the REA ontology, while preserving its fundamental principles and concepts. The revised scheme focuses on the operational semantics of REA, but it can consistently be extended to cover other REA concepts, such as commitments and contracts. Authors would appreciate feedback, comments and suggestions.

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