ISA-95 based Task Specification Layer for REA in Production Environments

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Abstract. Resource-Event-Agent (REA) has been applied to various engineering and business domains, with a focus on transfer activities rather than transformation activities. In the context of smart manufacturing, vertical integration of IT systems (e.g., business applications and production control systems) is a key factor. In this work, we shed light on the integration of REA concepts into production environments by investigating properties of REA transformations and aligning them with concepts from an international standard for enterprise-control system integration (ISA-95).

Keywords: REA, ISA-95, Vertical Integration, Enterprise Resource Planning System, Manufacturing Execution System

1 Introduction

Resource-Event-Agent (REA) has been in discussion for decades regarding the application of REA concepts in different engineering domains, including accounting (the origin of REA), enterprise resource planning (ERP), and value modeling. REA has been described to represent a three-layered system when it comes to different levels of detail of viewing an REA system, where the original REA framework resembles the middle layer.

While determining the top layer (a value chain view) through abstraction from REA primitives has been realized on both a conceptual and an implementation level, the bottom layer has received less attention in the past. Viewing REA from a production environment, the bottom layer can be understood as the production process underlying REA transformation primitives. As such, we propose using the concepts of an industrial standard (ISA-95) as the means for modeling low-level information and thus representing the task layer for REA-driven production processes.

The remainder of this paper is structured as follows: in Section 2, condensed background information about the ISA-95 standard is given. Then, after related work is presented in Section 3, we will provide an overview on a semantic alignment of REA and ISA-95 elements, as well as a conceptual approach for using ISA-95 to describe the task level of production-centric REA systems in Section 4.

Fig. 1. Hierarchy levels of industrial automation (from [5]).

2 ISA-95

ISA-95 (standardized as IEC 62264) is a series of standards that addresses the integration of the enterprise domain with the manufacturing & control domain, i.e., levels 3 and 4 of the industrial automation hierarchy (cf. Fig. 1).

Part 2 of ISA-95 deals with the integration of ERP-level concepts that can be roughly differentiated between (i) basic resources that depict the static definitions of an enterprise with regards to its production facilities (e.g., personnel, equipment, and material) and (ii) operations management information that resembles operational data (e.g., operations capabilities, schedules, and performance) [6]. While the ISA-95 basic resources define concepts that are related to the REA "standalone" concepts agent and resource, the operations management information is more related to interlinked pieces of information such as REA events, commitments, stockflows, and schedules. The metamodel of ISA-95 and the metamodel of REA share some core modeling concepts and also some specific model elements, which makes an alignment of these two metamodels meaningful and feasible. As such, we believe that an integration of REA-based enterprise resource planning logic with manufacturing execution systems can be made in a very transparent way.

Part 4 of ISA-95 concentrates on the integration of manufacturing operations management information and thus deals with concepts one level below the ERP-level [7]. It refines the site-wide operations management information models of part 2 with area-wide workflow information, work requests, and job orders.

3 Related Work

In the literature, three different levels of detail of the REA business ontology are mentioned (cf. Fig. 2) [1,2,11,4,3]. In the literature, the middle level is often called "business process level", however in the business informatics community the term "business process" is usually affiliated with a flow of tasks, such as in the business process model and notation (BPMN) standard [12] (which can be e.g. used to describe the task specification layer). Therefore we use the term "duality specification" for the middle level.

Value Chain Level: the most abstract view focuses on the resource-flow between business activities. One example, where value chains are implementation-wise integrated with core REA concepts is the REA-DSL [8].

Duality Level: describes business activities (i.e., dualities) in more detail—this level represents the original REA framework, including specifications about events, participating agents and affected resources.

Task Level: the most detailed view describes the process required that leads to an economic event.

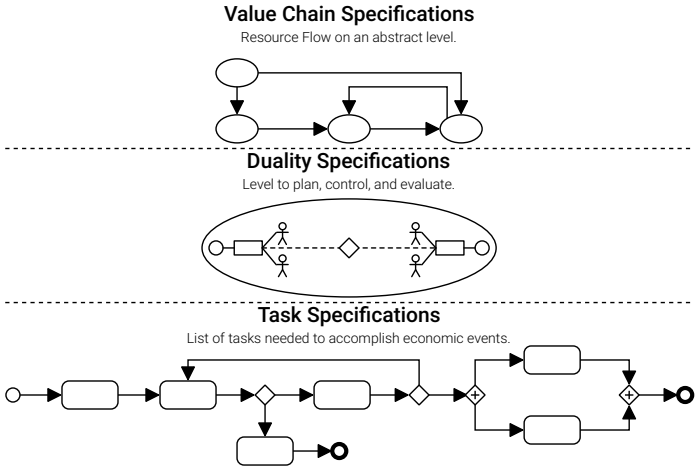

Fig. 2. Levels of detail in REA: the value chain level regards the resource flow between dualities, the duality level depicts resources, events and agents (the original core of REA), and the task level depicts the actions required that lead to these events (from [1,2,11,4,3]).

This work is influenced by [10,9], where an alignment of REA and ISA-95 has first been proposed and described based on a reduced set of elements of both ISA-95 and REA.

4 Alignment and Interoperability: ISA-95 and REA

4.1 Alignment of REA and ISA-95

ISA-95 defines four basic pillars of information which are of relevance to production systems (cf. Fig. 3) [5]:

Product Definition: provides basic information about the required types of resources for producing a certain good. This type of information is rather abstract and corresponds closely to elements of the REA type layer.

Production Capability: describes which resources are available. This kind of information can be computed from respective REA information, such as the availability of agents, already defined schedules, etc.

Production Schedule: corresponds to the planning layer of REA, i.e. commitments, reciprocities, schedules, etc. A production schedule can be mapped to a set of specific REA transformation commitments and their related REA elements.

Production Performance: represents the core REA concept of "logging information that has actually happened". As such, it corresponds to dualities, events, stockflows, participations, etc.

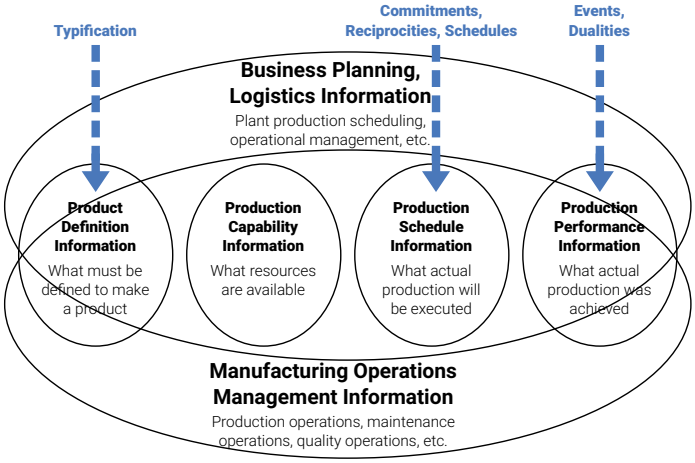

Fig. 3. Alignment of REA concepts to the four operations management information models of ISA-95 (from [5], REA-specific concepts added with blue color).

4.2 ISA-95 for Representing the Task Specification Layer of REA

ISA-95, part 4 defines objects and attributes for representing information that is relevant for level 3 activities of the industrial automation hierarchy. This kind of information is usually too detailed to be modeled with REA (which usually deals with events that lead to a record in the general ledger). However, this kind of information seems to be well-suited for the representation of the "task specification layer" of REA systems, because it describes the flow of tasks required that leads to a specific production step and as such an event on the "duality specification layer". Therefore, we propose using low-level ISA-95 concepts for the modeling of the task specification layer. Specifically, the work definition model of ISA-95 and its workflow specification are good candidates for such an effort. In addition, the work schedule model, work performance model, etc. provide data structures that can be used to e.g., track intermediate progress during production and use as base information for generating full scale REA information.

5 Conclusion

We have proposed an alignment of REA concepts with ISA-95 concepts in order to provide a basis for vertical information integration in production environments. Further, we have argued for the use of ISA-95 concepts for representing the task specification layer of REA-related production systems.

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