REA VALUE CHAIN AND SUPPLY CHAIN

František Huňka, Jaroslav Žáček, Zdeněk Meliš, Jaroslav Ševčík

Abstract: *Value chain model is a network of business processes that are bound by inflows and outflows resources. Resource Event Agent (REA) is an enterprise domain ontology based on value modeling perspective of business processes. REA value chain is a sequence of REA models (processes) utilizing the REA ontology that are interweaved into the chain by resource flows among them. Contrary to, supply chain is the entire network of enterprises involved in providing a particular product or service to an end customer. The paper focuses on finding common properties between supply chain and value chain, especially REA value chain and possibilities of REA ontology to be used to model supply chain. After describing the basic fundaments of the REA ontology, REA value chain and supply chain, the paper deals with the examining the principal aspects of the REA value chain that would bring closer and stronger bonds between the REA value chain and supply chain. In this way, the REA ontology can be potentially utilized as an integration of a value chain and a supply chain concept. Achieved findings and results are discussed and illustrated in accompanied figures.*

Keywords: *Value Modeling Business Ontology, REA Ontology, Value Chain, Supply Chain.*

JEL Classification: *L15, L23, M11, O22.*

Introduction

Enterprise Resource Planning (ERP) systems, in which data is classified using system of accounts, are rooted in the double-booking entry paradigm. Despite their success, the underlying paradigm they are built upon ensures that they have limitations. Value modeling business ontologies provide a different view on the topic. These ontologies are dealing with business process modeling with a special focus on resource control and value flows. Some of these ontologies may also include property rights modeling. Currently, they are represented by e^3-value ontology [6] and the REA ontology (Resources, Events, Agents) for enterprise processes [4].

The e^3-value ontology stipulates that the actors exchange value objects by means of value activities. The value activity should yield profit for the actor. Deeper insight in e^3-value modeling in e.g. [6] shows that this method only covers exchange and trade processes but leaves out production and conversion processes. The state-of-the-art e^3-value model only focuses on operational level (what has happened) but not on management policies (what could or should happen).

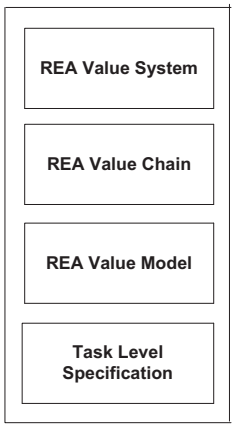
Object of our interest is the REA ontology, because it links together business process modeling with the underlying economic phenomena. REA ontology benefits from the presence of a semantic and application independent data model, an object oriented perspective, and abstraction from technical and implementation details. In addition to other aspects, it offers full traceability of all activities that influence the

value of the enterprise's resources. This enables the possibility to calculate the value of the enterprise's resources on demand. The ontology uses five specific concepts to create a model: *economic resource*, *economic agent*, *economic event*, *commitment* and *contract*. Further more, the REA ontology contains rules for formulating well-formed models of enterprise processes. The goal of economic agent's processes is to increase the value of its economic resources. All well formed REA models obey a fundamental rule, that there is no increase of the resource value for free, that is, every increase of a resource value is for an economic agent always paired with some decrease of the value of some of its resources. This fundamental feature of every REA model is that it answers the question why an enterprise performs a given activity, that is, why the economic events occur.

1 REA Enterprise Ontology

By [4] the REA ontology is described as a three-level architecture consisting of the *REA value chain*, *REA value model* and *Task level specification*. However, in some publications e.g. [8] the REA ontology is presented as a four level architecture, see Fig. 1. The fourth level creates the most upper level that is called *REA value system.* This level focuses on the resources that are exchanged between the enterprise and its various external business partners such as suppliers, creditors/investors, customers, and employees. In this context, the top level (REA value system) is much closer to the supply chain concept.

Fig. 1: REA four-level architecture



Source of data: [8]

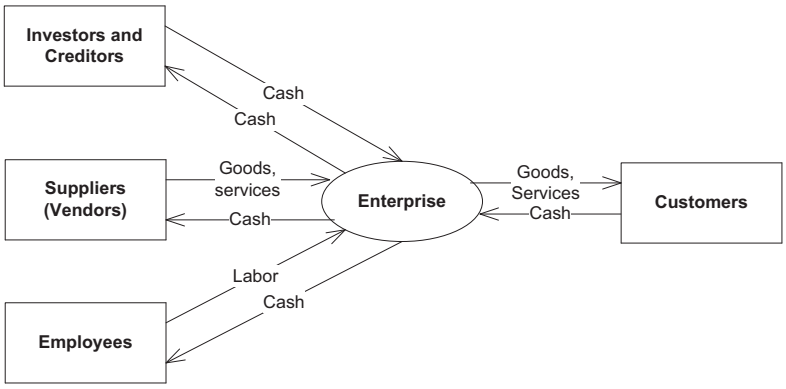
The *REA value chain level* focuses on the resource flows between interconnected business processes and on the economic events that accomplish the resource flows. The *REA value model level* represents a business process level and focuses on one or more transaction cycles in the enterprise's value chain. A *task level* addresses itself to the individual steps involved in accomplishing events in an enterprise. Tasks are

activities that may be changed or eliminated and therefore should not serve as foundational elements in enterprise information systems.

1.1 REA Value System

REA value system clearly identifies external business partners and the resources that are exchanged among them. Fig. 2 describes typical REA value system in an enterprise. As can be seen from the figure, external business partners for the company are: *Investors* and *Creditors*, *Suppliers (Vendors), Employees* and *Customers*. There are resources such as *cash*, *goods* and *services*, *labor* that are exchanged between the enterprise and its business partners. This model level illustrates only exchange processes. Conversion processes remain hidden inside the company. (REA ontology distinguishes only these two kinds of business processes - exchange and conversional process). Between the enterprise and each of its business partners there are two ways of resource flows, inside and outside modeled concepts, in the same way as in supply chain.

Fig. 2: REA value system



Source of data: [8]

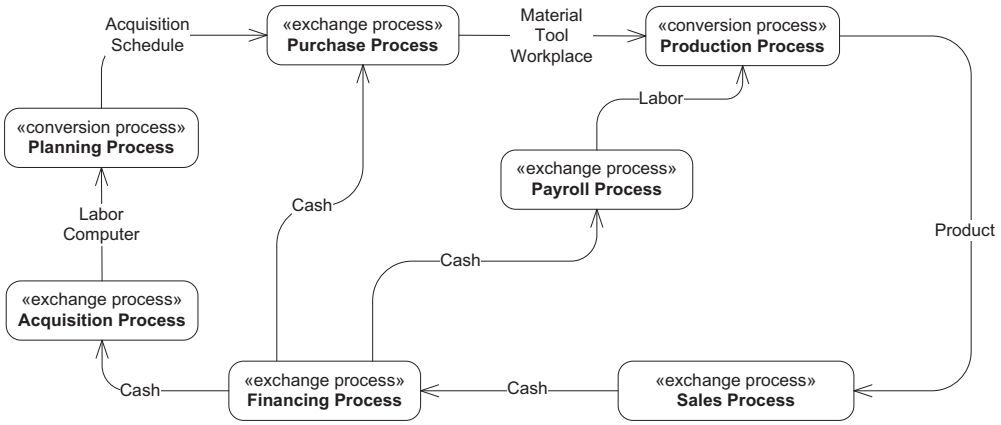
1.2 REA Value Chain Model

A value chain concept, developed and introduced by Michael Porter [10] can be arranged as a series of input-output business processes with resource flows between them, see [8]. A fundamental notion in value chain analysis is that a product gains value as it passes through a stream of production within the chain in an enterprise. If a resource flow is created by REA resources and business processes are modeled by the REA value models, we can speak about REA value chain. REA value chain is a network of business processes whose purpose is to directly or indirectly contribute to the creation of the desired features of the final product or service, and to exchange it with other economic agents for a resource that has a greater value for the enterprise [3]. While the business processes are in the REA ontology stick together by the *duality relationships* (see chapter 2.3), the value chain models are weaved by resource inflow and outflow relationships. Studying a value chain construction in a detail way, we can find out that only the flow of resources is carried out at the operational levels of the

REA process models. The resource flows thus create a firm frame of the REA value chain model. Fig. 3 shows resource value flows in the REA value chain model. The REA value chain provides overall view of the modeling domain. It can be also used for consistency checking. The REA value system depicted in Fig. 2, is transformed into REA value chain, illustrated in Fig. 3, in the following way:

- *Financing Process* expresses relation between *Investors* and *Creditors* and the *Enterprise*.
- *Purchase Process* describes relation between *Suppliers (Vendors)* and *Enterprise.*

Fig. 3: REA value chain model



Source of data: authors

- *Payroll Process represents relation between Employees and the Company.*
- *Sales Process illustrates relation between the Enterprise and Customers.*
- *Production Process is a conversion process inside the company.*

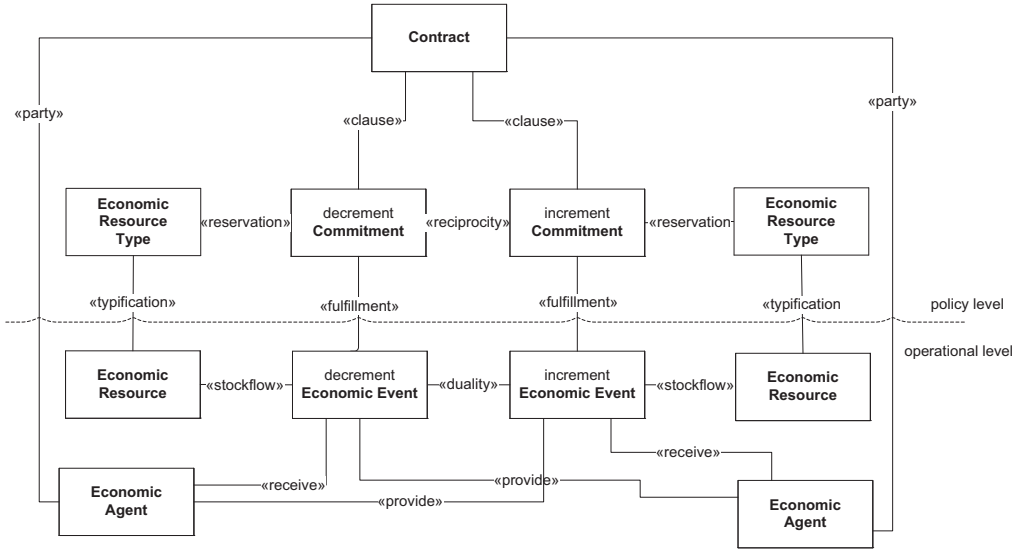
The REA value chain model also describes managing processes e.g. *Planning process* that is closely connected with the *Acquisition process*. The aim of the *Planning process* is to create *Acquisition schedule* that precisely specifies the needs of the *Purchase process* which ensures material, tool and workplace for ensuing *Production process*. *Acquisition process* is needed for arranging skillful labor and computer that are necessary resources for *Planning process*.

1.3 REA Value Model

The REA value model represents a model of a business process and creates a fundamental view provided by the REA ontology. This value model is further specified as an exchange or conversion. While the REA exchange process models exchange property rights of the economic, the REA conversion process models conversion of resources to another kind. The REA value model is basically composed of two levels, the *operational level* which deals with activities within the period of past and near present time and the *policy level* which deals with activities within the period of future time, especially those activities that should, could and must happen.

The operational level creates three kinds of entities, an economic resource, an economic event and an economic agent. An *Economic Resource* is a thing of given value that is scarce, and has utility for economic agents. In business applications, economic resources are changed or converted for another economic resource. Examples of economic resources are products and services, money, raw materials, and labor. An *Economic Agent* is an individual or organization capable of having control over economic resources, and transferring or receiving the control to or from other individuals or organizations. Examples of economic agents are customers, employees, vendors, and enterprises. An *Economic Event* represents either an increment or a decrement in the value of economic resources that are under the control of the enterprise. Some economic events occur instantaneously, such as the sale of goods; some occur over time, such as rentals, labor acquisition, and the provision and use of services. Apart from entities, the REA value model declares relationships between both different entities and between entities of the same type. The most important of these relationships is the duality relationship that links decrement events with an increment event.

Fig. 4: REA value model – exchange process



Source of data: [9]

The policy level of the REA exchange value model is created by a *contract*, *commitment*, *resource type*, *event type* and *agent type*. The *Commitment* is a promise or obligation of economic agents to perform an economic event in the future. Examples of commitments in exchange processes represent obligations of economic agents to provide or receive rights to economic resources. Each commitment is related to an economic event by the fulfillment relationship. Decrement commitments relate to increment commitments by the reciprocity relationship and bear resemblance to the duality relationship among different events. A contract is a series of things or activities that should be done during a given time interval. More specially, a contract is

a collection of increment and decrement commitments. Examples of contracts are sales orders, purchase orders and contracts for providing various services.

Typification semantic abstraction is utilized between the policy and the operational level of the REA model; see [5]. The main use of this semantic abstraction is in defining constraints and guidelines. It may be also used for the categorization of physical entities. The typification relationship that relates category items at the policy level to physical items at the operational level is a very powerful tool for business process modeling. Examples of this relation are links between the resource type and resource.

Reciprocity relationship interconnected with duality relationship creates in this way the transaction pattern described by [7] as a core of business processes. Fig. 4 illustrates general exchange process that corresponds to one of the *exchange processes* in Fig. 3.

2 Supply Chain

Supply chain is the entire network of enterprises (e.g., retailers, wholesalers and transportation firms) involved in providing a particular product or service to an end customer by [8]. Supply chain activities transform natural resources, raw materials and components into a finished product that is delivered to the end customer. Supply Chain Management (SCM) emerged in the 1980s as a new integrative philosophy to manage the total flow of goods from suppliers to the ultimate user [2]. The essence of this approach was the management of a chain of supply as though it was a single entity with the primary objective of fixing the suboptimal deployment of inventory and capacity [12].

The value chain, also known as value chain analysis, is a concept from business management that was first described and popularized by Michael Porter. It is a chain of activities for an enterprise operating in a specific industry. That is why it is said that supply chains link value chains. Porter's value chain is a tool and conceptual framework for examining and diagnosing the competitive advantage of a company. Although very useful as a modeling technique for business systems, the original purpose of Porter's value chain was not to design software business applications. This concept divides processes of the enterprise into *core business processes* that add value to the end products of the enterprise, and *support processes* that enable the core processes and add value indirectly. In fact, every process adds value (otherwise a rational enterprise would not have it), and the result of analysis should be a complete model expressing how every process contributes to the complete chain.

3 REA Value Chain and Supply Chain

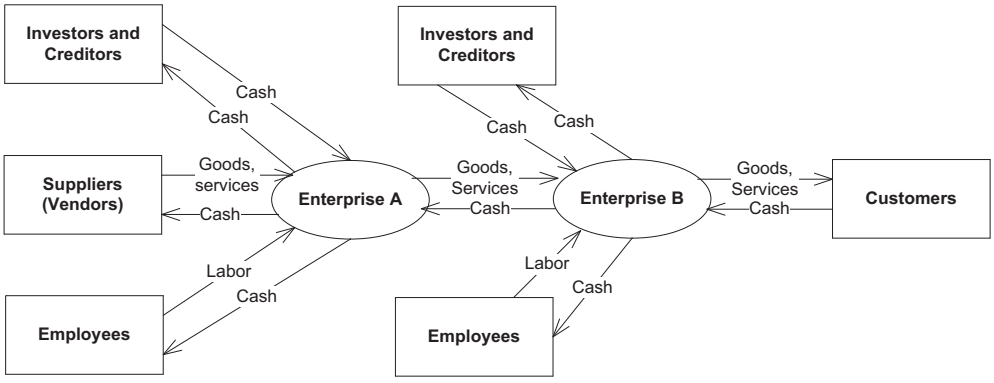
In general, a supply chain and a value chain are complementary views of the extended enterprise with integrated business processes enabling the flows of products and services in one direction, and of value as represented by demand and cash flow in the other [1]. The REA ontology in its essence follows the resource value flows. There

is no explicit general distinction between these individual directions. Each REA value model distinguishes outflow and inflow of resource values.

REA value system, as it is illustrated in Fig. 2, is still delineated for one enterprise only. However, the main purpose of the supply chain model is to cover all enterprises and their business partners that participate in the final product production. Fig. 5 shows possible connection of two enterprises in the REA value system model.

As can be seen in Fig. 5, the diagram can also contain other enterprises in a similar way. We suppose for simplicity that each enterprise would require the same structure of their business partners. During transformation of the *REA value system* into *REA value chain*, we encountered a challenge of dependent and independent views that have their origin in REA value model and are also showed in REA value chain. REA value model traditionally represents the given agent side of view. It can be e.g. customer or entrepreneur side of view. Actually, by the view it is distinguished whether the economic event is either incremental or decremental.

Fig. 5: REA value system for two enterprises



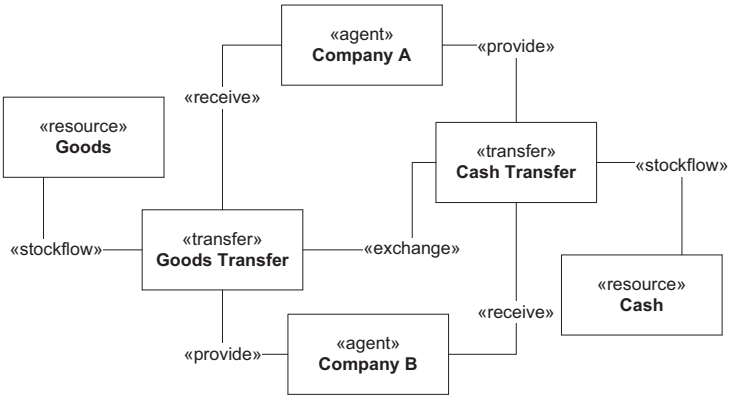
Source of data: authors

If we take the view of another agent, the meaning of the events will be changed. In case, the application model also covers planning (policy level) it is necessary to take into account also commitments and to set proper meaning for incremental and decremental commitment. In this way the same economic events have a different meaning.

However, it is possible, in contrast to the trading partner models, to create the model from the perspective of an independent view. This independent observer is illustrated in Fig. 6. Note that in the independent view, the concepts of increment and decrement do not exists, economic events represent transfer. Likewise, relationships of inflow and outflow do not exist, and are represented by stockflow relationships. For simplicity, Fig. 6 depicts only operational level of the REA value model. Above mentioned solution may typically represent *purchase/sales exchange process*. For one agent it is purchase process while for another it is sales process. This situation will happen when REA value chains of different REA value systems are connected

together, see Fig. 7. In this case, an exchange process (purchase/sales) must be modeled utilizing an independent view.

Fig. 6: REA value model – independent view

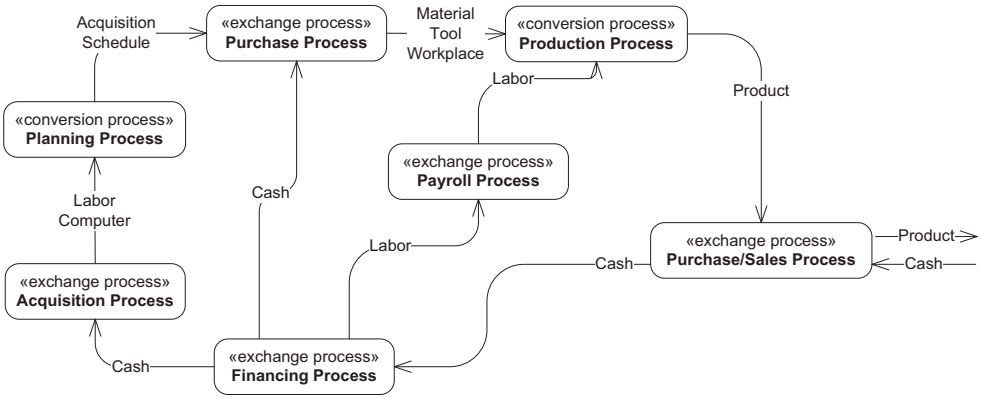


Source of data: [9]

The first conclusion for applying REA ontology in supply chain is utilizing independent view in the bordering of the exchange processes. By border we mean boundary of the individual REA value systems.

The next challenge concerns the core idea of the value chain concept designed by Porter [10]. The value chain concept distinguishes between processes that add value to the final products and those that do not. The current REA value chain is developed on the notion of a resource flows. In this way, the resource flows create a framework of the REA value chain. But there is a growing demand for including managing processes in the standard REA value chain and thus increase modeling possibilities, see [11]. In short, managing process creates managing entities such as a *contract* and a *schedule* and also produce resources containing overhead (indirect) costs.

Fig. 7 REA value chain for one enterprise



Source of data: authors

This is the way, how to include other business processes into a value chain. Some research in this area was performed but there is still some work to be done to completely finish this challenge and prepare for utilization. Fig. 7 illustrates the REA value chain model of an individual enterprise. It is supposed that purchase/sales process in the right hand side of the figure can be used for connection to another REA value chain.

Conclusion

REA ontology provides semantic and application independent data model, uses object oriented perspective and introduces concept of coherence between data of different business events, as well as a means to define future data. From the architectural point of view, it was proven that the two top levels of the REA ontology are semantically very close to the supply chain concept. The essence of Supply Chain Management (SCM) is the management of a chain of supply as though it was a single entity with the primary objective of fixing the suboptimal deployment of inventory and capacity. Utilizing REA ontology in SCM would bring more detail description of the business processes inside supply chain and thus enables more detail modeling of the topic. Modeling itself can start with REA value system and will continue through REA value chain and ends up with the REA value model. In this way, supply chain could use all benefits of the REA ontology approach.

On the other hand, it was illustrated that some adaptations and further research has to be done on the side of the REA ontology. In some cases, it will be necessary to introduce so called independent view for some of the REA value models as it enables easier connection of these models mainly between different enterprises or enterprise and customer. The other challenge concerns the fact that the value chain concept distinguishes between the core processes that add value directly to the final product and support processes that add value indirectly to the final product. On the other hand REA value model can model both core and supportive processes. This area of incompatibility needs further research too. Nevertheless, using REA ontology seems to be useful and beneficial means for integration of both these concepts.

References

[1] CLEMMER, J. (1990) The Three Rings of Perceived Value. *The Canadian Manager*. Jun 1; 15(2); p. 12-15.

[2] COOPER, M. C., DOUGLAS, M.L., JANUS, D.P. (1997) Supply Chain Management: More Than a New Name for Logistics. The International Journal of Logistics Management, Vol. 8, No 1, pp. 1-14.

[3] GEERTS, G. L., MCCARTHY, W. E. (1997) Using Object Oriented Templates from the REA Accounting Model to Engineer Business Process and Tasks. Paper presented at European Accounting Congress, Gratz, Austria

[4] GEERTS, G. L., MCCARTHY, W. E. (2000) The Ontological Foundations of REA Enterprise Information Systems. Paper presented at the Annual Meeting of the American Accounting Association, Philadelphia, PA.

[5] GEERTS, G. L., MCCARTHY, W. E. (2006) Policy-Level Specification in REA Enterprise Information Systems. *Journal of Information Systems*. Vol 20, No. 2 pp. 37-63.

[6] GORDIJN, J., AKKERMANS, H. (2003): Value Based Requirements Engineering:Exploring Innovative e-Commerce Ideas. *Requirements engineering*, 8, No 2. [cit. 22.3.2010] URL:

http://www.springerlink.com/content/5ne64nnr0jun0nxk

[7] DIETZ, J. L. G. (2006): *Enterprise Ontology: Theory and Methodology*. Heidelberg: Springer Verlag, 244 p.

[8] DUNN, C. L., CHERRINGTON, O. J., HOLLANDER, A. S. (2004): *Enterprise Information Systems: A Pattern Based Approach.* New York: McGraw-Hill/Irwin

[9] HRUBY, P. (2006) *Model-Driven Design Using Business Patterns*. Springer-Verlag Berlin Heidelberg

[10] PORTER, M. (1980) *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. New York: Free Press. 398p.

[11] HUNKA, F., HUCKA, M., KASIK, J., VYMETAL, D. (2010) Detail REA Production Planning Model Using Value Chain. WCIT 2010 Istanbul Turkey. In: Proceedings Computer Science 3 (2011) pp. 408-413 ISSN: 1877-0509.

[12] LASETER, T., OLIVER, K. (2003) When will supply chain management grow up? *Strategy + Business,* No. 32, pp. 20-5.

Contact Address

doc. Ing. František Huňka, CSc.,
University of Ostrava, Faculty of Science, Computer Science Department
Dvořákova 7, 701 03 Ostrava 1, Czech Republic
Email: frantisek.hunka@osu.cz
Phone number: +420 597 092 175

RNDr. Jaroslav Žáček,
University of Ostrava, Faculty of Science, Computer Science Department
Dvořákova 7, 701 03 Ostrava 1, Czech Republic
Email: jaroslav.zacek@osu.cz

Mgr. Zdeněk Meliš,
University of Ostrava, Faculty of Science, Computer Science Department
Dvořákova 7, 701 03 Ostrava 1, Czech Republic
Email: zdenek.melis@osu.cz

Mgr. Jaroslav Ševčík
University of Ostrava, Faculty of Science, Computer Science Department
Dvořákova 7, 701 03 Ostrava 1, Czech Republic
Email: jaroslav.sevcik@osu.cz

Received: 23. 06. 2011
Reviewed: 26. 09. 2011
Approved for publication: 30. 11. 2011