Effective Supply Chain Information Management in Supply Networks using Enterprise 2.0

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Abstract - *New trends enabled by state-of-the-art information and communication technology (ICT) are transforming and streamlining supply chain information management. This paper examines the potentials arising from flexible, loosely-coupled integration and ad-hoc information exchange by the use of current interactive and collaborative Web 2.0 concepts and technologies within and between enterprises ("Enterprise 2.0"). The ongoing research project SCIM 2.0, which stands for effective Supply Chain Information Management in supply networks using Enterprise 2.0, is taking a step beyond current Enterprise 2.0 concepts by adding semantic representation techniques and applying it to members of a whole supply network. The methodology of the project, the research questions addressed by the project and the expected results are discussed. Furthermore, the paper proposes a novel evolutionary process to apply the results of the project and to overcome the complexity of phasing-in supply chain information integration within all members of a supply network. Open issues for a full end-to-end visibility are discussed finally.*

Keywords: Enterprise 2.0, semantic network, supply chain information management, supply network

1 Introduction

Global competition accompanied by intense business pressure is asking for an adoption of networked concepts and methods to stabilize and expand supply chains. This requires companies to turn away from traditional concepts of competition towards a networked, service-oriented economic thinking and the dissolution of hierarchical structures in favor of decentralized, networked forms of organization, which enables targeted, integrated exchange of relevant supply chain information such as planning data and forecast data. The effective identification, generation and utilization of information and knowledge has become a top priority in supply chain management (SCM) and establishes itself as a unique selling point to secure competitive advantage, continuous growth and prosperity for all supply chain partners [1]. An ideal type of work-sharing, interactive value-added processes in supply chains, including all actors from producers to end users and involving all relevant information, can hardly be found in current practice. The classical electronic data interchange (EDI) played an important role in the evolution of SCM. However, the adoption of EDI standards and formats has not been progressed as rapidly and widespread as expected. Comprehensive technical requirements, specific technical know-how and high investment costs for expensive and inflexible infrastructure in conjunction with customization of business processes needed to be in accordance to EDI standards can be considered the main reasons for that [2]. This led to the point that EDI formats were primarily used by larger companies, which causes that many Small and Medium Enterprises (SMEs) are excluded from the automated exchange of information in supply chains or are forced by larger companies to implement EDI standards in order to keep up business with them [3, 4]. Without the support and involvement of all actors, the integration and subsequent management of the supply chain can not be fulfilled effectively. In addition, troublesome, costly and time-delayed technical integrations create long-term dependencies causing EDI-based integration to be applied only in very stable supply chains, with a high level of trust between the partners [5]. But, long-term and inflexible cooperation reduces innovation speed and is contrary to the pursuit of global networking where fast and easy cooperation between companies is a requirement to compete successfully in global competition [6]. The main objective of the research project *SCIM 2.0*, which stands for *effective Supply Chain Information Management in supply networks using Enterprise 2.0,* is to overcome these deficiencies.

State-of-the-art information and communication technology (ICT) offers great potential for "Supply Chain Information Management" (SCIM) to transfer implicit into explicit knowledge. This offers a chance to reconsider traditional organizational and technological support for SCIM and to solve fundamental problems in supply chains. According to Yu et al. [7] SCIM creates sustainable win-win situations for all participants in the supply chain. Not only the bullwhip effect, caused by vague and inaccurate demand forecasts, can be stemmed, but also uncertainties due to price fluctuations, batch orders and incorrectly reported quota limitation can be reduced or avoided completely.

Currently discussed concepts of "Enterprise 2.0" subsume the use of interactive and collaborative Web 2.0 technologies, concepts and applications for use within and between companies. McAfee [8] defines Enterprise 2.0 as "the use of emergent social software platforms within companies, or between companies and their partners or customers". Enterprise 2.0 uses the potential of Web 2.0 by specifically addressing the requirements of knowledge

management, internal communication and virtual collaboration with inexpensive and easy to use tools based on Web 2.0 technologies. The primary objective of Enterprise 2.0 is the support of internal and external information and communication processes and to ensure that relevant information is available in companies and supply chains through the use of lightweight technology [9].

To enable automatic accumulation, interpretation and re-use of information on the supply chain level generated by means of Enterprise 2.0 in a bottom-up process by each supply chain partner, a semantic schema for intelligent representation and presentation of information and explicit knowledge is required. Enterprise 2.0 in conjunction with concepts for the semantic processing of information that are based on accepted W3C (www.w3.org) standards such as the Resource Description Framework (RDF), Web Ontology Language (OWL) and Semantic Web Rule Language (SWRL), provide the necessary potential to manage information and knowledge flows across the enterprise efficiently and effectively. The rapid adoption and diffusion of Web 2.0 technologies showed potential in the consumer sector and analysis of well-known IT market research and consulting companies like Gartner Inc. (www.gartner.com) and Forrester Research Inc. (www.forrester.com) locate and predict great opportunities and potential benefits of Enterprise 2.0, whenever the focus doesn't rely on technology but on information and content [10].

According to Kaipaia and Hariala [11] these particular characteristics allow an improvement at various levels of SCIM, beginning with decentralized control up to centralized information sharing. If shared information is relevant and meaningful, the benefits of SCIM will affect all partners of the supply chain including improved inventory management, higher sales, and better understanding of demands. Such end-to-end visibility is defined as "the sharing of all relevant information between supply chain partners, also over echelons in the chain" [11]. Therefore the project SCIM 2.0 focuses on potentials arising from end-to-end visibility of information by the use of Enterprise 2.0 and semantic representation technologies.

The objective of this paper is to point out the main characteristics of the ongoing project SCIM 2.0 by illustrating and discussing the research questions, the scientific methodology and the expected results. Furthermore the paper explains how the project addresses the complexity of phasing-in Enterprise 2.0 concepts and technologies and semantic representation techniques within a whole supply network. Finally, concluding remarks on barriers and critical success factors are discussed.

2 The Research Project SCIM 2.0

2.1 Research Questions

The research is carried out to achieve promising supply chain information management (SCIM) practice. According to Wang et al. [12] practitioners in companies need - besides concepts and theoretically sound principles - practical tools to support them to achieve what the theory has stated and to find out, if these concepts will be beneficial for their own business. Therefore, the primary goal of the research is to (i) *develop a conceptual procedure* that allows to effectively and efficiently identify, process, accumulate and subsequently exchange relevant and meaningful information among members of the supply chain, (ii) *implement the concept* using state-of-the-art Enterprise 2.0 as well as semantic representation technologies, and to (iii) *proof the concept* in the form of exemplary pilot projects together with industry partners within a supply network. This goal will be achieved by answering the following research questions (RQ):

RQ1. What are the requirements at various levels to carry out effective and efficient exchange of information and knowledge in the course of Supply Chain Information Management (SCIM)?

RQ2. How can the requirements of RQ1 be assigned to state-of-the-art Enterprise 2.0 concepts and technologies and semantic representation techniques for SCIM (hereinafter: SCIM 2.0 Tools) and be transformed to a criteria catalogue for decision support for introducing such concepts and technologies for SCIM in supply chains?

RQ3. How can the criteria catalogue for decision support for the introduction of SCIM 2.0 Tools be designed, implemented as a software prototype and reviewed according its adequacy?

RQ4. How can the process of introducing SCIM 2.0 Tools be conducted holistically, taking into account the requirements of the enterprise?

RQ5. How can the cumulative requirements of the decision support system (RQ3) and the process model (RQ4) be designed, implemented as a software prototype and applied to all partners of an exemplary supply network?

2.2 Methodology and Expected Results

To answer the main research questions, a corresponding project methodology was designed. The following phases will be performed during the overall project:

(i) *State-of-the-art analysis and concept construction.* The project started with a literature review concerning requirements at various levels for effective and efficient exchange of information within a supply chain (RQ1). Requirements are considered to originate from data and interfaces of enterprise information systems (e.g. ERP system), integration middleware (e.g. Microsoft BizTalk Server), technologies and services for avoidance of media disruption (e.g. RFID, e-billing), and collaborative business processes across enterprises [13]. The next step required the identification of state-of-the-art SCIM 2.0 Tools (RQ2) with thematic research. The identified tools were matched against requirements from the different levels of SCIM (cf. Fig. 1) and are still being consolidated. The main result of this phase is an empirically proven *Criteria Catalogue* of Enterprise 2.0 concepts and technologies as well as semantic representation techniques ("SCIM 2.0 Tools") according to their suitability

for information and knowledge sharing in supply chains. The following example illustrates one requirement and criteria the catalogue consist of: "The requirement 'automatic notification' is supported by the three identified tools 'RSS-Feeds, Twitter and Email'. Considering the criteria "length of message greater than 1,000 characters" leads to the decision to use RSS-Feeds, as Twitter allows only messages up to 160 characters and Email is no adequate SCIM 2.0 Tool.

(ii) *Software-Prototype: "Decision Support System".* The Criteria Catalog, main result of the first phase, is the basis for a conceptual design of a web-based software prototype for decision support. The design is followed by the systematic implementation of a *Decision Support System* for the introduction of SCIM 2.0 Tools using the prototyping-oriented spiral development model procedure. To gain some practical evidence of the prototype, two pilot projects are planned. The documentation of the pilot projects is based on case studies using the method "PROMET Business Engineering Case Studies" [14], covering the use of the Decision Support System before, during and after the pilot project, taking into account economic, process-oriented, technical and marketing-oriented perspectives. The involvement of companies in the evaluation of the software ensures a systematic review of the adequacy of the prototype and increases acceptance at the same time. This procedure is characterized by repeated feedback from the companies to successively improve the prototype.

(iii) *Process Model*. This phase aims at the development of a process model for the introduction of SCIM 2.0 Tools. Besides a literature research in the field of Enterprise 2.0 and business-to-business (b2b) integration, the procedure of the conducted pilot projects is part of the analysis to assure practical relevance. The methodology identified in science and practice is consolidated by the integrated *Process Model*, which allows an effective and efficient introduction of SCIM 2.0 at the companies of the supply chain.

(iv) *Prototype "SCIM 2.0 Control Center".* The second prototypical implementation is an Enterprise 2.0-based control center for the entire supply chain, where all relevant information of the network members is made available. The conceptual design of the web-based software prototype *SCIM 2.0 Control Center* is taking into account the cumulative

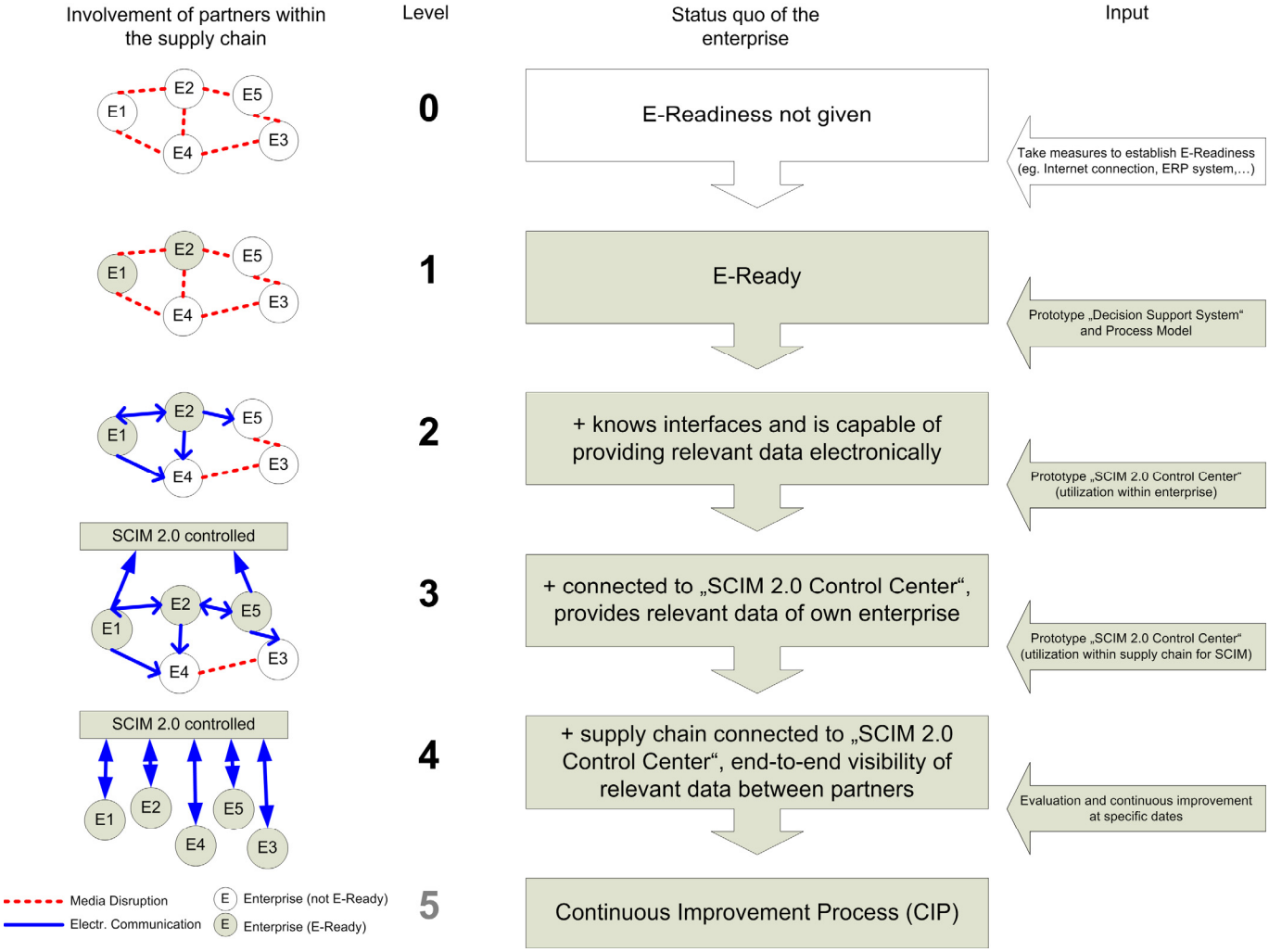

Fig. 1. Effective Supply Chain Information Management using state-of-the-art Enterprise 2.0 concepts and technologies as well as semantic representation techniques as evolutionary process in the course of the research project SCIM 2.0.

requirements of the Decision Support System and the Process Model, as well as considerations on how relevant information with its logical and semantic relationships can be accessed, linked, commented, merged, visualized and categorized. At the next step, the SCIM 2.0 Control Center is systematically implemented by using the prototyping-oriented spiral development model procedure and proved several times within at least one integrated pilot project including several members of a supply network.

In accordance to McAfee [8] and the related work of the ongoing EU funded project OrganiK (focusing on organizational knowledge of single knowledge-intensive SMEs [15]) the acronym SLATES, which stands for Search, Links, Authoring, Tags, Extensions, and Signals can be used to indicate the basic components of the SCIM 2.0 Control Center prototype. The following architectural components will be implemented:

a. *Search* means locating the information sought by the employee using keyword searches. Our architecture uses semantic search (e.g. a semantic Wikipedia) and visual search via APIs of a mapping provider (e.g. Google, Yahoo, or Microsoft) to locate relevant information.

b. *Links* to the most important information have to be on prominent place. This issue is addressed by using social or collaborative bookmarking (e.g. like www.delicious.com).

c. *Authoring* is about identifying and commenting on information gathered from own employees. We propose Blogs and Wikis incorporating the whole supply network, single enterprises, groups of employees, or individuals.

d. *Tags* let employees categorize information by attaching keywords. Tagging is being made available for all technologies used for Links and Authoring.

e. *Extensions* are vital for analyzing the activities of employees, and adapting the services offered according to their needs. This task is to be fulfilled by a semantic recommender system.

f. *Signals* notify employees of new and relevant information. RSS feeds are considered to be an adequate solution for notification.

2.3 Evolutionary Process

The focus of the research lies in the reduction or elimination of the lack of information in supply chains through the uncomplicated and easy-to-implement exchange of relevant information between various partners using SCIM 2.0 Tools. The research methodology takes into account that all members of a supply network have to be able to exchange supply chain related information, i.e. deploy SCIM 2.0 Tools. As supply chain information integration is a very complex, dynamic and strategic process and is stalled by factors such as rival cultures, information technology deficiencies, lack of process alignment and other organizational legacies [16], the results of the research cannot be deployed at once for a whole supply network. Instead, this is achieved through an evolutionary process, shown in Fig. 1, in which every member of the supply chain starts at and passes through different levels when phasing-in the results of the SCIM 2.0 project.

Level 0. E-readiness is not given within the enterprise. E-readiness is defined as the ability of an enterprise to "successfully adopt, use, and benefit from information technologies" [3]. In the context of this research, information technologies are utilized to electronically exchange relevant information with members of the supply chain by the use of SCIM 2.0 Tools. If the company is not e-ready, activities to establish e-readiness (such as installment of a broadband Internet connection, internal storage of the supply chain relevant data in a centralized, structured database, introduction of an ERP system, etc.) have to be taken. As e-readiness is considered as a prerequisite for supply chain information integration, these activities are not subject of this project.

Level 1. At this level, the enterprise is e-ready, but did not yet pay attention to SCIM 2.0 Tools for electronic exchange of information. Therefore, the enterprise is offered the Decision Support System for proper use of SCIM 2.0 Tools in the form of a software prototype. The prototype provides an appropriate start for the use of SCIM 2.0 Tools and helps to overcome barriers such as EDI standards suffered in the past. The Decision Support System is accompanied by the Process Model for the introduction and use of SCIM 2.0 Tools within the enterprise.

Level 2. At level 2, the enterprise is familiar with SCIM 2.0 Tools and their potential for appropriate use within the supply chain. The enterprise is aware of the need to integrate data and process interfaces, and is able to provide supply chain relevant data for the SCIM 2.0 Control Center electronically. The enterprise is now ready for connecting to the SCIM 2.0 Control Center and using the prototype within its own business.

Level 3. The enterprise uses the SCIM 2.0 Control Center for management of information and knowledge in its own business. The enterprise is considered to be "early adopter" of the SCIM 2.0 Control Center in the corresponding supply chain and therefore has taken a pioneering role. The enterprise has the possibility to make available information to other members of the supply network and manipulate it in real-time through the SCIM 2.0 Control Center.

Level 4. At level 4, the supply network is highly penetrated by enterprise partners at the SCIM 2.0 Control Center. Supply chain information is available across the entire supply network. All participating members are capable of finding, viewing, linking, annotating, and categorizing relevant and meaningful information. Fig. 2 shows an example of a supply network connected to the SCIM 2.0 Control Center.

Level 5. The supply network members need to improve their competences all the time, which requires a continuous learning and improvement process [12]. The SCIM 2.0 Control Center is deployed by all members of the supply network; it is evaluated and continuously improved at specific dates.

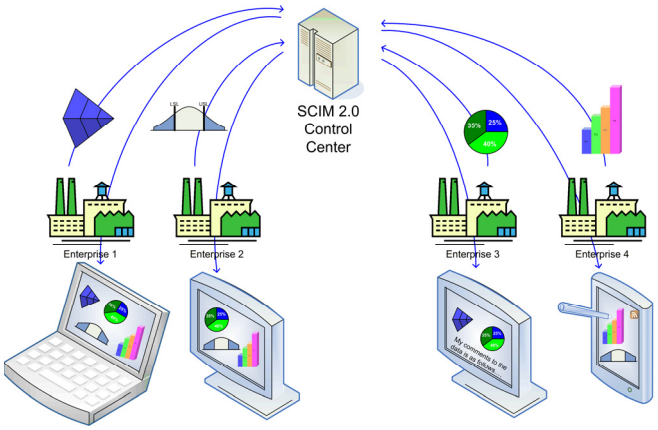

Fig. 2. Example of a supply network (Level 4) connected to the SCIM 2.0 Control Center with relevant information being available across the entire network.

3 Conclusions

The paper demonstrates a novel and innovative approach to manage supply chain information by the means of state-of-the-art Enterprise 2.0 concepts and technologies in combination with semantic representation techniques (SCIM 2.0 Tools). The literature review constitutes a huge potential of easy-to-use SCIM 2.0 Tools for effective and successful supply chain management (SCM). The authors proposed an evolutionary, level-based process to provide loosely-coupled integration solutions and ad-hoc information exchange supported by SCIM 2.0 Tools within supply networks. Despite the technical issues (e.g. information security and availability, etc.) there are a lot of other success factors for SCIM 2.0 that need to be addressed by the project: (i) Measurements to develop the social dimension in general is seen as one of the biggest challenges, (ii) Motivation and selection of key users, (iii) Development of interaction skills, (iv) Joint generation of information need, information demand and information solution, (v) Provision of a suitable, attractive collaboration platform that encourages an integration of all members of the supply chain (not only large companies such as in the "early EDI days"), (vi) Measures to overcome internal barriers and build a "SCIM 2.0 enabling" corporate culture. These success factors will be addressed by our future work in the SCIM 2.0 project.

4 References

[1] C. Wu, "Knowledge creation in a supply chain," *Supply Chain Management: An International Journal*, vol. 13, no. 3, pp. 241–250, 2008.

[2] D. C. Chou, X. Tan, and D. C. Yen, "Web technology and supply chain management," *Information Management & Computer Security*, vol. 12, no. 4, pp. 338–349, 2004.

[3] M. Fathian, P. Akhavan, and M. Hoorali, "E-readiness assessment of non-profit ict smes in a developing country: The case of iran," *Technovation*, vol. 28, no. 9, pp. 578 – 590, 2008.

[4] T. Gulledge, "B2b emarketplaces and small- and medium-sized enterprises," *Computers in Industry*, vol. 49, no. 1, pp. 47–58, Sep. 2002.

[5] M. Groll, *Koordination im Supply Chain Management: Die Rolle von Macht und Vertrauen*. Deutscher Universitäts-Verlag, 2004.

[6] P. Schönsleben and R. Hieber, "Gestaltung von effizienten wertschöpfungspartnerschaften im supply chain management," in *Integriertes Supply Chain Management. Theorie und Praxis effektiver unternehmensübergreifender Geschäftsprozesse*, 2nd ed., A. Busch and W. Dangelmaier, Eds. Gabler, 2002, pp. 45–62.

[7] Z. Yu, H. Yan, and T. E. Cheng, "Benefits of information sharing with supply chain partnerships," *Industrial Management and Data Systems*, vol. 101, no. 3, pp. 114–119, 2001.

[8] A. P. McAfee, "Enterprise 2.0: The dawn of emergent collaboration," *MIT Sloan Management Review*, vol. 47, no. 3, pp. 21–28, 2006.

[9] M. Bächle, "Ökonomische perspektiven des web 2.0 - open innovation, social commerce und enterprise 2.0." *Wirtschaftsinformatik*, vol. 2, pp. 129–132, 2008.

[10] N. Dufft and S. Tietz, "Web 2.0 in unternehmen: Potenziale von wikis, weblogs und social software," Berlecon Research GmbH, Tech. Rep., Apr. 2007.

[11] R. Kaipia and H. Hartiala, "Information-sharing in supply chains: five proposals on how to proceed," *The International Journal of Logistics Management*, vol. 17, no. 3, pp. 377–393, 2006.

[12] C. Wang, C. Fergusson, D. Perry, and J. Antony, "A conceptual case-based model for knowledge sharing among supply chain members," *Business Process Management Journal*, vol. 14, pp. 147–165, 2008.

[13] A. Auinger and D. Nedbal, "Towards a guidance model for business integration solution," in *Proceedings of the International Joint Conference on e-Commerce, e-Administration, e-Society and e-Education (e-CASE), Bangkok, Thailand*, 2008.

[14] E. Senger and H. Österle, "Promet business engineering case studies (becs) version 2.0," Bericht BE HSG / BECS / 1, Institut für Wirtschaftsinformatik, University St. Gallen, 2004.

[15] D. Bibikas, D. Kourtesis, I. Paraskakis, A. Bernardi, L. Sauermann, D. Apostolou, G. Mentzas, and A. C. Vasconcelos, "Organisational knowledge management systems in the era of enterprise 2.0: The case of organik," in *BIS 2008 Workshop Proceedings*, 2008, pp. 45–53.

[16] A. Smart, "ebusiness and supply chain integration," *Journal of Enterprise Information Management*, vol. 21, no. 3, pp. 227–246, 2008.