Future applications in Supply Chain Integration via the World Wide Web.

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FUTURE APPLICATIONS IN SUPPLY CHAIN INTEGRATION VIA THE WORLD WIDE WEB.

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Abstract

The “Semantic Web” is a development in which software applications on one computer are able to talk directly and intelligently to software applications on any other computer via the Internet. “Software agents” are programmes that search, reason and interact with both semantic web applications and other software agents autonomously. When combined, these technologies have the potential to drastically reduce the amount of human input into hitherto knowledge intensive activities. In SCM these applications include sourcing, procurement, partner identification, design collaboration and materials management. Effort to develop this potential is resulting in growing numbers of academic publications. Commercial software is beginning to mature and some (mainly larger) organisations are beginning to build the technology into their future supply chain plans.

This paper reviews the current status of the technological developments outlined above and presents a case for their commercial exploitation in supply chains where closer integration is a goal.

Key Words: e-business, web services, B2B, supply chain integration.

Introduction

...The second side to the Web, yet to emerge, is that of machine-understandable information. As this happens, the day-to-day mechanisms of trade and bureaucracy will be handled by agents, leaving humans to provide the inspiration and the intuition. This will come about through the implementation of a series of projects addressing data formats and languages for the Web, and digital signatures...

In the quotation above, Tim Berners-Lee (1998), a key figure in the development of the World Wide Web (WWW), alluded to a number of developments aimed at enabling a whole new set of information technology (IT) capabilities, where programmes would ultimately locate each other and interact autonomously via the Internet. He, and others, predicted that this new functionality would dramatically alter the way in which hitherto ‘knowledge intensive’ activities (e.g. information exchange aspects of SCM), are carried out (Alshawi, 2001; Jones et al, 2001 Karageorgosa, et al 2003). Whilst some of the challenges to which he referred still remain, others are reaching a level of maturity whereby both software developers and business service providers are moving to market the technological potential. In the view of a growing number of academics and practitioners, the stage is set for a transformation in the use of IT perhaps more radical even than that brought about by the WWW itself (Maes et al, 1998; Tucker & Jones, 2000; Wortmann & Szirbik, 2001; Ahn & Lee, 2004; Violino, 2003).
The aim of this paper (presented in a modified form at the Institute of Small Business and Entrepreneurship 28th National Conference, 2005) is to draw these innovations to the attention of the Supply Chain Management (SCM) community, explaining the technology, and positioning their current development status.

Research and development of the underlying technology and its commercial deployment is at a key stage (AgentLink III, 2004b). Many current applications are developmental and generic in nature, and yet there is evidence of commercial use, and some (mainly larger) organisations have announced their longer term intent to deploy (Anthes, 2003; Bybee, 2005; Magenta Technology 2004). Thus far there is little published work addressing the uptake or future adoption by SMEs.

Definitions

The Semantic Web: The organisation at the heart of, and driving the development of, the Semantic Web is the World Wide Web Consortium (W3C) who describe it thus (W3C, 2005):

“The Semantic Web provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries. It is a collaborative effort led by W3C with participation from a large number of researchers and industrial partners. It is based on the Resource Description Framework (RDF), which integrates a variety of applications using XML for syntax and URLs for naming”

Web Services: To computer programmers, web services refer to a set of programming standards used to make different types of software talk to each other over the internet, without human intervention (Kerstetter, 2005). One of the standards is XML, pioneered in the mid 1990’s. XML is a cross-platform, software and hardware independent tool for transmitting information. It allows programmers to define tags which describe the ‘type’ of data in a document. These tags are then recognisable and meaningful to other programmes. Another standard is ‘Standard Object Access Protocol’ (SOAP), which is a sort of ‘virtual envelope’ for computer code that acts like an introductory letter, saying what’s inside and where it should go (Kerstetter, 2005).

Finally Web Services Definition Language (WSDL) offers the true potential for different types of software to interact without human intervention.

Software Agents: In a broad sense, Russel and Norvig (2003) define an agent as being anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actors.

A software agent has been defined (Krupansky, 2005) as:-

... a computer program which works toward goals (as opposed to discrete tasks) in a dynamic environment (where change is the norm) on behalf of another entity (human or computational), possibly over an extended period of time, without continuous direct supervision or control, and exhibits a significant degree of flexibility and even creativity in how it seeks to transform goals into action tasks...

This definition allows another useful distinction to be made in relation to the use of agents in SCM semantic web applications. This is the definition between single and multi agent systems (Hendler, 1999). A single agent operates autonomously, and interacts with other programmes, parts of the network and humans (Krupansky, 2005), but not with other software agents. Multi-agent systems are made up of agents that interact with each other, as well as interfacing at all the points of a single agent. It is in the development of multi-agent systems that the most novel and powerful SCM application potential is seen (Jones et al., 2001).
The term software agent is often used synonymously with “intelligent agent” or “autonomous agent”, the latter being more applicable to single agent technology (Pitkaranta, 2004).

**An illustration of application potential**

In this section, the author will describe an SCM application that has often been used to illustrate the potential of the technologies defined above (Dasgupta, 1999; Gerber & Russ, 2001; Pitkaranta, 2004). To set the explanation in its wider context, the definition of supply chain management favoured by the author is that its defining goal is “having the right product in the right place, at the right price, at the right time and in the right condition” (Blackwell, 1997). Consider a part of this process, the typical purchasing activity of selecting a vendor for a component in a new product design.

Whilst it is essential that key decisions in the above selection activity are made by company personnel, it is also true that some aspects are more routine. Time and effort on the part of both buying and selling personnel might be saved if software from the purchasing organisation were able to locate, and communicate with, software from suitable vendors. In a computerised replication of the manual process, the buying 'software agent' would be cognisant of a list of requirements, and would be able to interrogate the sellers’ systems, eliciting such information as availability, standard terms and conditions, lead times and even a baseline price. The buying software agent could then sort and rank the vendors, perform short listing functions and, in more clear cut purchasing decisions, suggest a vendor and even place the order. The extent to which the 'automated' computerised decision making would take over from the human would depend upon the nature of the component. For more critical components - which require customisation, design work, special manufacturing facilities or other services that are specific to the purchasing organisation - the buyers software agent might serve only to draw-up a ‘rich shortlist’ of information about suppliers with the necessary capability, capacity, location, and with acceptable price, quality and delivery commitment.

Figure 1 (Pitkaranta, 2004) gives a high level diagram of an experimental system in which a software agent handles the request for quotation (RFQ) process, vetting the quotations and proceeding to contact acceptable vendors. The system is described in more detail later in the paper.

**Figure 1: (Pitkaranta, 2004) Overall process for B2B request for quotation.**

**Development and deployment status**
The view of the authors of this paper is that the technology is transitioning from theoretical domain (academic and practitioner) to application domain (figure 2) e.g. the work of BT’s iOpt (British Telecom 2004a and British Telecom 2004b) and the previous work of BT technologies (Jennings et al 2000). It could be argued therefore that the technical case has been proven and that what lies ahead is potential adoption.

![Figure 2: Representation of technology transfer](image)

Eymann et al (1998) created a simulation environment Avalanche in order to investigate the role of software agents in the co-ordination of business transactions in order to inform the debate on whether future development of this technology would co-ordinate on an economically pluralist ‘move-to-market’ or centralist ‘move-to-hierarchy’ basis. The level of co-operation that was observed led to the conclusion that a trade network was in operation and that “agents disperse[d] over the network while cooperating and maintaining the value chain coordination.” Eymann et al (1998) p4.

In their Consumer Buying Behavior (CBB) Model, Maes et al (1999) present a paradigm that can be applied to agent-based commerce. The model consists of six stages: need identification, product brokering, merchant brokering, negotiation, ‘purchase and delivery’ and ‘service and evaluation’. Although based on retail markets the authors assert that these principles are transferable to transactions between businesses and transactions between consumers.

In an example of potential real-world deployment, Anthes (2003) presents an illustration of Procter & Gamble’s (P&G) envisioned “Agent-Enabled Supply Network in 2008”.

A number of commercial software providers are experimenting with products utilizing the technology, as summarized in table 1.

<table>
<thead>
<tr>
<th>Company</th>
<th>Product</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agentsis Software</td>
<td>Goal-Directed™ Agent Technology</td>
<td><a href="http://www.agentissoftware.com">www.agentissoftware.com</a></td>
</tr>
<tr>
<td>Magenta Technology</td>
<td>i-Schedulers</td>
<td><a href="http://www.magenta-technology.com">www.magenta-technology.com</a></td>
</tr>
<tr>
<td>Sockeye Solutions</td>
<td>Bespoke applications</td>
<td><a href="http://www.sockeyesolutions.com">www.sockeyesolutions.com</a></td>
</tr>
<tr>
<td>Whitestein</td>
<td>Living Systems® Adaptive Transportation Networks</td>
<td><a href="http://www.whitestein.com">www.whitestein.com</a></td>
</tr>
</tbody>
</table>

*Table 1: Commercially available agent software*

Conclusions
The paper has summarized the development and deployment status of a potentially significant set of information technology developments, concluding that they are transitioning from the theoretical to application domain. Representative examples of work in each of these areas as applied to supply chain management have been described and the paper concludes the developments to be in an 'incubation' phase, ready for more widespread commercial application.

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