

Using Peer-to-Peer Protocols to Enable Implicit Communication in a BDI Agent Architecture

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Abstract. The objective of the research described in this paper is to extend current agent platforms in order to provide both explicit, message-based and implicit, document-based communication and co-ordination within a uniform framework, and to make this unified framework available for the agent-oriented design and enactment of business processes. This is achieved by interfacing a BDI agent platform with an underlying peer-to-peer (P2P) platform, where the P2P framework is used to virtualize certain sections of the belief sets of the BDI agents; after a review of existing approaches to integrate multiagent with P2P concepts, a prototype technical realization is presented using two state-of-the-art platforms: the Jack BDI agent platform and the P2P Business Resource Management Framework (BRMF) platform.

1 Introduction

With multiagent systems and technologies becoming more mature, they are finding their way into business applications, such as business process management (BPM) or collaborative product development (see [1], [2]). What makes multiagent system appealing both from a modeling and a runtime angle is their ability to provide natural mappings to concepts usually found in BPM models, such as organizations, roles, and goals, and their intrinsic support to flexible business service composition and loosely coupled coordination and cooperation, as they are often found in collaborative, cross-enterprise business environments.

However, there are some fundamental limitations in the level of support current agent platforms can provide for the execution of business processes. In particular, popular platforms such as Jade¹ or Jack Intelligent Agents^{TM 2} base their

¹ <http://jade.tilab.com>

² <http://www.agentsoftware.com.au>

interaction models on the paradigm of message-based communication between agents. This is well suitable for business processes that are clearly structured according to e.g., FIPA³ interaction protocols [3]. Example for processes that can be easily supported by today's agent-based solutions are for example order management or procurement processes, which are complex in that there is a wealth of situation-dependent choices regarding the behavior of the individual participants, but which are structured in that interaction follows clear rules and protocols. However, today's agent platforms and the traditional speech-act- and protocol-based messaging are less suitable to model and support processes that are less structured, and more event-based.

It is our claim that agent-based *explicit* messaging needs to be complemented by an *implicit*, blackboard-style communication and coordination paradigm to be able to support unstructured, document-centric and event-driven business processes. In the collaborative product design use case, a suitable paradigm for the interactions within the supplier network is that of a peer-to-peer (P2P) organization where each party maintains copies of the documents or models in question, and is notified when another party changes one of the documents. The negotiation comes to an end when each party agrees to the current set of documents available. The idea to describe a process by reactions to changes of documents is radically different from traditional business process design.

The objective of the research described in this paper is to extend current agent platforms in order to provide both explicit, message-based and implicit, document-based communication and co-ordination within a uniform framework, and to make this unified framework available for the agent-oriented design and enactment of business processes. In particular, we found a suitable paradigm for efficient implementation of implicit, decentral coordination and resource management within the P2P community.

In this paper we describe a first step towards combining the use of BDI agents to model and enact CBPs process flows with the use of a P2P platform to enable event- and document-driven "publish-subscribe style" collaboration. In doing so, we can provide architects of business application with the concepts and tools to integrate both process-centric and event-/document-centric business collaboration requirements within one unifying architecture. Technically, the first step of this endeavor is achieved by interfacing a BDI agent platform with an underlying P2P platform, where the P2P framework is used to virtualize certain sections of the belief sets of the BDI agents; a technical realization concept is presented using two state-of-the art platforms: the Jack BDI agent platform and the P2P Business Resource Management Framework (BRMF) platform.

The paper is structured as follows: In Section 2, we introduce the Collaborative Product Development (CPD) application used throughout this paper to describe the concepts. Section 3 outlines related work in using multiagent system and P2P concepts for business applications. In Section 4, existing approaches to combine agent and P2P computing are discussed, and the main

³ <http://www.fipa.org>