Engineering e-Collaboration Services with a Multi-Agent System Approach

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ABSTRACT

With recent advances in mobile technologies and e-commerce infrastructures, there have been increasing demands for the expansion of collaboration services within and across systems. In particular, human collaboration requirements should be considered together with those for systems and their components. Agent technologies have been deployed in order to model and implement e-commerce activities as multi-agent systems (MAS). Agents are able to provide assistance on behalf of their users or systems in collaboration services. As such, we advocate the engineering of e-collaboration support by means of MAS in the following three key dimensions: (i) across multiple platforms, (ii) across organization boundaries, and (iii) agent-based intelligent support. To archive this, we present a MAS infrastructure to facilitate systems and human collaboration (or e-collaboration) activities based on the belief-desire-intension (BDI) agent architecture, constraint technology, and contemporary Web Services. Further, the MAS infrastructure also provides users with different options of agent support on different platforms. Motivated by the requirements of mobile professional workforces in large enterprises, the authors present their development and adaptation methodology for e-collaboration services with a case study of constraint-based collaboration protocol from a three-tier implementation architecture aspect. They evaluate our approach from the perspective of three main stakeholders of e-collaboration, which include users, management, and systems developers.

Keywords: BDI Agents, Collaboration, Constraints, Cross-Organization Business Process, Mobile Workforce, Multi-Agent Systems, Three-Tier Architecture, Web Services

DOI: 10.4018/jssoe.2010092101
INTRODUCTION

The Internet has become a common platform where organizations and individuals communicate amongst each other to carry out various e-commerce activities (Chiu et al., 2004). As such, systems and human collaboration has recently become a focus of systems engineering and design. In particular, as the objective of all systems has the fundamental mission of serving humans, human collaboration requirements should never be ignored along with those for systems and their components. We refer to such integrated systems and human collaboration as e-collaboration. However, the recent turbulence of the globalized economy together with fast-evolving information and communication technologies (ICT) has caused great impact on how businesses are being carried out currently and in the future. Such ever-growing complexity and requirement evolution demand a critical re-thinking on the methodologies for the engineering of e-collaboration services, which also demands for much flexibility and intelligence.

Recent advances in information and communications technologies (ICT) have created a plethora of mobile devices (Lin & Chlamtac, 2000) with ever increasing range of communication, computing, and storage capabilities. New mobile applications running on such devices provide users with easy access to remote services regardless of differing locations (Hong et al., 2004). Interesting mobile applications taking advantage of the ubiquity of wireless networking emerge to create new virtual worlds through expanded e-collaboration services (Hong et al. 2007; Chiu et al., 2009). An example application is the management of mobile workforce in this knowledge and service based economy (Chiu et al., 2006), which is applicable to a wide range of domains such as supply-chain logistics (Wang et al., 2009), dynamic human resources planning, negotiation support (Chiu et al., 2004b), and tourism (Chiu et al., 2009). At any time and regardless of location, the management as well as professional workforces needs to collaborate with colleagues and communicates with information systems, not only within their own organization but also among other broader systems not directly synchronized with their own.

Mobile devices nowadays are generally equipped with adequate processing power to support reasonably complex computations (Chiu et al., 2004). Sophisticated intelligence for collaboration and decision support, usually in the form of agents, is now possible on these platforms. This functionality is able to relieve people from repetitive tasks like their personal assistants (He et al., 2003; Chiu et al., 2004; 2006). Thus, there are increasing demands to expand e-collaboration services in the following three dimensions: (i) across multiple platforms, (ii) across organization boundaries, and (iii) agent-based intelligent support.

However, to the best of our knowledge, no previous research effort has been made to systematically study the engineering of e-collaboration services to these three dimensions specifically. In particular, there is no unified implementation framework yet to incorporate all these three types of expansion, integrating all the enabling technologies together coherently. New challenges arise from such new computing and communications environment, such as the handling of mobility, handsets with reduced screens and varying bandwidth to support users’ ubiquitous access, privacy and security of individual users and across organizational boundaries, and so on. Therefore, it is necessary to address these new challenges with a platform independent solution based on a coherent technological framework. To achieve this, we consolidate and extend our previous research in negotiation support system (NSS) (Chiu et al., 2004; 2004b; 2005), cross-organizational process management (Chiu et al., 2001), and mobile service (m-service) adaptation methodology (Chiu et al. 2004; Hong et al., 2007).

In this article, we summarize our experience in engineering e-collaboration services with the use of agent technologies, and particularly a Multi-Agent System (MAS). A MAS consists of multiple intelligent software agents that exchange messages and collaborate on behalf
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