

CASCOM: Context-Aware Service Coordination in Mobile Computing Environments

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Abstract

The research project CASCOM will implement, validate, and trial value-added support for business services for mobile workers and users across mobile and fixed networks. The vision of the CASCOM approach is that ubiquitous application services are flexibly co-ordinated and pervasively provided to the mobile users by intelligent agents in dynamically changing contexts of open, large-scale, pervasive environments. The essential approach of CASCOM is the innovative combination of intelligent agent technology, semantic Web services, peer-to-peer, and mobile computing for intelligent peer-to-peer (IP2P) service environments. The services are provided by software agents exploiting the co-ordination infrastructure to efficiently operate in highly dynamic environments.

1 Introduction

The essential approach of CASCOM¹ is the innovative combination of agent technology, semantic Web services, peer-to-peer, and mobile computing for intelligent peer-to-peer mobile service environments. The services of CASCOM environment are provided by agents exploiting the CASCOM coordination infrastructure to efficiently operate in highly dynamic environments. The CASCOM intelligent peer-to-peer (IP2P) infrastructure includes efficient communication means, support for context-aware adaptation techniques, as well as dynamic service discovery and composition planning.

CASCOM will implement and trial value-added support for business services for mobile workers and users across mobile and fixed networks. The vision of the CASCOM approach is that ubiquitous application services are flexibly co-ordinated and pervasively provided to the mobile users by agents in dynamically changing contexts of open, pervasive environments.

For end users, the CASCOM system provides seamless access to semantic Web services anytime, anywhere, and using any device. This gives freedom to mobile workers to do their business whenever and wherever needed. For network operators, CASCOM aims towards vision of seamless service experience

providing better customer satisfaction. For service providers, CASCOM provides an innovative platform for business application services.

The project will carry out highly innovative research aimed at providing a framework for agent-based data and service co-ordination in IP2P environments. CASCOM will integrate and extend existing technologies in areas such as agent-based mobile computing, service co-ordination, and P2P computing in mobile environments. A generic, open IP2P service environment with its agents and co-ordination mechanisms will be prototypically implemented and deployed in CASCOM mostly as open-source software enabling instant take-up and use within European and world community.

In general, it is expected that the outcomes of CASCOM will have significant impact on the creation of a next-generation global, large-scale intelligent service environment. Both, research results on methods for service provision, discovery, composition and monitoring, and the deployed prototype of an open IP2P service environment in the context of nomadic computing will advance the state of the art of European and world knowledge in areas related to the deployment of services in open systems.

2 Technical Approach

Figure 1 depicts the technologies that we use in the CASCOM project. Software agents will be a key

¹ <http://www.ist-cascom.org>



Figure 1: CASCOM Technologies

technology to address the challenges of the CASCOM architecture (see Figure 2). IP2P networks provide an environment for agents to collaborate as peers sharing information, tasks, and responsibilities with each other. Agents help to manage the P2P network complexity, and they will improve the functionality of conventional P2P systems. Our innovations in this domain will concern the development of context-aware agent-based semantic Web services, and flexible resource-efficient coordination of such services in the nomadic computing field. Further, context-awareness is investigated in the context of IP2P environment and we will develop context-aware agents which provide various business application services.

Using agents in wireless environments has been studied extensively. We will build on the previous work by using existing agent platforms as a basis of our architecture. However, the P2P aspects are insufficiently taken into account in these platforms and therefore our research represents advancements in this direction. CASCOM will provide solutions for agent communication between agents without assumption of any fixed infrastructure.

Service co-ordination mechanisms of P2P systems can be applied to multi-agent systems to improve their efficiency. Although this may be accepted on a conceptual level, the combination of agents and P2P environments certainly deserves more innovative research, especially regarding nomadic environments. As an example, many P2P

overlay network algorithms lacks support for rapid node movements. The dynamic topology of IP2P networks, characteristics of wireless network connections, and the limited capacity of mobile devices pose several challenges that have been addressed inadequately in service discovery architectures. In CASCOM, we will investigate mechanisms for service discovery algorithms for dynamic IP2P environments.

The problem of service co-ordination can be split into several sub problems: discovery, composition planning, execution monitoring, and failure recovery. CASCOM will advance the state of the art by carrying out innovative research on how these problems can be solved in IP2P environments. Especially CASCOM will provide flexible and efficient matching algorithms to be performed in large scale and resource limited IP2P environments.

Using AI planning formalisms in service composition and planning are developed for problems where the number of operators is relatively small but where plans can be complex. In Web service composition for open, large-scale IP2P environments planning methods dealing with huge number of possible service are required. However, plans are not necessarily very complex, and therefore planning methods must follow more closely the structure of the service directories. CASCOM will develop planning mechanisms that establish plan fragments directly on top of the service directory to solve this problem.

Acknowledgements

This work has been supported in part by the European Commission under the project grant FP6-IST-511632-CASCOM. The authors would also like to thank all CASCOM consortium members (DFKI (Germany), TeliaSonera (Sweden/Finland), ADETTI (Portugal), EPFL (Switzerland), URJC (Spain), FrameTech (Italy), UniBAS (Switzerland) and EMA (Finland)).

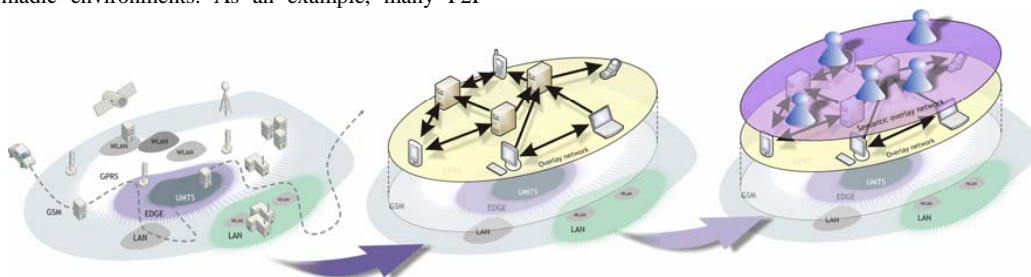


Figure 2: The CASCOM IP2P architecture