HYDRA Project - Use of Semantic Technologies for Networked Embedded System Middleware

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Abstract. The paper describes the IST-2005-034891 project HYDRA funded within the IST, 6^{th} Framework Programme of the EU. HYDRA aims to develop middleware based on service-oriented architecture, deployable on both new and existing networks of distributed wireless and wired devices. The embedded service-oriented architecture will provide interoperable access to data, information and knowledge across heterogeneous platforms. The vision of the project, overall design objectives and scientific objectives are outlined.

Key words: semantic technology, service-oriented architecture, ontology modelling, networked embedded systems, ambient intelligence, middleware

1 Introduction

The IST-2005-034891 Project HYDRA (in full "Networked Embedded System Middleware for Heterogeneous Physical Devices in a Distributed Architecture") is an Integrated Project funded by the EC within Information Society Technologies (IST) Programme within FP6. Project started on July 1^{st}, 2006 and its expected duration is four years. The project consortium consists of 13 partners from UK, Sweden, Denmark, Germany, Spain, Italy, and Slovakia (9 companies, 3 universities and one research institute), the Project Coordinator is C International Ltd. from UK, and one of the project partners is also the Technical University of Košice. The project was submitted and approved within the 5^{th} IST Call under the Strategic Objective 2.5.3 Embedded Systems. Total estimated effort behind this project is 1395 person-months.

The HYDRA project is addressing the problem, which is frequently faced by producers of devices and components - the need for (which is actually becoming a trend) networking the products available on the market in order to provide higher value-added solutions for their customers. This requirement is implied by citizen centred demands requiring intelligent solutions, where the complexity is hidden behind user-friendly interfaces to promote inclusion.

The vision of the HYDRA project is rather ambitious: *To create the most widely deployed middleware for intelligent networked embedded systems that will allow producers to develop cost-effective and innovative embedded applications for new and already existing devices.*

To put it in practical terms: In the ambient world of the near future, interconnected intelligent devices will surround us, at home, work, or while travelling. These devices and their local networks will also be connected to the outside world through broadband and/or wireless networks. Numerous services to support us in our personal life will be provided through these ambient devices and over the connection to the outside world. To adapt to our personal lifestyle, and to offer the right service at the right time in the right place, such services will rely on the use of private data - which means putting emphasis also on security and privacy. It is expected that the HYDRA will contribute to this scenario.

2 Challenges addressed and Project objectives

In comparison with the state-of-the-art on the technology market the project is facing several challenges:

1. The first challenge is to allow for the seamless access to the features of many devices, regardless of its manufacturer, technology, interfaces, location, communication mechanism, etc. and to create seamless, intelligent and secure interoperability between such devices.
2. Second challenge is related to fast changing environments of mobile users - ambient services and applications should thus adapt to changing local and global sets of accessible sensors and actuators, and must put together partial states of internal and location-determined information. When an end-user moves around interacting with any device in either private or public space, it is the right information that must follow their migration from different locations in changing surroundings.
3. Third challenge is to develop a framework for secure, trustworthy communication among networked embedded systems and supporting self-adaptive interplay of different components, not only sensors but also controlling components and actuators.

Overall project objectives can be summarised in the following points:

1. Development of a middleware based on a Service-oriented Architecture, to which the underlying communication layer is transparent, and consists of:
   (a) Support for distributed as well as centralised ambient intelligent architectures;
   (b) Support for reflective (i.e. self-) properties of components of the middleware;
   (c) Support for security and trust enabling components
2. Design of a generic semantic model-based architecture supporting model-driven development of applications.

3. Development of a toolkit for developers to develop applications on the middleware.
4. Design of a business modelling framework for analysing the business sustainability of the developed applications.

From scientific point of view the project will carry out foundational and component research as well as application and system integration within the following research areas:

- Embedded and mobile service-oriented architectures for ubiquitous networked devices;
- Semantic Model-Driven Architecture for Ambient Intelligence implementation;
- Ontology-based knowledge modelling;
- Hybrid architectures for Grid enabled networked embedded systems;
- Wireless devices and networks with self-* properties (self-configuring, self-healing, etc.);
- Ambient intelligence autonomic computing;
- Distributed security and privacy.

The implemented HYDRA middleware and toolkit will be validated in real end-user scenarios in three user domains: a) Facility management (intelligent homes), b) Healthcare, c) Agriculture (to be specified).

3 Conclusions

The paper gives an overview, in terms of challenges addressed, project objectives and technologies used, of the R&D EU project HYDRA. The project is aimed at development of middleware for networked embedded systems with the use of advanced technologies, enabling intelligent properties of the whole system. Technical University of Košice, as one of the project partners, will be within the project responsible for: ontology modelling, ontology evolution, annotation of dynamic events, use of semantic technologies for security and privacy, knowledge discovery, classification and inference etc.; For more information on HYDRA look at http://www.c-lab.de/en/research-projects/hydra/index.html.