

HYDRA – Network Embedded System Middleware for Ambient Intelligent Devices

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Abstract. This paper describes the IST-2005-034891 project HYDRA (full title “Networked Embedded System Middleware for Heterogeneous Physical Devices in a Distributed Architecture”) funded within the FP6 IST Programme. HYDRA is an integrated project (IP), which started in July 2006, its planned duration is 48 months. The project consortium consists of 13 partners: private companies - SMEs as well as large companies (Siemens, Spanish Telecom), research institutes (two Fraunhofer Institutes), and universities (including Technical University of Kosice). Planned total effort is 1 395 person-months and overall budget 12 833 650 EUR. HYDRA project aims at development of middleware for intelligent networked embedded system 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. These devices and their local networks will also be interconnected through broadband and/or wireless networks. Numerous services will be provided through these networked ambient devices. To be able to adapt to personal lifestyles of users, and to offer the right service at the right time in the right place, such services will rely on the use of private data - what puts emphasis also on security and privacy issues. An implemented HYDRA middleware and a toolkit will be validated in real end-user scenarios in three different user domains: Facility management (smart/intelligent homes), Healthcare, and Agriculture. This paper presents the overall vision of the project as well as major challenges, project overall and scientific objectives and technologies to be used. End-user scenarios and application domains are also briefly described.

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

1 Introduction

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 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. Overall project objectives can be summarised in the following points:

2 Project Goals

1. Development of a middleware based on a Service-oriented Architecture, to which the underlying communication layer is transparent, and consists of:

- Support for distributed as well as centralised ambient intelligent architectures;
- Support for reflective (i.e. self-) properties of components of the middleware;
- 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. A Hydra SDK must provide a standardized, portable and simple API; and it must contain a complete and suitable documentation, too. In addition, there should be a compiler that either generates portable code or that is capable of cross compiling. Tools for virtualization, testing and configuration of devices should also be included in the SDK.

4. Design of a business modelling framework for analysing the business sustainability of the developed applications.

The project will carry out foundational and component research and development 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
- Ambient Intelligence support
- Hybrid architectures for Grid enabled networked embedded systems
- Wireless devices and networks with self-* properties (self-configuring, self-healing, etc.)
- Distributed social trust and behaviour as well as security and privacy
- Business innovation

Hydra will develop middleware based on a Service-oriented Architecture (SOA), to which the underlying communication layer is transparent. Hydra middleware will be designed to run on a variety of stationary and mobile devices. The middleware will include support for distributed as well as centralised architectures, security and trust, reflective properties and model-driven development of applications. It will be deployable on both new and existing networks of distributed wireless and wired devices, which operate with limited resources in terms of computing power, energy and memory usage. It will allow for secure, trustworthy, and fault tolerant applications through the use of novel distributed security and social trust components and advanced Grid technologies.

The embedded and mobile Service-oriented Architecture will provide interoperable access to data, information and knowledge across heterogeneous platforms, including web services, and support true ambient intelligence for ubiquitous networked devices. Furthermore Hydra will develop a Software Development Kit (SDK), which will be used by developers to develop innovative Model-Driven applications using the Hydra middleware. Middleware and connected devices should enable developers to implement applications that depend on and adapt to context information. In particular, the developers stressed the acquisition and management of spatial context information that allows for locating devices attached to the system and for the positioning of people and assets. The Hydra project will validate the middleware, the SDK toolkit in real end-user scenarios in three user domains.

3 Application Domains

The Hydra middleware addresses two different types of users:

- Developer users, who will use the Hydra middleware,
- End-users, which will use Hydra applications developed by developer users.

Both types of users are involved and studied in the project.

One from the first tasks in Hydra project was creating scenarios of end-user behaviour and interaction with platform functionality in three different user domains, which were selected – Building automation, Healthcare, and Agriculture. Scenarios were created by using the IDON method that consists of two parts:

- Scenario development using experts and based on knowledge and systematic analysis. The aim is to develop four mind-challenging scenarios for each user domain by mixing inevitable trends with creative fiction.
- Scenario deployment – in this part technical experts and project decision makers interpret the scenarios and extract a framework for the functional and trust and security requirement specifications.

After exhaustive planning (who, why, how) a one-day workshop for each user domain was held. The participants came from various parts of Europe and they were experts from different areas according to the workshop subject (one from the selected user domains). The result of workshops is twelve equally plausible scenarios for the future

use of Hydra middleware in 2015 in already mentioned user domains – Building automation, Healthcare, and Agriculture. These scenarios provide coherent, comprehensive, internally consistent descriptions of plausible futures built on the imagined interaction of key trends.

Scenarios for every domain were created from two clusters:

- *Building Automation domain* – “Interconnectivity” (in contrast to interoperability) and “Universal focus” (pointing to either end-users or developer users),
- *Healthcare domain* – “Technology Drive” (either in convergence or divergence with clinical drive) and “Clinical Innovation” (which can either be evolutionary or revolutionary),
- *Agriculture domain* – “Farming Methods” (traditional or high-tech) and “Consumerism” (conscious or indifferent consumers).

4 Conclusions

The purpose of this paper is to give a basic overview of the R&D EU project HYDRA. The paper gives a description of the major addressed challenges; project overall and scientific objectives and technologies used. As one of the project partners, Technical University of Košice, will participate on several tasks within the project. As experts in the area of knowledge modelling and annotation and extensive expertise in area of knowledge modelling, knowledge management and web technologies we will be responsible for tasks involving the ontology modelling, ontology evolution, annotation of dynamic events, use of semantic technologies for security and privacy, knowledge discovery, classification and inference etc...

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