Collaborative Business Items: Decomposing Business Process Services for Execution of Business Logic on the Item

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Abstract

Collaborative Business Items (or CoBIs) is an EU FP6 project aimed at enabling close collaboration of enterprise software systems with wireless sensor networks. This collaboration will mitigate the error-prone media break between an enterprise, as it is modeled in business software, and its physical counterpart. The execution of business logic will be done directly in a peer-to-peer manner on small sensor nodes attached items, rather than forwarding any low-level data to the backend and executing the business logic remotely. By building a platform abstraction layer, we will both enable uniform access to three European sensor networks platforms and collaboration in heterogeneous networks of them.

1. Introduction

Today, more and more companies use enterprise software systems to execute their business processes more efficiently and reliably. The software helps them to maintain a digital model of the company that delivers to employees all the information they need to do their job. However, still most of the information is fed into the system by people using keyboards. This human input introduces a media break between the modeled enterprise and the physical one. Manual input is wearying for the employees as well as unreliable and error-prone to the system. Additionally, many services cannot be automated by the enterprise software, because it is not aware of the current situation in the physical world (for example the current location of certain assets).

2. Project consortium

The project brings together European academic researchers in the area of wireless sensor networks hardware and software: University of Karlsruhe (DE) with its TecO lab, University of Twente (NL) and the Computing Department of Lancaster University (UK) (see [1][2][3][4][6][8]). They work together closely with corporate research from the small startup company Ambient Systems (NL) selling WSN hardware and operating systems, and industry key players Infineon Technologies (AT) leader in RFID technology and developer of open, standard sensor hardware [9], BP (UK) delivering real-world application scenarios in the oil, gas and chemical industry and SAP Research (DE) with its in-depth knowledge on enterprise services and processes [5] [7]. SAP is also responsible for the overall management of the project.

3. Application-driven top-down approach

The project is focused on two main application scenarios provided by the partners responsible for application and exploitation of the project's results. However, the system design for CoBIs will create general tools to build a broad class of CoBIs applications.

The first application is provided by BP, a major player in the oil and gas as well as in the chemical industry. BP wants to use CoBIs to fulfill legal obligations to prevent dangerous situations in chemical plants. CoBIs nodes attached to containers for chemicals (see Figure 1) can detect if the safe limit for local storage of a highly reactive chemical is exceeded or if two chemicals are stored together that are particularly reactive with each other or if a container is

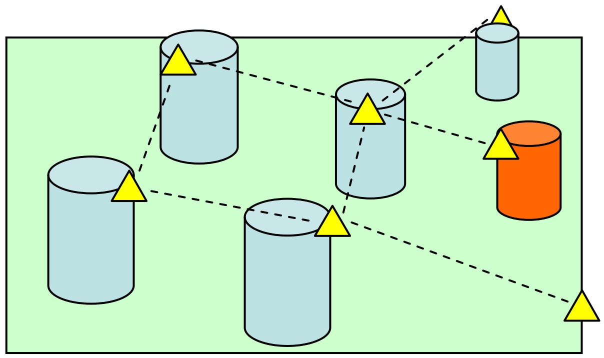

***Figure 1** – Chemical drums with CoBIs nodes*

stored in an unsafe environment that doesn't have the necessary safety protocol.

The second application is a combination of sensor networks with RFID technology. Here, an RFID reader is seen as just another type of sensor, sensing identification data stored on RFID tags. The idea is to build self-configuring smart shelves for warehouses and stores that contain a reader in each shelf (see Figure 2). The CoBIs nodes attached to every reader have to perform three tasks: First, they negotiate a TDMA schedule so that no two readers close to each other are activated at the same time, which causes interference between them and degrades reading results. Second, the nodes route the identification data they sense to a central access point, and third, the data is filtered, since sometimes a reader inside a shelf also reads tags that are on the shelf below or above the current one. In this scenario, unlike in classical sensor nets, power consumption is not critical as the RFID readers have to be plugged anyway and the CoBIs nodes can be connected to the power source as well.

4. Describing services in CoBIL

One of the ideas behind CoBIs is to take services that are currently provided by the backend and decompose them to a combination of simpler services that can be executed directly on CoBIs nodes. All these services (the simple and combined ones) will be described by CoBIL (CoBIs Language). CoBIL will describe the interface of a service in a similar way like web services are described in WSDL. In case of a composed service, a CoBIL description will also contain the way of combination of the underlying services. It does not describe the behavior of a service itself which has to be implemented separately.

The description of a service's interface will allow for automatic mapping of services to deployed nodes by finding the best match regarding to the needs of a

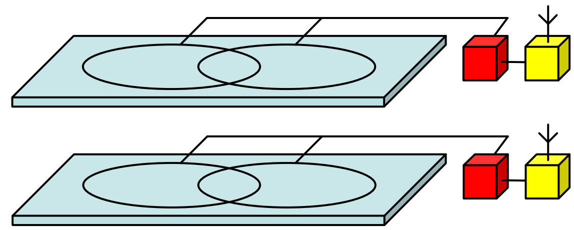

***Figure 2** – Two smart shelves with RFID readers connected to CoBIs nodes*

service (e.g. in bandwidth, power, processing power etc.) with the status information gathered from the nodes.

CoBIL may also contain semantic information that can be used for optimization on the hardware level, e.g. if you know that a certain business process requires action only one time per hour, you could turn off the nodes that deal with this process far longer than energy management at a lower level in the stack could do.

5. Abstraction of hardware platforms

The partners bring three established European wireless sensor net platforms into the project: The *Particles* from TecO, University of Karlsruhe, the *Eyes Nodes* from the University of Twente and Ambient Systems and the *Sindrion Nodes* from Infineon Technologies. One important goal of the project is to provide a platform abstraction layer (PAL) in form of an API that allows the construction of applications device-independently. This also enables us to connect networks of different devices via gateway nodes, forming a compound heterogeneous network.

The PAL should provide both high level functions like deployment of a service onto a certain node or routing, as well as low level functions that are needed for system management like sending nodes to sleep or getting a raw sensor value or neighbor list.

6. Collaboration framework

On top of the platform abstraction layer, a collaboration framework will be established. It will enable basic features that are needed in CoBIs networks like sampling sensors and data exchange between local and remote services. It may also include disributed query processing features like data aggregation, consensus finding as well as collaborative mathematical operations like averaging or finding the median of a set of sensor values.

Lancaster University has developed a system that can collaboratively do rule-based inference and demonstrated its value to the given scenarios in [8].

The focus will be on implementing the functionality that is needed by the aforementioned application scenarios.

7. System management

The goal of system management is to enable the user to perform the task of deploying a large-scale network of CoBIs and instancing and managing the services on them as easy as possible without hindering flexibility.

With the administrative tools created in the project, the user can graphically model the business service he needs by combination of simpler services. The system will then try to give an advice on how to map the specified service to the deployed nodes. This decision is based on the description of the services in CoBIL. The description of the composed service may be automatically composed of the descriptions of the underlying services, but can also be edited by the user for refinement.

8. Application and Exploitation

BP will evaluate the hardware and software built in the project by installing the system in a chemical plant or a refinery to actually monitor safety guidelines for dangerous chemicals.

Infineon will install smart shelves equipped with CoBIs nodes with attached RFID readers as sensors at an industrial selling point of one of its customers in the textile industry.

SAP will define interfaces for wireless sensor networks and enable their collaboration with the business process platform of its enterprise software, allowing CoBIs network services to integrate smoothly into existing business processes. The goal is to integrate wireless sensor network services just as we successfully integrated RFID identification services [10].

Ambient Systems can profit from this integration that enables them to sell "SAP-ready" WSNs.

9. Status and future outlook

The project, currently in month 5 of 30, is in its definition and analysis phase. First results include a detailed survey of the capabilities of the hardware platforms, a classification of enterprise services, an analysis of management and maintainance requirements and a requirements specification for the platform abstraction layer. There also exist basic lab trials showing working examples of the BP scenario under lab conditions.

The first prototypical implementations are planned for month 12.

10. References

[1] M. Beigl, H. Gellersen (2003), "Smart-Its: An Embedded Platform for Smart Objects", *Smart Objects Conference (sOc'2003), May 15-17, Grenoble, France*

[2] Michael Beigl, Tobias Zimmer, Christian Decker (2002). "A Location Model for Communicating and Processing of Context", *Personal and Ubiquitous Computing*, Vol. 6 Issue 5-6, pp. 341-357.

[3] H. Gellersen, A. Schmidt and M. Beigl (2002), "Multi-Sensor Context-Awareness in Mobile Devices and Smart Artifacts", *In ACM Mobile Networks and Applications (MONET),* Oct 2002.

[4] H. Gellersen, G. Kortuem, M. Beigl and A. Schmidt (2003), "Physical Prototyping with Smart-Its", *IEEE Pervasive Computing*.

[5] S. Haller, S. Hodges (2002). "The Need for a Universal Smart Sensor Network", *Auto-ID Centre White Paper, November 1, 2002*.

[6] P. J. M. Havinga and G.J.M. Smit (2001). "Energy-efficient wireless networking for multimedia applications". *In Wireless Communications and Mobile Computing*, Wiley, 2001.

[7] U. Kubach (2003). "Integration von Smart Items in Enterprise Software Systeme", *Praxis der Wirtschaftsinformatik,* Special Issue on Ubiquitous Computing.

[8] M. Strohbach, H. Gellersen, G. Kortuem, C. Kray, "Cooperative Artefacts: Assessing Real World Situations with Embedded Technology", *The Sixth International Conference on Ubiquitous Computing 2004*

[9] Y. Gsottberger, X. Shi, G. Stromberg, T. F. Sturm, W. Weber, "Embedding Low-Cost Wireless Sensors into Universal Plug and Play Environments", *EWSN 2004: 291-306*

[10] C. Bornhövd, T. Lin, S. Haller, J. Schaper, "Integrating Automatic Data Acquisition with Business Processes, Experiences with SAP's Auto-ID Infrastructure", *30th International Conference on Very Large Databases, VLDB'04, Invited Paper, Toronto, Canada, Aug. 29 - Sep. 3, 2004*