EURIDICE – An enabler for intelligent cargo for the logistics sector

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ABSTRACT

EURIDICE is an EU funded project in the area of ICT for the development of a free and open standards based platform with key objectives of distributed intelligence on item level and easy business process integration for companies and institutions in the logistics area. This paper will provide an overview about the architecture and key technologies.

Keywords: Distributed intelligence, Intelligent goods, Logistics, Mobile Agents, SOA, JADE, FIPA

INTRODUCTION

Transport and logistics act in a worldwide distributed business world as an aorta of the economic system. Therefore a high quality standard in this area is the basic prerequisite for the success. The investments in mobile infrastructures of information and communication infrastructures (e.g. UMTS, Galileo) allow a re-orientation of the logistic control systems to guarantee a comprehensive quality assurance of the logistic processes. Starting point for the project EURIDICE [1] is the single logistics object which should be pursued individually and be steered. By using local computation and communication resources logistics objects should reach a very high degree in self-control, can immediately react to unexpected events and minimize the communication expenditure.

The basic idea of EURIDICE is the implementation of a platform for information services in the area of logistics systems which enables the possibility, on the basis of a federative system, to offer logistic services for transported goods. In the centre are the single goods and their interactions with the most different IT systems and users.

By using new information and communication infrastructures (e.g., Galileo, UMTS) it is possible to define a uniform information triple item (time, place, status) for all transported goods in Europe. The use of these data limits itself currently, nevertheless, in primarily to easy „tracking and tracing“-functionalities. In the project EURIDICE, based on this information, added value services should be defined, allowing an individual control of the transported goods in the European home market. For an effective implementation the data acquisition and decision-making should result to a very great extent on mobile devices, installed at the cargo (e.g. a box) itself, being able to react on one hand without delays to logistic events and on the other hand to reduce communication expenditures.

VISION OF INTELLIGENT CARGO

The fundamental question that is related to this issue is whether bit it is worthwhile to retain to structured processes or whether it would be better to define a new self-controlled process regarding future logistics operations. The European project EURIDICE opted for the later approach. The project is based on the assumption
that in the future the usage of passive and active RFID chips will increase and as such the availability of intelligent mobile devices will likewise also increase. This will lead to a situation where more and more local intelligence is available and thus also the capability to process information locally and take local decisions on the basis of this information. EURIDICE predicts a future where the computing capabilities will be more and more decentralized, and thus will lead to a situation where the distributed computing capabilities will be used on the spot to make local decisions within the local environment, rather than taking the typical client server approach of today’s service infrastructures into account.

The core design of the platform is based on available standards like SOA (Service Orientated Architecture) and multi-agent-systems for realization of the cargo-centric-approach. This core is enhanced with implemented services derived from extensive requirements analysis at different stakeholders in logistic chains, e.g. logistics service providers, infrastructure providers, ports and authorities and production companies (Figure 1).

Figure 1: EURIDICE vision of intelligent cargo and value added services for different stakeholders

ARCHITECTURE

The main goal of the project is the development of an ICT platform providing value-added services on top of a SOA for stakeholders in logistics chains for efficient transportation and monitoring of goods. Through combination and orchestration of the available services whole business processes can be implemented on top of the platform. By utilizing these services and concepts for “intelligent cargo” the platform can react autonomous on defined events or assist the operating department in decision making.

The whole framework and platform will consist of services in different levels and scopes. Roughly the services can be distinguished as shown in Figure 2.

Figure 2: General levels and scopes of EURIDICE services
The common EURIDICE specific services allow the composition of applications specific services for the definition and orchestration of business processes on top of them. These application specific services or whole business processes can also be used by other application specific processes. On lower levels of the framework, the generic components level, EURIDICE will also provide services but only for internal use within the framework and not compromising them to the public, although they are based on open standards and if necessary, this manner can be easily changed in the future.

The concept of a distributed and intelligent platform intends that every good has its own intelligence. On one hand for the realization of an efficient tracking and tracing of the goods, on the other hand to also receive and evaluate other relevant information with regard to the transported goods on a real-time basis.

Round these single intelligent goods an open platform is created to integrate the preserved information and offered services with existing (legacy) systems and to offer the services by means of SOA to other ICT systems, and interoperability with most different software products is thereby guaranteed on the basis of established standards and technologies (Figure 3).

![Figure 3: EURIDICE services orchestration and business process integration](image)

The communication between the single services is handled by an “Enterprise Service Bus” (ESB). On top of the ESB a Business Process Engine will be used for the orchestration of these services and the business processes needed for the business cases.

One key issue for the easy adoption of the system is the interoperability and adaptability not only for the implemented pilot applications, but also in the future by other companies and authorities involved in the transportation sector, first of all in Europe, but possible also elsewhere, therefore open standards are a must. The realized web services will be based on available standards for them and for the modeling and implementation of business processes on top of them BPEL and BPMN will be used.

**INTELLIGENT DEVICES**

Since we are able to build microcomputers of the size of a mobile phone or even smaller, computers are no longer bound to any certain location. Small computers like mobile phones or other mobile devices can be relocated very easily. Today a mobile phone fits into every pocket, radios are equipped with high end micro controllers or MP3-players contain very sophisticated hard and software. The paradigm of ubiquitous computing offers new possibilities to provide processing power wherever you want.

The EURIDICE project takes advantages out of this new trend. Not only transport vehicles, but also single cargo items can be equipped with quite sophisticated devices communicating with each other and other IT-systems. Every single part is responsible for a quite small amount of functionality where a combination of the single parts results in a quite complex and powerful system. If single nodes of the system need to communicate involving mobile devices, they need to use some wireless communication facilities like Bluetooth for short range and GPRS or UMTS for long range communication. The whole system becomes a distributed one which appears coherent and continuous to an end user. [2].

The EURIDICE system extends the paradigm of ubiquitous computing by adding some context awareness to the application. Context awareness means that an application is able to sense its environment in terms of detecting its global position, accessing several sensors or reacting on environmental events. [3]

The platform implies more or less sophisticated devices (depending on the mission to fulfill) installed at single cargo items where the architecture uses the Multi-Agent approach with all its benefits. A software agent is a piece of software that acts on behalf of someone else. It is responsible for carrying out a particular mission or task. Users delegate missions or tasks to an agent where the agent tries to solve it autonomously without any user Interaction. Software agents work continuously and autonomously in a particular environment. They communicate and corporate with each other and with other processes. They are self-aware and context aware. This means that they are aware of their mission and they are able to sense their environment to look for any possibilities to fulfill their tasks.

Intelligent software agents on the devices offer information services, observing the cargo and enabling an intelligent behavior for single cargo items. Typical tasks performed by intelligent cargo-agents could be tracking
and tracing of goods, anomaly detection concerning the environment of the cargo in the meaning of critical temperatures, g-forces or humidity levels, but also wrong traveling directions, delays or early arrivals. The local computation-approach allows minimizing the use of centralized systems to organize and redistribute the data. By sensing the environment, the mobile and intelligent agents can react on changes or events appropriately by initiating counteractions or alarming a monitoring unit. An agent has the ability of adaption, which means they are able to adapt their strategies to react on changes inside of the agent network by learning from their experiences.

**Mobile Agents**

Basically a mobile agent [4] is the same as a software agent [5]. The difference between a mobile agent and a software agent is that mobile agents can move from one host to another. To do that, they stop their current execution and transform themselves to a Byte-Stream and move over a network to another host to continue their execution.

EURIDICE will use a large number of mobile agents. These agents can be installed on several devices on several transportation vehicles like trucks, ships, etc. The goal of the agent network is to observe the cargo, the business state and to offer real-time information for business-process optimization. A problem is the limited power supply and resources on the transporting vehicles, inside of a container or inside of a packet. But there will be different power supplies and resources between these three environments. To benefit from this fact, EURIDICE will use an agent-hierarchy where the different levels of the hierarchy will handle different tasks. The basic agent hierarchy of EURIDICE is shown in Figure 4.

For the implementation of a Multi-Agent architecture, an open-source and FIPA-compliant framework called JADE is used. It is published under LGPL and written in pure JAVA. Therefore it enables the use of quite cheap, JAVA enabled devices down to J2 Micro Edition – mobile-phones.

**Software infrastructures and technologies**

This part will give a short overview about the used software infrastructures and technologies for the mobile agent concept of EURIDICE. For the mobile agent concept in general the FIPA standard and the JADE middleware will be used for this project.

**FIPA (Foundation for Intelligent Physical Agents) [6]:** “FIPA is an IEEE Computer Society standards organization that promotes agent-based technology and the interoperability of its standards with other technologies.” [7]

FIPA defines some basic design issues, the services for the infrastructure and a communication standard between agents in a multi-agent system. An FIPA standard-compliant agent ensures interoperability to other systems utilizing FIPA. Moreover standardized libraries and middleware can be used.

**JADE [14]:** “JADE (Java Agent DEvelopment Framework) is a software Framework fully implemented in Java language. It simplifies the implementation of multi-agent systems through a middleware that complies with the FIPA specifications.” [8]

JADE uses a FIPA-compliant agent platform which includes an Agent Management System (AMS), a Directory Facilitator (DF) and an Agent Communication Channel (ACC).

- The AMS is appropriate for the operations of the platform (e.g. creating an agent); it offers the description of the platform and is therefore the managing authority of it.
- The DF offers information to other agents about agents inside an agent network. Inside of an agent network there can be several DFs with the possibility of forming federations.
- The ACC is a CORBA IIOP server object which listens for remote invocations.

JADE also offers some additional features like:
- Agent platforms can be distributed on different devices
- Connecting different agent platforms to a network
- Graphical user interface for managing agents and agent platforms

![Figure 4: Basic agent hierarchy in EURIDICE](image-url)
To run JADE on lightweight devices which are running the J2ME-CLDC / MIDP 1.0 environment the JADE-LEAP [9] library was developed.

CONCLUSION

The described platform offers an implementation of new services that are strictly good or “things” related, thus turning the current process orientated architectures around and placing the goods in to the middle of SOA. In principle this change can be compared with the change from functional to object orientated programming languages and this fundamental change will allow a much better usage and customization of services according to the real needs of users. However this change also requires an adoption of existing applications like ERP, SCM, etc. since these are mainly process orientated and do not cover the usage of distributed decision making or de-centralized intelligence.

PROJECT SUMMARY

The EURIDICE project is planned for the duration of 3 years. It started with 1st of February 2008 and will last until 31st of January 2011. The described high level architecture and used technologies are acknowledged by the consortium. The next steps in the project will be the software implementation of the platform and the adoption of it for the usage within the pilots and the business cases in the project. For regularly updates on the project progress have a look on the website of the project, as it is the first and most up-to-date information source about EURIDICE.

ACKNOWLEDGEMENT FOR PUBLICATIONS

This work was supported by the Seventh Framework Programme of the EUROPEAN Commission through the EURIDICE Integrated Project contract number ICT 2007-216271

REFERENCES