LocON – a Platform for an Inter-Working of Embedded Localisation and Communication Systems

Sylvie Couronné, Niels Hadaschik, Marc Faßbinder, Thomas von der Grün
Fraunhofer Institute for Integrated Circuits IIS
Erlangen, Germany
{cor, hsk, fam, vdg}@iis.fraunhofer .de

Martin Klepal, Widyawan
Cork Institute of Technology
Cork, Ireland
{ martin.klepal, widyawan}@cit.ie

Maarten Weyn
Artesis University College
Antwerp, Belgium
maarten.weyn@artesis.be

Tim Denis
Perlocus, 52M
Antwerp, Belgium
td@52m.be

Abstract— **LocON, a platform capable of delivering location information, obtained through several technologies working seamlessly together, enables service providers to deploy services, which benefit from location information in large scale infrastructures. By employing the LocON platform, the access to underlying technologies becomes transparent for both, the end user and the service provider. The goal of LocON is also to develop a standard, which guarantees compliance with the platform and its services, as well on the hardware side as to the application layer.**

Keywords - localisation; middleware; platform; security

I. Introduction

LocON is a platform which provides location information to services, which can benefit hereof. By providing this information through a well defined and documented interface, several applications can be developed for a wide variety of environments, such as harbours, airports, or large manufacturing sites. To do so, LocON uses different location technologies, such as GPS, Wi-Fi based solutions, UWB or RFID related technologies. These technologies communicate with the LocON platform through an interface, which is proposed as a standard to the market. Doing so enables a wide variety of location technologies to reside below the LocON platform, either existing technologies or technologies to be developed in the future (cf. Figure 1.). The advantage of this approach is clear: every location technology has its strengths and flaws, but by combining different systems, a unified location system arises which is capable of exploiting the individual strengths and avoiding the weaknesses, i.e. delivering a location, which is accurate, fast, reliable, and trust-worthy in different environments and areas of a large scale infrastructure.

The outline of this paper is as follows: firstly, we describe the architecture of the LocON platform, its major parts and sensor data fusion, together with the coexistence capabilities of different systems working with LocON. Then, the standardization activities on the LocON protocol and the validation of the project are discussed. This is followed and concluded by a description of the current status of the project and the next steps.

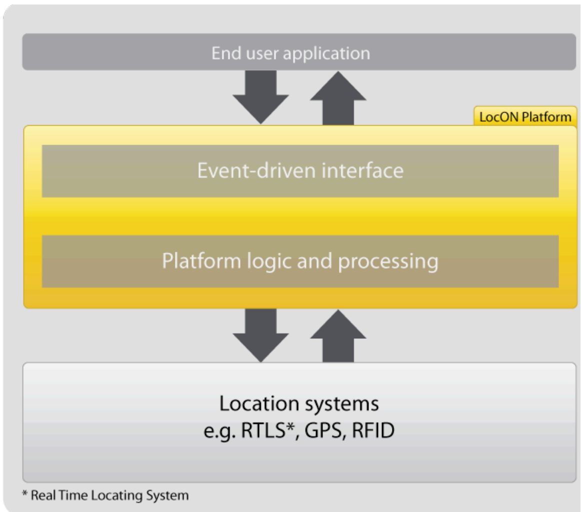

Figure 1. Layered architecture of LocON

II. ARCHITECTURE

LocON implements a layer topology as displayed in Figure 1. in order to achieve the goals previously explained. In the 'LocON Platform' layer, several different building blocks are present to provide the functionality needed.

For combining location data from different technologies, and improving the quality of location, a sensor fusion engine is present in the LocON environment. By means of motion and measurement models, based on previous location and other location related data, the current position can be determined with greater precision and higher availability. Also exploiting the knowledge of logical connections between the objects to be located improves the locating results. For further details on the platform architecture, please refer to [2].

A. General overview

The platform is divided into functional blocks, of which all play a specific role in the processing of the sensor data coming from the different locating systems. This data is used based on predefined rules and split up in location data and other data which can be used later for data mining purposes. The location data is being used by the sensor data fusion to estimate the location of the object, which is discussed in the next section.

The sensor data fusion works closely together with most blocks in the platform. One of them is the Object Relation Evaluator, which is responsible to dynamically detect relations between objects (e.g. a person who enters a bus) to be able to combine the sensor data of these objects. Another block is detecting gaps in the locating systems, which will probably generate localisation problems and generate a potential security risk.

All location estimates are stored and are used by an event broker which delivers all data needed to the business logic through events. The final applications can subscribe to different events and will receive in an event driven way all useful information, which can consist out of not only location data but also other data which is delivered by a context data mining object using location and non location related data.

The rest of the LocON platform consists of different blocks that manage the communication towards the systems, and that handle the monitoring functions and the configuration of the platform.

B. Sensor Data Fusion

Single localisation technology and approach typically suits only to a specific environment and application. There is no single technology, which can provide satisfactory performance in all environments and scenarios, and various localisation technologies have to collaborate in order to deliver a flexible locating system, instead.

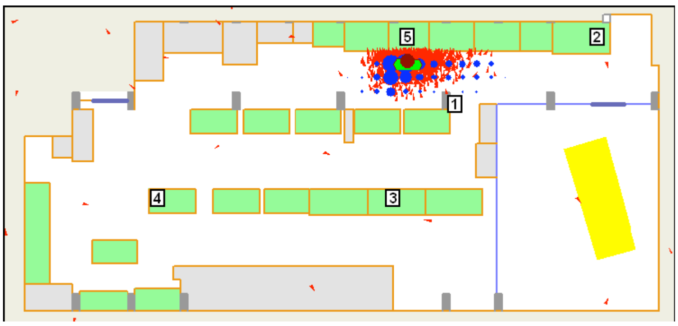

Figure 2. A snapshot of a particle filter (red arrows) used for tracking people, blue dots represent the likelihood observation function.

Sensor data fusion is the key modules for the realisation of the aforementioned goals. Sensor data fusion will combine sensory data from different localization technologies to outperform any individual systems working alone.

Particle filter, a technique that implements a recursive Bayesian filtering using the sequential Monte Carlo method, is currently one of the most advanced techniques for data fusion. It is based on set of random samples with weight, or particles, to represent the probability density (see Figure 2).

The weight of the particles can be calculated as a combination from different sources of sensor data. The particle states are controlled by a motion-model, which can be used to fuse navigational sensor data. The motion model also takes advantage of the map filtering technique [5], when the environment description becomes available (see Figure 3).

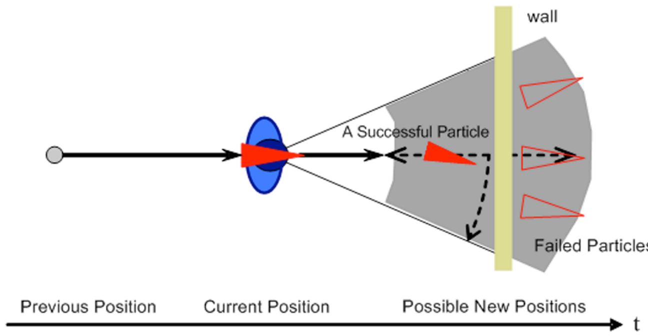

Figure 3. Illustration of map filtering.

C. Coexistence

If realizing various radio locating and communication systems that make use of the same part of the radio spectrum at the same time, collisions of heterogeneous radio frames are unavoidable. On the physical layer, these collisions are regarded as radio interference that adds to the omnipresent noise level affecting severely the system functionality. The interference reduces the precision of the radio locating system, or it may even hinder for a reliable localisation of an object at all. Especially, those systems, operating in the ISM band, like e.g. WLAN of the IEEE 802.11 family or Bluetooth, but also several available localisation systems, face strong mutual interference. Additionally, the envisioned airport scenario is vulnerable to unauthorized radio transmissions. Consequently, the coexistence between the sets of localisation systems, the communication networks, and the airport systems is investigates carefully.

Importantly, in order to achieve full area coverage and in order to profit from sensor data fusion of the location information, the interconnected locating systems serve overlapping areas per definition. Thus, a careful distribution of the radio resources becomes vital for optimal locating precision. The coexistence analysis then provides deployment rules in the planning phase. The rules can be expressed as strict requirements like a minimum separation of a localisation node to a WLAN node operating in the same or a neighboring spectral ranges or less strict advices on the system configuration – supporting high coverage at acceptable precision.

Furthermore, the resulting guidelines enable emerging localisation system providers an organized and secure entry into localisation networks according to the LocON standard.

III. Standardization Issues

The goal of the standardization activities in the LocON project is to establish a common standard for integrating heterogeneous locating systems independent of their topology and their physical layer, and for communicating with the LocON platform and middleware. In order to ensure the compatibility with the platform, the interfaces are defined and standardized. The locating systems have to be classified employing common, specific parameters. However, the main task is to grant interoperability of the locating systems by standardizing the designed data stream layer and the protocol as introduced above and elaborated in [3], [4].

The interface towards the application layers is event driven and strongly dependent on the application under consideration. Consequently, it is currently not considered in the standardization activities.

The consortium investigates the related activities of several standardization bodies like ETSI and ISO, and plans to introduce the LocON data stream and the LocON protocol into an established, suitable standardization group.

IV. Validation

In order to validate the concept of LocON, to point out its benefits in terms of new services and to highlight the improvements in terms of safety and security a system prototype will be deployed at Faro Airport, Portugal, late 2010. Selected critical scenarios based on controlling and monitoring airport vehicles and staff in relevant security areas will validate the results of the project. Therefore, multiple localisation technologies available in the consortium will be installed and integrated into the LocON platform in order to obtain reliable indoor and outdoor positioning information in a seamless way.

By combining the location information with an event driven platform, new context aware services in any environment can be easily developed based on the LocON concept and platform.

V. Current Status of the Project

The project started in June 2008 and the live presentation at the end of 2010 will close it.

During the first year, the project concept has been completed, assessing the user requirements for safety and security applications, but including also more generic use cases. Additionally, the requirements from the various, heterogeneous technologies incorporated in a LocON based system have been identified. From the analysis of those requirements, the architecture of the LocON framework has been derived. After a classification of localisation technologies and the extraction of common and technology specific parameters, the common LocON layer integrating the various localisation technologies in the LocON platform is developed. For a broader impact of the LocON concept, standardization activities for the common LocON layer are ongoing.

For validation purpose, the critical scenarios are accurately defined. The related, innovative control services in an airport environment are identified and specified. A site survey is planed in order to finalize the preparation of the hardware deployment.

VI. Next Steps – Outlook

The implementation phase has already started, comprising the platform modules, and the interfaces to the heterogeneous localisation technologies and to the control services. A LocON test laboratory will be installed in order to perform first functional tests as well as coexistence tests prior to the deployment at the airport site.

This proof of concept is a first step to show the capabilities of LocON. The industry partners in the consortium will be able to transfer LocON into a commercial product and promote the LocON platform and their localisation technologies in a wider application field. Then, the partners may also provide further LocON based services.

Besides, new localisation technologies may emerge compensating for potential technical gaps, we do not foresee today. Due to the open concept, they can be easily integrated into LocON.

At last, the LocON concept and platform offer to end-users looking for improved or new (safety and security) services better applicability and manageability for the localisation technologies underneath.

VII. Acknowledgment

The research leading to these results has received funding from the European Community's Framework Programme FP7/2007-2013 under grant agreement no. 224148. Consortium: Fraunhofer Institute for Integrated Circuits IIS, ANA – Aeroportos de Portugal, Perlocus - 52M, Symeo, BIJO-DATA, CEA - LETI, INESC - INOV, Cork Institute of Technology, Artesis University College.

References

[1] M. Fassbinder, S. Nagy, H. H. Frühauf, and G. Ergeert. "Deliverable 1.3: Requirement Draft for the Global LocON standard", available on http://www.locon.org, Mar. 2009.

[2] T. Denis, G. Ergeerts, and M. Weyn. "Deliverable 3.1: Schematic overview of the LocON framework and guidelines for environmental requirements", available on http://www.locon.org, Mar. 2009.

[3] S. Wibowo, W. W. Najib, B. Hantono, M. Klepal, N. Daniele, S. Couronné, G. Ergeerts, M. Weyn, P. Gulden, M. Fassbinder. "Deliverable 4.1: Classification of Localisation Technology and general description of the LocON ambient aware data stream and protocol", available on http://www.locon.org, Feb. 2009.

[4] H. Millner, P. Gulden, M. Weyn, M. Faßbinder, and A. Casaca. "Deliverable 4.2: Description of the LocON protocols", available on http://www.locon.org, April 2009.

[5] Widyawan, Klepal M., Pesch D., "*A Bayesian Approach for RF-Based Indoor Localisation*", IEEE ISWCS, Trondheim, Norway, October, 2007.