A Fusion Component for location management in mobile devices

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1. Summary and objetives

When indoors, several positioning technologies and systems may coexist (e.g. WiFi, Bluetooth, ZigBee, HF-RFID or bidi codes serving as beacons, cellular networks, etc.); each of them delivering its location estimates with a given accuracy at a given computational cost. In this paper, we describe a Mobile Fusion Component (MFC) -prepared to run in a mobile device- which aims at optimizing the selection of the available positioning systems by handling Quality-of-Location (QoL). The objective of the MFC is to offer the (best) location estimation which fulfills the consumer applications' QoL needs, at the same time that minimizes resource consumption in the mobile device. Additionally, the MFC will provide seamless hand-off among location technologies and allow the user to establish his own privacy level for location data sharing. The MFC is part of a service-oriented mobile framework which offers 'Context Acquisition Services anD Reasoning Algorithms' (*CASanDRA Mobile*) to accelerate the development of context-aware applications.

2. A fusion algorithm for the MFC

The fusion algorithm for the MFC handles a Quality-of-Location [1] tuple which gathers information about the accuracy, availability and freshness of the location estimation provided by the available localization systems. 'Accuracy' refers to the mean error in the location estimate; 'availability' includes data from the electromagnetic visibility of relevant components of the localization infrastructure (e.g. number of available access points); finally, 'freshness' gathers the age of the estimate.

The MFC is dynamically configured to adjust its output to the consumer application's requirements in terms of QoL. It compares the available location estimates from different sources, provides the application with the estimate that better fits its needs, and initiates or stops sensors to optimize resource consumption. The QoL tuple is provided by the available location systems, together with the location estimate. When different technologies are available, the MFC prioritizes those offering better accuracy whenever the 'availability' in terms of visible infrastructure is enough and the estimation is recent enough ('freshness') to fulfill the application's needs.

In order to prototype our MFC, we consider that GPS and Cell-ID positioning are available when outdoors, and the latter also when indoors. Additionally, in closed environments (such as our laboratory), we assume that a deployment of WiFi and Bluetooth access points may be used to locate a mobile device [2] [3]. Moreover, some HF RFID tags will be situated in waypoints to be read from a mobile device. Each of these location systems may offer a given QoL, being the RFID method the most accurate (cms) but offering non-continuous location (event-based) (the full paper will describe the information flow to make the estimator's choice). Another important issue to consider for the MFC is how to handle hand-offs between localization systems, always guaranteeing seamless transfer and resource consumption optimization. The 'availability' information in the QoL parameter is used to start additional sensors and to adjust periodic wake-up of slept sensors.

3. The Fusion Component as part of CASanDRA Mobile architecture.

The Mobile Fusion Component has been designed to work in the architecture of CASanDRA Mobile (Fig.1) [4], to be offered as a standard feature for the framework. In brief, CASanDRA Mobile is composed by three building blocks - Acquisition Layer, Context Inference Layer and Core System. To implement the MFC, the Acquisition Layer needs to contain five sensors gathering data from communication interfaces (WiFi, Bluetooth, RFID, cellular networks and GPS), while the Context-Inference Layer will host six enablers which process raw data from sensors (localization algorithms). The Fusion Component's intelligence is bundled in the Location Fusion Enabler (LFE). Additionally, the Core System will provide standard features for development, such as discovery and registry management of new elements. Both 'sensors' and 'enablers' publish their output data in the middleware through an event manager. Applications run on top of CASanDRA Mobile middleware.

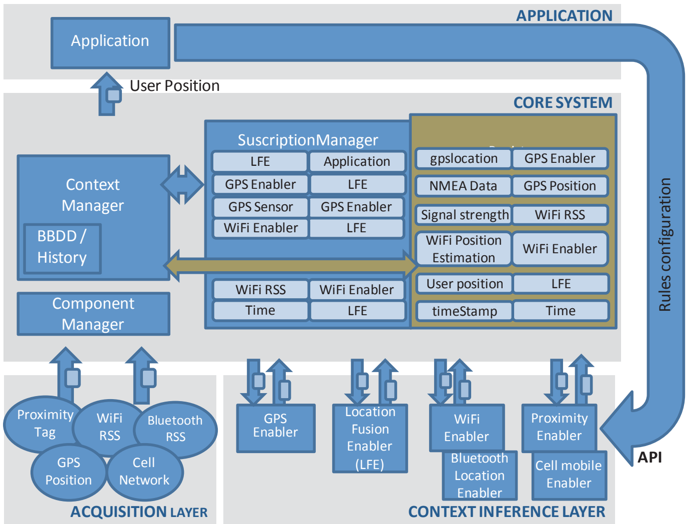

Figure 1. CASanDRA Mobile Middleware prototype is implemented on Windows Mobile 6.1 OS. The middleware is based on the Equinox OSGi platform.

4. Full paper contents

The full paper will go depth in the QoL concept, explaining the relevance of all its elements from the state-of-the-art. The fusion algorithm will be exemplified with cases of use, and the scalability feature will be clearly demonstrated. The performance of the component will be evaluated in terms of energy and memory consumption. Moreover, the full paper will include a detailed description of the MFC in CASanDRA Mobile.

References

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