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TOWARDS THE DEVELOPMENT OF INTERNET OF THINGS COMPLIANT GPS NAVIGATION SYSTEMS

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Abstract: *Satellite navigation applications are covering an increasing number of business domains. Global market estimation regarding products and services in this domain sata that the sales will reach billions of Euro by 2020. According to the FP7 ICT Roadmaps, ICT R&D activities should be focussed on the development and standardization of new technologies to sustain the Internet of Things. There is a necessity for the development of RFID compliant devices, the main enabler for the development of the Internet of Things infrastructure. The use of standard compliant intelligent objects for both economical and private purposes increases the demand for interaction-based devices. Navigation systems capable of both operating in GPS permissive and denying environments and communication with intelligent objects are becoming a research necessity and opportunity.*
Key words: *Intelligent Objects, Internet of Things*

1. INTRODUCTION

Since the Global Positioning System (GPS) became widely accessible, localization in the absolute frame (or geo-location) has been applied in many different fields. This technique provides a good estimate (within a few meters) for the 3D positioning, in areas where there is a good line-of-sight (LOS) to GPS satellites. However, indoors and in densely populated urban environments, geo-location becomes a challenging problem. Typically, the GPS signal is not strong enough to penetrate through most materials. As soon as an object obscures the GPS satellite from the user's view, the signal is corrupted. This represents a functional constrain and restricts the usefulness of GPS to open environments. However there is an increasing need for accurate geo-location in cluttered environments, in addition to open spaces.

In commercial applications, for example, the tracking of inventory in warehouses or cargo ships is an emerging need. In military applications the problem of "blue force tracking," i.e., knowing where friendly forces are, is of vital importance. This is not a problem in open environments where systems can rely on GPS, but in dense urban or indoor environment, no satisfactory solution exists at the moment. (Stanescu, 2007)

The aim of this paper is to provide an overview of the requirements for IoT oriented devices and to provide a model for a IoT, GPS oriented device.

2. INTERNET OF THINGS, THE CONCEPT

A new step towards integration and seamless communication has been made together with the development of "intelligent objects" allowing virtualization capability, meaning that such an object is able to interact with users and other intelligent objects in the virtual world. An example of such an interaction may be created between a GPS device and its surroundings consisting of "intelligent object". The interaction can generate virtual objects on the device's map. These virtual objects become the correspondent of the real objects providing for the encoded information.

The concept of enabling interaction between intelligent objects is closely related and supported by the imminent change from the "Internet of Data" to the "Internet of Things".

We can define the "Internet of things" as: "*the Internet of the future will be suffused with software, information, data archives, and populated with devices, appliances, and people who are interacting with and through this rich fabric*". The 2D communication provided by the "internet of data": any time, any place is completed to a 3D model by a new dimension: anything. In this context "changing business strategies becomes the name of the game" (Santucci, 2009).

The new proposed "intelligent objects" are capable of unrestricted communication between themselves and any other entity through the infrastructure provided by the Internet of Things.

Three main benefits have been emphasized within the Internet of Things research area: "things on the move", "ubiquitous intelligent devices", "ambient and assisted living".

The "things on the move" concept will allow: better identification and transport efficiency of food products along the Supply Chain from the producer to the distributer, the shop floor, cashier and check-out leading to the intelligent logistic management. This will also prevent counterfeiting and assure consumers of controlled origin of the food product.

The "ubiquitous intelligent devices" concept will allow the possibility of information exchange between any intelligent object. Another capability is the implementation of reactive behaviors according to a predetermined set of actions.

One of the main advantages for the user is the "ambient and assisted living" concept. The development of "digital assistants" connected to the internet of things makes "choice" easier in regard to diet and health issues. But the implementation of such devices has to take care of the right choice and opinion (***, 2009).

These features of the "Internet of Things" (IoT) will enhance considerably human-robot collaboration if the robot becomes part of the network and has access to important information that otherwise he cannot acquire. Thus, the robot will have more information for the decision process and more action power, being able to send direct commands to other smart objects/devices in the environment.

3. INTERNET OF THINGS ORIENTED DEVICES

Integrating devices and everyday objects to a smart environment is the first step towards the Internet of Things.

The integration of objects within the "Internet of Things" produces greate benefit, but it is not easy to implement at this point, taking into consideration the following aspects (Sorensen, 2008):

- different intercommunication and interoperation standards
- different service descriptions and capability declaration
- different radio interfaces and media access
- different resources management
- different encryption methods

- different publication and subscription of devices

Technical, extensible standards and protocols suitable for “Internet of Things” are required in order to integrate all types of devices. A set of standards has been proposed for identifying and tracking objects based on RFID tags widely accepted (***, 2006):

- EPC (Electronic Product Code) – analogous to IP address
- ONS(Object Name Service) – analogous with DNS
- PML(Physical Markup Language) – analogous with XML

A consistent set of middleware for interfaces, communication and other services are also necessary to ease the creation of applications for smart devices within the network.

Two system architectures can be implemented using the set of standards described.

First architecture requires an Object Name Service in order to produce the information or data associated with the “intelligent object” EPC acquired code as shown in Fig. 1. In this case the device must be connected to the IoT in order to be able to identify the object and to download its proprieties.

The other approach will require, along with the middleware software, an interpreter or parser capable of converging the coded information within the object’s memory as shown in Fig. 2. This approach will require a standard property coding language. One choice for such a standard language may be represented by PML. The connection with the IoT will not be necessary, in this case, in order to describe the object, but it can still be used in order to facilitate the communication with other IoT compliant objects.

We have identified the following prerequisites to integrate a GPS device within IoT:

- The device must be equipped with a RFID reader
- The device must have a IoT compliant communication module
- The robot must be compliant with a RFID / IoT Standard Architecture

As for the other standards and protocols it depends entirely on the application.

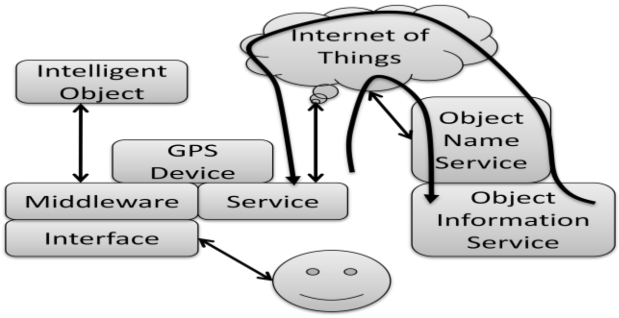

Fig. 1. Object identification using an Object Information Service

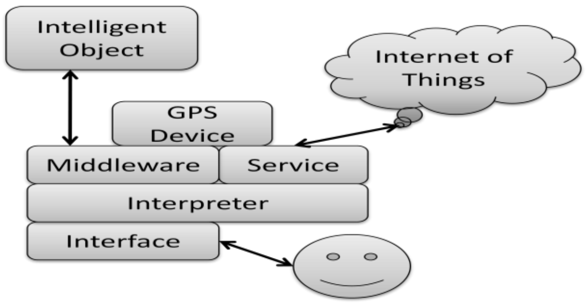

Fig. 2. Object identification using an Interpreter

4. THE GPS NAVIGATOR ARCHITECTURE

The proposed solution for navigation devices will have the following characteristics:

- The system should "just work" requiring minimal-to-no training for operation.
- The system should be ready to operate in a GPS-limited or GPS-denied environment.
- The system should provide for the fusion of multiple references in order to provide location information.
- The system should provide auxiliary data sources for location information.
- The system should acknowledge when it is operating in a degraded information mode.
- The system should provide for a limited/text-based data transfer from tracked/remote nodes.
- The system should provide for object recognition using the assistance of an Object Information Service and integrate the information within the navigational map.

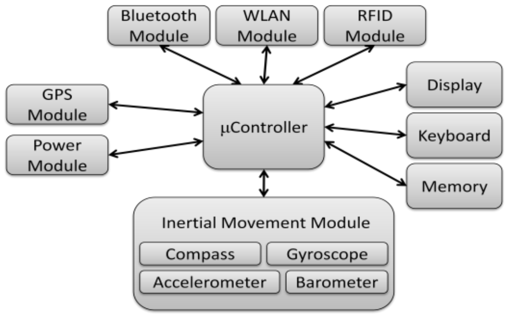

Fig. 3. Internet of Things enabler GPS Navigator Architecture

This application will allow positioning on maps for tracking and recording and for the use of Web–services for data transmission and object identification.

5. CONCLUSION

Leading edge research within the IoT will help extend technologies into tomorrow's e-services and intelligent objects. Developing IoT compliant GPS navigation devices will extend the user experience, offering a new way to interact with the environment.

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