A WEB PLATFORM TO COLLECT, MANAGE AND SHARE HETEROGENEOUS SENSOR DATA

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Abstract

In the last years, the scientific and technological advances generate an exponentially growth of the number of sensors producing a huge number of data. In this paper we present Paraimpu, a prototype of a scalable platform able to collect, manage and share heterogeneous kinds of sensor data.

1. Introduction

The scientific and technological advances in medicine, (bio)physics, (bio)chemistry and (bio)engineering generates an exponentially growth of the number of sensors. As a consequence, they generate the need to collect, manage and share the huge mass of sensor data. With the current trend of the Web of Things (WoT), Internet-enabled items become active actors in the Web and rely on common HTTP-based communications. The idea of a general-purpose platform for millions of Web-enabled sensors and actuators guided us toward the creation of Paraimpu (http://paraimpu.crs4.it), a platform that allows to connect a data source with a data consumer and to socially share them with friends/contacts.

2. Platform Technologies

The WoT vision includes any everyday object: environmental sensors, micro-scopes, telescopes, clothes, healthcare appliances, commodities, utensils, mechanical devices, furniture, buildings, monuments, books and many others. Today, they are estimated in about 50000 billion [6]. So a WoT platform must collect, manage and forward thousands of concurrent sensor data items ensuring availability and performances. The Web server must efficiently face the C10K problem [3] and the underlying database must provide scalability partitioning data over multiple nodes. To realize such a system we have chosen: Tornado Web Server, a scalable, non-blocking Web server and tools; NGINX, the load balancer

used in conjunction with Tornado; and MongoDB which natively stores schema-free, JSON-like documents, manages replication and supports sharding.

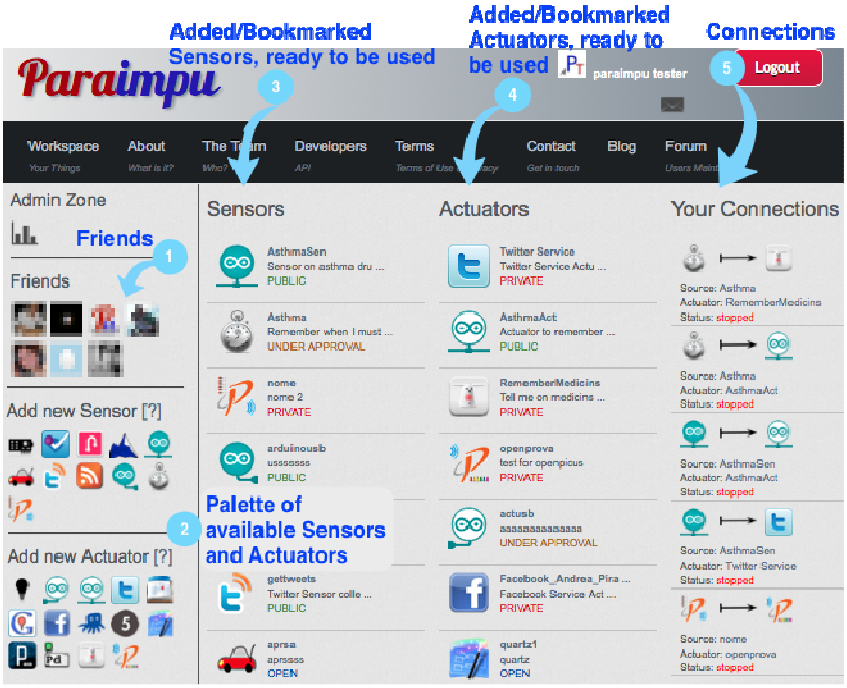

Figure 1. Example of user workspace in Paraimpu.

3. Things, Connections and Sharing

With the term "*things*" we include either physical sensors or objects and virtual Web things like social networks, services or other software applications. In order to represent things in a more abstract way, we generally distinguish them by function: *Sensors*, able to produce data; *Actuators*, anything able to perform actions by consuming data items produced by a *Sensor*.

From these abstractions, we derive the *Connection* one. It represents a real-time data flow established between one *Sensor* and one *Actuator* independently by their nature. In this way, with the same simple steps, a sensors-equipped smart board can be connected to a PWM motor controller, to Twitter or to an email sender. Obviously, it raises data heterogeneity problems and a data adaptation mechanism is mandatory. *Connections* can be properly configured specifying rules for data filtering and data adapting. For each connection, the system is responsible to process user-defined rules by a JavaScript-based rule engine. In case of actuators consuming complex data structures, Paraimpu guides user with ad-hoc widgets and GUIs to facilitate the definition of filters and mappings.

One common aspect of today Internet applications is “socialization”. Paraimpu is social-by-design and enables users to discover and bookmark *Sensors* and *Actuators* shared by other friends/contacts. In fact for each instanced thing, the user can select one access policy among private, public or moderated. If a thing is shareable, it can be bookmarked by user contacts and used in their *Connections*. Moreover, existing social networks profiles can be used as *Sensors* or as *Actuators*, like any other thing. For example, Paraimpu uses Facebook as an *Actuator* to post text messages, Foursquare as a *Sensor* producing geo-located data while Twitter is available both as *Sensor* and as *Actuator*.

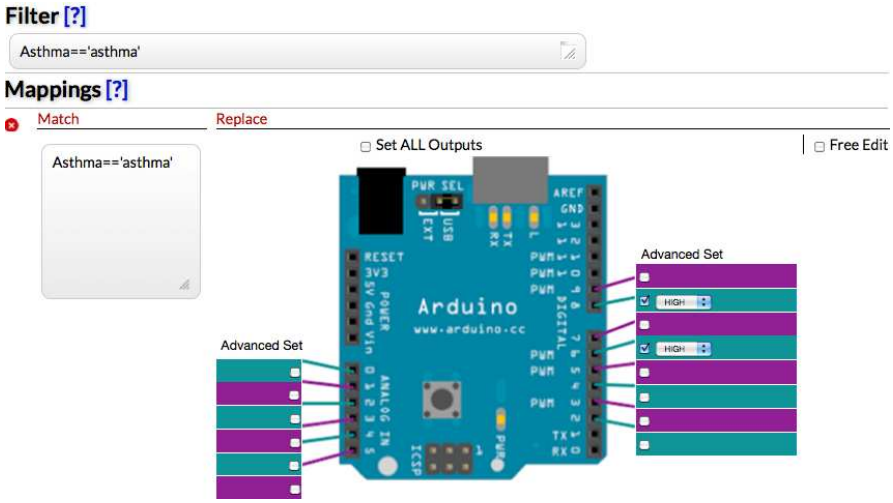

Figure 2. Example of filtering and mapping applied on a textual sensor controlling a smart board.

4. Example of Real Scenarios

Instancing *Sensors* and *Actuators* and combining them in *Connections*, users have the chance to realize truly personalized and pervasive applications. Let us to depict some of them.

Remember to take medicines. Forgetting to take medicines is a common lack for everybody but for some people (i.e. elderly and mild cognitive people) it is a daily important task. In such a typical Ambient Assisted Living (AAL) scenario, a Paraimpu timer sensor sends a signal when it is the time to take the medicine. The signal is used to activate the Paraimpu-enabled objects in patient’s home: a medicine box on the dock containing the medicine box and his Karotz rabbit. The LED on the table lights on and, rotating its ears, Karotz tells to take the asthma drug tablets. The patient takes the drug box and the tablet. When he re-places the box on the dock, the LED switches off and one tweet is automatically sent.

Tlight. It is a permanent interactive artistic installation created by the Quit

group (http://www.quit-project.net). On the top of big circular glass tower of the THotel of Cagliari – Italy, they realized a lights system controlled by Paraimpu in order to allow everyone to change the color tones and the behaviour of the RGB lights just posting a message on Twitter containing the hashtag #thotel and one color or sequence name (i.e. wave, couple or pulse).

CityScripts. This on-going scenario verifies the platform on Smart Cities field. Thanks to SmartSantander project [4] funded by European Commission under contract number FP7-257992, CityScripts aims to experiment how users can satisfies some common urban questions like how many free parks on a street or noise level on an area. They can compose public data from sensors placed in Santander – Spain with personal data from their devices or services using a conditional mapping to adapt data exchanged by heterogeneous items, build connections and trigger actions.

5. Conclusions

Thanks to a scalable-by-design architecture, from the adopted Web server to the data persistence layer, Paraimpu addresses in a comfortable and user-friendly way the need to simplify the collection, forwarding, sharing, filtering and adaptation of data items coming from millions of *Sensors* in order to be used by software and hardware *Actuators*.

Other works experiment platforms to integrate smart objects [5] and creates smart spaces [2]. In [1], social networks influence things and places. Paraimpu merges these three elements. By *Things* and *Connections* abstractions and its social nature, Paraimpu can lead to a broad WoT development and adoption, ranging from Smart City scenarios to artistic installations or AAL situations.

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