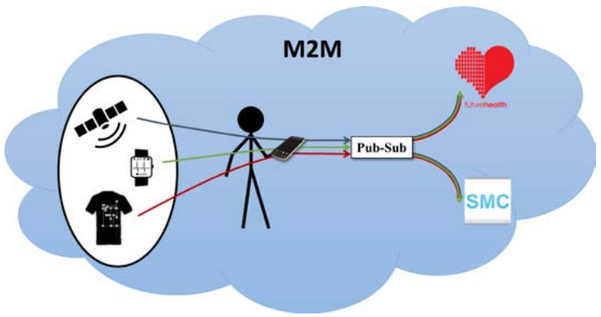
Energy Management for M2M Gateway

Machine-to-Machine standards are driving the emergence of INTERNET OF THINGS (IoT) applications by providing autonomic interoperability. Smartphones, with vast connectivity and sensing capabilities, are the natural choice to serve as personal IoT gateways. In this project, we designed and developed an ETSI M2M compliant IoT gateway on a smartphone, and demonstrated it in a well-being use case.



Main Project Team

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Funding Agencies

Portugal Telecom, Inovação, S.A	**20,000€**
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Indicators

Journal Papers	1
Conference Papers	1
Concluded MSc	1

Two Main Publications

C. Pereira, A. Aguiar, **Towards Efficient Mobile M2M Communications: Survey and Open Challenges, Sensors**, Vol. 14, No. 10, pp. 19582 - 19608, October, 2014

C. Pereira, J. Rodrigues, A. Pinto, P. N. Rocha, F. Santiago, J. M. Sousa, A. Aguiar, **Smartphones as M2M Gateways in Smart Cities IoT Applications**, International Conference on Telecommunications - ICT, Thessaloniki, Greece, Vol. -, pp. 184 - 190, May, 2016

PROJECT WEBPAGE URL

https://www.it.pt/Projects/Index/2062

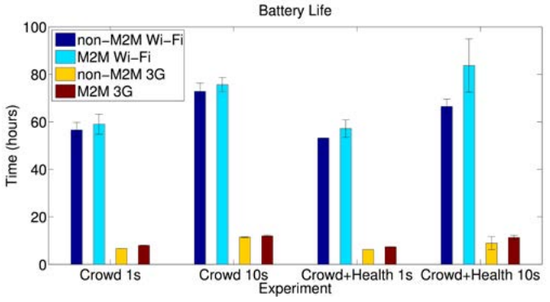

Fig. 1 Implementation of the M2M GW. GA can access the M2M system by intermediate of a GA API.

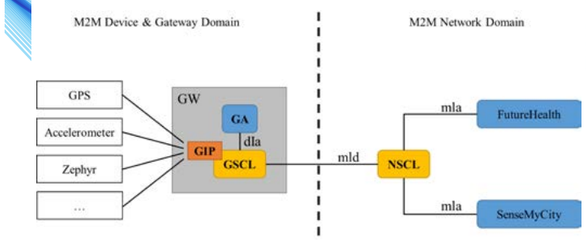

Fig. 2 Comparison between performance of SenseMyCity and FutureHealth applications in a non-M2M and M2M scenarios. The higher the bars are the higher the battery life. There is an increase of the measured battery life of the smartphones when M2M is used and two or more applications use the same data. The use of 3G severely depletes the battery when compared to the use of Wi-Fi.

GENERAL MOTIVATION AND OBJECTIVES

Many IoT applications are mostly inefficient vertical silos using proprietary protocols and encoded data, with limited options for efficient communication and networking decisions. Although other applications might be interested in the same information streams, data from one sensor usually cannot be easily used by any service, independently of the user's will, because interoperability is not a reality. E.g. a user's choice of a wearable device binds him to the services available from the manufacturer: after choosing a well-being bracelet like Fit-Bit or Jawbone's Up, the user can only profit from the processing algorithms provided by the manufacturer. This silo mentality is throttling the adoption of IoT applications.

This work focused on the role of the smartphone in IoT applications supported by M2M. We explored use cases for demonstrating the potential of M2M as an IoT enabler in which a smartphone is a gateway. We designed and implemented an ETSI M2M GW, consisting of an M2M Gateway SCL (GSCL) and a M2M Gateway Application (GA), in a smartphone (Android OS). We mapped two exemplary smart city services into M2M architecture as demonstrations.

CHALLENGE

Interpretation and implementation of the ETSI M2M standards is a cumbersome task that could only be overcome through the close cooperation with the team of PT Inovação. A significant challenge is resource-awareness to avoid battery depletion in the GW.

WORK DESCRIPTION AND ACHIEVEMENTS

Use Case

Jonathan suffers from a health condition that requires the monitoring of his daily activity and vital signs. Jonathan is also an enthusiast of smart city applications, and thus in his daily life he uses other applications for monitoring him, contributing to the city's mood map, and enabling him to analyse the routes he takes in his daily life.

Instead of collecting individually and separately the desired data from Jonathan's devices (wearable system or smartphone), applications can obtain it by making subscriptions for each

type of data they are interested in being notified of. Furthermore, applications can share their own processed data, or any other kind of information, if they are willing to, by re-publishing on the M2M system where others may use it further.

Mapping Use Cases To M2m

M2M GW registers itself under its own SCL below the sclBase at the NSCL. Applications are mapped as NAs on M2M, registering themselves directly at the Applications resource collection below the sclBase at the NSCL. Figure 1 shows the mapping. The M2M GW is composed of an M2M GA and an M2M GSCL that are required to manage sensors and data on the M2M Device and Gateway domain. The M2M NAs subscribe at the M2M NSCL, the broker, all the sensor information they are interested in receiving from each M2M GW, as long as they have permission to access the resources. Every entity needs to be contactable so, unless additional mechanisms are deployed, entities usually run a thin web server to receive notifications. When new sensor data is collected, the M2M GW notifies the NSCL, by means of a publication, which itself notifies all the M2M NAs that made the subscription to that type of event. If there are no subscriptions to data collected, the M2M GW does not send any data. All M2M communications use the standardized interfaces.

Results

Using the M2M middleware less sensor data is transmitted, leading to an increase of battery life of the smartphones. There is no impact of adding even more applications running at the same smartphone, as long as they use the same data.

The use of aggregation increases the battery life 46% when using Wi-Fi and 53% when using 3G for the M2M scenarios. Data aggregation is thus a useful mechanism when using resource-constrained devices as gateways.

Challenges

Finally, we identified challenges to the deployment of mobile ETSI M2M gateways on resource constrained devices: mobility, private IP addresses, data collection, resource–aware application development. These challenges should be addressed if M2M is to gain momentum as IoT enabler.