

Sensonet: a low-cost open-source objects network framework

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Abstract: Machine-to-machine (M2M) networks is one of the major assets of smart cities and the internet of Things (IoT). Such networks are evolving fastly due to Information Technologies (IT) and evolved telecommunication networks (GSM, 3G, LTE)[9]. Business applications based on sensor networks are commercially available for a long time. In Africa M2M solutions remain expensive and mainly used by international companies for infrastructure monitoring. Thanks to a good GSM coverage and new IT assets, small and agile M2M solutions could be a leverage for development and new businesses in Africa. This paper deals with the description of a complete low-cost open-source sensor network solution from the sensor to its associated SOA core framework.

Introduction

IoT systems become more and more popular and industrial solutions cover lot of vertical markets (health, transport,..). M2M plays a key role for smart cities of Internet of Things innovation area fields[1]. The 2011 Mason analysys indicated a quick massification of M2M enabled devices with up to 2,1 Billion connected things worldwide in 2020[2].

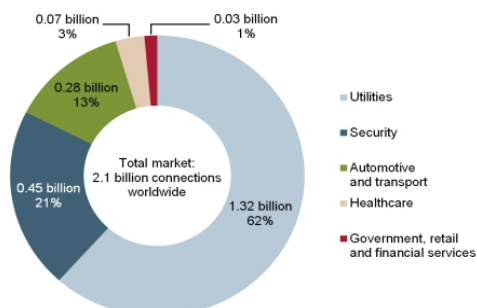


Fig 1: Commercial and consumer M2M device connections by industry sector, worldwide, 2020 src Analysys Mason, 2011

IoT and M2M solutions for Africa

"M2M in Africa: A matter of life and death"[3] was published by Telefónica in 2012. This article described how the M2M system developed by Sequoia Technology reduced from 40% the risk of HIV transmission from pregnant women to their babies in Mozambique. N.Lidington, managing director of Sequoia claimed that the challenge was to use the only mode of communication you can reliably say is everywhere in Africa: the cellular network[4].

Sensonet

In Sensonet, M2M is used as support to enable IoT.

At the beging, Sensonet was design as Probe/sensors network but has been extented to more : connected objects.

Sensonet has been designed for Africa to create and manage low cost innovative connect objects networks. It can be quickly and easily used for any experimental studies as mentioned in the table below.

Use case	Description	Probes & Sensors
Water survey	A sensor network has been designed in order to automatically retrieve the level of the water sources in Sahel in order to optimize the path of nomadic farmers.	An pressure and ultrasound sensor measure regularly the water level and reports major changes to Sensonet. The probes is fully autonomous.
Solar panel monitoring	Schools in Niger have been equiped with solar pannels. The maintenance is realized by a central entity located in the captial. The sensor network check that the remote panels are still working and alert if it is not the case.	The sensor measure that electric power is produced.

Architecture

Overview

The object collect information and send them to the object network backbone by SMS. Probes may be part of the general network or a dedicated sub-network.

In the opposite way, objects receive data and command from the object network backbone by SMS. The SMS are managed by Sensonet Aggregated information are available through a REST-Full API witch also permit to trigger actions on probes and objects. The overall architecture of the solution may be described as follow:

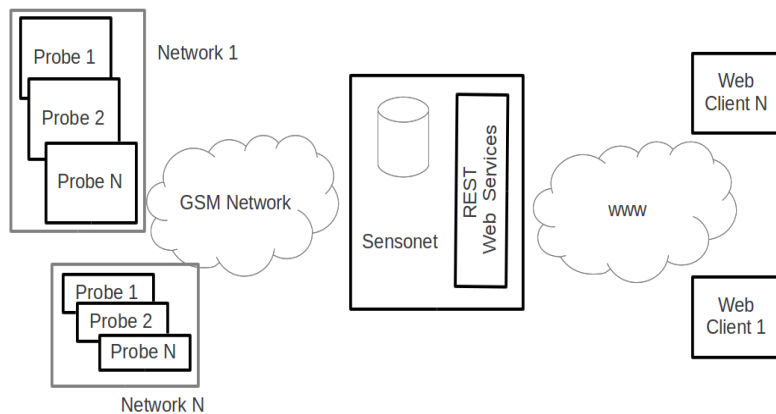


Fig 2: Sensonet architecture

The Sensonet "backbone" may monitor deployed objects. SMS, even if there is no guarantee of delivery, is a robust protocol suitable for sensor data collection or for prototyping small experiments with a very level of requirement in terms of infrastructure to deploy objects.

Object & feature

One of the key elements of the architecture is the Object. It is practically realized with an open source micro controller arduino and sensors and activators. It may be described as follows:

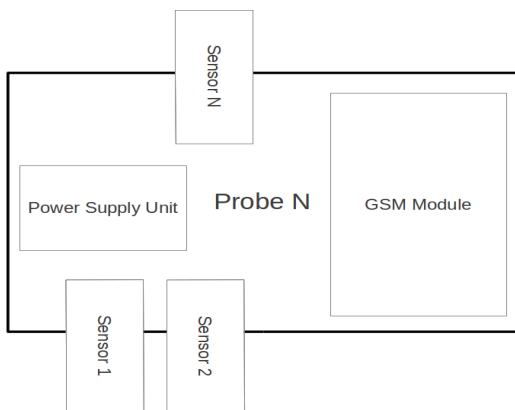


Fig 3: Details on Sensonet probes

The internal architecture of objects can be summarized as follows:

- a Probe (object) component, managing relations between the arduino and the backbone via SMS
- Sensors (feature) : elements measuring physical data via physical sensors, reacting to information received via activators. Practically it is a device connected to the arduino board
- Power supply (battery and small solar panels)

The probes are generic, it means that they may deal with any physical value an arduino sensor may measure (e.g. temperature, water level..) but also control systems (relay, motors.....). This Arduino library is published under free licence and can be adapted. The SMS based protocol specifications are also published as open source so it's possible to develop libraries to integrate with Sensonet any other platform for probes.

Create an object is simple : Create a probe, create a Sensor, plug it : it's done.

It is also possible to add a GPS extension in order to manage mobile probes. By default all the probes are geo localized statically (initialization). Each data collected and stored in Sensonet is geolocated and timestamped. The code of the probes have been optimized for a better autonomy of the system as well to minimize SMS traffic. The probes can be fully autonomous thanks to a battery and small solar panels.

Backbone

The backbone is able to manage many different sensor networks simultaneously. It has been implemented on a open source PHP Platform as a Service called Emerginov[6]. This platform provides a simple SMS management framework (originating and terminating SMS), web hosting and data storage. The backbone includes REST web services in order to allow any application to subscribe to any sensor networks. The backbone includes also a visualisation tool to map the sensor networks on maps.

Finally an android application has been developed to complete the Sensonet tooling and get a mobile application to manage the sensor networks.

Sensonet SOA framework

Description

Sensonet provides a REST-Full API to access and manage sensonet objects. It supports xml and json format.

Content negotiation is based on usage of standard HTTP Header

All the data defined in the object model may be accessed via the API - Networks/Probes/Sensors/Event and EventSubscription objects.

The API also permit to trigger event on probes, e.g. trigger probe reboot.

Event subscription

It is possible to subscribe to Events at different levels:

- Network level: all events related to all probe/sensors of a network will be published
- Probe level: all events related to all sensors of a probe will be published

Subscriptions are related to a subscriber (owner). So, for each subscription resource (i.e web service call), the requester must authenticate.

Conclusion

The Sensonet solution, an open innovation IoT toolbox, allows the creation of simple objects networks. The opportunities related to such networks are big in many domains (health, transport, agriculture, urbanism,...). The agility, simplicity, cost effective and open source nature of the solution could lead to a large adoption by the maker communities and local entrepreneurs. It could thus be a leverage for local development and be a simple way to study the opportunity related to the Internet of Things also in Africa.

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