

COSMOS**Grant Agreement N° 609043*****Cultivate resilient smart Objects for Sustainable city applications***

Newsletter, Issue 2**<23/12/2015>**

Introduction

Dear readers,

We are very glad to introduce you the second newsletter of the COSMOS project.

COSMOS is a European project, which is developing a set of methods, tools and techniques to enable smart city IoT applications to take full advantage of its technologies, through three representative scenarios:

Smart Heating Application Scenario (Camden)
Smart Mobility Application Scenario (Madrid)
Smart Energy Management Application Scenario (Taipei)

COSMOS consists of a set of innovative baseline functionalities and during Year 2 of the project, we focused on how to combine them in order to achieve more complex functionalities and a higher application level structure adapted to our Use Cases needs and therefore to produce significant societal impact. To this end, we have defined two main application archetypes derived from our use case scenarios mentioned above: *Smart Event Flows* and

Social Autonomic Applications; **Node-Red** tool is used for orchestrating flows between the various elementary components.

Smart Event flows

In COSMOS, one of our intended objectives is to bridge the gap between historical data analysis and real-time data analysis solutions. In this regard, we have explored and developed a platform based on OpenStack Swift for storage and using multiple Spark libraries on the top of it for analysing historical data at one end and developing a micro Complex Event Processing (μ CEP) engines for analysing real-time data stream in a distributed manner. It exploits the main *smarts events functionality* whose main steps are listed below:

- Data feed ingestion and storage from raw data
- Data retrieval, training of Complex Event Processing (CEP) limits using Spark and updating of CEP operational rules
- Runtime usage: smart event identification & visualization

The final goal of the functionality is the automatic definition and runtime update of the rules boundaries.

Why this approach?

The main benefit of this approach is that enables us to integrate different forms of data feeds, coming from multiple data sources, which still remains a big challenge in the context of IoT. It is also an adaptable and extendable architecture, meaning that, for example, possible new events for Madrid Smart Mobility App should extend only the CEP rules and/or the main app logic or other example applications may replace data inputs/outputs adapting per case.

Social Autonomic Applications

Social autonomic & evolving applications for self-management, minimizing user involvement in terms of e.g. heating schedule management, including embedded social communication and learning, actuation and evaluation, providing links between events and potential actuation plans. Each application is typically designed to handle a set of situations based on its available local data. However, this can be extended, through the help of other similar applications and experiences, by exploiting social interactions. In a team of individuals (in this case application instances), this knowledge will most probably not completely overlap, thus having the potential of being shared in order to mutually benefit the parties involved. The COSMOS project works on enabling smart city applications and developers to take full advantage of IoT technologies by exploiting synergies and knowledge sharing and gives small devices the ability to overcome their structural limitation, in the following manner:

- Linking Problems to Solutions: Creating new Apps through new structures
- Creating Knowledge Flows: Connecting Things Efficiently
- Making Things Social: Establishing and Monitoring Relations of Trust & Reputation

Why this approach?

The benefits of this approach are listed below:

- Adapted at the Virtual Entity (VE) level device, hiding smart objects behind it and exposing their data
- Embedded social communication and learning, actuation and evaluation
- Can have *ad hoc* VE services that exploit local data and expose added functionalities based on app logic
- Inserts fail-safes for actuation during operation
- Extendable in terms of supported objects

Thank for your interest in our work.
The COSMOS consortium

What is in store for you?

During 2015, COSMOS project furthermore specified its innovative results as following:

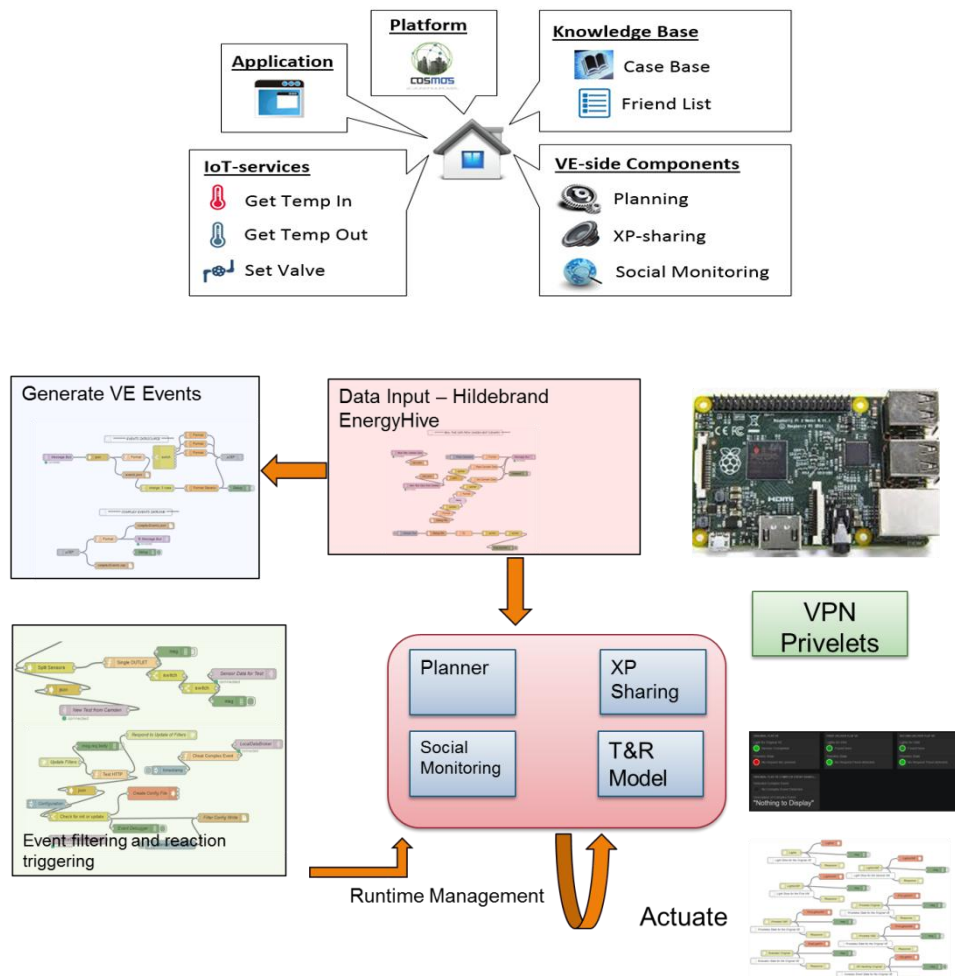
- We defined a domain specific ontology to semantically describe smart homes and their sensors.
- We introduced and implemented the concept of Experience Sharing between Things in both reactive and proactive manner, following events detection achieved using lightweight CEP techniques.
- We created a Trust & Reputation model based on complex social characteristics of Things, like Popularity, Trust, Reputation, Dependability and Reliability, which are used to measure the quality of intra Things communication.
- We built a framework under which Things, and therefore their users, can communicate with each other in a trustworthy way, keeping their real identity secret and their private data safe; Privelets
- We extended Secor open source tool to support saving IoT data, in Parquet format, in OpenStack Swift Object storage, also enabling tagging objects with metadata and uploading the metadata to Swift.
We applied Apache Spark SQL methods and Spark Machine Learning algorithms in historical data stored in the Cloud Storage, in order to generate critical thresholds that can be used to make decisions on real time IoT data streams.

How to put COSMOS in place?

Smart Heating Application Scenario (Camden)

The proposed scenario takes into account that the End Users typically desire an increased amount of cost efficiency, without having to be manually acting in order to provide feedback or actuation to a heating schedule of their flat. A manual or suggestive approach is time consuming and will eventually alienate users even if the data is provided in understandable monetary terms and not in consumption metrics. Thus the COSMOS side autonomic app, running on a Raspberry Pi, handles the creation of the schedule, by splitting the problem in smaller fragments. If information on a specific fragment is not available locally, it then triggers the social mechanisms to recover it from one of the peers in the network (other flats). The returned solution is evaluated after actuation and the relevant social metrics are updated.

The application scenario exploits some of the COSMOS technologies like Case-Based Reasoning, Trust & Reputation Model, Privelets and CEP.



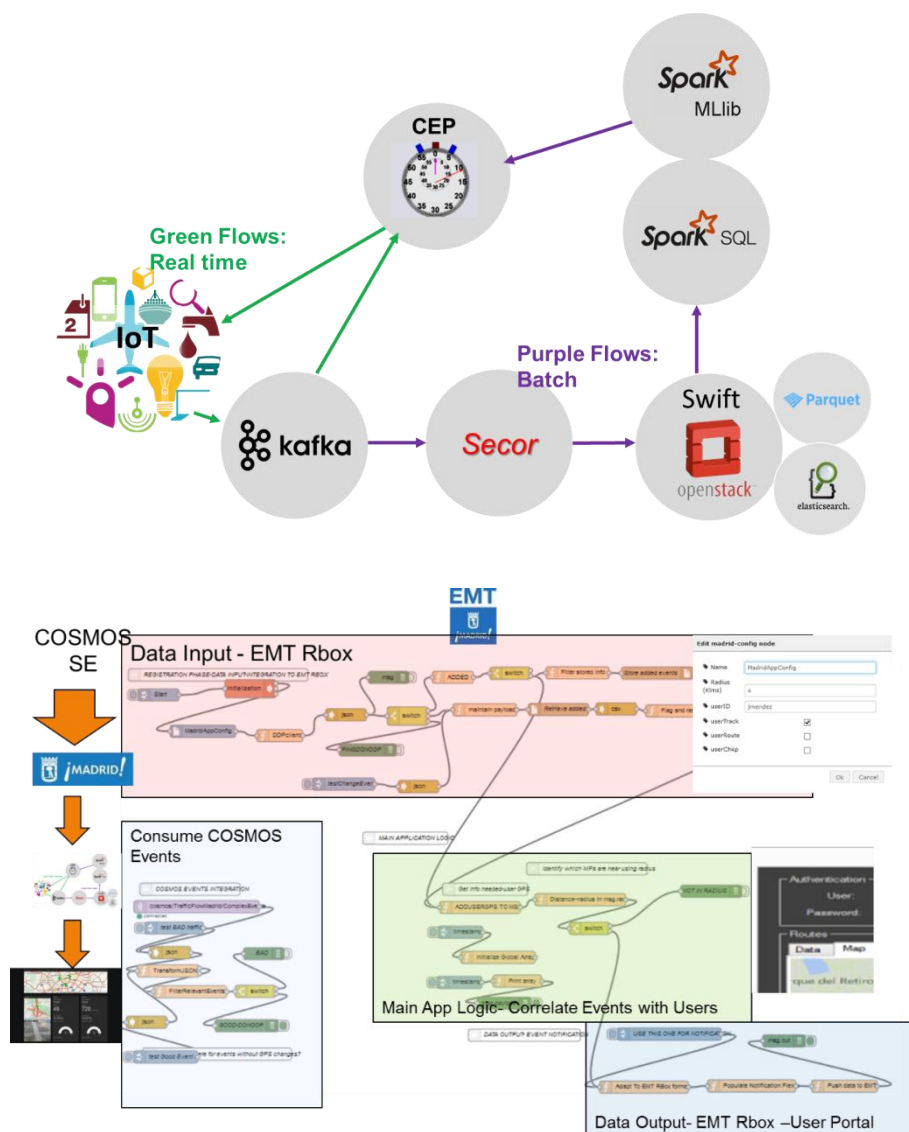
Smart Mobility Application Scenario (Madrid)

Passengers that have special needs such as children, elderly, disabled and the like, may choose to use the bus system if they can get assistance on the beginning and end of their journey. Assistance would come in the form of a caregiver who might help the passenger plan their journey and track the passenger's progress. However a number of events might occur that influence the user's journey and this is where COSMOS kicks in, in order to optimize user experience. In this case the caregiver plans the route and the COSMOS environment tracks the user through its journey. At the same time, Madrid city traffic data are gathered, stored and analyzed in order to identify the limits after which a bad traffic condition is identified. This information is fed into CEP in order to detect, in real time these events, and then broadcast them to the COSMOS system. In case the app logic detects that the specific measurement point in which the event occurs is near the user, relevant notifications are produced to the involved parties.

The flow of the scenario consists of the following steps:

- Ingestion & Analytics
 - Collect data from devices (traffic sensors)
 - Aggregate into objects with metadata

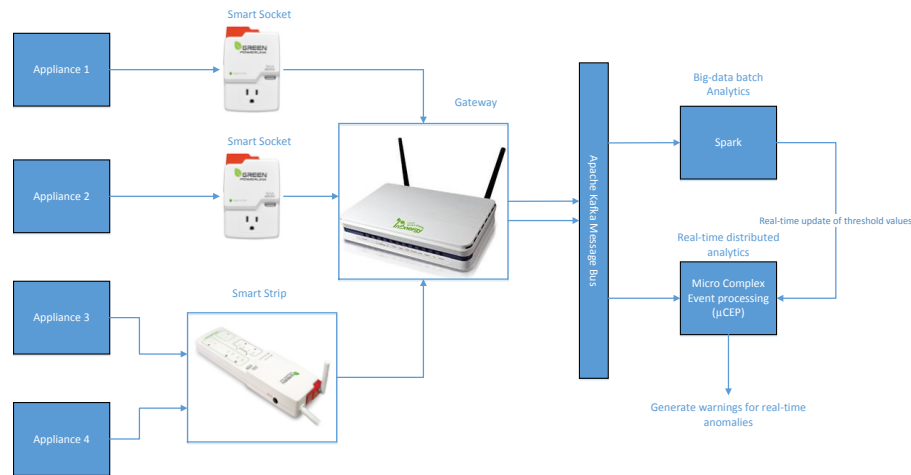
- Index the metadata
- Clustering based on time of day, location
- Classification based on good or bad traffic conditions
- Real Time Response
 - Definition of CEP rules
 - Apply what was learned on real time data stream; take action



Smart Energy Management Application Scenario (Taipei)

In Taipei, Ill is providing services to hundreds of houses with thousands of devices connected to their smart sockets. Smart sockets provide the users about real-time energy usage in order to make them more aware of their energy consumption. Different appliances are connected to smart gateways with the help of smart plugs. Smart plugs monitor real-time electricity consumption data which are published in real-time on the specific topic in apache Kafka Message Bus. These data are being collected and analysed in Apache Spark (similar to the previous case of Madrid) in order to calculate their statistical properties and the normal working range of appliances which is used as threshold values for CEP rules. The latter are

analysed in real time through the μ CEP engine of COSMOS. Anomalies for a specific appliance are highly dependent on time as well. For example, switching on the TV in an evening is a normal behaviour whereas switching it on during midnight can be an anomaly. Analytics on historical data enable to have specific characteristics with respect to particular user or appliance. It helps to understand the behaviour of users in a better way.



Did you know that?

COSMOS has published more articles related to our research goals. Following, a list of the new publications is included.

Publications

- Panagiotis Bourellos, George Kousiouris, Orfefs Voutyras, and Theodora Varvarigou. 2015. Heating schedule management approach through decentralized knowledge diffusion in the context of social internet of things. In Proceedings of the 19th Panhellenic Conference on Informatics (PCI '15), Karanikolas Nikitas N., Akoumianakis Demosthenes, Nikolaidou Mara, Vergados Dimitris, and Xenos Michalis (Eds.). ACM, New York, NY, USA, 103-108. DOI=<http://dx.doi.org/10.1145/2801948.2802009>
- Achilleas Marinakis, Spyridon Gogouvitis, Dimosthenis Kyriazis, George Kousiouris, Panagiotis Bourellos, Orfefs Voutyras and Theodora Varvarigou. A Cross Layer Management Framework for Achieving Added Value IoT Services. In Proceedings of 12th European Mediterranean & Middle Eastern Conference on Information Systems (EMCIS 2015). <http://emcis2015.emcis.eu/EMCISfiles/Proceedings.pdf>
- Adnan Akbar, Francois Carrez, Klaus Moessner and Ahmed Zoha. Predicting Complex Events for Pro-Active IoT Applications. In Proceedings of 2nd IEEE World Forum on Internet of Things
- Adnan Akbar, Francois Carrez, Klaus Moessner, Juan Sancho and Juan Rico. Context-Aware Stream Processing for distributed IoT Applications. In Proceedings of 2nd IEEE World Forum on Internet of Things

Attended Events

There is a wide range of events in which COSMOS has participated during 2015, in order to reach audiences and demonstrate our work and results:

Net Futures 2015

COSMOS project was present on the 25th and 26th of March 2015 in Net Futures conference (<http://www.iot-cosmos.eu/node/1644>) in Brussels. The scope of the event is to maximize competitiveness of the European technology industry. During the two days of the event over 700 attendees share their thoughts and work in the ICT domain. COSMOS presented the work developed in a Pitch Panel session where eight projects showed the results and the expectations for the market take-up of the developed solutions.

SIdO Event

SIdO 2015 took place in Lyon, France, on April 7 & 8 and focused on providing a tradeshow where start-ups, manufacturers, tech companies, digital players, labs, investors, designers, contractors and media could gather to explore the Internet of Things and make it the new economy. COSMOS participated in this event (<http://www.iot-cosmos.eu/node/1636>) as one of the 12 members of the EU/IERC village that SMART-ACTION coordinated to promote research results of the project to SMEs and start-ups. COSMOS booth attracted many individuals as well as companies who had the chance to learn about the current results of the project through software demonstrations and dissemination material.

IoT Week 2015

The IoT week is a yearly event organised by the IoT Forum. The IoT Week 2015 was hosted in Lisbon between the 16th and 18th June at Lisbon Congress Centre. COSMOS had a booth (<http://www.iot-cosmos.eu/node/1792>) where visitors had the chance to see our demonstrations regarding geospatial Madrid metadata search, traffic state in Madrid City and Trust & Reputation ranking in participative social smart buildings. As part of IoT Week, there was a session dedicated to IERC AC3 Cluster to which COSMOS belongs. COSMOS project presented the work done in the pilots in the last IoT week (<http://www.iot-cosmos.eu/node/1679>). There was a session where different projects covered by this cluster presented the work towards the execution of the pilots and demonstration. The talk focused on the main achievements and also highlighting the locks and barriers found towards a successful execution of the plans.

Smart Cities day

Smart Cities Day is a new conference based on case studies of the most inspiring cities worldwide. The event took place in Marseille, France on 16/09/2015. COSMOS presented in the event the Madrid Smart Transport Use Case (<http://www.iot-cosmos.eu/node/1753>).

ICT 2015

COSMOS participated in the ICT 2015 event, which was held in Lisbon, Portugal on 20-22/10/2015. The project had a booth (<http://www.iot-cosmos.eu/node/1794>) where visitors had the chance to see our demonstrations regarding traffic state in Madrid City and Trust & Reputation ranking in participative social smart buildings. Furthermore, the project has been selected for extended visibility by the organizers, thus contributing to a specialized article on the Digital Agenda website.

Apache Spark Summit Europe 2015

In October 2015, IBM presented “How Spark enables the Internet of Things: Efficient integration of multiple Spark components for Smart City use cases” at the Apache Spark Summit Europe taking place in Amsterdam (<http://www.iot-cosmos.eu/node/1783>). This presentation covers work done as part of the COSMOS project by IBM, the University of Surrey and ATOS.

OpenStack Summit 2015

The OpenStack Summit is a four-day conference for developers, users, and administrators of OpenStack Cloud Software. COSMOS presented “Boosting the Power of Swift using Metadata Search”, showcasing the EMT use case and showing our geospatial metadata search on EMT historical bus trip data (<http://www.iot-cosmos.eu/node/1812>).

Annual Polis Conference

The Polis Conference is a major platform for cities, metropolitan areas and regions to exchange on their transport challenges. 2015 Annual Polis Conference on "Transport innovation for sustainable cities and regions" took place on 19 and 20 November 2015 in Brussels. COSMOS presented “An open platform for transport data in Madrid”, demonstrating the development of an open platform through which the various elements related to transport and traffic are made available to citizens and businesses under a completely new and innovative model (<http://www.iot-cosmos.eu/node/1837>).

IBM Insight 2015


During this event, COSMOS presented recent work on integrating Swift either as a data source and/or target with a range of open source projects such as Kafka (via Secor), Spark, CouchDB, Tachyon, Hadoop, and ElasticSearch (<http://www.iot-cosmos.eu/node/1808>).

Do you want to be part of it or know about it?

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This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 609043.

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