Towards Interoperable IoT Deployments in Smart Cities - How project VITAL enables smart, secure and cost-effective cities

Gregor Schiele, John Soldatos, Nathalie Mitton

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How project VITAL enables smart, secure and cost-effective cities

Gregor Schiele[1], John Soldatos[2] Nathalie Mitton[3]
[1]Insight Centre for Data Analytics, NUIG, Ireland, [2]Athens Information technology, Greece, [3]Inria, France

Teaser: **IoT-based deployments in smart cities raise several challenges, especially in terms of interoperability. In this paper, we illustrate semantic interoperability solutions for IoT systems. Based on these solutions, we describe how the FP7 VITAL project aims to bridge numerous silo IoT deployments in smart cities through repurposing and reusing sensors and data streams across multiple applications without carelessly compromising citizens' security and privacy. This approach holds the promise of increasing the Return-On-Investment (ROI), which is associated with the usually costly smart city infrastructures, through expanding the number and scope of potential applications.**

IoT technology enables the orchestration and coordination of a large number of physical and virtual Internet-Connected-Objects (ICO) towards human-centric services in a variety of sectors, especially in Smart Cities [1]. Many research, pilot and commercial applications have been developed, ranging from RFID/Wireless Sensor Network applications to more sophisticated ones involving large numbers of different devices and ICOs. They are directly associated with significant business and societal impact, which makes the IoT paradigm part of relevant policies for sustainable urban development. However, this has resulted in the creation of several (parallel) IoT ecosystems, leading to IoT application silos within modern smart cities as shown in Fig 1. Such technical silos are often the reflection of organizational silos in local government. As an example, the separation of law enforcement from the department of transportation and from the public works department results in different IoT deployments and associated technical silos.

In this paper we present the FP7 VITAL project [url1], which sets out to overcome IoT silos in Smart Cities and to enable ICO deployment and integration independently of the underlying IoT architecture. VITAL is a three year joint European project, started in September 2013 by a consortium of ten partners from Ireland, France, Greece, Italy, Spain, the UK and Turkey.

Semantic Interoperability solutions for IoT

Interoperability of IoT systems extends beyond technical/syntactic interoperability towards *semantic interoperability*, which mainly explores the use of a common ontology for describing resources across disjoint IoT systems [2].
Recently, several research initiatives have extended the ontology of the W3C SSN incubator group, which aims at overcoming the limitations of pre-existing XML-based formats [3] and the fragmentation of sensor ontologies into specific domains or applications [4]. This ontology describes sensors, observations, and related concepts but not domain concepts, e.g. for Smart Cities.
As an example of a system providing a common semantic layer, the OpenIoT project [url2] enables humans, devices and services to announce and annotate different (virtual) sensors/devices as W3C SSN compliant sensors. OpenIoT offers an open source Cloud-based IoT platform [url3], including components like a Sensor Middleware, a Cloud Data Storage and a Scheduler.

VITAL: Semantic Smart City Interoperability

The VITAL project builds on these approaches and extends them to ensure the semantic interoperability of evolving Smart City IoT applications and projects. It uses the SSN ontology to model data and OpenIoT as a common data management component. It extends them in two main aspects. First, it provides a much richer data model for Smart City applications, including city-wide information like demographics and Smart City stakeholders, as well as Smart City application information with city-specific Key Performance Indicators, e.g. for smart energy, smart transport, smart security etc. Second, it provides interoperable access not only to data coming from different IoT systems (like e.g. OpenIoT does) but also to services provided by these systems, e.g. discovery, monitoring and complex event processing. This allows to create higher level services that integrate these system-specific services into a single federated service view.
VITAL will be validated in two smart cities that are represented in the project consortium: London (represented by the London Borough of Camden) in the UK and Istanbul (represented by the Istanbul Metropolitan Municipality) in Turkey.

Conclusion

VITAL will enable application and service providers to integrate services and data streams stemming from multiple IoT ecosystems, architectures and middleware infrastructures.
This will allow to reuse and repurpose existing sensors and IoT systems, increasing the ROI (Return-on-Investment) associated with costly Smart City infrastructures. Subsequently, we hope to jumpstart the cost and time efficient development of new Smart City applications, both by city authorities and by an open developer community, leading to a new wave of such solutions in cities all over Europe.

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[4] M. Compton, P. Barnaghi, L. Bermudez, R. G. Castro, O. Corcho, S. Cox, et. al.: "The SSN Ontology of the Semantic Sensor Networks Incubator Group", Journal of Web Semantics: Science, Services and Agents on the World Wide Web, ISSN 1570-8268, Elsevier, 2012.

[url1] http://www.vital-iot.com
[url2] http://openiot.eu/
[url3] github.com/OpenIotOrg/openiot

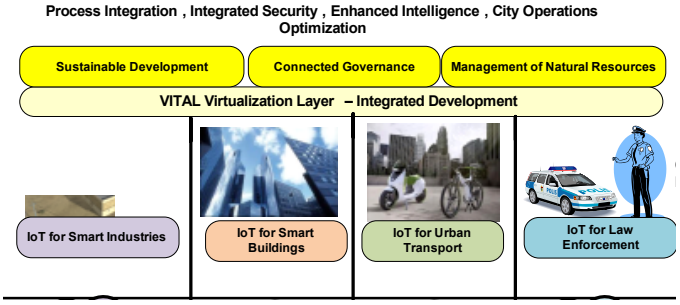

Fig 1. Technical and organisational silo deployment in smart cities.

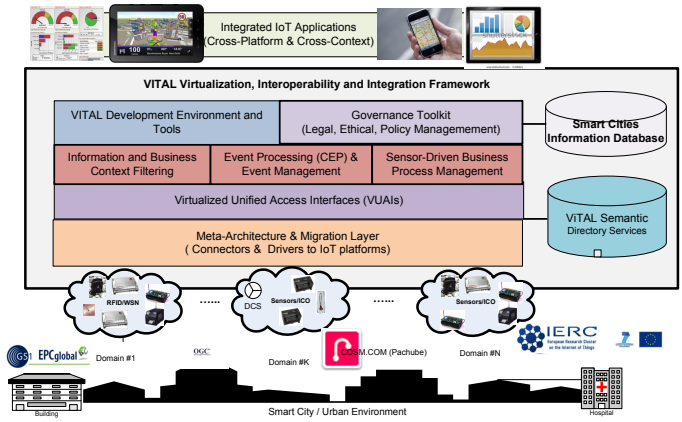

Figure 2. VITAL platform overview.