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Is there a Need for a Cloud Platform for European Smart Cities?

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Abstract: This paper proposes an innovative solution for city administrators to provide 'intelligent' services to citizens and visitors exploiting Cloud computing and frequency identification technologies. Using the EPIC platform, cities can become 'smart' by extending their applications with a new set of technical, functional and business capabilities based on the particular requirements of each city and the needs of end users for applications. The applications deployed on EPIC will take the advantage of the platform services for scalability, sustainability and low operational cost becoming available to a pan-European (and possible worldwide) market. In addition, the EPIC Roadmap will simplify the process of extending existing applications or developing new 'smart' services for cities and leverage the involvement of enterprises and SME creating new business models and value networks.

1. Introduction

The current economic crisis, combined with growing citizen expectations, is placing increasing pressure on cities to behave in a 'smarter' way: to provide better and more efficient infrastructures and services, often for less cost. This trend has contributed to the growing popularity and use of the term 'Smart City' [7].

Definitions of a 'Smart City' vary widely – ranging from the use of discrete Future Internet technologies such as RFID or augmented reality for improved city e-governance through to a more holistic conception of an intelligent, integrated innovation environment that is, in essence, linked to the concept of Living Labs and user-generated services [7]. More specifically, Smart Cities collectively tend to suggest the use of innovative ICT-based technologies such as the Internet of Things (IOT) and Web 2.0 to deliver more effective and efficient public services that improve living and working conditions and create more sustainable urban environments that are associated with the provision and consumption of "intelligent" public services on a pan-European level.

In recent years, Living Labs have proved to be an effective means to close the gap between innovative R&D in the Smart City arena and market take-up, and make the innovation process more effective. However, many Living Labs are still fragmented and hyper local phenomena [1]. Also, it is not entirely obvious how the Living Lab idea of a trusted real-life experimentation platform for ICT products and services can be tied in with the large-scale and efficient day-to-day operations of a Smart City.[6].

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In this context, it is clear that to be successful a holistic Smart City approach needs to dispel the uncertainties related to operational and regional fragmentation, and overcome the systemic failures that currently prevent innovative synergies between large technology and service providers, city administrations, small and medium enterprises, and end-users [8]. Going beyond the existing cluster and Smart Grid paradigms, one paradigm that is increasingly being proposed to overcome such fragmentation, while adapting to highly distributed environments, is that of cloud computing. This paradigm encompasses both a user experience of IT and a business model that is built on the inspiration of consumers using Internet services and providers delivering them. It is a style of IT delivery in which applications, data and IT resources are rapidly provisioned and provided as standardized offerings to users over the web via a flexible pricing model and self-service. It is also an infrastructure management and service delivery methodology which can be used to deliver services with elastic scaling - thereby representing an industrialization of IT services. As a result, cloud computing can be conceptualised in terms of a parallel and distributed system that is dynamically provisioned and presented as a set of unified computing resources and services established through negotiation between service providers and consumers [5].

The following discussion is designed to examine the cloud platform paradigm in the Smart City context, based on a first set of results from an ongoing European project – European Platform for Intelligent Cities (EPIC). The discussion is structured as follows: The proceeding section introduces the objectives and methodology underpinning the EPIC project. Section Three then details the business need and technical solution that EPIC proposes to help European Cities deliver more innovative public services and work 'Smarter.' Section Four discusses preliminary lessons learned and key challenges while Section Five explains the ultimate benefits of the proposed solution for cities, citizens and businesses. Finally, Section Six briefly concludes our work.

2. Objectives and Methodology

The EPIC project is designed to examine the needs, requirements and added value of a pan-European 'Smart City' service delivery platform for leading ICT companies, specialist SMEs, Living Labs, and established and 'wannabe' Smart Cities. The specific objective of the project is to explore the particular implementations of the cloud platform paradigm as the basis for a pan-European service delivery platform that will enable a more holistic approach to making cities smarter. Toward this end, the proposed solution is based on an innovative cloud platform that weds the new Living Lab methodology for public service reform to future-oriented technologies such as augmented reality and the Internet of Things.

Living Labs have become an established part of local and regional innovation systems. Living Labs research is particularly well-suited to improve R&D processes thanks to the way in which it specifically engages users to help tackle key issues concerning behavioural change and innovation, business modelling and impact assessments, organisational processes and structures, multi-stakeholder participation, and (multi-)cultural specificities. As such, the Living Lab approach has the potential to help advance Smart City operations through 1.) its focus on merging research and innovation processes with the daily, real-life context of people in their roles as citizens and consumers and 2.) its ability to leverage the involvement of enterprises and SMEs in a manner that creates new business models and value networks.

As already outlined earlier, the term "Smart City" is rather broad and can include a variety of services that are offered to citizens and visitors as well as different concepts and objectives that vary from city to city, even in the same country. Therefore, a key objective of the project is to produce an empirically-based methodology to help cities become smart(er). This methodology will underpin a fundamental part of the solution, and will be based on the lessons learned by three cities – Brussels, Issy-les-Molineaux and Manchester

- that are actively using the Living Lab focus on engaging end-users in service design to create new 'Smart City' services.

In Brussels, project partners will help to create a new *Relocation Service* for families moving to Brussels. The new application will be designed to help a family find a new place to live according to their specific requirements. Augmented reality will be used to visualise inquiry results, and citizens will ultimately be able to walk through their new neighbourhood and ask questions along the way. In Issy-les-Molineaux, a new *Urban Planning* service will create a virtual space for consultation and dialogue between public administrators, citizens and business on proposed urban developments. The application will combine rich media, 3D modelling, and symbolic information to enable users to experience planned developments for themselves. Thanks to state-of-the-art technology, users will be able to fly over a digital 3D model of a city and experience new developments for 'real.' Finally, in Manchester, a new *Environment Service* will integrate new and existing RFID/IoT technologies to help households monitor their carbon consumption. IoT data collectors will measure environmental factors such as electricity usage, temperature and gas consumption to provide households with a snapshot of their energy use. Cities, in turn, will then be able to use the information gathered to influence policy and achieve carbon reduction targets.

The three scenarios outlined above were chosen as they each pose different requirements for the EPIC platform and cover different aspects of the Smart City concept. To ensure that the platform is best suited for the deployment of these types of new application services, several workshops with the main stakeholders and end users of each application (city councils, city administrators, SMEs, etc.) will take place throughout the lifecycle of the project to identify key platform functionalities as well as effective strategies for the adaptation and development of public services provided by the EPIC environment.

The success of the EPIC portal in terms of its ability to use a cloud-based service platform to deploy cross-border 'smart services' will be tested through the deployment of the newly created services in the 'virgin' city of Tirgu Mures, Romania which is only just now beginning to introduce 'smart city' concepts into its service delivery model. The ultimate validation for EPIC will lie in its ability to 1.) help simplify the processes of developing and extending 'smart' services within the Living Lab environment and 2.) use the cloud to deliver these 'smart' services in a sustainable cost effective manner to a pan-European (and possible worldwide) market.

3. Business Need and Technology Answer

Cloud computing is a common buzzword in eGovernment circles these days, and holds the potential to help European cities transfer and share innovative public sector applications amongst themselves [9]. Despite all the hype, however, very few public administrations really understand the long-term benefits of cloud computing in terms of helping cities realise key strategic goals and work 'smarter.' Whilst many public sector bodies are beginning to understand that the cloud can help them to reduce cost and achieve economies of scale, uncertainty is rife in terms of how to migrate current systems to the 'cloud' let alone to 'future proof' for on-stream technological advances such as IoT. According to a recent global survey by Red Shift, only 23% of organizations in the public sector are actually using cloud computing, versus 42% of private-sector companies, whilst just only 25% of public-sector organizations considering use of the cloud at this point in time believe they have the necessary in-house expertise to do so [10].

In light of this current state of affairs, the EPIC platform is intentionally designed to combine cloud computing technology with more advanced features such as IoT middleware and semantic capabilities in a manner that facilitates easy implementation. In so doing, the EPIC technology solution aims to create a 'one-stop' pan-European service delivery

ecosystem that public administrators can easily use to plug-and-play innovative new 'Smart City' services. The platform is comprised of three core elements:

EPIC Test and Development Cloud
At its core, EPIC will deploy IBM's Test and Development Cloud [1] as the basis for single point of access for European public administrators. The IBM Test and Development Cloud was chosen because it is designed to answer the current 'Smart City' need for a flexible and cost-efficient computing infrastructure and back office portal server that is accessible and relatively easy to use. The platform's self-service test environment, ease-of-use design, service request management, automated provisioning and configuration management are all intended to help overcome current public sector resistance to innovative use of the cloud by providing on-demand access to both basic and pan-European 'Smart City' services.

Semantic Layer
The current fragmentation and hyper local nature of the European Living Lab environment means that is often difficult to promote, let alone share, innovation across the European public sector. This problem is further complicated by the numerous languages spoken throughout Europe. To address this challenge, EPIC includes a Command and Control Lexical Grammar (C2LG) [2] to facilitate multi-lingual access to the service application and lay the foundations for easy cross-language adaptation and communication within the Cloud. To access and deliver innovation applications from across Europe via the cloud, all a 'Smart City' will need to do is to map information into C2LG, convert it into the target language and modify the ontology for local usage.

IOT Middleware
One of the most innovative aspects of the EPIC platform is the use of the 'Internet of Things' (IoT) to provide common middleware for advance, future-oriented 'Smart City' services. IoT middleware will provide access to all kinds of geo-location and IoT technologies from 3D representations through to RFID sensors and Geo-tagging. The true value of the IoT is the combination of public services with sensor technology that enables connectivity between current and future devices. Under the EPIC 'Smart City' vision chosen objects will be able to "think", "feel" and "talk" [3] with each other, making it possible for city administrators to monitor and control these objects everywhere and anytime and ultimately create an intelligent or 'smart' service. The platform will make it easier for third parties such as Living Labs and SMES to develop and provide IoT "plug-ins" that will allow any device within reason to be connected to the cloud. This type of advanced service model 'hides' the complexity of the underlying cloud infrastructure whilst at the same time meeting complex public sector requirements for cloud such as security, heterogeneity, interoperability, scalability, extensibility and configurability.

4. Preliminary Lessons Learned and Challenges

As noted above, the creation of the new EPIC Cloud environment seeks to make it easier for European cities to use cloud computing to become 'Smarter' by introducing and sharing state-of-the-art 'Smart City' applications across Europe. As the project is still in its scoping phase, it is too early to discuss detailed implementation findings. Nonetheless, work to date has identified a number of preliminary lessons learned and key challenges in terms of fulfilling the EPIC vision.

Firstly, feedback from workshops with public administrators in the advanced Smart Cities of Issy-les-Molineaux, France, Belgium, Brussels and Manchester, UK suggests that to become 'Smarter' cities believe that they need the tools and means, including the Living Labs approach, to improve existing services rather than create entirely new ones. As one

administrator from Brussels observed, 'There's no need for additional public services. We should concentrate [instead] on the ability to find the information and bypass bureaucracy issues. We should also focus on getting the data we need from other city administrators.' [15]. In general, workshop participants agreed with Issy-les-Molineaux that 'a 'Smart City' should have more efficient services for citizens, better communication between citizens, local administration and enterprises, and better access to information.'

Whereas the Red Shift survey identified a lack of in-house skills as a barrier to the use of cloud computing, our workshops found that when the notion of cross-border service delivery is further introduced into the equation, trust also becomes an important factor, particularly in terms of data protection. To successfully promote the adoption cloud-based services as the basis for the promotion and exchange of innovative Smart City services, our findings suggest that it will be critical to ensure a clear, detailed and systematic definition of the roles, rights and responsibilities of data owners, custodians and users. As one application developer from Manchester pointed out, at present 'the city hall and city administrators define the data access policies'. In time, EPIC users believe that national - as opposed to local - data protection laws will establish the parameters for shared services. At the same time, they recognise that to successfully promote the adoption of cross-border 'smart services,' cities would also benefit from a more systematic pan-European approach.

When it comes to actually sharing new service applications, workshop respondents believe that the establishment of negotiated and appropriate Service Level Agreements will help to overcome aggregated service dependency on basic public functions, especially when provided by third parties. Toward this end, they cite the need for a common interface for basic public functions as well as for a common taxonomy amongst them. In terms of business models to deliver sustainability, respondents were divided. While some believed it is important to begin creating and sharing via the cloud in an 'experimental' environment, others believe that license agreements were necessary from the start in order to ensure privacy and engender trust. Participants did all agree, however, that even where 'licence and fees for Services, subscriptions and Software as a Service for some categories of customers' are anticipated, applications 'should always be free for citizens.'

Finally, when asked about priorities for the front-end of a shared cloud-based service platform, respondents agreed that compliance with accessibility regulations takes priority over functionality issues such as quick access to information or fast communication between public administrators and citizens. 'There is the need for compliance W3C recommendations for our city,' said one participant from Brussels. 'After this, we also need ease of use, and a process oriented user-engagement process.'

5. Business Benefits and Impact

One of the main objectives of the EPIC project is to offer public administrations an opportunity to reduce costs and drive innovation by providing them with access to a shared cloud computing infrastructure that facilitates rapid prototyping and testing as well as wide accessibility and availability. The project's cloud-based platform and accompanying 'Smart City' service applications are still under construction and will not be fully available until 2013. Nevertheless, upon completion it is envisioned that EPIC will accelerate the move towards 'Smart Cities' at both the service delivery and infrastructure level by creating an open, pan-European platform for web-based infrastructure and software as a service that leverages the Living Labs approach and enables 'smart cities' to learn from one another and exchange practical working models in a real-life context.

Through EPIC, information, communication sources and applications, which are currently only available to specific city councils, will be adapted to the Cloud-service portal and offered as service to cities across Europe. At the same time, innovative new products that are created locally will be adapted for the cloud and made available using retributive

models for the city and businesses. In this way, EPIC will help SMEs to significantly accelerate their business plans and upscale from the Living Lab environment to real-life urban deployment not just locally but throughout Europe.

By making it easier for cities to take advantage of Living Lab innovations, EPIC will help the public sector to collaborate more effectively with the private sector - and especially SMEs - in the creation of more personalized and customized services. By making it easier for them to use cloud computing and other cutting-edge technologies, it will help them to minimize the capital and operational costs for their own organizations. Finally, by providing a truly pan-European platform, EPIC will help European Cities gain the agility and scalability they need to deliver "intelligent" applications via the dynamic and on-demand provisioning of resources in a self-service context.

6. Conclusion

This paper began with the premise that current operational and regional fragmentation in the Smart City paradigm has prevented a holistic approach to making cities smarter. Despite the potential to unleash innovation synergies between Smart City stakeholders, the Living Lab methodology which underpins much Smart City work currently lacks the economies of scale and network effect necessary to operate on a pan-European scale. At the same time, key European interoperability barriers – including languages and adaptation of the standards and protocols of newly identified technologies - have yet to be overcome.

This paper set forth to examine the way in which a new European project – EPIC – aims to meet these challenges by combining Living Lab processes, advanced e-Government service applications and new Cloud computing technologies to create a truly scalable and flexible pan-European ecosystem for smarter, user-driven public service delivery. In particular, it examined the way in which the EPIC project is seeking to create a European 'innovation ecosystem' through its in-depth exploration of the needs, requirements and added value of specific implementations of a 'Smart City' Cloud-based service platform that will enable public administrators, citizens and business to create sustainable, user-driven 'smart services' and take shared service delivery beyond the current state of art.

As the project is in its initial stages, it is not yet possible to assess detailed implementation findings. Nevertheless, preliminary workshops with public administrators, citizens and businesses in the advanced Smart Cities of Brussels, Issy-les-Molineaux and Manchester confirm the present fragmentation of the European Living Lab environment. While each of these cities currently uses the Living Lab methodology to help provide more intelligent services to citizens, they currently have little choice but to work in isolation. They share common concerns – such as the need to share information within and between cities more effectively and the desire for enhanced cross-border protocols, particularly with regard to data protection – yet lack a common infrastructure and methodology for collaborating more effectively. This being the case, it is not hard to extrapolate the further challenges inherent in transferring knowledge and applications between these types of advanced 'Smart Cities' and newcomers like Tirgu Mures in Romania.

In its next phase, EPIC will test whether it is possible to use an innovative Cloud architecture which connects and integrates) several services to overcome these challenges by creating a scalable pan-European platform for e-service delivery. The case for the need has been made. The challenge of delivery remains to be met.

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