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Authors:

Andreas Menychtas (NTUA)
Pavlos Kranas (NTUA)
Margarete Donovang-Kulisch (IBM)
Ulrich Schade (Fraunhofer FKIE)
Catalina Vasilescu (IM)
Pukul Rana (MCC)
Werner Brebels (IBBT)
Leonidas Kallipolitis (ATC)
Marc Van Gastel (DELOITTE)

Internal Reviewers:

Shenja van der Graaf (IBBT)
Hugo Kerschot (ISP)
Susie Ruston (21c)
Konrad Dwojak (ISP)

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1 Executive Summary

The overarching goal of the EPIC Project - European Platform for Intelligent Cities - is to develop an openly accessible platform that provides every city in Europe with the opportunity to create and share innovative city web service-based information and applications. These services will deliver benefits to citizens and small and medium enterprises (SMEs) as well as efficiency and effectiveness for the city administration. EPIC's novel solution for intelligent services in cities along with a roadmap for exploiting the platform is expected not only to change the way that city services are developed and offered, but also to leverage new market trends and business opportunities across Europe.

This document describes the vision of the EPIC Project, funded from the EC ICT Policy Support Programme under grant agreement n° 214777, and summarizes the project objectives and innovations by consolidating all participants' views regarding the final outcome of EPIC. The study of the project vision work was carried out within task T2.1 of WP2 – *Requirements Analysis* - identifying the current challenges that European cities must overcome in order to become 'smarter', and defining the functionality that is required from the EPIC Platform in both technical and business levels to support the 'smart' city services.

The structure of the remaining document is as follows: Section two introduces the EPIC project and describes the problems and challenges for delivering an intelligent solution for city services. The EPIC key objectives and innovations that will help to address all these issues are analyzed in section three. Section four provides an overview of the state of the art technologies that will exploit EPIC to deliver the intelligent services to cities across Europe. Moreover, a wide description of the three pilot applications that will be firstly adapted to the EPIC platform and will evaluate the project's target outcomes is included in section five. In addition, section five describes a key outcome of EPIC, the roadmap for the transition of e-Government services and applications to pan-European cloud enabled services. Finally, section seven concludes the document with a consolidated project vision that will help guide the project throughout its lifecycle.

2 Introduction

The current economic crisis, combined with growing citizen expectations, is placing increasing pressure on European cities to provide better and more efficient infrastructures and services, often for less cost. Innovative, ICT-based solutions - particularly those created in the user driven, open innovation environments of Living Labs (LLs) - hold an important key to helping European cities resolve this dilemma and work 'smarter'.

Following significant support from the European Commission (EC), LLs have proved to be an effective means to close the gap between innovative research and development (R&D) and market take up, and make the innovation process more efficient. Networks such as ENoLL [1] and EC-funded initiative and best

practice projects like Apollon [2] have, in turn, helped to mainstream this new and important means of innovating.

Nowadays, six significant forces are re-shaping societies and governments across the world [3]:

1. Changes in demographics;
2. Accelerating globalization;
3. Evolution of social networks;
4. Rising environmental concerns;
5. Growing threats to social and public stability and order;
6. Expanding impact of technology.

These six drivers share the need for the creation of flexible and interoperable solutions for effective government transformation. This need can be met using the principles and methodologies of "Enterprise Architecture" [4].

Despite these strides, however, the outputs from LLs still remain relatively fragmented – making it hard for European cities to learn from one another and for SME's to market innovative new, user-driven applications in a scalable and cost effective manner. EPIC aims to address this short-coming head-on by creating an open, pan-European platform for web-based 'business process and application as a service' that enables 'smart cities' to learn from one another and exchange practical working models in a real-life context. In this sense, EPIC represents a logical 'next step' in EU policy in that it is intentionally designed by SME's and larger industry players to operationalise the benchmarking work of pioneering projects like Apollon.

As in any other industry, government and governmental organizations are challenged to fulfil their mandates in a more effective, efficient and standardized manner. As a result, e-Government will be transformative and become citizen- rather than government-focused in delivering both emergency- and non-emergency public services. In general, citizen and business constituents' expectations and cost optimization needs require an always increasing integration between governmental and non-governmental organizations with the ultimate objective of presenting to the citizen and to the business a '**single-image Government**' they can deal with as a single virtual organization.

The EPIC platform will combine the industrial strength of IBM's 'Smart City' vision, the IBM Government Industry Framework [5] as the governance and interoperability platform and a cloud computing infrastructure with the knowledge and expertise of leading European LL's and municipalities such as Apollon partners IBBT iLab.o, ISSY-Media and Manchester to ensure the development of a European 'innovation ecosystem' that provides an extensive range of opportunities for sustainable, user-driven web-based services for citizens and businesses. At the same time, the EPIC project as a whole will help to significantly accelerate the uptake of these new business and e-government services across Europe to create and disseminate a robust roadmap that will help cities across Europe upscale from the LL environment to a real-life urban deployment.

The EPIC team understands that to be truly 'smart', a city must be able to easily access and leverage the benefits of SME and citizen-driven and tested services as well as to anticipate and plan for powerful new innovations such as the Internet of Things (IOT) [6] and Future of the Internet which will, among other things, enable them to digitize and connect their infrastructures in a manner that infuses them with intelligence.

Ultimately, EPIC will combine i) user-driven open innovation, ii) connected smart cities and iii) web-based services in the following manner:

1. Living Labs partners will engage citizens and SME's in the innovation process to help drive creation of the type of 'Apple iPhone' services that citizens, businesses and city visitors want and are potentially willing to pay for.
2. Cities partners will work to plug existing and new co-designed web-based services into the open EPIC platform so that other cities, such as relative newcomers like Tirgu-Mures in Romania, can easily connect to the platform and use them.
3. Consultant and scientific partners will use findings from pilot trials to help create a business-oriented, public-private partnership roadmap that incorporates a variety of differing business models from open source, to pay per use and licensing.

EPIC has two main target groups: i) the Cities and their LL partners and ii) the Citizens and Businesses either located in the city or visiting it.

i) Cities and Living Labs need to migrate rapidly to a 'smart', industrial strength web-based service delivery infrastructure in a scalable and cost-efficient manner enabling to access easily new innovative applications from across Europe.

ii) Citizens and businesses require user-driven and localized government services that are on a par with other private sector offerings when it comes to their operational speed, functionalities, customisation, personalisation level and similar.

EPIC will help to fulfil both these needs by using the IBM Smart City Cloud as the basis for a robust, pan-European service delivery platform that will enable Cities/Living Labs and SME's to use and share rapidly prototyped, tested and user co-designed applications. In addition EPIC will create a practical, business-tested roadmap to help cities in using the platform and enable them to bring services to markets across Europe through sustainable business models such as 'Public-Private Partnerships'.

The main use of EPIC focuses on two user categories. The first category consists of the typical city and LL who will be able to use relevant authentication protocols to access the administrative back office, and fill in a 'Smart City Information' template that includes all relevant service data for the City or connects to relevant live data feeds. Moreover, it will be possible to add the template to the EPIC platform database and plug-in or upload new user driven applications using common interfaces. Finally, cities and LLs will use standard template to customize and use applications of other cities handling ongoing

actives such as updating and maintenance. The second user category consists of the typical citizens and businesses. They will be able to use the device of choice i.e. internet, mobile, TV to access the EPIC platform URL and to easily access and use the service of choice. Standard Web 2.0 tools as well as future internet 'things' will give the opportunity to this user category to contribute new content on topics of interest.

EPIC innovatively combines cloud computing and industry frameworks technology, IOT middleware, and semantic capabilities to create a flexible and scalable pan-European Service Delivery Platform that can be used to 'plug 'n play' EPIC's pilot services. These Internet-and open-standard-based web services reflect a balanced mix of state-of-the-art technologies, including IOT, RFID, 3D, semantics and geo-localization.

3 EPIC Objectives and Innovations

Since early 1995, the European Commission has attempted to improve government services, through the funding and deployment of a wide variety of strategic ICT initiatives. However, technical and procedural limitations have prevented European cities from taking the full advantage of leading technologies, making them work in isolation and produce fragmented products and services. LLs, using innovative ICT solutions combined with their user-driven environments, have helped to close the gap between innovative R&D and take-up by the cities. However, despite the strides, the outputs from LLs still remain relatively fragmented not least of all because the means for sharing innovative testing procedures and applications across Europe in a 'real-life' cost-effective manner have been virtually non-existent.

EPIC aims to address this short-coming head-on by combining innovation ecosystem processes, fully researched and tested e-Government service applications and new business process as a service cloud technologies to create the first truly scalable and flexible pan-European platform for innovative, user driven public service delivery.

LLs help individual public administrations harness the power of Web 2.0 and future policy directions to develop and deliver citizen- and business-driven services. Cloud implementations are increasingly helping the private sector to reduce cost, increase efficiency and work smarter. EPIC is unique in that since it combines both of these innovations in a first-of-its-kind way to enable 1) local SMEs to rapidly prototype scalable new user-driven solutions; 2) innovative public administrations to test and deploy them; and 3) cities across Europe to ultimately access and use them.

In so doing, EPIC will present public administrations with a unique opportunity to cut costs and drive innovation by providing access to a market-leading shared infrastructure that facilitates rapid prototyping and testing as well as pan-European deployment and availability. At the same time, EPIC will help innovative SMEs to significantly accelerate the marketing and uptake of these new services in order to create and disseminate a robust roadmap that is fully future-proofed for new instrumentations such as 'smart water, electricity and

transport grids' and specifically designed to help cities across Europe upscale from the LL environment to real-life urban deployment.

As a matter of fact, 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 'business processes and applications as a service' delivery that enables 'smart cities' to learn from one another and exchange practical working models in a real-life context.

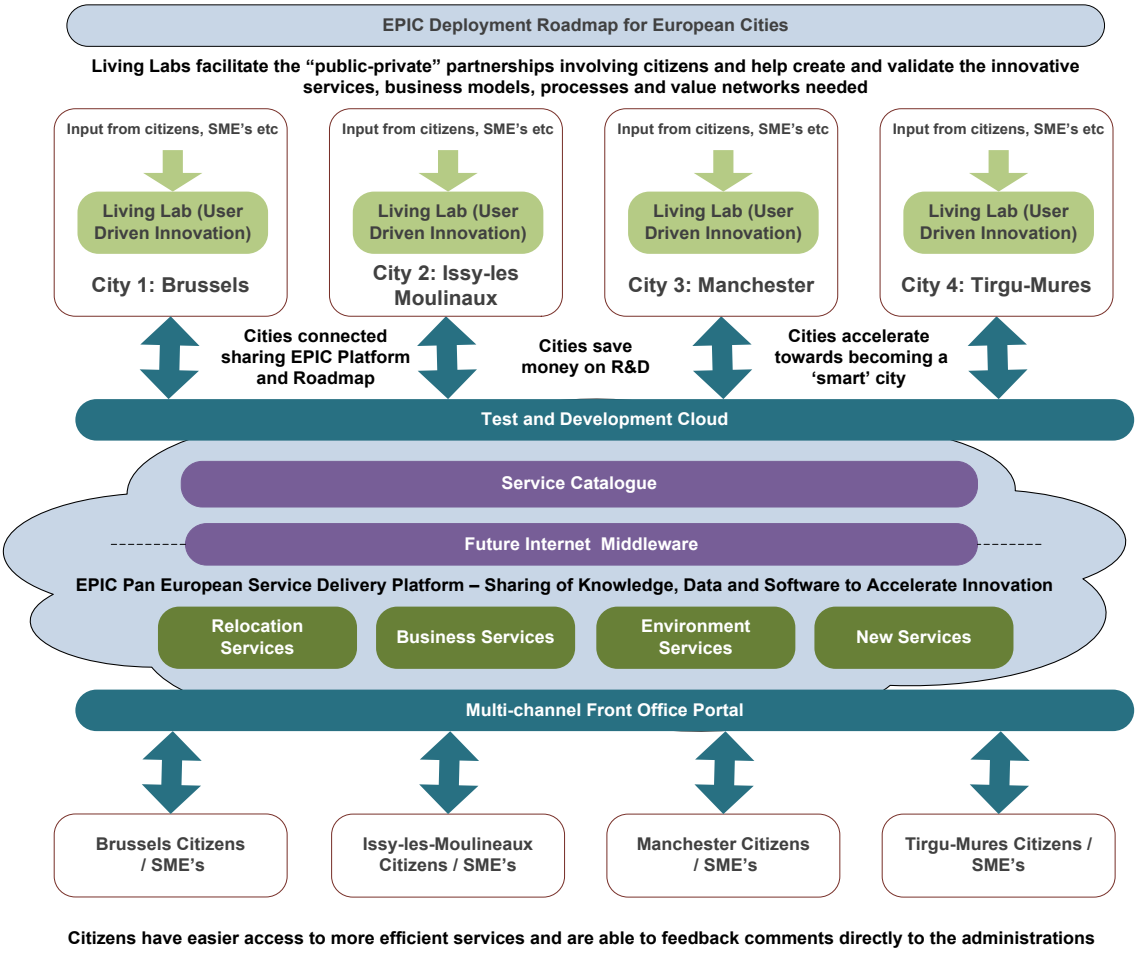


Figure 1: High level overview of the EPIC platform

3.1 Objectives

One of the main objectives of the EPIC platform is to try to investigate and understand how to overcome key European interoperability barriers such as **shared authentication, security, languages and the adaptation of the standards and protocols of the new identified technologies**. The success of this research will be determined by two factors: (1) the level of involvement of end users in solution adaptation and; (2) the use of lessons learned from other related European cities and LLs.

Another key objective of the project lies in the successful extension of innovative open cloud architecture which in turn will lead to **create an industrial strength**

scalable European wide platform for eService delivery. The solution will combine both large industry players and SME expertise to deliver a scalable, interoperable non-device specific and open technology solution. Existing validated applications from LLs will be used to deliver true value within the collaborative platform and take service delivery beyond the state of the art. Three pilot applications will be loaded onto the cloud, making it possible for other cities to test, download and use them in a manner that meets localised needs and regulations. Therefore, it will help in achieving another key objective – the provision of **added value to e-Government through the rapid uptake of the new services**.

Feedback from the cities, citizens and businesses will be evaluated and used to identify future improvements to the platform. At the same time, a **business-focused roadmap to increase the cities' level of knowledge on how to become a 'smart' city** will be developed, with the focus on business models and standards for user-driven open innovation.

In sum, the project's overarching goal is **the creation of sustainable offerings that will provide a wide range of opportunities of new and higher quality services for citizens and businesses.** A comprehensive business plan will ensure the sustainability of the project and its solutions after the initial funding will end.

3.2 Innovations

EPIC aims to be a pioneer by taking lessons from the private sector in order to create a first of its kind EU-wide platform that will provide a **cloud-based common infrastructure for service delivery**. The EPIC platform will combine the latest state-of-the-art technologies, from a **semantic engine** and **3D geo-locating** to the **IOT** in order to provide new tools and possibilities to existing city innovation ecosystems to enhance their R&D process and enable them to deliver 'smarter' city services. EPIC will also provide the tools cities need to use to utilize the platform appropriately for becoming 'smarter'. The production of a pioneering EPIC roadmap will guide cities through the routes, decisions and steps they need to undertake for improving service delivery to achieve the benefits of 'smart' working.

In other words, the Smart City test and development cloud will create a scalable, cost effective computing infrastructure that has never been deployed before in the public sector. Making use of the Semantic Engine will facilitate easier access to relevant services so citizens will not have to wade through masses of public info. Future Internet Middleware will make possible the development of new interfaces and drivers that will help to enable the 'plug and play' aspect of the EPIC platform benefiting cities and business. With the use of Smart Relocation Service Application, citizens inquiring about relocating, will be provided with relevant services they wish to engage with. Moreover, Smart City Urban Planning Application, with its geo-locating capabilities will enable 3D city replications and virtual tours for citizens as well as assisting the internal work of city planners. Finally, with the IOT sensors it will be possible to monitor changes in the home and to feed back the data to the Internet, enabling citizens to see their energy

consumption against data submitted by other citizens and address their behaviour accordingly.

The industrial strength of the consortium and pilot cities' stakeholders will bring together service expertise through LLs and business organizations, delivering a robust, truly practical, usable and scalable solution. In addition, the utilization of established networks of smart cities will enable smooth dissemination of project outputs to easily realize the benefits throughout Europe. EPIC will create a seamless platform making it possible for cities to deliver **cost effective services** so that they can access and share rapidly proto-typed and tested user designed services using state-of-art technology to achieve 'smart' goals, establishing an effective and sustainable framework for sharing good practice. Moreover, LLs offer a platform for real life user testing that helps to improve the final product so that the latter will meet costumer's needs and improve the knowledge sharing between advanced e-Government countries and lesser advanced countries. Finally, the generic roadmap on how to become a 'Smarter' city will support the incorporation of future policy trends such as the IOT, and binding EU National and sub-National strategies for e-Government in a comprehensive manual.

4 Technical Solution

EPIC leverages all European interoperability initiatives (IDABC [7], ISA [8], EIF [9]) and builds on interoperable middleware which is based on a core set/stack of open standards and technologies:

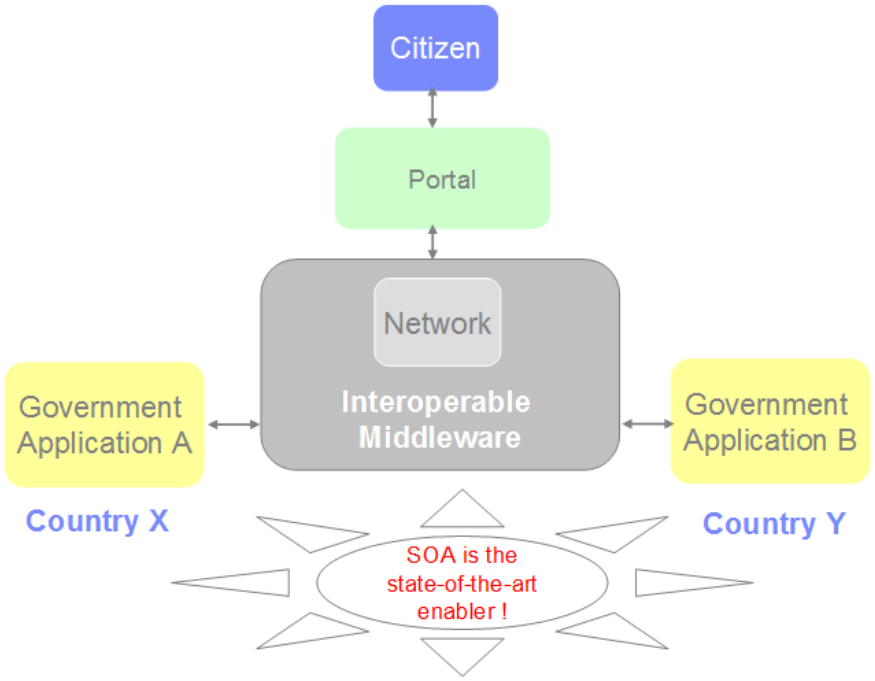


Figure 2: Interoperable Middleware

- ***Internet Protocol (IP):*** which has become the de facto communication standard for IT systems;

- ***eXtensible Markup Language (XML) [10]:*** which is a simple, very flexible text format derived from OASIS (ISO 8879) and provides a standard format for data exchanging on the web;
- ***Web Services [11]:*** decouple business function from its IT implementation by providing standardized means for universal description, discovery and invocation of application services and functions to a service Broker;
- ***Web Services Resource Framework (WSRF) [12]:*** The purpose of the OASIS WSRF Technical Committee was to define a generic and open framework for modeling and accessing state full resources using Web services;
- ***Java Platform, Enterprise Edition:*** Java EE is the industry standard for implementing enterprise-class service-oriented architecture (SOA) and next-generation web applications;
- ***Open Document Format (ODF) [13]:*** the ODF (ISO/IEC 26300, full name: OASIS Open Document Format for Office Applications) is a free and open file format for electronic office documents, such as spreadsheets, charts, presentations and word processing documents;
- ***Unstructured Information Management Architecture (UIMA) [14]:*** UIMA framework is an open, industrial-strength, scalable and extensible platform for building analytic applications or search solutions that process text or other unstructured information to find the latent meaning, relationships and relevant facts buried within;
- ***Web Ontology Language (OWL) [15] and Resource Descriptor Framework (RDF) [16]:*** UIMA in particular includes means for semantic, ontology-based search and discovery. In order to share knowledge across sovereign organizations, e.g. in pan-European public service processes, using these high-level standards and feeding the models into UIMA becomes increasingly important; OWL in order to share and merge the underpinning ontology and RDF to achieve registry interoperability.

The innovative EPIC service platform involves combining and integrating a number of trusted elements:

1. **EPIC City Portal** – front end interface to access the city applications and services;
2. **Semantic Layer** – for exploiting the solution to a mass audience overcoming language barriers;
3. **Future Internet (IOT) Middleware** – embeds the future Internet technologies interface into the fabric of the EPIC platform;
4. **EPIC Smart Cities Services Catalogue** – provides information about all the available services;
5. **EPIC Test and Development Cloud** – provides a managed virtualized innovation infrastructure.

By bringing these solution components together to implement the unique EPIC platform, the project will reach out en mass to cities, LLs, businesses and other stakeholders to involve them in accelerating innovation and smart service delivery on a grand, never before attempted scale.

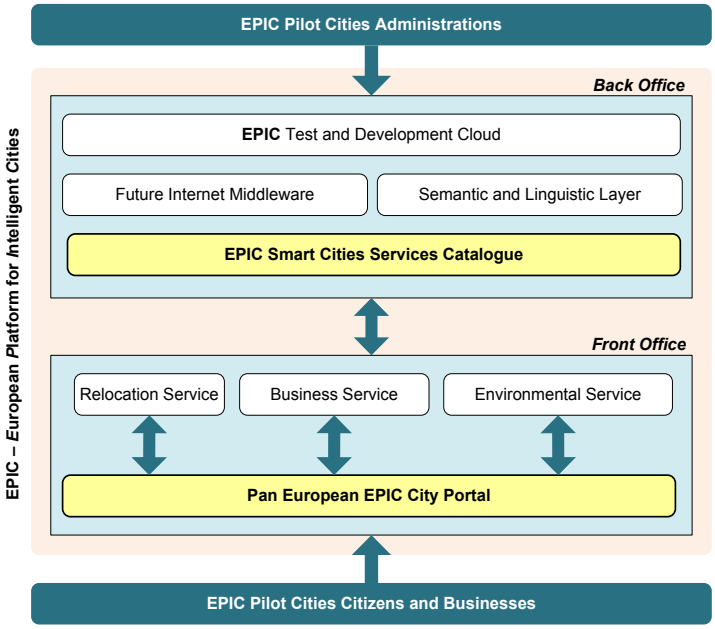


Figure 3: Overview of EPIC's Technical Solution

The remainder of this chapter will provide an overview of the key features for each building block and which is followed by a description of the steps involved that brings these elements together in the EPIC platform.

4.1 EPIC City Portal

Nowadays, most governments are predominantly concerned with innovating ways to effectively serve their citizens better. Governments are moving from the traditional 'counter' method of service delivery to an online 'office' providing self-service capabilities through a variety of channels. Another eye-catching trend is the integration of multiple back-end processes underpinning a single multi-purpose front-end. This aims at providing a one stop shop for service delivery. While multi-channel integrated citizen services require changes in the service delivery process, they offer opportunities in the following areas:

- the strategy of how to serve citizens;
- citizen services processes, e.g. citizen self-service;
- new, integrated desktops for front office employees including e.g. semantic search capabilities for a unified access to knowledge, information and services;
- contact centre implementation and citizen relationship management;
- services for mobile connected citizens and/or employees (e.g. parking fees or fines);
- infrastructure to serve multiple channels;
- infrastructure to support SOA.

In this context, the EPIC City Portal aims to organise and display a comprehensive layer of existing city information alongside access to chosen web service applications residing in the EPIC cloud.

More specifically, the EPIC cloud platform provides a portal server managing the role-based look and feel of the EPIC portal for different stakeholders e.g. city civil servants, application providers, citizens. Based on different authentication means, these personalized portals provide either immediate access to services (single sign on) or allow the user to search for currently available services for a specific intent - e.g. finding an overview of available accommodation in another city ('relocation scenario'). The portal server also allows for the device specific presentation of "web pages" by either transforming the "screen" or via downloading device-specific application code during service consumption.

Different types of users will be able to log-in, search and/or make specific requests in order to get the required information, hints, and forms to support their needs. The portal will run on a SOA-BPM (Business Process Management) platform orchestrating the consumption of back office web services. It will be possible to access it with all the major Internet browsers and modern mobile devices giving a strong focus on smart phones. Additionally, the EPIC City Portal will enable the exposure of some of the available services as separate "widget-like" applications to be used anywhere on the Web. This will allow the cities to share some of the services deployed in their portal to another website or portal, and reach a wider audience.

Life-event specific "points of single contact" will be connected to the portal and in their role act as case managers steer the business processes providing the required information, hints, and forms as requested. Therefore, there will be a specific Web service, the INTENT - INTelligent ENTrance, provided by the platform through a GUI (Graphical User Interface), in which the users will be able to type their request. As a result, other relevant services will be consulted in order to produce the information, hints and forms that satisfy this particular request. In the 'relocation service' example, the users may want to get more information related to the available companies offering relocations services from Cologne to Brussels. The results list will then be provided by a specific service specialized on relocation and presented to the user.

In order to provide the cities with services in an innovative and user friendly way, the EPIC City Portal front-end will be largely based on SOA capabilities:

- New, multiple channels require a common functional layer of business services which is best implemented by SOA technologies.
- Integration of multiple agencies in new front-end workflows relies largely on the standardization of their interfaces. SOA integration and dynamic discovery and composition capabilities make this system topology flexible, scalable and reliable.
- New front-end technologies based on XML (e.g. e-forms, Ajax, etc) best leverage XML-based business functions like Web Services.
- New form of dynamic information integration (e.g. data federation, master data management) necessary to build the front-end's Single View of the Citizen, are best implemented on a SOA infrastructure.
- Workflow capabilities of the Case Management tool blend very well with SOA service end-points as task actuators.

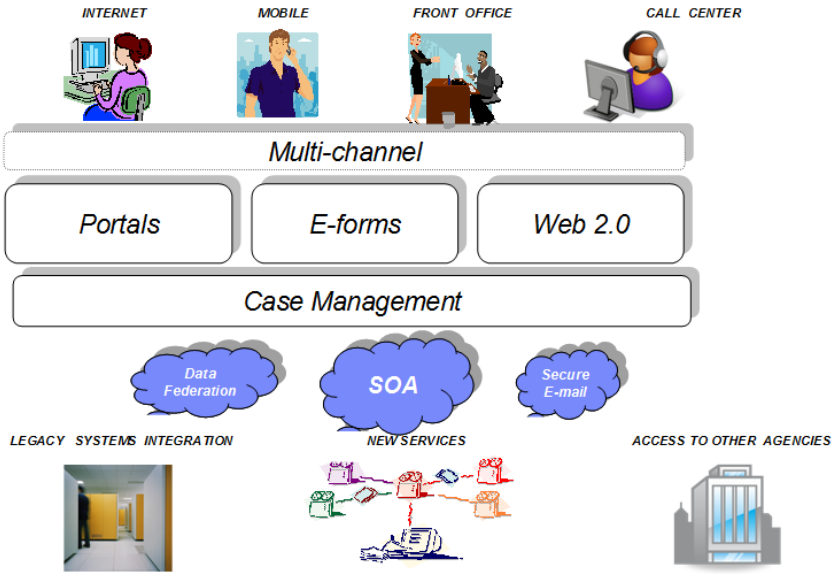


Figure 4: Multi-channel public services (supported by IBM portal server)

4.2 Semantic Layer

A user of the EPIC City Portal may be a civil servant, an application service provider or an individual citizen. They connect using the specific 'entrance' web service INTENT to identify themselves. The identification includes their role as a civil servant, as a provider or as a citizen. After identification, the user is enabled to operate the portal. Naturally, the type of operations depends on their role.

Let us first take a look at the citizen operations. Citizens will get help from the EPIC City Portal. This help includes information on requests as well as providing hints, knowledge data and forms as long as the user shares their intent with the portal. For example, if the user expresses an intent to relocate, the Portal offers information about topics that are related to relocation, e.g. information about relocation companies. The portal will then offer the user any relevant forms they may need to fill in during the relocation process.

In order to provide the relevant information, the input of the user is analyzed in the Portal's 'Semantic Layer'. As a result of that analysis, the Semantic Layer indentifies relevant services from the 'EPIC Smart City Services Catalogue' (see below), then sends the appropriate requests to these services catalogue, takes their answers, and prepares out of that information its own answer to the user. In order to do this, the Semantic Layer relies on ontology. The ontology represents knowledge about the services of the catalogue and about business procedures identified by the SMEs. This information is used to identify the relevant answers out of the catalogue in order to obtain the relevant data from the catalogue's services.

Application service providers will be enabled by their portal to set up their applications in the Service Catalogue and to maintain them. The Semantic Layer will provide them with a form so they can provide relevant information to update the Semantic Layer's ontology.

Civil servants can use the EPIC City Portal in the same way as citizens do to get information. However, they may also want to maintain or update the Semantic Layer's knowledge about their city's business procedures. To do so, they, like the application service providers, can fill in a specific form online that enables the Semantic Layer's ontology to be updated.

4.3 IOT Middleware

The Internet of Things (IoT) is a term used widely to encapsulate a vision of a world of interconnected heterogeneous objects, which communicate and exchange information using a combination of short-range wireless and Internet backhaul. From one perspective, IoT can be viewed simply as the cumulative result of the natural progression towards greater inter-connectivity between increasingly intelligent objects and the convergence of fixed and mobile computing and the Internet. As such, IoT can act as a societal enabler, empowering citizens and democracy by providing in fettered access to information. From an alternative perspective, IoT could represent a disturbing vision of a "Big Brother" surveillance society, where everything is known about everything and everyone, thereby removing entitlements to privacy. As a matter of fact, one of the challenges for IoT is to maintain a balanced perspective, respecting the rights of citizens to individual freedom and privacy whilst empowering them and others, through greater access to relevant personalized information feeds in real-time.

IoT was predicated on the future availability of very low-cost passive radio-frequency identification (RFID) technology, which would allow individual items to carry a unique identifier, termed an Electronic Product Code (EPC). Using pervasive connectivity to the Internet, the EPC read from the RFID tag could be used to link the item to information held about the item distributed across the Internet. RFID is in fact very important in IoT as the usage of wireless communications allows automated communication with mobile objects. Moreover, in order to allow information about an item to be carried with an item or to be retrieved from a remote data source, it is necessary at minimum to carry a unique identifier on the item and use this as a "key" for remote data look-up. Finally, the usage of a very low-cost potentially throw-away technology enables routine tagging of everyday objects. Therefore the combination of these three factors can be met using passive (i.e. battery-less) RFID tags fixed to the items which either move close to tag readers or which co-exist with mobile readers. RFID is therefore seen as a key enabling technology for IoT in combination with mobile technology and wireless Internet access.

Sensor networks on the other hand, and, particularly, wireless sensor networks, are becoming a widely used technology which can be deployed rapidly and flexibly for a disparate range of purposes. Some RFID tags have a sensory capability (commonly temperature measurement) while the larger active tags can include GPS as well as other capabilities. Sensor networks are encompassed within the EPC framework and are an integral element of the IoT vision. Sensor networks can take a variety of forms and range from very small self-powered wireless measurement nodes or "motes" which spontaneously form a wireless mesh to sensors that are plugged into a PC or directly to an IP network, and

which may also include the ability to serve information directly to a browser, for example, to so-called IP or network cameras, etc.

Our vision in EPIC is to broaden the energy monitoring focus to include generic forms of smart-sensors, not just energy monitoring. The logic is that it would be useful to see not only what the energy inputs to a property are (e.g. electricity, gas, etc) but also the context of use and the prevailing weather conditions around the property. For example, the ability to accommodate measurements of internal temperature from sensors in the home (e.g. lighting levels, occupancy, solar gain etc.) and then to integrate these with information about the local weather conditions from other sources so as to be able to identify patterns of consumption. In other scenarios, feeds from IP cameras and other high-bandwidth sensors could be included into a generic monitoring and access framework, and thus when exploring a city using the Urban Planning Service, it would be possible to access feeds from sensor services that are discovered in the city's space.

4.4 EPIC Smart Cities Services Catalogue

Current policy makes it clear that humans – not technology – are the focus for future-Internet-based city operations and that the technology is only an enabler when well matched to the business.

Mutually beneficial collaboration undertaken to meet a mission or implement a policy can be considered as a sequence of service consumptions, with each unit in the network consuming the services of each other, defining a service-oriented enterprise (SOE).

While the concept of service offerings and the consumption of business services is not new, fresh challenges resulting from globalization and global sourcing of business functions has led to the need to orchestrate them in a flexible and agile manner. Business architecture (BA) [17] is seen as the science and methodology of delivering coherent, dynamic and complete business designs [18]. Using the same concepts and rigorous methodologies promises to transform the delivery of smart city capabilities and, in particular, to deliver agile networks able to respond to threats and evolve quickly and efficiently to opportunities in the same way that modern businesses are able to do.

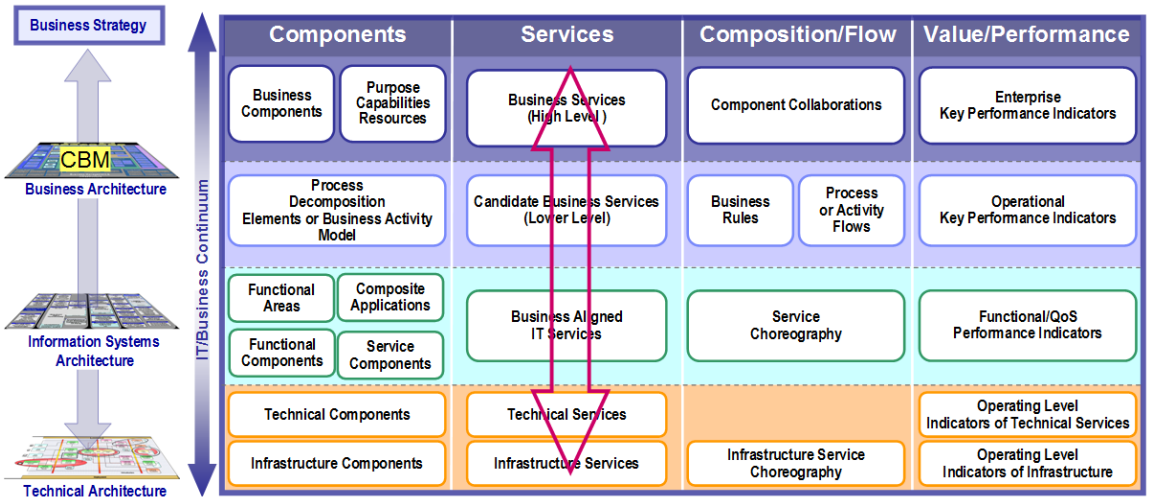


Figure 5: Continuum of the Service Oriented Enterprise (SOE)

A SOE is primarily about bridging the immanent gap between business and IT infrastructure – for all architecture artefacts: components, services, compositions and value to business. In the terminology of Enterprise Architecture (EA), there are needs for a model for each type of artefact. These models cannot be considered and developed independently, but rather they have to be closely interlocked. In particular, the end-to-end service identification and implementation needs to provide traceability of performance impacts both forwards and backwards between the functional and operational level in the business as well as in the IT-infrastructure level. As outlined earlier, semantic interoperability and a common understanding of abstract business objects is fundamental to SOE. The consideration of both business processes and semantic meaning of business objects in the services specification is said to lead to improved value from SOA and cloud infrastructure adoption.

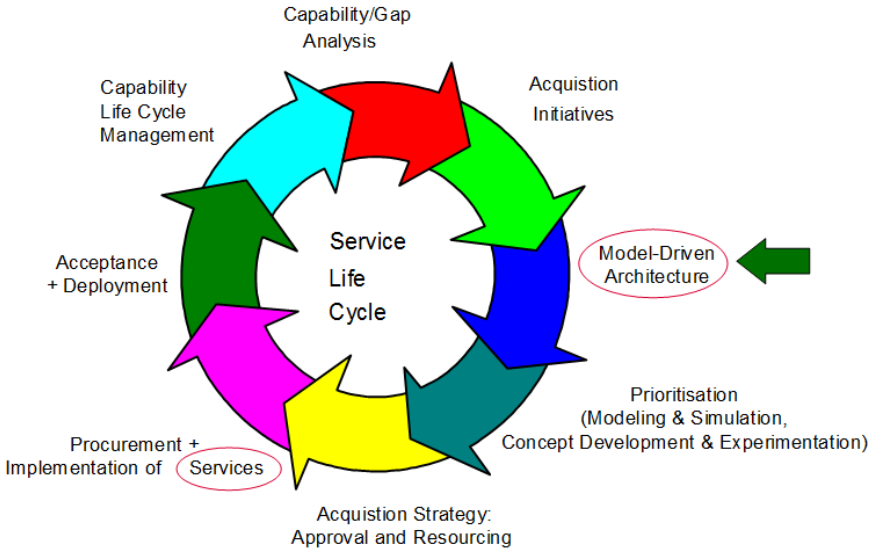


Figure 6: Service Life Cycle Management

4.5 EPIC Test and Development Cloud

EPIC will be implemented using the physical IT infrastructure of the IBM Smart Business Test and Development Cloud [19]. On this managed cloud, the core enterprise services offered by the IBM Government Industry Framework will be deployed:

- an enterprise service bus
- a web service catalogue
- interaction services
- process services (e.g. standards and compliance)
- identity and access management services
- business innovation and optimization services (e.g. semantic search)
- development and management services (e.g. service quality and security)

These core enterprise services ensure the interoperability on the technical (Web services), semantic (metadata standards) and procedural (interaction rules) levels, and hence instantiating the conceptual model of the European Interoperability Framework (EIF).

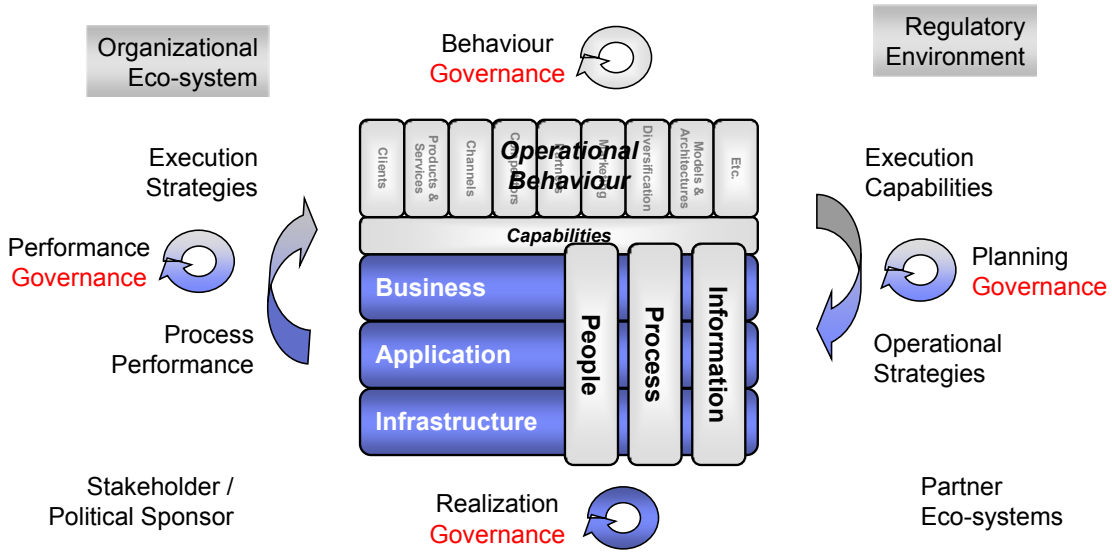


Figure 7: IBM Cloud/EIF Enterprise Architecture & Governance

Collaboration as enabler

Collaboration enhances the capabilities of governmental and non-governmental organizations via back-office integration of internal and external people, processes and data. Inter-office and inter-agency collaboration become more and more a necessity for Governments in order to face new challenges like security threats, or as a means to manage ever-complex environments such as ports and national borders.

Collaboration incorporates both human factors and the process management aspect, and requires the building of extensive and flexible knowledge bases.

In order to get to knowledge-based centers of excellence, solutions need to be provided for:

- support of internal and external collaboration processes
- threat and operation control centers, integrated intelligence exploitation and enhanced decision making (policy maker, process managers, commanders)
- maintaining public safety and security
- federated identity management, incl. identification and verification capabilities
- integrated case management

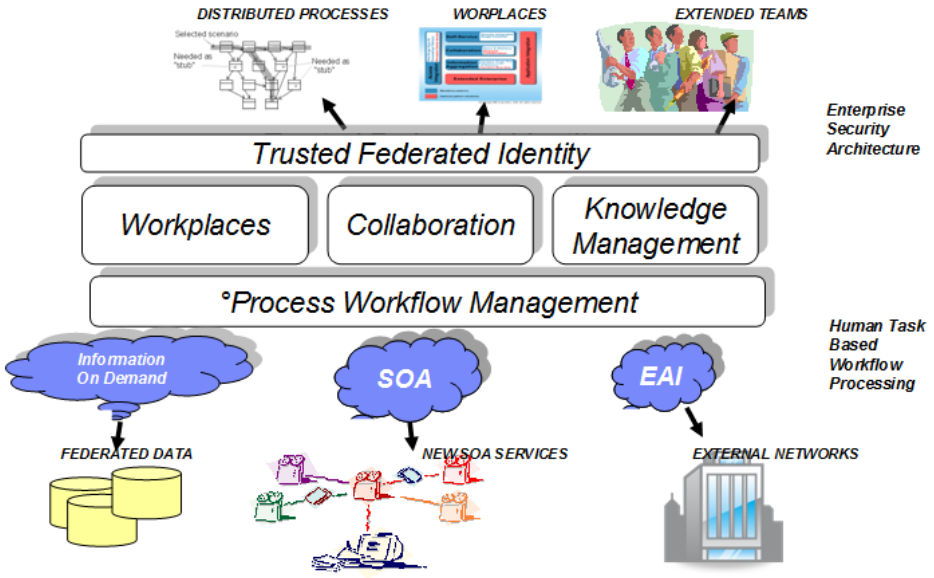


Figure 8: Components of an integrated collaborative information environment

The SOA infrastructure is the cornerstone that ensures the needed flexibility to the x-agency collaboration compared with other types of infrastructures. In fact, without the dynamic discovery capability of SOA services, the collaboration environment would be based on a typical 'all or nothing'-paradigm, where failure in the availability of one of the participants halts the entire process. Instead, in the case of SOA the presence of alternate providers is made transparent to the process, as are the customization of capabilities to the different user roles. In addition, the federated identity standards, which are at the basis of distributed access and authorization, are better carried on SOA infrastructures.

Innovation through optimization and SLA management

This innovation domain is twofold: it includes all optimizations linked to cost reduction or efficiency initiatives, from server consolidation and virtualization to reduce power consumption (green data centers) to the improvement of the agencies' capabilities through enhanced availability of services, e.g. 24x7, security, safety and privacy enforcement, faster process turnaround and improved response time for electronic transactions. Solution examples include:

- data center and network consolidation
- implementation of shared service centers, e.g. via out tasking or outsourcing

- establishment of lifecycle management of infrastructure and services
- addressing environmental issues, e.g. green data centre
- support for the adoption of emerging technologies or industry trends, e.g. second life

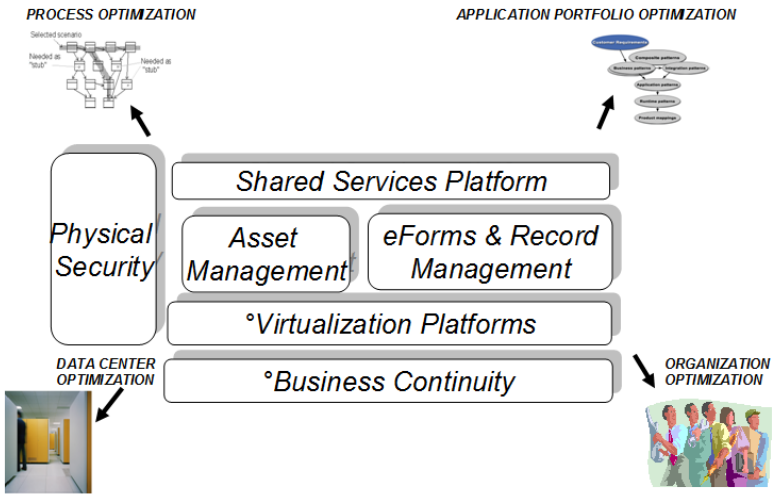


Figure 9: Optimization on all levels

SOA plays again the role of key technology enabler of these capabilities. For instance, in Shared Service Centers a real flexible service delivery platform would require at its core an ESB capability [20], while the measurement of business-related Service Level finds its foundation in the business-to-service mapping of the service-oriented modelling and architecture (SOMA) methodology [21].

5 Pilot Applications

In order to highlight and validate the capabilities of the EPIC Platform, three pilot applications, already deployed for different smart cities across Europe, will be adapted to the platform. The following chapter describes each application and focuses on their special issues that will be addressed by EPIC.

5.1 Relocation Service

The relocation application takes the scenario of a family relocating from a European country to Brussels. The application will provide tools that allow the user to find an appropriate place to live in Brussels. The user will be able to perform queries to the application with the aim to find certain locations in the city that meet certain constraints. The results of these queries will be visualized on a map. Another important feature of the application is that the results will be visualized in an augmented reality environment. In this way, the users will be able to engage in the city and visit physically and virtually the locations that have been returned by the query. Strolling through the city, they will also be able to access information about serendipitous discoveries that they encounter when engaging in the city.

The application will integrate data services coming from the Produpress Immoweb [22] and CIBG [23] underpinned by a combination of a search interface and visualizations produced both as a map and as an augmented reality interface.

5.2 Urban Planning Service

The Urban Planning Application allows civil servants to manage, share and communicate about urban planning and development projects of the city. It is a virtual space of consultation and participation, designed for professionals and citizens alike, and complements the already existing "Urban Planning Center" of the city, a public area for consultation and communication where interested stakeholders can meet and exchange information about urban development, projects and studies that are to be carried out in Issy-les-Moulineaux.

The application combines a simplified view, 3D modelling, rich media and symbolic information. Users can simply fly over, move into the digital 3D model of the city and enter into major sites like in a video game. The 3D interactive navigation allows to explore the territory, to navigate from one place to another, to zoom in to view points of interest or any particular site and access and experience additional information like sounds, statistics, geomatics, dynamic flows, media and so on understanding for the city and experience potential developments.

The service will be extended and adapted by Issy Media and Navidis for use within the EPIC platform with the purpose to enable efficient real time networking between businesses and citizens but also an interconnection between city of Issy-les-Moulineaux SMEs. Proposing new services enriched with important information (who, what, how) so as to enhance local activity by bringing SMEs and population closer together, could be a way for SMEs themselves to advertise their products and inform others about changes and evolutions. It will enable professional exchanges and a smooth flow of information between enterprises that offer services and jobs and local citizens who are interested in them. An advertising-sales system will be put in place to enhance the level of communication available at a global level. Another extension will be developed based on NAVIDIS Urbadeus concept for making citizens able to publish specific content through the platform using web applications or mobile phones.

5.3 Smart Environment Service

The Smart Environment Application integrates new and existing technologies to support households to reduce their carbon consumption. The user is provided with real-time information, collected through a range of IOT data collectors that will measure environmental factors such as electricity usage, temperature and gas consumption, providing a snapshot of a household's energy usage. Presenting this information online and to make it accessible through an attractive dashboard, enables users to review their home's performance against a community average to see how they compare. Providing this information online

allows users multiple access points using a number of devices at their own convenience.

Seeing one's household's energy consumption instantaneously provides each user with the ability to adjust their behaviour effectively, with the benefit of being able to see the results of this change immediately. At a city level, this provides us with a large amount of valuable data that can be used to develop recommendations based on real-time insights, and which can support the achievement of carbon reduction targets and influence future policy.

6 EPIC Roadmap

One of the major outcomes of the EPIC project is the development of a roadmap to be used as a guide for a pan-European exploitation of the platform. The roadmap will cover all the important aspects of EPIC and will describe all the required steps for a successful exploitation of EPIC for both cities and businesses.

First, EPIC will disseminate the project's findings to other cities administrations / decision-makers and SMEs. It aims to encourage them to take up the EPIC platform through adopting a practical, business-tested roadmap that will help to guide cities in adopting the new cloud technologies. In addition, new instrumentations such as 'smart water, electricity and transport grids' can be specifically designed to help cities across Europe upscale from the LLs environment to real-life urban deployment.

It is also important to include a mere practical focus on working business models, including Public-Private Partnership (PPP). The business models will be defined by specific assumptions concerning the involved participants, the functions they perform, the key terms between them, provided funding and ownership. Technology and services used by each pilot application must be taken into account. Moreover, the business models must meet specific needs for accessibility, security and authorization, regularity enablers and different constraints. Finally, the vision of the EPIC project and its policy must be defined clearly, including the financial and technical viability.

After having defined the business models, the stakeholder management best practices will be detected and registered. Cities or urban areas are constantly faced with important challenges that necessitate investment in innovative solutions (notably ICT-based) to improve the quality and efficiency of their infrastructures and services. Building on existing user-driven innovation initiatives in Europe, the aim is to ensure a wider implementation of open platforms for the provision of Internet-enabled services in cities. These platforms should help to develop innovation ecosystems accelerating the move towards 'smart' cities and providing a wide range of opportunities for new, higher quality, and sustainable services for citizens and businesses.

The experience gained from the pilot lead's application will lead to the development of a truly interoperable 'e-Government' case concerning a family moving from a city in one member state to another. By offering a holistic

approach to relocating to a foreign city, the family relocation service hopes to solve the following problems:

- housing: finding a temporal/more permanent place to stay
- overcoming the language barrier, and making visible implicit knowledge
- streamlining the often tiresome practical government-related duties for a person moving abroad
- offering an augmented layer of government and non-government data concerning the city.

The two other cases (Urban Planning Services and Smart Environment Services) will add to the Roadmap's aim to upscale and leverage LL applications into a real life city environment.

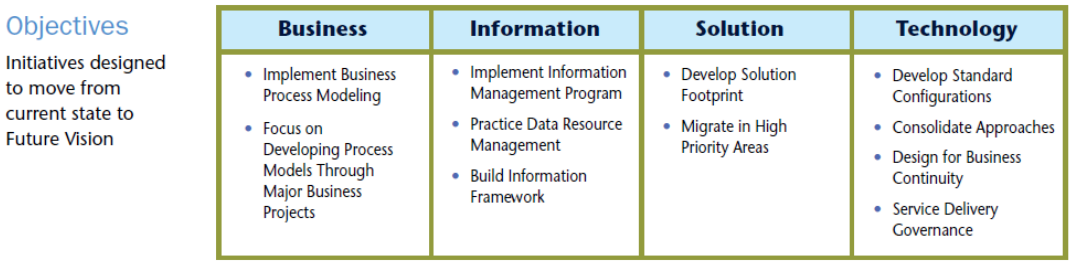


Figure 10: EPIC Roadmap Objectives

Finally, the EPIC Roadmap will include a complete deployment guide that indicates, among other things, how a 'Smart' City can transform e-Government and other services to Web-based services and Cloud Computing.

7 Conclusions

The EPIC project 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.

So, in summary, the mission for EPIC is to create a cloud-based service delivery platform for the public sector that enables cities across Europe to become more **innovative**, **connected** and **efficient**.

Therefore EPIC's vision statement is as follows:

"To be the first choice service innovation and delivery platform for cities across Europe, where any city can cost-effectively share, access and adapt a range of services to meet the needs of most, if not all, their citizens".

Over the next two years the EPIC 'Intelligent City' mission will become a reality for Brussels, Manchester and Issy-les-Moulineaux. In support of delivering the EPIC vision, will your city follow?

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