# Intelligent Cities

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**Abstract:** This paper reports on the ongoing IntelCities (Intelligent Cities - IST no. 507860) integrated project, which commenced in January 2004 that seeks to integrate e-governance and e-urban planning. IntelCities is still at a formative stage and the paper seeks to explain the background, the research questions and preliminary design of prototyping studies to be carried out in the cities of Marseille, Siena, Helsinki, Rome, Leicester, Dresden, Berlin and Manchester. These prototypes are to be linked together to demonstrate an integrated open system city platform. The main business opportunities for IST companies and in terms of increased efficiency in e-urban planning are explored. The main outcomes are anticipated, which include a new public asset in terms of a city-wide intelligent information system.

## 1. Introduction

Internet access is expanding rapidly, with penetration into households across the whole of the EU likely to exceed 50% in the near future. As over 70% of Europeans live in cities, visions of the knowledge society (KS) are largely framed in an urban context in the form of information and computer technology (ICT) enabled, intelligent communities. EU policy has explicitly cast cities in the role of engines for change for regional, national and European economic progress. Hence, from an EU policy perspective, the interaction between cities and ICTs is expected to act both as the key driver and as the primary location for the delivery of the knowledge economy and society.

In this context the main objective of INTELCITIES – developed from the Intelcity Roadmap project in FP5 [1] – is to create a new and innovative set of interoperable e-government services to meet the needs of both citizens and businesses. This will provide interactive citywide on-line applications and services for users that will make all aspects of what is "going-on" in the city available to all, which will support:

1. the everyday needs and requirements of citizens and business through 24 hour access to enhanced transactional city services;
2. more efficient city management and administration by integrating functions and services across city authorities, regional and national governmental agencies, utility and transport system providers and citizens/NGO networks;
3. much more innovative and effective approaches to urban planning through more reliable electronic city modelling, using advanced visualisation and predictive techniques, which will enable citizens and businesses to play a far more participative and inclusive role in influencing how planned changes in the city will affect their lives.

## 2. Objectives

The main objectives of the project address the broad requirements of an "integrated project" as a new form of EU research instrument include [4]:

1. RTD in terms of interoperability and advanced visualization for e-local Government and e-Planning services, including open system architecture, data mapping and integration, and indicators and benchmarks;
2. Prototyping and demonstrations in a number of EU cities in terms of e-Local Government Services, including enhanced Information Services, e-Transport Information and Mobility, e-Land Use and e-Regeneration, and issues of e-Inclusion and e-Participation;
3. Knowledge Management in terms of capturing good practice in the participating cities and development of e-Learning and capacity building modules for city officials, business and citizens;
4. Innovation and transformational changes in e-Local Governance for more effective exploitation and implementation in Cities and business opportunities for ICT companies particularly SMEs.

## 3. Methodology

The new forms of electronic governance are at an experimental stage in which learning by doing in cities is the key, especially for developing and utilizing best practice. In the project, prototype system development will test interactive forms of electronic service delivery over different technology platforms, e.g. iDTV, PC based and mobile, in diverse socio-economic environments. The underlying objective is to ensure that all the applications and services can be made to work together in a seamless and interoperable manner. At the same time the project is addressing key human factors in order to ensure that these approaches maximize support for social inclusion so that all citizens, regardless of gender, age, ethnicity and disability, will be able to use the applications and services in ways which will increase their knowledge of, and involvement in, the city. Ultimately the aim is to ensure that people can use these to enhance their lives and to participate more fully in the information society and the knowledge economy.

The five main areas of activity structuring the project – technology development (city prototyping activities), ICT research, technological development and innovation; knowledge transfer and capacity building; governance and business development and innovation; and project management and communications – will be integrated to develop the Integrated Open System City Platform (IOSCP). Stakeholder participation plays a central role in the project and is the major factor that drives the research design. The consortium's construction and structure reflect this and the cities will be considered as social learning laboratories in which iterative action research experiments will take place. Each will develop modules of the IOSCP through technology implementation and the re-engineering of administrative and planning processes that seek new e-solutions for advancing the relations between citizens, public administration and business.

The work is divided into three phases: development requirements and specifications, implementation of the prototype studies and final evaluation. The main project outcome is a prototype of the IOSCP and a detailed specification for the development and deployment of it in cities. Figure 1 shows the overall logic and interactions within the iterative process anticipated within WPs 1-5. This is mediated by the current state of the art and maturity of ICTs and the possibilities presented by RTD in terms of the content and concept development of the prototyping studies to be undertaken. The user-needs must also drive the benchmarking tool that is to be developed and used in the assessment and evaluation of the prototyping pilot studies. Together this will ground the proposals in terms of realistic

appreciation of needs and outcomes with all stakeholders and identify feasible development paths from the current situation in cities towards the IOSCP prototype. Each of the cities hosting a study is at a different stage of development in terms of eGovernment administrative and planning systems.

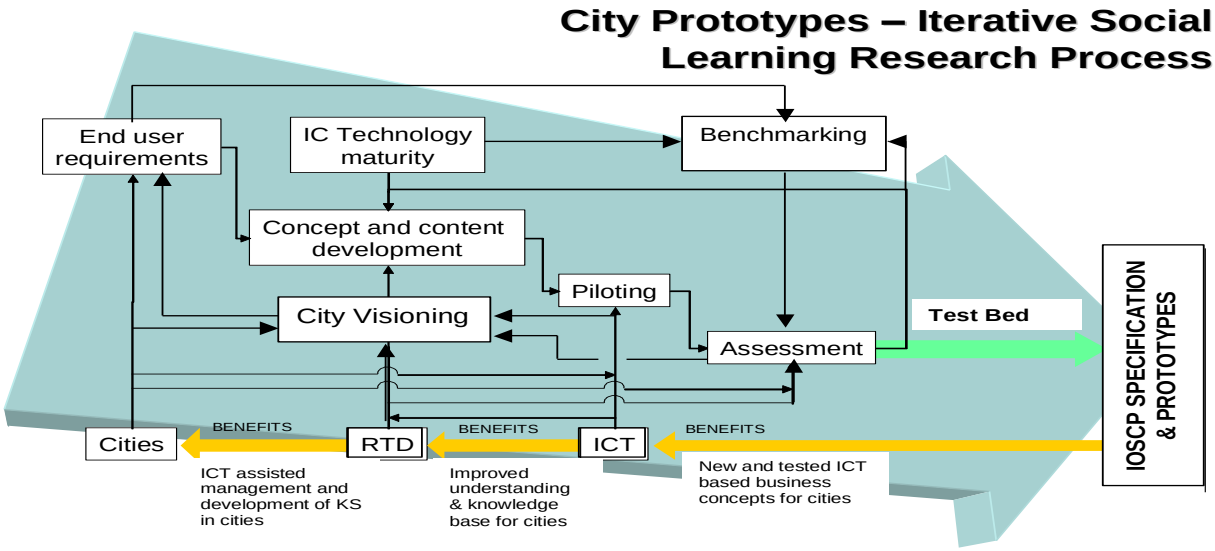


*Figure 1: Iterative social learning research process*

The evaluation points, at six month intervals, address human factors in city and business process re-engineering as well as technological developments and integration problems identified from all the WPs. This evaluation is dependent upon the Benchmarking Model and associated indicators developed in WP8. Evaluation will include a review of development experience in order to identify and understand the development paths from each host city's "legacy" system towards the IOSCP.

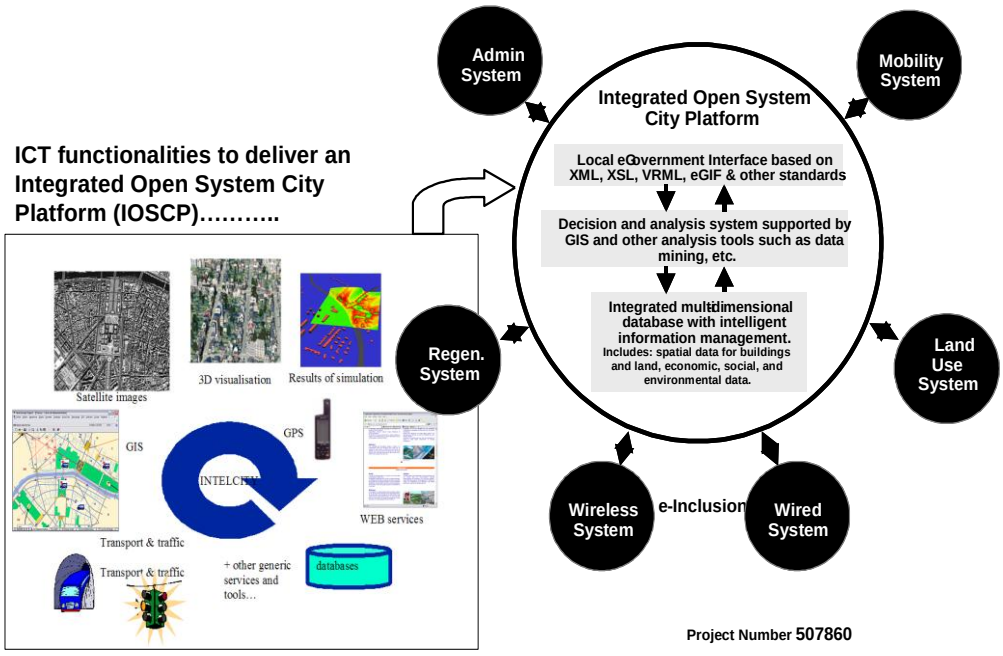


*Figure 2: ICT functionalities to deliver an Integrated Open System City Platform (IOSCP)*

## 4. Technology Description

The IOSCP will link local e-Government interfaces based on XML, XSL, URML, eGIF and other standards with decision and analysis systems using GIS and other analysis tools such as data mining supported by an integrated multi-dimensional database with intelligent information management. In this interoperability questions form the main technical challenges.

The overall system architecture is based on state-of-the art technologies for multi-tier distributed architectures. Innovation lies in the way these various technologies are integrated and used to meet the end-users needs. The challenge also relates to the federation of different domains and fields of interest (represented by the "prototype applications" in Figure 2) and integrated in the IOSCP. The architecture proposed is based on *multi-tier distributed business components architectures (e.g. Sun's Enterprise Java Beans and OMG's CORBA Component Model) and* takes into account Intelcities end-users requirements namely:

- Services distribution. IntelCities vertical services will be distributed over the network. End users will access the applications through a web browser, Wi-Fi enabled PDA, etc. Also, the services themselves could make use of distribution (e.g. parallel super computers).
- Heterogeneous environments. Services will be developed using various languages and technologies, and that they will sometimes make use of platform-specific resources. Thus, the IntelCities integration framework need to support virtually any kind of application running on any kind of platform.
- Transversal features. The vertical applications will make use of transversal features that should be provided by the framework. These features concern IT-specific, "low-level services" (e.g. support for transactions, security, etc.) as well as "domain-specific facilities" (GIS, nD modelling, etc.).
- Deployment facilities. Applications will be "deployed into" the IntelCities framework to be made available to end-users. Some procedures and tools will be defined for the prototype applications designers to allow easy deployment of applications (Component Deployment Toolkit).
- Scalability, Quality of Service. The IntelCities framework should improve the citizen's quality of life. What if the system crashes or provides poor performance level? This issue is crucial, and has to be considered at the earliest stage in the project. The IntelCities system needs to provide quality of service and scalability features.

### *4.1 The "proxy container" approach*

The proposed architecture can be described as a "proxy container" that relies on container-based environments, with the introduction of an additional level of indirection. The IOSCP needs to be able to integrate remote heterogeneous vertical services, and allow them to rely on our container to provide low-level and transversal features. The idea is to represent the services in a container, allowing them to make use of container-provided features, and let the services run remotely. All IntelCities vertical applications/services could then run somewhere on the network and publish their API, with no considerations for the underlying implementation, and be represented by a "proxy" in the IOSCP. The proxy would be the only gateway to the service, and would handle security, transactions and so on.

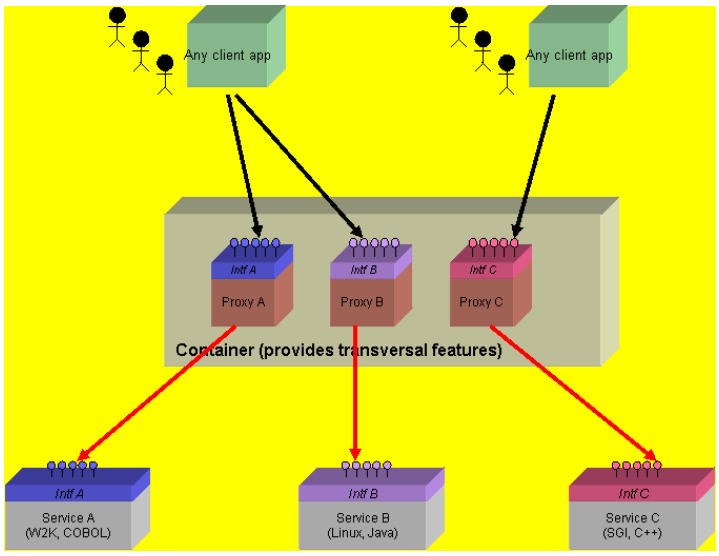


*Figure 3: proxy container – the big picture*

In figure 3, one can see, starting from the bottom:

- The services developed in city prototypes (grey boxes). They are running on different platforms, and implemented using various programming languages. Nevertheless, they all have a common "property": they expose their business methods through an interface. The implementation is encapsulated in a non-intrusive way under this interface, and no one needs to know what's going on below. The three interfaces may of course be different since they address different business domains. What is common is that they are all expressed using a common standard interface definition language (e.g. IDL, WSDL, etc.) which allows the container to manipulate them.
- The red arrows show invocations of the services by proxies in the container. At the moment, the only thing that has to be noticed is that these invocations should be done in some "private" and "secured" networks, enforcing that only the container can invoke them.
- The yellow box in the middle represents the container. Its role is to manage the proxies for each service and allow their invocation by client applications. It also provides the proxies with transversal features.
- The three boxes in the container represent proxies. Each service proxy exposes the service's interface to the outside world (client applications). This allows the client to use the proxy as if it was the service itself, transparently. The proxy will handle the calls from clients and react in consequence. It could do security checks before the real method is invoked, start/end transactions, etc. The code for doing this is not in the service, but in the proxy, therefore this specific code is in no way intrusive in the code of the service itself. Last but not least, access policies to some of the transversal features could be done declaratively at deploy-time, "à la EJB!" The code of the proxy itself is not hand-written but is generated by container-provided tools (i.e. Component Deployment Toolkit).
- Last (upper) level is where client applications come into the scene. These end-user applications could be web-based (accessed through a web browser), running on PDAs or whatever. They are "client" applications in the sense that they use the services (transparently through their proxies) of the IntelCities framework. Typically, these applications will be Graphical User Interfaces and more generally they will concern the presentation layer of multi-tier applications, business logic and resources being handled by the service itself.

## 5. Developments

As already explored in the methodology section above the project will carry out a number of prototyping studies as shown in Table 1. Due to limited space the development of one of these – No. 5 e-Regeneration (the Manchester case) is explored in more detail below.

*Table 1: Nature of the prototyping studies in WPs 1-5.*

| WP | Main City location | Main Focus | ICT Platform & Development | Main Questions | Anticipated Outcomes |
|---|---|---|---|---|---|
| **1. e-Admin** | Marseille | Nature and provision of Local Administrative Services | Enhanced Web systems and formats | Future possibilities of advance web based services | Development and migration routes from existing web services |
| **2a e-Inclusion (wired)** | Siena | New and more inclusive ways of working – expanding use of existing wired system | Technical enhancement of existing broadband multi-media system | Steps towards expanding use and e-participation | Detailed understanding of economics and use factors of TV/ set-top-box potentialities. |
| **2b e-Participation (wireless)** | Helsinki | Initial community experiments via mobile interaction | Development of mobile devices and software | Role of mobile interfaces in local participation | Preliminary understanding of mobile devices for e-participation |
| **3. e-Mobility & Transport** | Rome & Leicester | Real-time mobility information services | Technical integration of transport information systems | Possibilities+ functionality of mobility information service | Understanding of technical integration problems and solutions |
| **4 e-Land Use Information** | Dresden + others | e-Broker land use information system | Integration of and open access to GIS systems and data. | Development towards open GIS system(s) | Understanding role and potential of urban GIS |
| **5 e-Regeneration** | Manchester | e-planning (Inclusive strategic planning and development control) | Integrating nD data bases + GIS/VR & Internet | Appropriate systems and ways of working for community decision-making | Development of stakeholder ownership of plans and programmes |

### *5.1 Manchester Prototype*

From the perspective of Intelcities there are 2 significant factors in the Manchester experience. Firstly, Manchester has a long and strong tradition of support for the non-statutory sector and encourages community involvement. The means of undertaking community engagement and the success of these initiatives has varied but it is politically encouraged. Secondly there is an equally strong tradition of supporting the use of ICT in business and community development. This goes back over 13 years with the launch of the Manchester Host – the UK's first ever public access integrated email, bulletin board and online database service in 1991, through the launch of the Electronic Village Halls in 1992, the Manchester Community Information Network in 1994 and the Manchester Digital Development Agency (MDDA) in 2003.

Workpackage 5 focuses on urban regeneration in Manchester as it relates to the post industrial city moving into the knowledge economy, including physical, social and economic aspects together with their interdependencies and how emerging ICTs can be configured to support this. The Manchester Regeneration Statement [2] places the council policy within a strategic framework and explains how that policy will be executed. This takes an holistic approach, encompassing relatively rapid and large-scale change across the physical, economic and social landscape of an area. Potentially there are multiple impacts to factor into any decision-making structure and a range of issues to be addressed in developing regeneration programs and evaluating their success. Thus involving stakeholders in the decision-making process is a challenge. The e-Regeneration systems will be designed and tested to support stakeholder decision-making with a particular emphasis on the support of citizens. Issues such as strategic planning, development planning and accessibility are also being addressed.

Development planning is both an analytical and visual process. Also there is a need for communication within the design team and between the design team and all other stakeholders. These requirements can be met by systems that closely link analytical modelling (based on GIS technology) and visual modelling (based on VR technology) accessible over the internet. In research work over the last 6 years at the University of Salford a system has been specifically designed to support public participation in urban planning via the internet by integrating VR and GIS technologies. The prototype study involves the deployment of this system in a regeneration area in East Manchester.

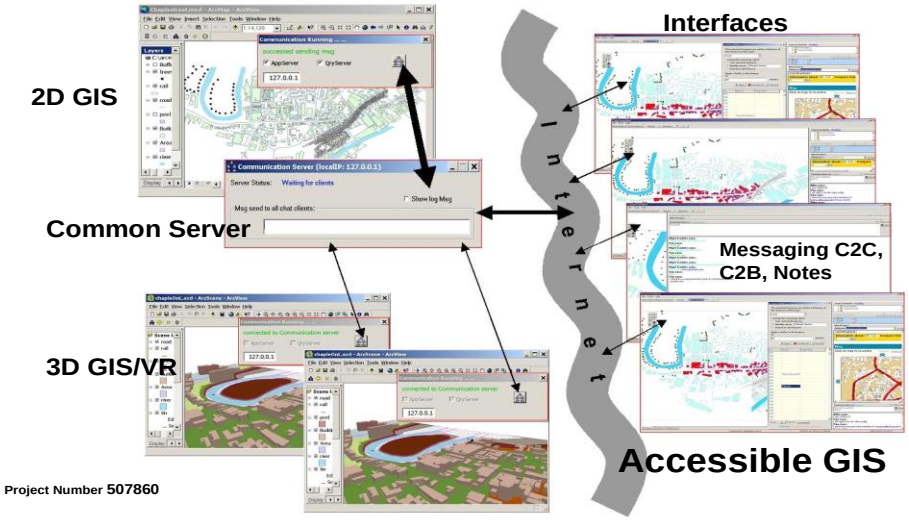


*Figure 4: GIS and VR integrated and delivered over the Internet*

Strategic planning systems for the City will be provided by Manchester University and will incorporate aspects considered important by the City. The model will be used to predict possible city futures. The city will work with CISCO to identify and evaluate technological and social solutions to support social and economic inclusion covering access in the home (via PC and iDTV) and in community locations.

Individuals and community groups will use the e-planning system to explore proposed redevelopment (e.g. a new school or some shops) in both 2D and 3D environments (3D is especially suitable for the lay person). They will be able to discuss issues about the plans with other residents, community leaders, and planners using email, chat, web discussion, etc. A feature will be the ability to leave messages in the 3D environment (e.g. controlled road crossing needed here for new school). These messages will be represented by icons in the 3D environment (and stored in the system database) to be read by all future visitors to the e-Planning system. Other systems have been developed that address some of the issues discussed in this paper but none provide the holistic view for all stakeholders in the same way as Intelcities. In this way the Manchester prototype study will examine the potentials and impacts of the system.

## 6. Business Benefits and Challenges

In order to address the challenges referred to in this paper the project brings together 18 cities, led by Manchester and Siena, with 20 ICT companies including Nokia and CISCO and 36 research groups to pool advanced knowledge and experience of electronic government development, interoperability, virtual planning systems and citizen participation from across Europe. This critical mass of partners will enable the project to explore new forms of public private partnerships in the development and provision of the IOSCP as the basis for the intelligent city of the future.

The integrated e-planning system(s) described above support ***complex multi-stakeholder problem-solving*** linking environmental *science*, city *society, industry and businesses.* They harnesses nD modelling, visualisation and simulation *and knowledge management resources from* cities and researchers *across Europe and bring them to the desktop* or mobile interface of any planner, politician, architect, engineer, utility and transport service provider and most importantly to each citizen. This provides important business opportunities for ICT companies, including the established players and SMEs, in terms of new interfaces and software as well as extending the market for current and close to market devices. Also, because of the complexity of the urban planning problem, development control is often characterised by protracted and adversarial decision-making processes that provide significant disincentives to inward investment, undermining business confidence and competitiveness. The e-planning processes and ICTs under development will re-engineer urban re/development planning in order to accelerate urban development control decision-making. In this way the social learning experiments underway will start to address the uncertainties over community reaction to proposals and how inward investment can be secured for more ***sustainable growth***, urban regeneration ***and improved competitiveness*** of cities, and their constituent businesses components.

The exploration of user needs has highlighted that fact that use of e-Government portals is not the first place that citizen's turn to solve urban problems or express their views on local planning issues. There is a need to define and populate the local "virtual space". Thus the broader societal challenges of e-Participation and of ***"trust and confidence"*** and *individual rights* are emerging as the most significant barriers. This means that the knowledge management dimensions of the project through the creation of a "learning city" environment will have to supply a deeply supportive and very user-fiendly interfaces for e-skills learning and development.

## 7. Conclusions

The IOSCP will enable a more **intelligible and intelligent city**, directly related to the major e-Government drivers aimed at supporting achievement of a Knowledge Society by 2010 [3]:

1. Delivery of a more **streamlined city government**, city management and urban regeneration processes, aimed at achieving more efficient use of city facilities and resources and improve the economic competitiveness of cities.
2. Improved experience and good practice over "virtual" interaction between business, developers, local administration and citizens – the **'e-Agora'** [1], to promote social inclusion, extend citizenship and "ownership" of plans and proposals.
3. Promoting the concept a **NEW** form of **public asset** – not just as the basis for delivery of a wide range of integrated services but as a 'one-stop' intelligent metropolitan information infrastructure as the platform to secure institutional and government knowledge, that citizens value and are prepared to pay for (e.g. through pay on demand and/or through local taxes)

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