Landscape and Roadmap of Future Internet and Smart Cities

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This report presents an overview of the landscape of Smart Cities as innovation systems for Future Internet research. Interrelations between Smart Cities, Future Internet and Living Labs are explored. A collaboration framework is developed for smart cities, future internet research and experimentation, and open and user driven innovation in living labs. A thematic roadmap is proposed for developing collaborationships and building strategies towards Smart Cities.

ABOUT FIREBALL

The over-all objective of the FIREBALL project is to coordinate and align methodologies and approaches in the domains of Future Internet (FI) research and experimentation testbeds and user driven open innovation towards successful innovation in smart city environments.

In doing so, and in covering the whole FI research and innovation value chain driven by smart cities being the users of the FI, FIREBALL aims to establish effective forms of cooperation across the FI innovation value chain, creating synergies and cooperation practices among different research and innovation communities related to the FI.

www.fireball4smartcities.eu

ATTRIBUTES OF THIS OBJECT

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1 INTRODUCTION

1.1 OBJECTIVE AND CONTEXT OF THIS REPORT

This final D2.1 report forms a synthesis and further extension of the previous reports D1.2 [M6] and D1.2 [M12]. The key topics addressed in this report reflect the key priorities of the WP2 and are:

- **Understanding the Smart City, providing state of the art and trends**. FIREBALL understands Smart Cities as innovation ecosystems for the Future Internet. The three areas of Smart Cities, Future Internet and Living Labs are explored including their interlinkages and how they can be exploited. This results into a mapping of the new landscape of Smart Cities and the Future Internet.
- **Smart City case studies**. Seven cases have been elaborated as a means to explore and examine current developments, objectives, strategies in "smart cities" and establish collaboration between Smart Cities and the Eurocities community on one side and Future Internet and Living Labs on the other.
- **Collaboration models for Smart Cities innovation.** In particular we focus on collaboration models that are fundamental to developing and implementing common innovation activities of the three communities constituting the FIREBALL domain: Smart Cities, Future Internet and Living labs.
- **Thematic Roadmap of Future Internet and Living Labs for Smart Cities**. This activity forms input for WP3 activities as well as to the Horizon 2020 development process supported by the FISA group of Future Internet Support Actions. The Roadmap activities also support the development of a strategy to implement collaboration models mentioned.

The work regarding collaboration models relates strongly to the companion D1.2 (M12) report on Common Assets and the D1.3 (M12) report on Access mechanisms. The D1.2 report identifies and describes smart cities, living labs and future Internet common assets, which is fundamental to the collaboration models mentioned. The D1.3 develops approaches to create access to these assets and proposes sharing mechanisms.

The topics addressed should be considered in close relation to the community building and collaborative activities that we have undertaken jointly with FIA and Eurocities communities since starting this project in 2010. Our intention has always been not only to produce reports but to play a proactive role in changing the research and innovation landscape as regards Future Internet, Living Labs and Smart Cities.

1.2 RECOMMENDATIONS FROM THE EARLIER REVIEW MEETINGS

Regarding the recommendations resulting from the first review (September 2010), we found next remarks from the Review report highly useful as a guide for further developing our WP2 activities:

"WP2 is a project priority; therefore the review team stresses the importance of outlining a strong and integrated methodology of collaboration and to prioritise the creation of a collaboration framework across the constituencies. Effective and efficient collaboration is a complex matter, especially because every community involved has different priorities, agendas and objectives. Therefore it is important to deeply analyse how all the partners will collectively benefit from this collaboration, when and at which level it is beneficial for them to engage in the collaboration. The Roadmap should clearly state how the collaboration model will be implemented by the constituencies involved."

Also, a number of general recommendations have been made e.g. to bring in more focus; and the observation that coordination of the constituencies can only happen through effective cooperation with existing projects and initiatives. As a consequence, the WP2 – and the FIREBALL activities over-all – has intensified focus on and strategy concerning collaboration. The key aspects of this intensified focus as regards WP2 emphasis are as follows:

- **Identification of key conditions of collaboration**, in the communities that are fundamental to FIREBALL. This implies an analysis of stakeholders, projects, and their objectives and ambitions, as well as identifying the benefits of collaboration.
- **Focusing community building activities on identifying and establishing the conditions for collaboration.** We have implemented this recommendation in our community building activities; see the D2.2 report.
- **Definition of the goals of collaboration.** This recommendation underlines the importance of developing a joint vision and roadmap.

The second review, covering the period M6 – M12, especially valued the landscape analysis and the related Smart Cities' case studies. It stressed the relationship with the common asset cases and recommended to further integrate our conceptual work with real life empirical case studies and solutions. The collaboration driven out of WP2 was found exemplary for community building through e.g. the strong engagement in FIA. Reviewers would find it a big step forward if a stronger involvement of Smart Cities could be realized after FIRE, FIA and Living Labs.

These recommendations have been taken as point of departure for the work carried out during the 2nd project year, which was strongly dedicated to the role of smart cities, continuing the work on case studies, bridging towards the Eurocities community and further consolidating the project findings.

We understand our activities not as a theoretical exercise. We are in the middle of ongoing interactions, developments and opportunities. We see ourselves as part of an "action research" process where we are working with actors involved in the three communities mentioned. Therefore we also must be pragmatic and practical. In working with the communities mentioned various opportunities for collaboration have been emerging – also in the context of EU programmes such as CIP and FP7-ICT - and we have worked towards elaborating, strengthening and exploiting these opportunities.

1.3 ACTIVITIES CARRIED OUT M1 – M24 FOR DEVELOPING THE D2.1

This report is the result of several exploratory and community building activities carried out in the two-year period of May 2010 – April/May 2012.

- **Studies of the state of the art and trends in smart cities, Future Internet and Living Labs.** Proposing a first framework for collaboration. This work was carried out in the first 6 months of the project and has been reported in D2.1 [M6].
- **Development of Smart City case studies**. It was found important also in our communication to the relevant communities (FIRE, Living Labs, Smart Cities) that FIREBALL is grounded in empirical information regarding the current situation, strengths and weaknesses as well as opportunities of cities. Four of the cases presented in this D2.1 report were published recently in the Journal of the Knowledge Economy, April 2012.

- **Participation in FISA Roadmapping.** In order to strengthen our collaboration with current projects in the domain of Future Internet, and to build collaboration regarding the development of the envisaged smart cities roadmap, we participated within the FISA (Future Internet Support Actions) working group to contribute to the Future Internet Roadmap to support the development of the Horizon 2020 framework programme.
- **Community building and collaboration.** Building strong community relationships (Future Internet community, Living Labs, Smart Cities), through joint organisation of workshops for the Future Internet week Ghent, December 2010 and Budapest (May 2011) as well as the FIA Aalborg (May 2012) where Smart Cities are central topic. FIREBALL also organised, jointly with EUROCITIES, a workshop on Smart Cities, January 2012, Brussels. Community building activities are reported in the D2.2. We have continued to establish close relationships with the constituencies involved and we are have built up joint activities with, in particular with:
  - ENOLL: European Network of Living Labs, www.enoll.org
  - FIA (Future Internet Assembly), www.future-internet.eu
  - Eurocities, as a platform for Smart Cities innovation, www.eurocities.eu
  - Related projects within the CIP ICT-PSP and FP7-ICT programmes (e.g. SmartSantander, FIRESTATION, ELLIOT, TEFIS and several others).
- **Developing a FIREBALL White Paper**, summarizing the results and recommendations for a wider audience.
- **Dissemination of our vision and results.** We prepared several publications and had several presentations at conferences.
  - FIA 2011 Book chapter on Future Internet and Smart Cities: The book has been published by Springer in May 2011.
  - ICE 2011 conference. Focus of this paper is on collaboration models based on common assets and user engagement.
  - EChallenges conference paper. This paper addresses the Roadmap work carried out within the FIREBALL WP2.
  - Journal of the Knowledge Economy Special Issue on Smart Cities and the Future Internet in Europe, April 2012. Guest Editors from FIREBALL: Nicos Komninos and Hans Schaffers. This special issue contains several FIREBALL smart city case studies.
  - Journal of Theory and Applications of Electronic Commerce, Special Issue on Smart Applications for Smart Cities. To be published December 2012. Guest editors: Hans Schaffers, Nicos Komninos, Carlo Ratti.

1.4 OVERVIEW OF PUBLICATIONS IN THE SCOPE OF FIREBALL WP2, 2010-2012:

- Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M., Oliveira, A.: **Smart Cities and the Future Internet: Towards Cooperation Frameworks for Open Innovation.** In: J. Domingue et al. (Eds.): The Future Internet. Future Internet Assembly 2011: Achievements and Technological Promises, pp 431-446, Springer.
- Schaffers, H., Sällström, A., Pallot, M., Hernandez-Muñoz, J.M., Santoro, R., Trousse, B.: **Integrating Living Labs with Future Internet Experimental Platforms for Co-creating Services within Smart Cities**. In: Proceedings of the ICE 2011 Conference, June 2011, Aachen, Germany. Published at IEEE Xplore.
- Pallot, M., Trousse, B., Senach, B., Schaffers, H., Komninos, N.**: Future Internet and Living Lab Research Domain Landscapes: Filling the Gap between Technology Push and Application Pull in the Context of Smart Cities.** EChallenges e-2011 Conference Proceedings, Paul Cunningham and Miriam Cunningham (Eds.), IIMC International Information Management Corporation, 2011.

- Komninos, N., Schaffers, H., Pallot, M.: **Developing a Policy Roadmap for Smart Cities and the Future Internet**. EChallenges e-2011 Conference Proceedings, Paul Cunningham and Miriam Cunningham (Eds.), IIMC International Information Management Corporation, 2011.
- Pallot, M., Trousse, B., Senach, B., & Scapin, D. (2010). **Living Lab Research Landscape: From User Centred Design and User Experience towards User Co-creation.** Proceedings of the Living Lab Summer School, Paris, August 2010.
- Pallot, M., Trousse, B., Senach, B. (2012). **A Tentative Design of a Future Internet Networking Domain Landscape**. To be published by Springer, in Federico Alvarez et al. (Eds.) The Future Internet, FIA 2012.
- Komninos, N., M. Pallot, H. Schaffers (2012): **Special Issue on Smart Cities and the Future Internet in Europe.** Journal of the Knowledge Economy, April 2012, http://www.springerlink.com/content/900816112p7qmwh2/
- Bakici, T., Almirall, E., Wareham, J. (2012): **Smart City Initiative: the Case of Barcelona.** Journal of the Knowledge Economy, April 2012, http://www.springerlink.com/content/9318pq8q61r06345/
- Komninos, N. and P. Tsarchopoulos (2012): **Toward Intelligent Thessaloniki: from an Agglomeration of Apps to Smart Districts.** Journal of the Knowledge Economy, April 2012, http://www.springerlink.com/content/g350361m41tu362k/
- Carter, D. (2012): **Urban Regeneration, Digital Development Strategies and the Knowledge Economy: Manchester Case Study.** Journal of the Knowledge Economy, April 2012, http://www.springerlink.com/content/1l8568n024328355/
- Hielkema, H. and P. Hongisto (2012): **Developing the Helsinki Smart City: The Role of Competitions for Open Data Applications.** Journal of the Knowledge Economy, April 2012, http://www.springerlink.com/content/m87r542g884n2p20/
- Concilio, G., De Bonis, L., Marsh, J., Trapani, F. (2012): **Urban Smartness: Perspectives Arising in the Periphéria Project.** Journal of the Knowledge Economy, April 2012 http://www.springerlink.com/content/y2366371221m8145/
- Zygiaris, S. (2012): **Smart City Reference Model: Assisting Planners to Conceptualize the Building of Smart City Innovation Ecosystems.** Journal of the Knowledge Economy, April 2012, http://www.springerlink.com/content/p80672k75w74n679/

1.5 OVERVIEW OF THIS REPORT

Chapter 2 presents the basic view of smart cities as open innovation ecosystems for the future Internet. Chapters 3, 4 and 5 provide a state of eh art overview and developments in smart cities, Future Internet and Living Labs. As a result, Chapter 6 presents a mapping of the landscape of smart cities and the Future Internet.

Based on previous chapters, Chapter 7 summarizes an over-all methodological framework for collaboration. In addition, Chapter 8 presents the background to thinking about collaboration models. This chapter was published as a chapter in the FIA 2011 book (published by Springer, May 2011).

Chapter 9 presents the analytical framework for description of the smart city cases. The seven cases themselves (Manchester, Thessaloniki, Oulu, Helsinki, Lisbon, Barcelona, and Amsterdam) are summarized, and elaborated in the Appendix.

Chapter 10 takes a wider view, grounded in previous chapters, to present the work on thematic roadmap development, which is also input to the FISA Roadmapping working group, and input for WP3.

Finally, in Chapter 11 we shortly summarize the main conclusions and results and we suggest a number of follow-up activities.

2 SMART CITIES AS OPEN INNOVATION SYSTEMS FOR THE FUTURE INTERNET

2.1 THREE CONCEPTS AND THEIR INTERRELATIONS

The terms "Smart Cities" or "Intelligent Cities" are often being used to denote the use of digital spaces and advanced ICTs to enhance the activities, services and economic development potential of cities. The Future Internet is a concept which represents a promise of advanced ICT infrastructure to enable services, applications and business models benefiting citizens and enterprises in the future. User driven open innovation represents a concept of an innovation ecosystem characterized by real-life experimentations and cooperation among all stakeholders including users across the value chain. It requires an active engagement of end-users of ICT-based innovations, such as citizens and businesses, to initiate and shape those innovations. Our interest is in the innovation ecosystem playground of cities constituted by these developments.

Clearly, there is a potentially beneficial relationship between the three concepts (Future Internet, Living Lab and Smart Cities) which needs further examination and also experimentation, in future pilot projects. Such relationship may lead to extended or even new models of collaboration among the involved constituencies. Some promising evidence of collaboration models is already available, such as the use of living lab concepts for innovation policy and the use of technical methodologies to stimulate innovation and socio-economic development in cities and regions.

Other aspects of the collaboration "triangle" are more demanding, for example how living lab facilities and Future Internet (FI) testbeds could operate together, or how the more technology push oriented Future Internet initiatives could benefit the socio-economic objectives of cities. Regarding the first aspect, one could be claiming that service or application scenarios could be explored within Living Lab facilities and experimented within FI testbeds. However, it would require that FI testbeds will be sufficiently flexible to accommodate different service or application scenarios co-created by users and necessary stakeholders such as testbeds designers. As for the second aspect, it could be argued that while FI initiatives bring the technology push, smart cities bring the application pull. As a potential outcome, it could be expected that the confrontation in between technology push and application pull will result in innovative services or applications with a higher potential of adoption by user/citizen communities.

It is also unclear in what way there might be a case for "direct" collaboration process between living labs, Future Internet facilities and smart cities, in terms of results of one activity to be used in the other. The activities mentioned comprise different time horizons, objectives and stakeholder settings. A different and more realistic vision on collaboration models could be built on the concept of innovation system of cities. Complementary and jointly developed "assets" or "resources" together with forms of strategic management of innovation stimulate the creation and transition of knowledge flows for innovation in business, and eventually for socio-economic development of cities and regions.

The key driver of collaboration can be seen in an extended, holistic view of what constitutes a smart city. A city can be defined as 'smart' when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance [1]. It is important to view the concept of smart city as a promise or ambition, not yet as a reality.

The same applies to the Future Internet. The current activities in many cities to deploy wireless of fiber-based broadband networks and experiment on ICT-based innovations demonstrate a willingness to exploit the opportunities of such infrastructure. There are many examples of interesting pilot experimentations in areas such as health and care, energy and e-government. However over-all we are still far away from scaling-up such pilots and deploying wide-scale applications to achieve real economic and social benefits in cities and regions.

The concept of "living labs" as a model of user driven open innovation in real-life is also promising as it is based on extended forms of collaboration and engagement of users in the co-creation of innovative scenarios. However, as it comes to concrete evidences, this concept is not yet an operational reality. There exist still only few mature examples of what truly could be called "living labs". However, during the last years, a lot of experimentation on this concept has been going on which shows a rich diversity of concepts, approaches, methodologies and practices.

2.2 THE INITIAL VIEW OF THE LANDSCAPE

The initial view that we propose regarding the landscape of Smart Cities, Future Internet and Living Labs, and their associated collaboration models, which we will explore in this report, consists of the following elements.

1) Future Internet research and experimentation, supported by experimental testbeds, creates the future ICT-infrastructure. This is mostly oriented to testing of technologies and services. In many ways, these technologies and services form the foundation of advanced future applications (healthcare, creative media, e-government, smart energy, domotics, assisted living).
2) Smart cities will be built upon modern ICT infrastructure, as one of the determinants of cities' welfare. Other determinants of cities' welfare will be important as well: the infrastructures for education and innovation, the networks between businesses and governments, the existence of demanding citizens and businesses to push for innovation and quality of services. Here we see a clear analogy to Porter's concept of national competitive advantage: the cities welfare potential.
3) The Living labs concept represents a general view of user driven open innovation ecosystems. As a concept applied to smart cities it embodies open business models of collaboration between citizens, enterprises and local governments, and the willingness of all parties including citizens and SMEs to engage actively in innovation, in different phases and at different levels (policy – innovation – implementation). The living lab concept should be considered also as a methodology, a model for organizing specific innovation programs, innovation projects and innovation experiments. Whereas the last aspect has gained most attention, both levels are important: shaping and operating the innovation ecosystem.
4) The innovation ecosystem view of living labs should recognize different drivers and origins of innovation and their potential for interaction and synergy. The first is emerging more or less technology push from Future Internet research and experimentation. "Valorisation" is the strategy to transform such research and experimentation into business. The second origin is more short term oriented to innovative applications, enabled by ICT-infrastructure, targeting the goal of city development and business creation. This is more in line with living labs thinking. The model of fostering the interactions among these innovation types is two-sided: both top down and bottom up [cf. Nonaka's view of knowledge creating company which has some analogy to cities].

The FIREBALL vision considers smart cities as innovation ecosystems in their own, an arena characterized by open innovation engaging the stakeholders including citizens, where the opportunities of the Future Internet and the needs of citizens and enterprises will be aligned.

2.3 URBAN VALUE CREATION SYSTEM

The concept of "national competitive advantage" developed by Michael Porter, which borrows from the national systems of innovation thinking of Chris Freeman, could be useful as an analogy to the city "value creation system". This is visualized in Fig. 2-1 using Porter's "diamond" model.

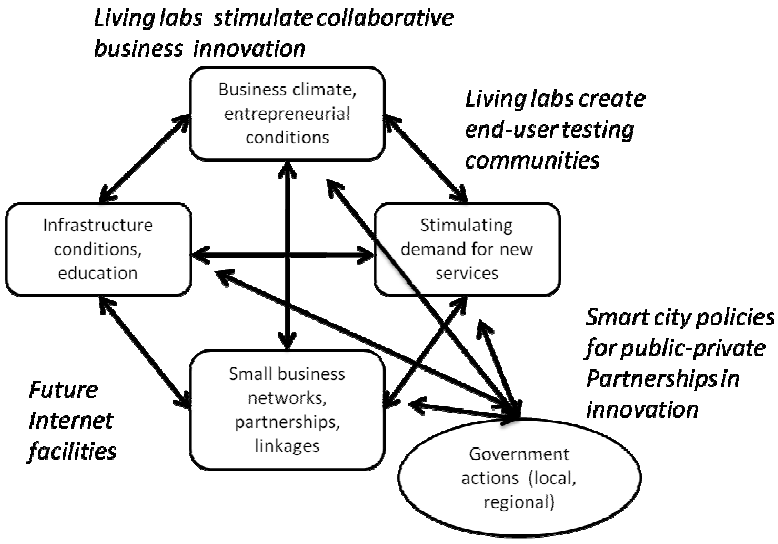


Fig. 2-1 Smart city value creation and innovation system (using Porter's concepts)

The city value creation system can be considered as constituted by four determinants: 1) infrastructure, 2) networks and collaboration, 3) entrepreneurial climate, 4) demand for services (active users). The value creation system is also affected by local governmental actions e.g. towards stimulating the building of networks, the creation of public-private partnerships, and the enhancement of innovative conditions.

2.4 COLLABORATION MODELS IN THE URBAN VALUE CREATION SYSTEM

Collaboration models underlying smart cities innovation ecosystems will be multifaceted. One level is public-private partnership in city innovation programs. The second level is collaboration within the innovation ecosystem, among innovation activities, to create synergies and exploit complementarities. The second level falls apart in two distinct collaboration types.

The first type is collaboration **within** the innovation process. The collaboration process model requires one activity to feed into the other. E.g. Future Internet research is testing a context-aware service; this service (software module) feeds into a living lab process to create innovative applications in a user-driven process.

The second type is collaboration across distinct research, experimentation and innovation processes. This model of "co-existence" considers different and focused innovation activities which could be demand driven (applications development in user contexts) or technology push (research on Internet technologies) or hybrid forms. The innovation ecosystem of cities in this respect builds on creation and exchange of knowledge, on stimulation of knowledge flows and interactions, less on the innovation process itself.

3 SMART CITIES: STATE OF THE ART AND TRENDS

3.1 DEFINITION AND DESCRIPTION

Our starting point is the description of Smart Cities found in Wikipedia (http://en.wikipedia.org/wiki/Smart_city): Urban performance currently depends not only on the city's endowment of hard infrastructure ('physical capital'), but also, and increasingly so, on the availability and quality of knowledge communication and social infrastructure ('intellectual and social capital'). The latter form of capital is decisive for urban competitiveness. It is against this background that the concept of the "smart city" has been introduced as a strategic device to encompass modern urban production factors in a common framework and to highlight the growing importance of Information and Communication Technologies (ICTs), social and environmental capital in profiling the competitiveness of cities. The significance of these two assets - social and environmental capital - itself goes a long way to distinguish smart cities from their more technology-laden counterparts, drawing a clear line between them and what goes under the name of either digital or intelligent cities.

Smart(er) Cities has also been used as a marketing concept by companies and by cities. The Smart Cities community can be described on multiple levels. On the one hand, Smart Cities is a concept that attracts attention from many cities. It provides a future image of how cities could look like, in terms of economic development, sustainability, innovation environment etc. This way it inspires city development strategies. Its importance is highlighted by the fact that several cities are working together in Smart City Networks. One of them is Eurocities (www.eurocities.eu) which is a network of 130 large cities in 34 countries. The role of Eurocities network is to prepare common approaches to issues of interest for large cities.

In relation to the Future Internet, their recent policy papers on ”Broadband Deployment” (Eurocities, 2009) and on ”Cities and innovation in Europe” (Eurocities, 2010) are of high interest. Internationally and outside Europe, several major cities have developed Future Internet policies as well, which exemplifies the potential linkage between Smart Cities and Future Internet.

The terms "Smart City" and ‘Intelligent City” have been used with various meanings to denote the use of digital spaces and information and communication technologies to enhance the activities, services, and economic development of cities. The “smart city” literature gives more emphasis on the use of sensors, embedded systems, devices, and mobile phones for creating the digital dimension of cities; while the “intelligent city” literature focuses more on broadband networks and the Internet as medium for organizing the collective intelligence of cities. A common denominator appears to be the well-known “Ambient Intelligence”, which is revealed as the historical root. Future Internet research brings those two digital dimensions of the city together envisioning an integrated ICT space of multiple 4G broadband networks, virtualization of infrastructure, RFIDs, smart mobile devices, Web 3.0, semantic web, the Internet of data and things.

Some formal definitions of smart or intelligent city to be found in literature are the following.

MIT Smart Cities Group http://cities.media.mit.edu/

“The new intelligence of cities, resides in the increasingly effective combination of digital telecommunication networks (the nerves), ubiquitously embedded intelligence (the brains), sensors and tags (the sensory organs), and software (the knowledge and cognitive competence).”

This does not exist in isolation from other urban systems, or connected to them only through human intermediaries. There is a growing web of direct connections to the mechanical and electrical systems of buildings, household appliances, production machinery, process plants, transportation systems, electrical grids and other energy supply networks, water supply and waste removal networks, systems that provide life safety and security, and management systems for just about every imaginable human activity. Furthermore, the cross-connections among these systems, both horizontal and vertical, are growing (Mitchell 2007).

URENIO Research

"The term 'intelligent city' describes a territory (community, district, cluster, city, and city-region) with four main characteristics: (1) a creative population and developed knowledge-intensive activities or clusters of such activities; (2) embedded institutions and routines for cooperation in knowledge creation allowing to acquire, adapt, and advance knowledge and know-how; (3) a developed broadband infrastructure, digital spaces, e-services, and online knowledge management tools; and (4) a proven ability to innovate, manage and resolve problems that appear for the first time, since the capacity to innovate and to manage uncertainty are the critical factors for measuring intelligence." (Komninos 2008).

Intelligent cities are organized as multi-layer territorial systems of innovation, bringing together knowledge-intensive activities, innovation support institutions, and digital communication spaces. These layers reflect both the different dimensions of intelligence (human, collective, artificial) and the deployment of innovation on physical, institutional and digital spaces.

The first layer includes the city's knowledge-intensive activities in manufacturing and services. The population of the city, knowledge workers, and innovative companies are the fundamental elements upon which intelligent cities are constructed. Proximity in physical space is important, integrating enterprises, production units, and service providers into a coherent system. Critical factor at this level is the intellectual capital of the city's population.

The second layer includes institutional mechanisms for knowledge creation and social co-operation in technology and innovation. Characteristic examples are institutions enhancing R&D, strategic intelligence, venture capital financing, technology transfer, and collaborative new product development. These are mechanisms that promote cooperation within the clusters of the city, between different clusters in the city, and between innovation processes taking place on physical and digital space. Critical factors at this level are institutional thickness and collective intelligence of the community.

The third layer includes broadband networks and e-services that enable online cooperation. These tangible and intangible infrastructures create virtual innovation environments based on multimedia tools and interactive technologies, which facilitate different innovation processes from market and technology intelligence to collaborative new product development and process innovation based on transaction-saving technologies. Critical factors at this level are content management, information automation, intelligent agents, virtual networking and web technologies.

European Smart Cities project (http://smart-cities.eu/)

"Smart Cities can be identified (and ranked) along six characteristics: (1) Smart economy (competitiveness), (2) Smart people (social and human capital), (3) Smart governance (participation), (4) Smart mobility (transport and ICT), (5) Smart environments (natural resources), and (6) Smart living (quality of life). A Smart City is a city performing well in a forward-looking way in these six dimensions, built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens."

The above perspective was the basis of a more comprehensive entry at Wikipedia Smart City entry: "Smart Cities can be identified (and ranked) along six main axes or dimensions. These axes are: a smart economy; smart mobility; a smart environment; smart people; smart living; and, finally, smart governance. These six axes connect with traditional regional and neoclassical theories of urban growth and development. In particular, the axes are based - respectively - on theories of regional competitiveness, transport and ICT economics, natural resources, human and social capital, quality of life, and participation of citizens in the governance of cities. A city can be defined as 'smart' when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic development and a high quality of life, with a wise management of natural resources, through participatory governance." See: http://en.wikipedia.org/wiki/Smart_City.

IBM Smart Planet Initiative http://www.ibm.com/smarterplanet/us/en/

A major contribution to smart cities is coming from IBM which made this concept a flagship of its business strategy.

"A smarter city is one that uses technology to transform its core systems and optimize the return from largely finite resources. By using resources in a smarter way, it will also boost innovation, a key factor underpinning competitiveness and economic growth. Investment in smarter systems is also a source of sustainable employment. Smarter cities make their systems instrumented, interconnected and intelligent:"

- Instrumentation, or digitization, of a city's system means that the workings of that system are turned into data points and the system is made measurable, with the ability to sense its environment and monitor its performance.
- Interconnection means that different parts of a core system can be joined and "speak" to each other, turning data into information.
- Intelligence refers to the ability to use the information created, model patterns of behaviour or likely outcomes and translate them into real knowledge, allowing informed actions. True intelligence is more than just embedding transistors into objects. It's the ability of these things to begin to manage themselves, to make choices and self optimize, and in some cases to learn (IBM Institute for Business Value).

3.2 STATE OF PLAY

A global outlook of cities developing smart and intelligent city strategies is given by the Intelligent Community Forum and the cities selected as best performers globally during the 2002-2010 period (see Table 3-1).

Apart from the above mentioned cities, some well known cases of European cities implementing smart or intelligent cities strategies are:

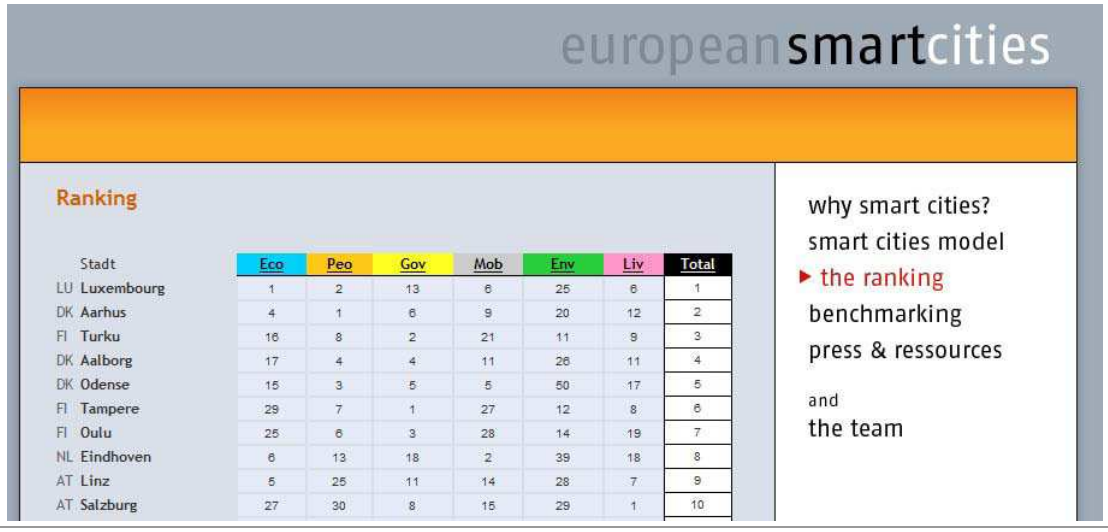
- Malta: Smart Island and Smart city projects on the development of ICT industry; the SmartCity@Malta initiative.
- Amsterdam: Amsterdam Smart City projects on energy saving and CO2 reduction. See: www.amsterdamsmartcity.com. Another Dutch city active in smart cities strategy is Groningen.
- Birmingham: the intelligent city programme on smart mobility.

	Asia and Australia	North and South America	Europe
2002	Bangalore, India **Seoul, S. Korea** Singapore	**Calgary, Alberta, CA** Florida, high tech corridor, US LaGrange, Georgia, US	Sunderland, UK
2003-04	Taipei, Taiwan Victoria, Australia Yokosuka, Japan	Spokane, Washington, US Western Valley, N. Scotia, CA	**Glasgow, UK** Sunderland, Tyne & Wear, UK
2005	**Mitaka**, Japan Tianjin, China Singapore	Pirai, Brazil Toronto, Ontario, CA	Issy-les-Moulineux, France Sunderland, Tyne & Wear, UK
2006	**Taipei, Taiwan** Tianjin, China Gagnam District Seoul Ichikawa, Japan	Cleveland, Ohio, US Waterloo, Ontario, CA	Manchester, UK
2007	Gangnam District	Ottawa-Gatineau, Ontario, CA Sunderland, Tyne & Wear, UK **Waterloo, Ontario, CA**	Dundee, Scotland, UK Issy-les-Moulineaux, FR Tallinn, Estonia
2008	**Gagnam District Seoul**	Fredericton, New Brunswick, CA Northeast Ohio, US Westchester, New York, US Winston-Salem, N. Carolina, US	Dundee, Scotland, UK Tallinn, Estonia
2009		Bristol, Virginia, US Fredericton, New Brunswick Moncton, New Brunswick, CA	Eindhoven, Netherlands Issy-les-Moulineaux, FR **Stockholm, Sweden** Tallinn
2010	**Suwon, South Korea**	Arlington County, VA Dublin, Ohio, US Ottawa, Ontario, CA	Dundee, Scotland Eindhoven Tallinn, Estonia

Source: Intelligent Community Forum (http://www.intelligentcommunity.org/)

Table 3-1: Cities developing smart and intelligent city strategies

We need to keep in mind the difficulty of ranking cities according to "smartness" indicators. Many rankings exist. For **mid-sized cities**, the European Smart Cities project (www.smart-cities.eu) has used an approach of indicators for "smartness" criteria: smart economy, smart people, smart government, smart mobility, smart environment, smart living (Fig. 3-1).



Stadt	Eco	Peo	Gov	Mob	Env	Liv	Total
LU Luxembourg	1	2	13	6	25	6	1
DK Aarhus	4	1	6	9	20	12	2
FI Turku	16	8	2	21	11	9	3
DK Aalborg	17	4	4	11	26	11	4
DK Odense	15	3	5	5	50	17	5
FI Tampere	29	7	1	27	12	8	6
FI Oulu	25	6	3	28	14	19	7
NL Eindhoven	6	13	18	2	39	18	8
AT Linz	5	25	11	14	28	7	9
AT Salzburg	27	30	8	15	29	1	10

Fig. 3-1 Ranking of mid-sized smart cities

Rank	City	Country	Global rank	2010 grade
1	Paris	France	2	1 Nexus
2	Amsterdam	Netherlands	3	1 Nexus
3	Vienna	Austria	4	1 Nexus
4	Frankfurt	Germany	6	1 Nexus
5	Copenhagen	Denmark	8	1 Nexus
6	Lyon	France	9	1 Nexus
7	Hamburg	Germany	10	1 Nexus
8	Berlin	Germany	11	1 Nexus
9	Stuttgart	Germany	13	1 Nexus
10	London	UK	14	1 Nexus
13	Stockholm	Sweden	17	1 Nexus
14	Rome	Italy	21	1 Nexus
16	Barcelona	Spain	26	1 Nexus
21	Helsinki	Finland	37	2 Hub
34	Manchester	UK	58	2 Hub
-	Lisbon	Portugal	-	3 Node

Table 3-2: Innovation Cities Europe index 2010 (Source: 2thinknow)

For "**Innovation Cities"**, cities were selected by 2thinknow on basis of factors such as health, wealth, population and geography. These cities were evaluated against more than 100 indicators and data were weighted against global trends. Some of the outcomes are presented in Table 3-2. Other rankings exist for **"Favourite business cities"** (1. London, 2. Paris, 4. Barcelona, 8. Amsterdam, 16. Manchester, 17. Lisbon) and **"Best cities"** (1. Vienna, 13. Amsterdam, 34. Paris, 35. Helsinki, 39. London, 44. Barcelona, 45. Lisbon).

Players in Smart Cities

Important stakeholders comprise local governments and policy makers, as well as industry. Major global ICT companies are involved in the smart city movement:

- IBM with its smarter city / smarter planet initiative: http://www.ibm.com/smarterplanet/us/en/sustainable_cities/ideas/
- Microsoft with applications and platforms for smart mobility: http://www.youtube.com/watch?v=jPHvzU6ZoYE
- CISCO's intelligent urbanization initiative: http://newsroom.cisco.com/dlls/2009/prod_021209c.html

A large number of research labs, academic institutes and research centres are active in the field of smart / intelligent cities, focusing on issues of city economic development, infrastructure management, intelligent environments creation, people participation, and services to citizens. The first academic paper on smart cities was published in 1992 (Gibson, Kozmetsky and Smilor 1992); while the first academic paper on intelligent cities appeared also in 1992 (Laterasse 1992).

An overview of smart and intelligent cities from the perspectives of concept, strategy, technology and applications is presented in Table 3-1.

3.3 TRENDS AND DEVELOPMENTS

From a Smart Cities perspective of urban development, the key drivers towards Future Internet Open Innovation are:

- Socio-economic ambitions of large cities and urban areas (but also strategies for city marketing)

- Need for connectedness (cities – rural areas – regions)
- Broadband deployment experiences, need for applications pull after the infrastructure and technology push. Need to create experimentation environments to stimulate innovation, driving network development as well.
- Impact of Internet infrastructure on business attractiveness of cities
- Need to create open innovation environments to attract business and knowledge centres

Smart Cities represent the evolving need for infrastructures at several levels: innovation infrastructure (networks of collaboration, experimental facilities, research and test centres etc), broadband Internet infrastructure (networks, services). Smart Cities are the "user" of future Internet infrastructure and applications. Smart Cities are the beneficiary of open innovation environments. Naturally, Smart Cities will be the key driver of living labs (user driven open innovation) approaches.

CONCEPT	**GENESIS**
	Origins / creation forces
	1. A digital space over the urban agglomeration and its regulation / urban planning
	2. Innovation economy, systems of innovation, global innovation systems / end-users involvement to innovation
		CONCEPT
		Different meanings
		• DIGITAL cities: Virtual representation of cities
		• CYBER cities: governance / control
		• SMART cities: Sensors / city space UI
		• INTELLIGENT cities:
		  ○ Intelligent innovation ecosystems
		  ○ Intelligent environments
		  ○ Intelligent communities
			STRUCTURE
			• **Layer 1**: Agglomeration, clusters, people, **mix** of activities: HUMAN INTELLIGENCE
			• **Layer 2**: Institutions, regulation, innovation system: COLLECTIVE INTELLIGENCE
			• **Layer 3**: Virtual environments - intelligence, learning, web-collaboration, ARTIFICIAL INTEL.
				ADDED VALUE
				1. **More innovative cities:**
				- Global suppliers and markets
				- New products based on Crowdsourcing
				- Cost reduction by e-delivery
				2. **Infrastructure cost reduction :** e-services for traffic, energy, water, environment, safety
				3. **Citizens:** Democracy, e-gov,

STRATEGY	**CASES: INTELLIGENT / SMART CITIES** • ASIA: Singapore iN15, Taipei, Cyberport, Seoul –Gagnam, Media city, Malaysia MSC Songdo, • USA: Florida, Cleveland, Waterloo • EU: Manchester, Glasgow, Issy, Tallin, Arabianranta, Stockholm, Malta, Zaragoza, Amsterdam	**CITY STRATEGIES** Major approaches of building intelligent / smart cities: • Sector-based strategies • Cluster or District-based strategies • Large-scale emerging intelligent cities / multiple cores and sectors • Infrastructure / utilities focus	**POLICY ORIENTATIONS / PLANNING** • INTELLIGENT COMMUNITY FORUM • EU Living Labs • EU smart cities • Smart cities for innovation – CIP • Multinationals: IBM – MS – CISCO	**MEASUREMENT** **Input indicators:** 1. Population education, skills, 2. Knowledge – innovation institutions, 3. Broadband - Virtual environments - Services **Output indicators:** Innovation performance
TECHNOLOGY	**INTELLIGENCE** • OLAP • BUSINESS/ CLUSTER INTELLIGENCE • DATA MINING • BENCHMARKING • COLLECTIVE INTEL – PYTHON	**CONTENT MANAGEMENT SYSTEMS** • JOOMLA • WORD PRESS • WIKIS • MASHUPS	**COLLABORATION WEB** • CO-DESING TOOLS • VIRTUAL COLLABORATION • WEB 2.0 NPD • CROWDSOURCING	**VISUALISATION** • WEB DESIGN – PHP • PANORAMA FACTORY • GOOGLE 3D • 3D STUDIO • TAGWHAT - AUGMENTED REAL
APPLICATIONS	**MAJOR DOMAINS** **Innovation economy**: **activity sectors / city districts**: (1) industrial, (2) services (3) commerce, (4) employment, (4) entrepreneurship, (5) company incubation **Smart infrastructure:** energy, water, environment, traffic, safety **Governance:** e-services to citizens, decision making, e-democracy,	**BUILDING BLOCKS** **Physical-virtual Knowledge functions** Building blocks for all applications 1. **Intelligence**: strategic, BI, Cluster 2. **Learning** - Technology transfer 3. **Innovation** – Collaborative New Product Development 4. **Promotion - e-Marketplace places** – Global dissemination	**APPLICATIONS** (1) Smart industry clusters (2) Intel university campuses (3) Smart ports / airport cities (4) Smart technology parks / incubator (5) Smart Central Business Districts (6) Virtual city tours / e-guides (7) Energy saving districts (8) Urban traffic management (9) Environmental monitoring / alert (10) Safety to public space (11) e-gov / e-city planning	

Table 3-3: Smart and intelligent cities overview

There seems to be a new interest in fiber networks deployment (FTTH)[1]. Internet has become mainstream, and bandwidth needs have increased. An important constraint is that a large part of European homes is still connected with copper loops of 1 km or more. Due to this fact, bandwidth is still constrained and higher bandwidth requires fiber. Fiber rollout will play an important role in next generation access infrastructure. Different financial models need to be developed, and also regulatory issues need to be resolved in order to push this development. Open innovation systems will be critical to align the interests of different players involved (telecoms, governments, universities, application providers, sectors in the economy and society).

One example is the Cities Network (Stedenlink) in the Netherlands, which has developed and actively promoted strategies to accelerate fiber optic deployment based on geographical bundling of demand for broadband services. Recently, the Task Force Next Generation Networks has identified different options for fiber rollout and has studied different financial models. The support of provinces, cities and housing corporations and the financial model is crucial for success. Promoting the Future Internet and Open Innovation should be grounded in these types of initiatives that already have a strong level of support from cities and provinces. The Eurocities document on Broadband policy (Eurocities, 2010) mentions several city-level broadband deployment initiatives in Europe. Here, we see the need to align policies and initiatives at different levels in order to create synergies and learning effects: city and province, national, and EU.

3.4 LINKAGES ACROSS THE COMMUNITIES

First we address the key actors within the Smart City community. Thereafter we explore the linkages between the smart City community and two other communities: Future Internet and Living Labs.

The Smart City community includes three distinct groups of organisations: (1) cities developing smart / intelligent city strategies, (2) large companies developing platforms and applications for smart cities, and (3) research labs, centres and experts performing research on the subject.

Interlinkages with Future Internet, Living Labs

Large cities have developed policies regarding economic development in relation to broadband deployment and open innovation. The living labs concept has also been endorsed by many cities, through the European Network of Living Labs. Some examples of city-level policies regarding living labs are the following:

- Helsinki: living labs projects e.g. smart urban spaces. See also Forum Virium (www.forumvirium.fi).
- Greater Paris
- Amsterdam: Amsterdam Innovation Motor, Amsterdam Smart Cities
- Barcelona
- Manchester: policies towards urban planning and connected cities. Creating environments for Open Innovation, driven by the living labs concept.

Smart City has now become an important topic in European programmes for research and innovation (INTERREG, FP6 Intelcities, FP7, CIP ICT-PSP Pilots on Smart Cities e.g. related to energy management, sustainable development). Through creating a network of Smart Cities and linking to ENoLL, Eurocities and also ERRIN (regions), a key element of the emerging landscape will be available for participation in Future Internet and Open Innovation PPP initiatives.

[1] McKinsey (2010): Creating a Fiber Future. See also: OECD (2009): Network Development in Support of Innovation and User Needs.

Becoming part of new networks of cooperation opportunities is the key driver of this development. The Smart Cities community will prepare and enrich Future Internet and Open Innovation policies at city level. They will represent the user base and actively involved in developing the innovation ecosystem at city and regions level. They also will prepare deployment strategies of fiber optic networks and broadband advanced pilots.

The Future Internet community e.g. represented by FIA collects the main business, technological and research players. These are also playing an important role in new initiatives such as Future Internet PPP. In order to succeed these initiatives need collaboration with Smart Cities to create experimentation testbeds and large-scale pilots.

The living labs community naturally is close to the smart cities network. However, living labs must become more mature in terms of methodologies, experimental facilities and large-scale pilots. Several initiatives at national and EU-funded level are working towards this goal.

The key vision could be to create interconnected facilities based on commonly shared assets (facilities, methods, technologies, know-how, human capital). This could take a point of departure in the vision of interconnected cities. However also at the smart cities and regions level we need to create interconnected facilities to support the creation of regional networks of innovation. E.g. a living lab initiative working together with experimental facilities of companies and knowledge centres. The challenge is to create open networks of knowledge and experimentation. One example could be in energy management and sustainable development in smart cities; another in regionally organised healthcare, and in learning and education.

3.5 EXPLOITING THE LINKAGES

Some opportunities to exploit the real and potential linkages between Smart Cities, Living Labs, and Future Internet are the following:

- Create field lab initiatives in cities and regions
- Create open innovation environments favourable for business participation
- Align funding opportunities at city, regions and EU level to establish open testbeds
- Develop concrete pilot ideas for open testbeds and open innovation ecosystems in sectoral domains such as energy, health, education and learning
- Resolve technical issues related to network architectures, interoperability

Topics to address include the creation of experimentation facilities for open innovation, the management of common resources and assets embodied in such facilities, and how to arrange access to common assets, IPR issues, and public-private partnership creation.

Smart cities and Future Internet linkages

Future Internet research community opens a new agenda for smart / intelligent cities. Today most platforms and applications for smart cities rely on broadband networks and a set of content / data elaboration technologies, such as programming languages, mainly Java and Python, OLAP, data bases and data mining, content management systems, and visualization technologies. Future Internet research extends this technological base with the Web evolution towards Web 3.0, future eBrowsers, Web as a Platform, HTML 5.0, Cloud Computing, Internet of things, RFIDs, Internet of Data and Services. Smart cities are testbed for these emerging technologies and experimentation with multiple devices and systems.

Within the recent Call 4 of the CIP ICT-PSP programme, on open innovation for smart cities, the Periphéria project (RFID for smart societal services) is related to the Future Internet.

Smart cities and Living Labs linkages

Within the framework of smart cities, Living Lab ecosystems provide the basis for innovation and economic development enabling the participation of the population in the design and development of new products and services. Innovation ecosystems based on Living Lab participatory processes combine both the strengths of collective intelligence of participants and the mediating role of ICTs in organising global value chains of suppliers and customers. Living labs and participatory open innovation ecosystems offer the economic base of smart cities.

Several cities, and also Eurocities, have developed visions and strategies towards Future Internet Open Innovation. Many cities are involved in broadband deployment and applications pilots (e.g. citizen participation, energy efficiency, content distribution etc). Also of relevance is ERRIN (www.errin.eu/en/) which is the European Regions for Research and Innovation Network of 70 regions in Brussels.

Priorities for Knowledge Society Forum, which is part of Eurocities and has 160 cities involved, are (see D. Carter, 2010):

- Next generation Broadband: fibre networks deployment, applications that could develop across next generation open networks (eHealth, eLearning, eContent, IPTV etc)
- eGOV 2.0, based on the use of social media
- Energy efficiency (towards low carbon economies, supporting behavioural changes in cities to reduce emissions and adaptive to climate change)
- E-Inclusion (tackling digital divides)
- mGOV, mobile applications.

One example of a Smart Cities vision is Manchester. They lead a group of cities within the Knowledge Society Forum (formerly Telecities) focusing on Urban policies on digital innovation and sustainable growth. One of the central elements of this work is to translate principles of physical planning (land use, built environment, physical infrastructures) into the digital world. There is a need for "Digital masterplans" and "digital design guides" to accelerate the development of digital infrastructures, applications and services towards "Connected Cities". The second element is to create a dynamic environment for open innovation and RTD, building on experience developed by the Living Labs community. The planned Connected Cities should provide the opportunities for new open innovation testbeds that allow mass deployment of new applications and services which should support e-inclusion and e-sustainability.

Broadband in city development

A recent paper of Eurocities (2010) discusses the role of broadband in city development policies. The paper argues that within our knowledge economy, a capable and future proof communication infrastructure is already crucial to a city's economic success and will be even more so in the coming decades. This paper makes the case for the role broadband can play in supporting cities to drive a European economy that is sustainable, inclusive and globally competitive.

It is believed that networks must be based on open access principles, be unbounded scalable & symmetric, be affordable, widely available and use fibre technology. The potential for broadband in cities has to be seen in the context of European policy and legislation, which provides the framework for cities to participate in network roll-out. A number of options exist under the current framework, however cities are still usually categorised as 'black areas', where the public sector should not invest in network roll-out. Nevertheless, there are a number of scenarios in which a case could be made for public intervention in network roll out at the city level, based on examples of current city activities. These include intervention in the case of market failure, providing broadband as a service of general interest, implementing wider public policy such as social inclusion, improving the competitiveness of a place and stimulating local innovation. A number of city examples are used to illustrate these scenarios.

Smart City projects in CIP ICT-PSP

The European Commission has strongly pursued the view that cities offer excellent infrastructure for Internet research and innovation. Broadband infrastructure is available, as well as active local research labs, efficient innovation ecosystems, and service infrastructures. Recent Calls on open innovation in smart cities in the CIP ICT-PSP program has resulted in several smart city pilots exploring the role of user driven open innovation (starting end of 2010):

- Smart Islands: smart transport, leisure, forest fire fighting, retailing.
- EPIC: Smart City vision. Service catalogue: relocation, urban planning, environment
- Life 2.0: new services for elderly.
- People: basic urban infrastructure.
- Open Cities: open innovation for public sector in cities.
- Periphéria: RFID for smart societal services.
- SmartIP: smart engagement, environment and mobility (Open Data, citizens as sensors, social (data) networking.

Of these projects, Periphéria seems the project mostly related to Future Internet issues as well (Internet of Things).

Also a number of other piloting projects in the CIP ICT-PSP are strongly related to smart cities issues, for example in areas such as health, e-government and energy. Examples are:

- Save Energy (ICT and energy efficiency)
- Apollon (Advanced pilots of Living Labs operating in cross-boundary networks)
- Best Energy (built environment sustainability and technology in energy)
- FREILOT (urban freight energy efficiency pilot)
- HosPilot (intelligent energy control in hospitals)
- In-Time (intelligent and efficient travel management for European cities)
- epSOS (smart open services; open health initiative for a European large-scale pilot of patient summary and electronic prescription).

4 FUTURE INTERNET INNOVATION: STATE OF THE ART AND DEVELOPMENTS

This chapter provides a preliminary description of the Future Internet (FI) Domain Landscape, including the Future Internet dimensions and research domains translating the main issues and players, as well as the potential and current relationships with the Living Labs (and Smart-Cities: later on) Domain Landscape. This chapter contributes to describing and analyzing the emerging holistic domain landscape comprising Future Internet, Living Lab and Smart Cities in the context of Open Innovation.

4.1 DEFINITION AND DESCRIPTION

A definition of Future Internet is available in Wikipedia (http://en.wikipedia.org/wiki/Future Internet):

"Future Internet is a summarizing term for worldwide research activities dedicated to the further development of the original Internet. While an increased public awareness of several critical shortcomings in terms of performance, reliability, scalability, security and many other categories including societal, economical and business aspects, has led to Future Internet research efforts. Given the diversity of technologies related to the Internet, extended by lower and higher layers and applications, the related research topics are wide spread. In addition, the approaches towards a Future Internet range from small, incremental evolutionary steps to complete redesigns (clean slate) and architecture principles, where the applied technologies shall not be limited by existing standards or paradigms such as client server networking, which, for example, might evolve into co-operative peer structures." The concept of Future Internet can be analysed by distinguishing 6 main aspects (Table 4-1).

Main Aspects	Technical issues	What it does	Questions addressed
Backbone	IPV6 High speed routers ..	Service Oriented Networking Monitoring Virtualisation	Mobility Security Naming and addressing New form of route planning
Network access to services	optical fibre dev improvement of high speed internet	home networking improvement of bandwidth use	Services continuity Economic models for open networks
Spontaneous network	Ad hoc mobile network Delay tolerant network Web of Wi-Fi P2P	Communication between vehicles , planes	
Internet of things	Active RFID technology replacing bar codes NFC techno	Chips able to detect themselves and communicate about objects	New architectures, new data bases, maintenance, data durability Huge flow of information, overload Energy consumption
Internet of contents	Congestion protocols,	Real time application for video games, TV, VoD, Triple-Play	Devices variety, access to various networks complexity of operations on content: Coding, storage, transportation …
Internet of usages and services	Cloud computing Sensors networks API interoperability VPN	New services and apps Contextual awareness Augmented reality Telepresence	Social network Virtual communities Trust Privacy Personal data storage

Table 4-1 Future Internet description

Internet of Things (IoT) is considered as a major disruptive innovation as it consists in interconnection between physical and virtual worlds with a huge amount of sensors and controllers largely distributed in vehicles, fixed devices, and close environments. One of the main questions is to find a way to link an object code with information about it, as this information will be distributed on different servers according to the stage of the production: distribution chain. There are major economic issues involved with respect to production and distribution cost reduction.

The movement towards the Future Internet is based on the belief that the current Internet has reached his limits. Tselentis (2010) states: "The current Internet has been founded on a basic architectural premise, that is: a simple network service can be used as a universal means to interconnect intelligent end systems. This simple premise has allowed the Internet to reach an impressive scale in terms of inter-connected devices. However, while the scale has not yet reached its limits, the growth of functionality and the growth of size have both slowed down. It is now a common belief that the current Internet would reach soon both its architectural capability limits and its capacity limits."

The current lack of domain landscape on Future Internet research domain appears to be an important issue for researchers. It would help to achieve a broader understanding of the Future Internet domain.

Dimensions of the Future Internet Domain

- Approaches for Internet Evolution towards Future Internet: from structured (Incremental evolution) to unstructured (Clean Slate or radical evolution from where emerge new generation networks)
- Research Types: from experimental research (testbed: functional test, users as observed subjects) to experiential and participative research (LLs: user co-creation)
- Evaluation Approach: from Reliability (Testbeds), towards Quality of Service (QoS) and Quality of Experience (QoE) for adoptability
- User Involvement: from individual users to very large or massive community of users
- Networking Types: from optic fibre to wireless communication networks
- Socio-Economic: from technological innovation to social/societal innovation.

Future Internet Research areas

Next Generation Network (NGN): a broad term to describe key architectural evolutions in telecommunication core and access networks that will be deployed over the next 5–10 years. The general idea behind NGN is that one network transports all information and services (voice, data, and all sorts of media such as video) by encapsulating these into packets, like it is on the Internet. NGNs are commonly built around the Internet Protocol, and therefore the term "all-IP" is also sometimes used to describe the transformation toward NGN.
http://en.wikipedia.org/wiki/Next_Generation_Networking

Autonomous Network (AN)

Autonomous System (Internet): a collection of connected Internet Protocol (IP) routing prefixes under the control of one or more network operators that presents a common, clearly defined routing policy to the Internet.
http://en.wikipedia.org/wiki/Autonomous_system_%28Internet%29

Autonomic Networking: follows the concept of Autonomic Computing, an initiative started by IBM in 2001. Its ultimate aim is to create self-managing networks to overcome the rapidly growing complexity of the Internet and other networks and to enable their further growth, far beyond the size of today. http://en.wikipedia.org/wiki/Autonomic_network

Cloud Computing (CC): Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand, like the electricity grid. http://en.wikipedia.org/wiki/Cloud_computing

Cognitive Network (CN): a new type of data network that makes use of cutting edge technology from several research areas (i.e. machine learning, knowledge representation, computer network, network management) to solve some problems current networks are faced with. Cognitive network is different from cognitive radio as it covers all the layers of the OSI model (not only layers 1 and 2 as with cognitive radio). http://en.wikipedia.org/wiki/Cognitive_networks

Cross-Layer Optimisation: an escape from the pure waterfall-like concept of the OSI communications model with virtually strict boundaries between layers. The cross layer approach transports feedback dynamically via the layer boundaries to enable the compensation for e.g. overload, latency or other mismatch of requirements and resources by any control input to another layer but that layer directly affected by the detected deficiency. Especially in information routing with concurrent demand for limited capacity of channels there may be a need for a concept of intervention to balance between e.g. the needs of intelligible speech transmission and of sufficiently dynamic control commands. Any fixed allocation of resources will lead to a mismatch under special conditions of operations. Any highly dynamic change of resource allocation might affect the intelligibility of voice or the steadiness of videos. However, as with other optimizing strategies, the algorithm consumes time as well. http://en.wikipedia.org/wiki/Cross-layer_optimization

Network Virtualization: the process of combining hardware and software network resources and network functionality into a single, software-based administrative entity, a virtual network. Network virtualization involves platform virtualization, often combined with resource virtualization. Network virtualization is categorized as either external, combining many networks, or parts of networks, into a virtual unit, or internal, providing network-like functionality to the software containers on a single system. Whether virtualization is internal or external depends on the implementation provided by vendors that support the technology. http://en.wikipedia.org/wiki/Network_virtualization

Virtual Private Network (VPN): a network that uses a public telecommunication infrastructure and their technology such as the Internet, to provide remote offices or individual users with secure access to their organization's network. It aims to avoid an expensive system of owned or leased lines that can be used by only one organization. The goal of a VPN is to provide the organization with the same secure capabilities but at a much lower cost. http://en.wikipedia.org/wiki/Virtual_private_network

Network Convergence: a broad term used to describe emerging technologies, and network architecture designs used to migrate voice and data networks into a single network. Specifically, Network Convergence describes the transition from separate circuit-switched voice network and packet-switched data networks, to a single packet-switched network supporting both voice and data protocols http://en.wikipedia.org/wiki/Network_convergence

Quality of Services (QoS):In the field of computer networking and other packet-switched telecommunication networks, the traffic engineering term quality of service (QoS) refers to resource reservation control mechanisms rather than the achieved service quality. Quality of service is the ability to provide different priority to different applications, users, or data flows, or to guarantee a certain level of performance to a data flow. For example, a required bit rate, delay, jitter, packet dropping probability and/or bit error rate may be guaranteed. http://en.wikipedia.org/wiki/Quality_of_Service

Quality of Experience (QoE): sometimes also known as "Quality of User Experience," is a subjective measure of a customer's experiences with a vendor. It looks at a vendor's or purveyor's offering from the standpoint of the customer or end user, and asks, "What mix of goods, services, and support, do you think will provide you with the perception that the total product is providing you with the experience you desired and/or expected?" It then asks, "Is this what the vendor/purveyor has actually provided?" If not, "What changes need to be made to enhance your total experience?" http://en.wikipedia.org/wiki/Quality_of_Experience

Internet of Things (IoT): In computing, the Internet of Things (also known as the Internet of Objects) refers to the networked interconnection of everyday objects. It is generally imagined as a self-configuring wireless network of sensors whose purpose would be to interconnect all things. The concept is attributed to the original Auto-ID Centre, founded in 1999 and based at the time in MIT. It includes concepts such as RFID and NFC. http://en.wikipedia.org/wiki/Internet_of_Things

Internet of Services (IoS) or **Semantic Web Services**: like conventional web services, are the server end of a client–server system for machine-to-machine interaction via the World Wide Web. Semantic services are a component of the semantic web because they use mark-up which makes data machine-readable in a detailed and sophisticated way (as compared with human-readable HTML which is usually not easily "understood" by computer programs).
http://en.wikipedia.org/wiki/Semantic_Web_Services

Wireless Internet (Spontaneous Network?): the suite of wireless protocols after Wireless Application Protocol 2.0 (WAP). It includes XHTML Basic, Nokia's XHTML Mobile Profile, and future developments of WAP by the Open Mobile Alliance. Wireless Internet Protocols are able to deliver XHTML pages to appropriate wireless devices without the need for HTTP to WAP proxies. Using Wireless Internet Protocols, web pages can be rendered differently in web browsers and on handhelds without the need for two different versions of the same page.
http://en.wikipedia.org/wiki/Wireless_Internet

IP Multimedia Subsystem (IMS): an architectural framework for delivering Internet Protocol (IP) multimedia services. It was originally designed by the wireless standards body 3rd Generation Partnership Project (3GPP), as a part of the vision for evolving mobile networks beyond GSM. Its original formulation (3GPP R5) represented an approach to delivering "Internet services" over GPRS. This vision was later updated by 3GPP, 3GPP2 and TISPAN by requiring support of networks other than GPRS, such as Wireless LAN, CDMA2000 and fixed line.
http://en.wikipedia.org/wiki/IP_Multimedia_Subsystem

Networked Media: rely on the technological process known as Convergence, thanks to which all kinds of media including text, image, 3D graphics, audio and video produced can be distributed, shared, managed and consumed through various networks, like the Internet, be it via Fiber, WiFi, WiMAX, GPRS, 3G and so on, in a convergent manner. Networked Media also encapsulates the concept of a decentralized medium of mass communication, in which the audience can actively contribute to the production of the media. As the Internet has revolutionised the access to multimedia content and enabled collaborative user-generated content (UGC), requirements in this field have huge impact for the Future Internet.

At the same time advances in audiovisual technologies such as Digital Cinema and 3D processing increase the level of immersion and the quality of the experience (QoE), but also give rise to innovative applications, notably in gaming technologies and in virtual worlds. In essence, Networked Media are decentralized media of mass communication, whose value chain features a network capacity, which can allow co-operative and collaborative practices enabling users to contribute to the production of the new media.

3D Media Internet: a basis of tomorrows networked and collaborative platforms in the residential and professional domains.

Semantic Service oriented Architecture (SSoA): a computer architecture that allows for scalable and controlled Enterprise Application Integration solutions.[1] SSOA describes a sophisticated approach to enterprise-scale IT infrastructure. It leverages rich, machine-interpretable descriptions of data, services, and processes to enable software agents to autonomously interact to perform critical mission functions. SSOA is technically founded on three notions: The principles of Service-oriented architecture (SOA); Standards Based Design (SBD); and Semantics-based computing. SSOA combines and implements these computer science concepts into a robust, extensible architecture capable of enabling complex, powerful functions. See: http://en.wikipedia.org/wiki/Semantic_service_oriented_architecture

Wireless Sensor Network (WSN): consists of spatially distributed autonomous sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants. Wireless sensor networks are used in many industrial and civilian application areas, including industrial process monitoring and control, machine health monitoring, environment and habitat monitoring, healthcare applications, home automation, and traffic control. See: http://en.wikipedia.org/wiki/Wireless_sensor_network

Fig. 4-1 presents the domain landscape of Future Internet innovation based on several dimensions.

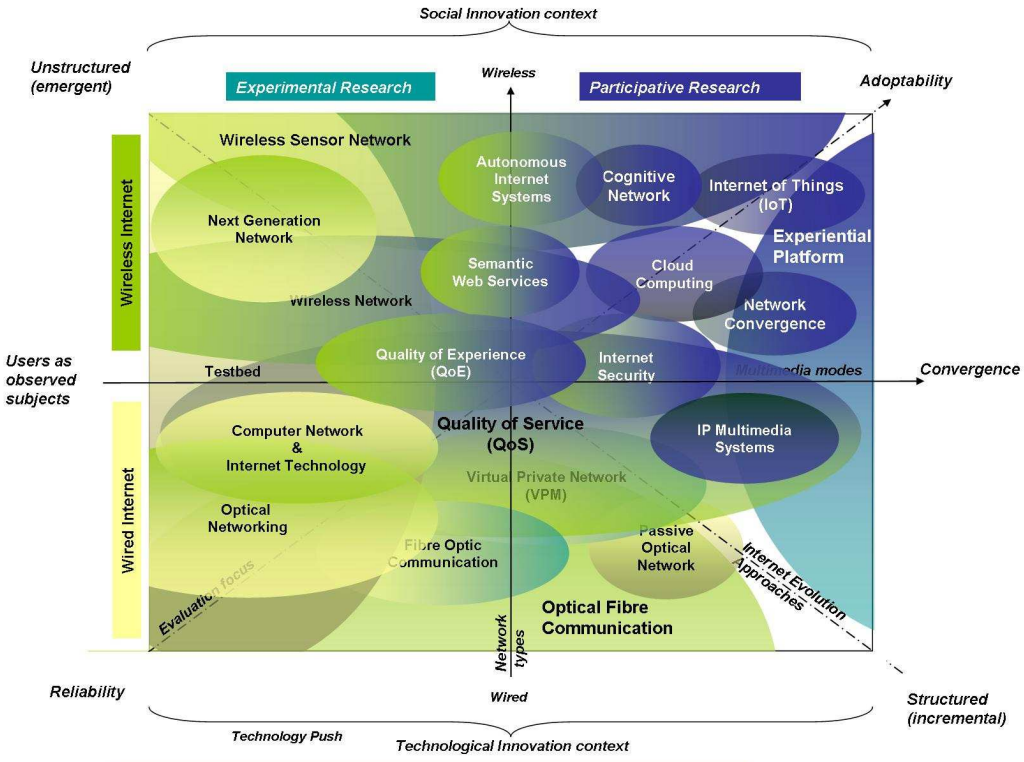


Fig. 4-1: Future Internet Domain Landscape (Pallot, Trousse & Senach, 2010)

4.2 STATE OF PLAY

We refer to available documents at www.future-internet.eu and to the FIA 2009 and FIA 2010 books. From the point of view of this report it is important to mention the current portfolio of FIRE projects, including projects related to FIRE facilities and projects related to experimentally driven research.

The Future Internet represents the evolving need for infrastructures at several levels: innovation infrastructure (networks of collaboration, experimental facilities, research and test centres etc), broadband Internet infrastructure (networks, services). Future Internet is the "provider" of future Internet infrastructure and applications. Naturally, Future Internet will be the key driver of technological supports for services and products to be tested in living labs (user driven open innovation) approaches.

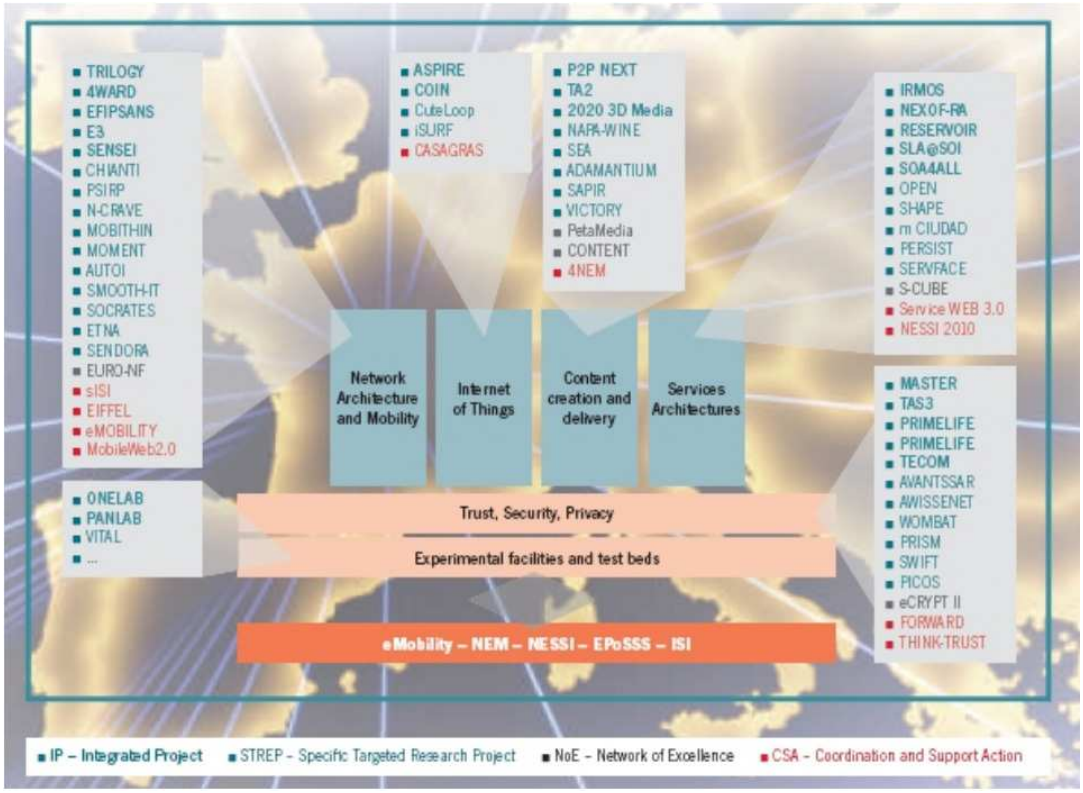


Fig. 4-2: EC-funded projects in the Future Internet area

The Future Internet community, at the European level, includes different distinct groups of organisations to be federated: (1) Institutions concerned with Future Internet (2) Projects, (3) Research labs, centres and experts performing research on the subject.

A federating approach needs to be developed around the following themes:

- The "Network of the Future" with a focus on solutions to cope with the issues of capacity, mobility, scalability and flexibility of the ICT infrastructure;
- The "Internet of Services" with a focus on issues such as virtualisation, dynamically composed service overlay over a modified network structure and service joint execution environments;
- The "Internet of Things" with a focus on networked object management and associated service and data discovery architectures, with integration in generic business environments.

- The "Security of ICT infrastructures and services" with a focus on secure, resilient and trusted networks and service architectures and composite end-to-end services, as well as identity management and business and personal data protection and privacy;
- The "3D Media Internet" with a focus on the architectural and related technological implications of 3D virtual environments over networked platforms.
- The "Experimental Facilities" with a focus on experimentally-driven research projects, which cut across several layers from connectivity via service architectures to applications, thereby addressing the Future Internet from a broad system perspective.

Future Internet Assembly

The Future Internet Assembly published its second book which tries to capture the emerging trends in Future Internet research, as they are presented through European funded research activities. The book contains 25 selected papers presenting a variety of European research results aimed at further developing the current Internet. It offers, above all, a vision of the future rather than an account of deployed solutions. It presents representative research results in seven interrelated area of research for Future Internet (Fig. 4-3): 1. Socio-economics; 2. Trust and Identity; 3. Experimental Research; 4. Management and Service-aware networking Architectures; 5. Service Offers; 6. Content Networks; 7. Real Word Internet.

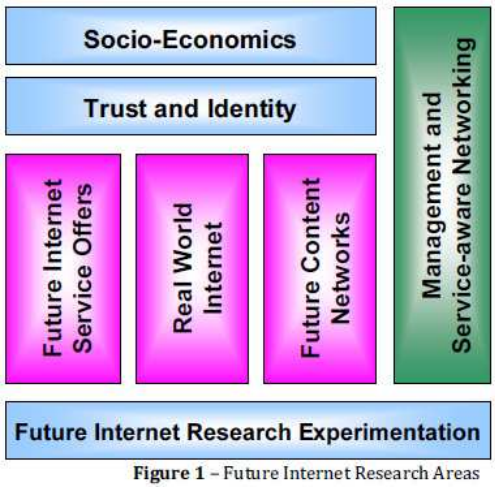


Fig. 4-3: Future Internet Research areas (FIA)

Eiffel Thinktank

Eiffel is a support action Support action of FP7 http://www.fp7-eiffel.eu/. The think-tank has identified as immediate problems:

- Resilience, failure tracking & management
- Availability & robustness to attack
- Information security scalability
- Resource accountability:
- Network-application coordination:
- Scaling for more extreme dynamics:

Among the big new ideas proposed are interconnecting the information & physical worlds; Natural social interaction; Governance models; Cater to new communication paradigms.

EIT ICT Labs

EIT ICT Labs (www.eitictlabs.eu, Fig. 4-4) will develop and deliver:

- Excellence and entrepreneurship in education
- Future Internet infrastructures
- Novel ICT services – for individual, business and society
- User-involved solutions for research and development
- European open innovation ecosystem for ICT and its applications

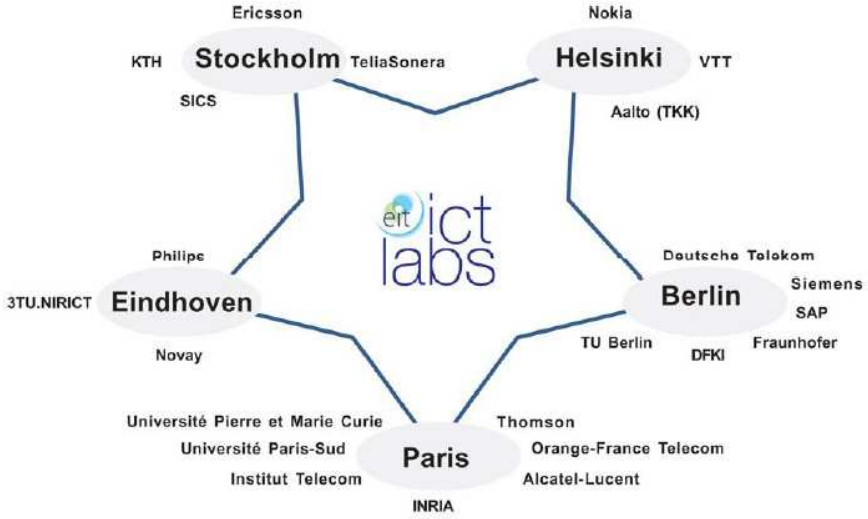


Fig. 4-4: EIT ICT Labs partner network

EIT ICT Labs aims to be a unique European arena for turning ideas into economic, social, and cultural benefits throughout the entire innovation web. The vision and mission of EIT ICT Labs is to turn Europe into the global leader in ICT innovation. EIT ICT Labs aims at the radical transformation of Europe towards a knowledge-based society turning ICT innovation into quality of life. EIT ICT Labs builds European trust based on mobility of people across countries, disciplines and organisations generate future world-class business building joint European innovation clusters.

- Improve quality of life through service based applications for citizens of Europe and beyond.
- Transform higher education to promote creativity and entrepreneurial spirit.
- Provide international top talent (experimental) ICT Labs for researchers, innovators and entrepreneurs.
- Establish five world class innovation centres in Berlin, Eindhoven, Helsinki, Paris and Stockholm.

Thematic areas:

- SmartSpaces - including service-centred home
- Smart Energy Systems - smart energy management, Green ICT
- Health & well-being - including ambient assisted living, digital medicine
- Intelligent Transportation Systems - novel forms of safer & sustainable traffic and transportation systems
- Future Media and Content Delivery - entertainment, education, accessing media
- Digital Cities - towards intelligent and sustainable digital cities

NSF GENI (Global Environment for Network Innovation)

Evolving technological and social networks, intertwined and worldwide in scope, are rapidly transforming societies and economies. The Global Environment for Network Innovations (GENI), a project sponsored by the National Science Foundation, is open and broadly inclusive, providing collaborative and exploratory environments for academia, industry and the public to catalyze groundbreaking discoveries and innovation in these emerging global networks. GENI is a virtual laboratory at the frontiers of network science and engineering for exploring future internets at scale. GENI creates major opportunities to understand, innovate and transform global networks and their interactions with society. http://www.geni.net/

GENI supports at-scale experimentation on shared, heterogeneous, highly instrumented infrastructure. It also enables deep programmability throughout the network, promoting innovations in network science, security, technologies, services and applications. Finally, it provides collaborative and exploratory environments for academia, industry and the public to catalyze groundbreaking discoveries and innovation.

The GENI community comprises different communities, such as:

- **PlanetLab**: a global research network that supports the development of new network services. Since the beginning of 2003, more than 1,000 researchers at top academic institutions and industrial research labs have used PlanetLab to develop new technologies for distributed storage, network mapping, peer-to-peer systems, distributed hash tables, and query processing. PlanetLab currently consists of 1120 nodes at 510 sites. PlanetLab is an open platform for developing, deploying, and accessing planetary-scale services. See: http://www.planet-lab.org/
- **Internet2**: the foremost U.S. advanced networking consortium. Led by the research and education community since 1996, Internet2 promotes the missions of its members by providing both leading-edge network capabilities and unique partnership opportunities that together facilitate the development, deployment and use of revolutionary Internet technologies. Internet2 brings the U.S. research and academic community together with technology leaders from industry, government and the international community to undertake collaborative efforts that have a fundamental impact on tomorrow's Internet. See: http://www.internet2.edu/.
- **National Lambda Rail**: a major initiative of U.S. research universities and private sector technology companies to provide a national scale infrastructure for research and experimentation in networking technologies and applications. See: http://www.nlr.net

Users Involvement in GENI

An important feature of GENI is to permit experiments to have access to end-user traffic and behaviours. For examples, end-users may access an experimental service, use experimental access technologies, or allow experimental code to run on their computer or handset. GENI will provide tools to allow users to learn about an experiment's risks and to make an explicit choice ("opt-in") to participate.

The GENI Gush team is designing and implementing a powerful and intuitive experiment control and management tool for GENI. Gush, which stands for the "GENI User Shell", permits users to add resources to a GENI slice; load software on to these resources; and start, stop and monitor experiments. Gush provides three user interfaces: a graphical user interface, command line interface, and a programmatic interface. It is being integrated with several of GENI's prototype control frameworks.

The objective of the Million-Node GENI project at the University of Washington is to enable millions of owners of end-user systems such as personal computers and mobile computing devices to make their systems available to GENI researchers for experimentation.

The 8th GENI Engineering Conference (GEC8) showcased a remarkable 34 demonstrations of the emerging GENI meso-scale prototype which now spans over a dozen US campuses. Nationwide, multi-campus integration is coming together extremely quickly, a testament to the very rapid and professional work of the campus IT staffs. A key feature demonstrated was the GENI Aggregate Manager API v1.0 providing direct, GENI-wide interoperability between PlanetLab, ProtoGENI, and OpenFlow. Other control frameworks become interoperable soon.

Over 260 participants from academia, industry, and government met from July 20th – 22nd in La Jolla, CA, hosted by Calit2, for the tri-annual meeting GENI Project Director Chip Elliott refers to as the "gathering of the GENI tribes." Plenary talks highlighted GENI's international collaborators from renowned research teams in Japan, Korea, and Germany, together with US researchers from Florida International University and the Starlight advanced optical network who provide strong international research linkages to a range of nations.

FIRE projects related to Experimental facilities

Experimental facilities in FIRE aim to test and validate new paradigms related to future Internet at large-scale and real-life conditions. FIRE promotes the set-up of large-scale experimental facilities, beyond individual project testbeds. These experimental facilities support research under real-life conditions, to explore interoperability, scalability and other issues. For this purpose, FIRE projects on experimental facilities develop interconnected testbeds. Projects so far include: ONELAB2, PII, VITAL++, WISEBED (first wave), and BONFIRE, CREW, OFELIA, SmartSantander, TEFIS (second wave). See Table 4-2.

In many ways the **Panlab project paved the way.** Pan-European Laboratory for Next Generation Technologies, networks and services. This is an FP6 support action project (2006 – 2008) to identify requirements of ICT industry for end-to-end testing and address these requirements by providing federated on-demand testing facilities via a Pan-European laboratory organization. The concept is based on federation of distributed interconnected test laboratories and testbeds for interoperability testing. Stakeholders: ICT industry, researchers. Short descriptions of 1st and 2nd wave projects in experimental facilities are as follows:

- **Federica:** Federated E-infrastructure dedicated to Researchers Innovating in Computer Architectures; 2008-2010; created scalable Europe-wide clean slate infrastructure to support experiments on Future Internet.
- **PII:** continues the PanLab project addressing the need for large-scale testing facilities.
- **OneLab2:** uses the PlanetLab Europe testbed (network of open computers distributed around the world) for testing of technologies such as content distribution, routing overlays, peer-to-peer social networks and geolocation services.
- **Vital++**: Pan-European testbed comprised of existing geographically distributed test sites integrated by IMS technology. This can be sued to test distribution of content to a customer base using P2P, and adapt existing telecommunications infrastructure to accelerate P2P operations.
- **WISEBED**: virtual network of sensor networks located at different locations throughout Europe.
- **BONFIRE:** building a multi-cloud facility to support applications, services and systems research targeting the Internet of Services community.

- **SmartSantander:** Future Internet research project in FP7-ICT, focused on Internet services in the city. Experimenting environment based on 20.000 sensors based on real-life IoT deployment in urban setting.
- **TEFIS:** offers single point of access to customized services allowing exploitation of different testing and experimental facilities for communities of software and business developers.
- **CREW:** established open federated testbed to facilitate research on advanced spectrum sensing, cognitive radio and cognitive networking strategies.
- **OFELIA:** this project creates an experimental facility allowing researchers to experiment on a test network but also to control the network through secure and standardized interfaces.

	FIRE facilities	**Experimentally driven research**
1st wave	ONELAB2 PII (federating testbeds) VITAL++ WISEBED (infrastructure of interconnected testbeds for large-scale wireless sensor networks)	ECODE N4C NANODATACENTERS OPNEX PERIMETER RESUMENET SMART-NET SELF-NET
2nd wave	BONFIRE (multi-site cloud facility for Internet of Services) CREW (open federated test platform) OFELIA SMART SANTANDER TEFIS	CONECT CONVERGE EULER HOBNET LAWA NOVI SCAMPI SPITFIRE

Table 4-2: FIRE projects overview

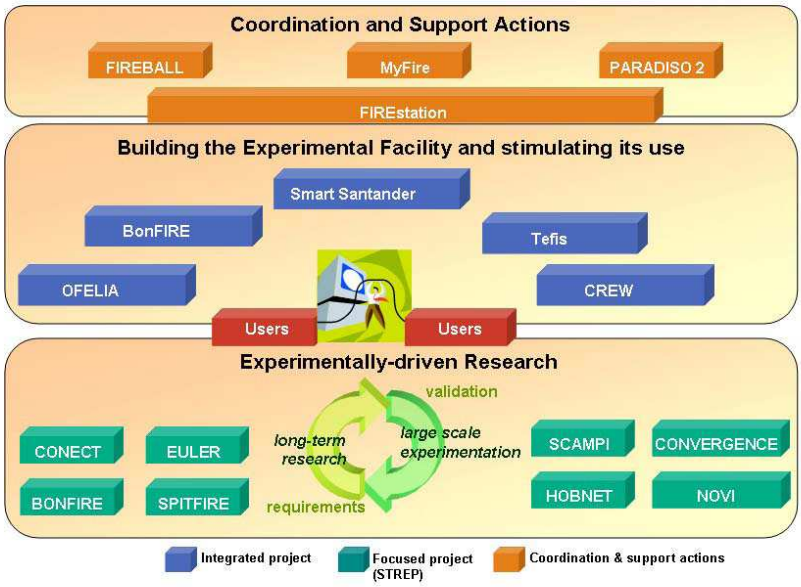


Fig. 4-5: Current FIRE projects in FP7

The role of users in FIRE

The role of users is different in FIRE facilities projects compared to living labs (Table 4-3).

- FIRE facilities projects involve users to assess the impacts of technological changes to the Internet in socio-economic terms. Living labs engage the users in the innovation process itself.
- FIRE facilities use the approach of controlled experimentation; Living labs engage the users within the actual innovation process.

	FIRE	Living Labs
Approach	Controlled experiments Observing large-scale use Federated testbeds	User co-creation by living labs methodologies Open innovation
Testing of what	Technologies, services, architectures, platforms, system requirements; impacts	User ideas, applications and solutions
Scale of testing	Large-scale mainly	From small to large scale
Stakeholders	Researchers, ICT industry	End-users, enterprises, SMEs
Objective	Facilities to support research Assess impacts of tested solutions	Support process of user driven innovation

Table 4-3: User role in FIRE and Living Labs

The Commission has clearly expressed its support for stronger user orientation in the Future Internet facilities projects. Not only users in terms of academic and industry researchers who will use these facilities for their research projects, but also end-users. Emphasis is on involving communities of end-users at early stage of development to assess impacts of technological changes.

The FIREWORKS project (now continuing in FIRESTATION) has carried out a portfolio analysis of FIRE projects. In relation to the functioning of the testbed facilities and user involvement conclusions are as follows:

- Integrated Projects have different notions of users, of use cases (related to federation) and of the range of collaborations that can be expected to augment the value of the technologies they bring to FIRE.
- FIRE differs to GENI in that FIRE emphasizes the value as seen by an end-user with its applications and services while GENI focuses more on basic infrastructure technologies.
- FIREWORKS has defined a set of issues that must be dealt with by a testbed or federation of testbeds to support real external users, e.g. user facing clearinghouse, terms and conditions, security and privacy, define, simulate and control experiments etc. These issues seem so far not to be covered systematically in the FIRE projects.
- Methods for end user involvement and end user experiments are not exploited that much. In PII this is discussed and taken up in some STREPs of Call 5.
- Cost and effort to maintain a user community is very high. Including external users is still low-level. Exception seems to be PlanetLab Europe (OneLab2). Still, end-users seem to be experts researchers only (it is mentioned astronomy as an example of users involvement). . Generally spoken: user support is a new and untested concept.
- The report recommends that the FIRESTATION project takes the lead in identifying appropriate levels of user support and ensuring that best practices are shared. Vision of end-to-end support for FIRE users needs to be integrated into upcoming Calls 7 and 8.

4.3 LINKAGES WITH OTHER COMMUNITIES

Altogether, Future Internet, Living Labs and Smart Cities form an ecosystem comprising ICT companies, research scientists and City policy makers. In this ecosystem, while Future Internet represents the technology push, Smart Cities represent the application pull and Living Labs form the exploratory and participative playground in between Future Internet and Smart Cities. In contrast with testbed[1], Living lab[2] constitutes a 4P (Pubic-Private-People-Partnership) ecosystem that provide opportunities to users/citizens to co-create innovative scenarios based on technology platforms such as FI technology environments involving large and SMEs as well as research scientists from different disciplines.

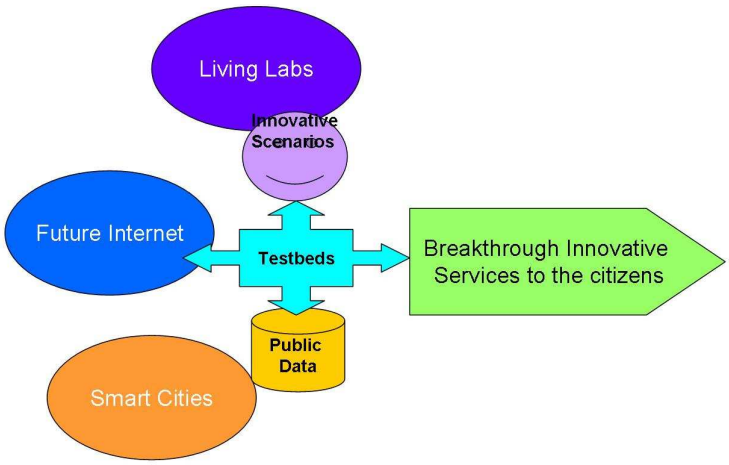


Figure 4-6: FI, LL and Smart Cities Ecosystem (Pallot, Trousse, & Senach, 2010)

4.4 EXPLOITING THE LINKAGES

There are already initial examples of projects showing the triangulation between Future Internet, Living Labs and Smart Cities such as APOLLON project with its pilot on eParticipation that involves Issy-les-Moulineaux, Manchester and Brussels. Eventually, a Future Internet testbed could be used as a technology platform enabling the co-creation of innovative scenarios by users/citizens contributing with their own content or building new applications that would mash-up with city public data.

[1] http://en.wikipedia.org/wiki/Testbed a platform for experimentation of large development projects. Testbeds allow for rigorous, transparent, and replicable testing of scientific theories, computational tools, and new technologies.

[2] http://en.wikipedia.org/wiki/Living_lab is a user-centred, open-innovation ecosystem, often operating in a territorial context (e.g. city, agglomeration, region), integrating concurrent research and innovation processes within a public-private-people partnership.

5 LIVING LABS FOR OPEN INNOVATION: STATE OF THE ART AND DEVELOPMENTS

5.1 DEFINITION AND DESCRIPTION

The Living labs phenomenon, which is relatively new in Europe, originated from the work of William Mitchell at MIT. He argued that a living lab represents a user-centric research methodology for sensing, prototyping, validating and refining complex solutions in multiple and evolving real-life contexts. Integrating users in the development context would ensure a more reliable market evaluation, as well as reduce technological and business risks. The idea was also that SMEs would benefit from living labs because they would be able to share resources without commercial risk financing. Larger companies would benefit from a wider base of ideas.

In Europe, several researchers explored different aspects and contexts of living labs innovation. To mention a few: Ballon et al. (2005), Eriksson *et al*., 2006; Bergvall-Kåreborn & Ståhlbröst, 2009; Svensson & Ihlström Eriksson, 2009a; Schaffers et al. 2010; Santoro & Conte 2009, Pallot et al. 2010. Electronic journal www.ejov.org publishes about living labs innovation.

Similar as with the open innovation paradigm (Chesbrough 2003, 2006), Living Labs draws on the notion of external ideas as a resource in innovation. Living labs can be considered as a specific form of open innovation. Such an approach primarily aims at supporting innovation processes that lead to usable products and services.

Ballon et al. (2005) have developed a useful categorization of six platforms for testing and experimentation, classified in two dimensions: focus (testing or design) and maturity of technology (Fig. 5-1). The six types of platforms include prototyping, field trial, testbeds, societal pilots, market pilots and living labs. This overview is useful as it not only positions living labs innovation, but also shows the potential interrelations between Future Internet testbeds, living labs, and social and market pilots to be found in city environments.

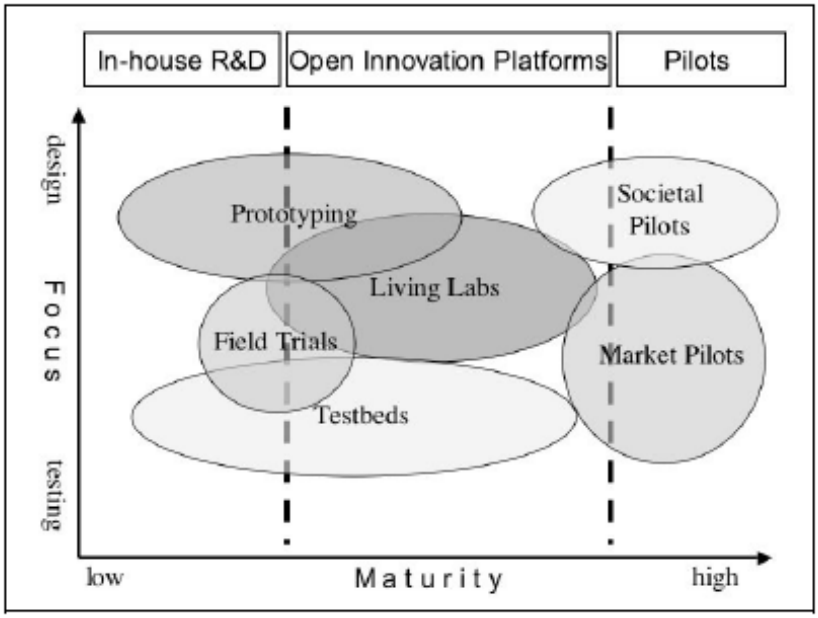


Fig. 5-1: Testing and Experimentation Platforms classification, Ballon et al. 2005

Focusing on living labs user engagement methodologies, a differentiated domain description was proposed by Pallot et al. (2010). See Fig. 5-2.

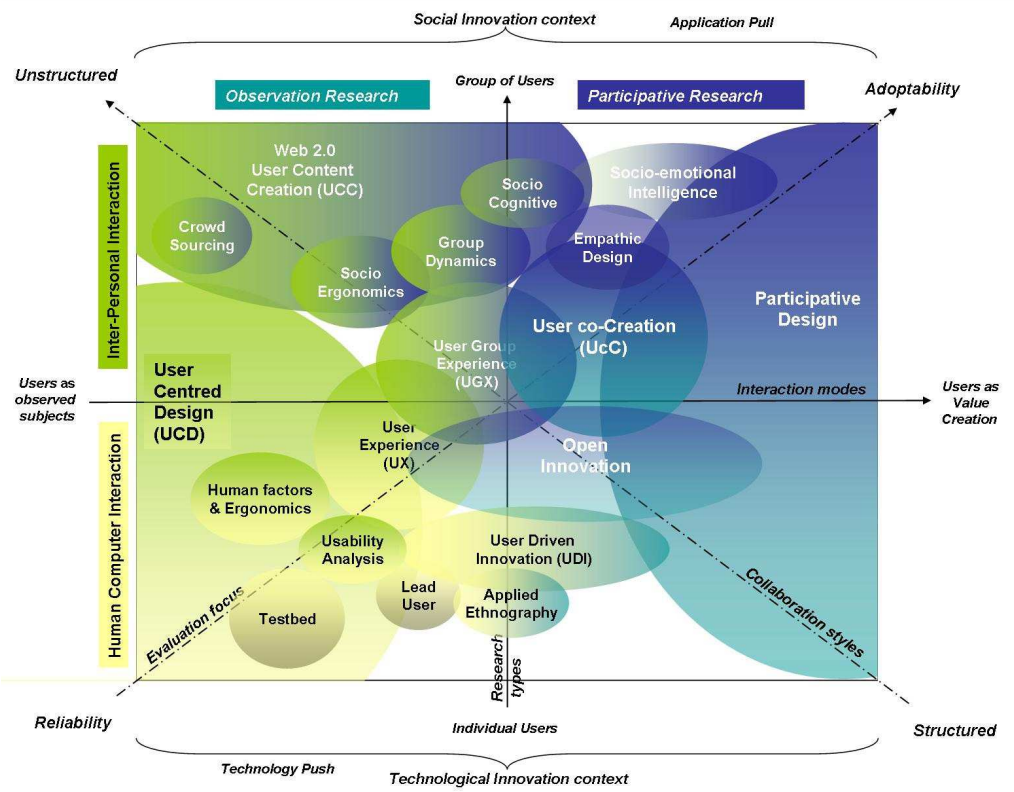


Fig. 5-2 Living labs domain landscape (Pallot et al. 2010)

Whereas this approach focuses primarily on user engagement, an approach to living labs innovation based on organizational, architectural and application development frameworks within an action research setting was developed and implemented in several pilots in the C@R project (Schaffers, Guzman, Merz, Navarro (Eds.) 2010). They distinguish between strategic and operational level methodologies. Strategic level methodologies are to initiate and establish an innovation environment including the business model, and approach to phasing living labs development. The key point here is living labs as innovation projects organisation (Fig. 5-3). Operational level methodologies aim to run living lab innovation projects and organize experimentation and evaluation cycles. Among the methodologies at that level, also showing a linkage to existing methods of software engineering and architecture development, were: cyclic development, action research (as problem oriented and collaborative approach), multi-disciplinary development groups, agile development, and methods for user community engagement.

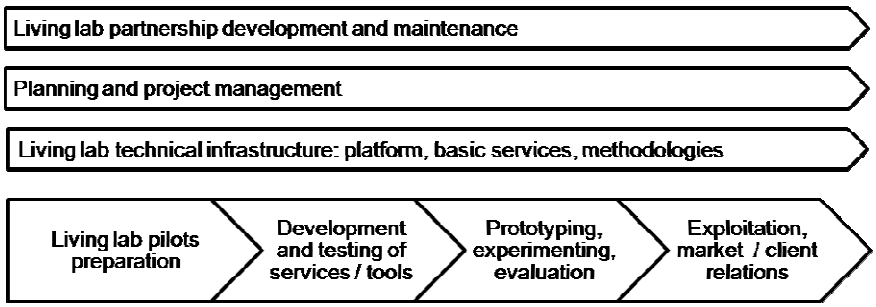


Fig. 5-3 Living lab as innovation projects organisation (Schaffers et al. 2010)

In a Living Lab approach e.g. researchers, firms, users, public partners and stakeholders of emerging technology collaborate in innovation processes in real-world settings. The phenomenon of Living Labs can be seen as a methodology, an organization, a system, an arena, environment and/or a systemic innovation approach. Based on our experience in the area we argue that a Living Lab is both an environment and a methodology or approach.

Fig. 5-4 illustrates the key components of Living Labs. The *ICT & Infrastructure* component outlines the role that new and existing ICT technology can play to facilitate new ways of cooperating and co-creating new innovations among stakeholders. *Management* represents the ownership, organization, and policy aspects of a Living Lab, a Living Lab can be managed by e.g. consultants, companies or researchers.

The Living Lab *Partners & Users* bring their own specific wealth of knowledge and expertise to the collective, helping to achieve boundary spanning knowledge transfer. *Research* symbolizes the collective learning and reflection that take place in the Living Lab, and should result in contributions to both theory and practice. Technological research partners can also provide direct access to research which can benefit the outcome of a technological innovation. Finally, *Approach* stand for methods and techniques that emerge as best practice within the Living Labs environment.

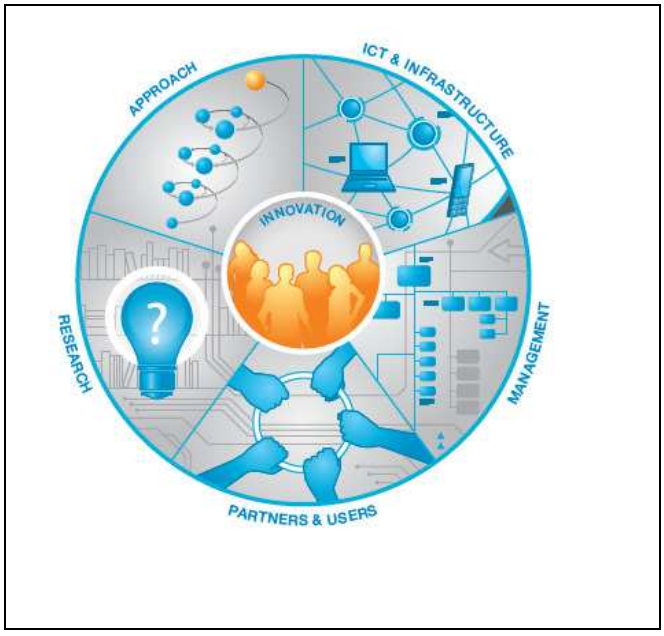


Fig. 5-4: Living Lab key components

Bergvall-Kåreborn *et al.* 2009 propose five key principles for Living Labs: Openness, Influence, Realism, Value and Sustainability.

Openness is crucial for the innovation process in a Living Lab, where it is essential to gather a multitude of perspectives that might lead to faster and more successful development, new ideas and unexpected business openings in markets. However, to be able to co-operate and share in a multi-stakeholder milieu, different levels of openness between the stakeholders seems to be a requirement. To stimulate creativity and create new ideas that can be turned into applications and bring value through use, Eriksson *et al*. (2005) suggest open collaboration between people of different backgrounds, with different perspectives that have different knowledge and experiences. More people, including consumers, need to be involved in the innovation process.

A key aspect of the **influence** principle is to view "users" as active and competent partners and domain experts. As such their involvement and influence in innovation and development processes shaping society is essential. Equally important is to base these innovations on the needs and desires of potential users, and to realize that these users often represent a heterogeneous group. This means utilizing the creative power of Living Lab partners, whilst facilitating their right to influence these innovations. By stressing the decision making power of potential users and domain experts the principle differs from related concepts such as participation, involvement, and engagement which instead focus on the activities carried out by users and users' psychological state (Barki & Hartwick, 1989; Baroudi *et al*., 1986).

In order to reduce the diversity and ambiguity related to the principle of influence, and to increase its positive impact in practical studies, it is prudent to define and explain the concept as clearly as possible.

One of the cornerstones for the Living Lab approach is that innovation activities should be carried out in a **realistic**, natural, real life setting. Orchestrating realistic use situation and user behaviour is seen as one way to generate results that are valid for real markets in Living Lab operations (CoreLabs 2007). However, the aim to create and facilitate realism is an endeavour that needs to be grappled with on different levels and in correlation to different elements such as contexts, users, use situations, technologies, and partners. The principle does not separate between the physical and the online world. Instead we argue that activities carried out in both worlds are as real and realistic to its actors.

Living Lab has the opportunity to create **value** based on all aspects of the value term: economical value, business value and consumer/user value and has to be viewed from different stakeholder perspectives.

Stakeholders	Source of value
Government	• Participative activities via citizen involvement • Regional and national development • Increased return of investments on innovation research
Companies	• Faster development cycles • More innovative ideas, both amount and heights • Developing right products • Reduced level of risk (higher level of adoptability) • Easier implementation • Access to a broader market • Better uptake of innovations • "Neutral" playing arena • New collaborations
Users	• Being able to influence technology development, hence getting what they need and want • Reduced level of risk (higher level of adoptability) • Getting access to test the latest technology before others • Opportunity to be involved in development of the society
Researchers	• Collaboration with users and companies • Real life comparative cases of new ways to perform, for example • Explore user involvement activities • Experiential development processes • Facilitate cross border networking • Experiment and evaluate technology artefacts • Facilitate technology transfer activities

Table 5-1: Sources of value in a living lab

Sustainability refers both to the viability of a Living Lab and to its responsibility to the wider community in which it operates. Focusing on the viability of the Living Lab highlights aspects such as continuous learning and development over time. Here, the research component of each Lab plays a vital role in transforming the everyday knowledge generation into models, methods and theories. Other important aspects related to the sustainability of a Living Lab is the partnership and its related networks since good cross-border collaboration, which strengthens creativity and innovation, builds on trust, and this takes time to build up. In order to succeed with new innovations, it is important to inspire usage, meet personal desires, and fit and contribute to societal and social needs.

However, in line with the general sustainability and environmental trends in society it is of equal importance that Living Labs also take responsibility of its environmental, social, and economic effects.

From the components and principles described above this is the Living Lab definition (Bergvall-Kåreborn *et al.* 2009): A Living Lab is a user-centric innovation environment built on every-day practice and research, with an approach that facilitates user influence in open and distributed innovation processes engaging all relevant partners in real-life contexts, aiming to create sustainable values.

5.2 STATE OF PLAY

European Network of Living Labs

In order to join forces, coordinate activities and share learning experiences, a European Network of Living Labs (ENOLL) has developed. This community of Living Labs is a loosely connected group that is organizing itself into a more structured network with the increasing size and influence of the ENoLL. At present the network has been through 4 expansion phases and currently has 212 members. Most of these members are in Europe, but 25 Living Labs are on other continents. Together the partners join forces as a network, to develop and offer a gradually growing set of networked services to support the "Innovation Lifecycle" for all actors in the system: end-users, SME´s, corporations, public sector and academia. It all starts by involving people in the streets and the users and user communities as contributors and co-creators of new innovations, of which the Future Internet is an important enabler and offers many possibilities as a platform for Living Lab and User Centric Innovation.

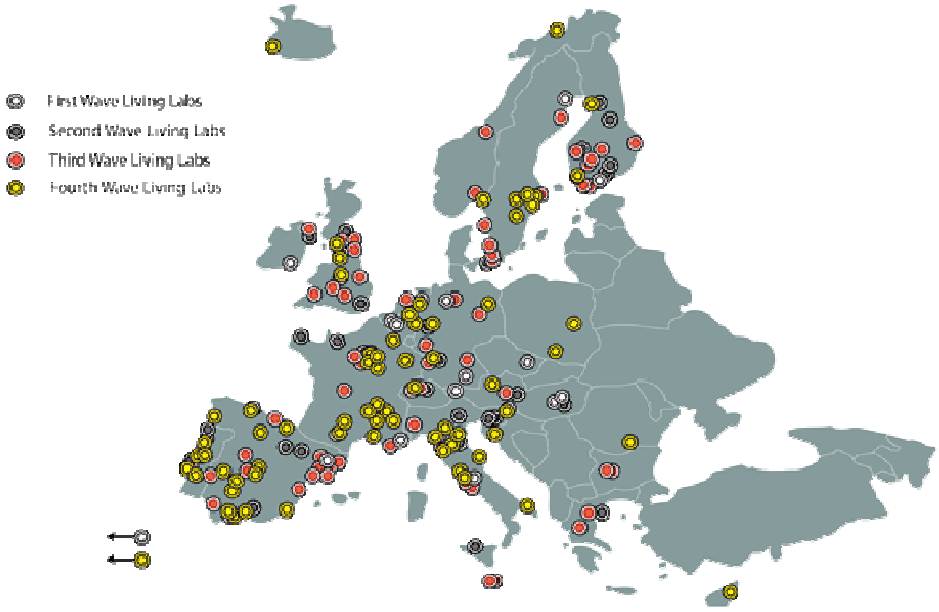


Fig. 5-5: Members of the ENoLL April 2010

Example: Botnia Living Lab

Botnia Living Lab, hosted by Centre for Distance-spanning Technology at Luleå University of Technology in Sweden, is a RDI cooperation to support human-centric innovation of advanced ICT Services for "Extending Human Capabilities". The basic idea is to engage end-users, individuals and stakeholder organisations, along a targeted value chain, in the total process from need-finding and idea-generation, through concept-development and prototype/usability testing to service piloting. The Botnia partnership includes some of the strongest international ICT/Telco organisations, numerous SMEs as well as national and regional public authorities and 7000 creative end-users from entire Sweden. Read more at: www.cdt.ltu.se and www.testplats.com (in Swedish)

Some examples of projects in Botnia Living Lab related to smart cities are:

- Smart traffic: The **iRoad** project is creating Intelligent Transport Systems (ITS) solutions for a fully integrated intelligent road to be tested in real-life settings under different climatic conditions. This intelligent road solution consists of sensors, processing capabilities and communication devices as complement to intelligent infrastructures and intelligent vehicles. The solution builds upon integrated intelligent road marking units that can gather information on road conditions and road properties. Additionally, the motion and position of vehicles travelling on the road is also of large interest, when it comes to the design of traffic management system and safety/support systems for road users.
- Smart people: The purpose with the **SATIN project** is to make it easier for end users to develop mobile services. In SATIN, a tool for visual programming is developed which greatly simplifies the process of developing services. Service components are picked and composed using "drag-and-drop" technique. Additionally, digital market places are studied, where services may be displayed and purchased. The SATIN project also looks into business models regarding mobile services and open-innovation methodologies.
- Smart energy: The **SAVE Energy** project is focused on how to reduce the energy consumption in public buildings via changes in user behaviour. The House of culture in Luleå is one of totally 5 pilots around Europe. The **Saber project** focuses on reducing energy consumption in house-holds. The complete solution, from the router collecting the sensor data to a personal visualisation on a mobile or web page, is developed in the project together with the users. The system is currently under test at 100 private homes. In **SITE** the aim is to develop energy consumption visualization services based on user needs and motivations in a school environment. Young pupils are engaged as co-creators of the solutions.
- Smart future Internet technologies: The **C4 program** is designed to support the special communication needs of harsh and challenging environments encountered in many settings from process and manufacturing industries, power companies to rural communities. **Basicnet**: *Broadband Access Services In Converging Networks:* The project targets the extension of the infrastructure based access network architecture to enable mobility of available and new broadband services in heterogeneous multihop wireless cum wired scenarios. **i2:** *The Intelligent Inland road:* The project is focused on evolving technology for the Intelligent car and road. New technology that can provide safer and cleaner transport systems and new business to the region. **Oricane** develops green software technology for a wide range of Internet applications. The goal is to reduce the total power consumption of the Internet and to minimize the environmental impact of Internet´s explosive growth.

Recently started "Sense Smart City" is a Swedish RDI project to make urban cities/areas "smarter". The project will generate new and better ICT solutions, which enable urban areas to gather and combine information (energy, traffic, weather, events, activities, needs and opinions) continuously as well as "on-demand". This will enable city environments to become "smarter", as more adaptive and supportive environmental, for its inhabitants and visitors - people as well as organisations.

The increased "smartness" will be recognized and measured in many ways, for example how resources (energy, public transportation, infrastructures, environments etc) are utilized and managed. The smartness will also be recognized in how quickly and efficiently new needs can be addressed, how problems/congestions are avoided and more swiftly resolved, and how information is provided more proactively and accurately with less risk for "information overload", based on increased system "awareness" and "responsiveness" towards changing local/regional needs, conditions and contexts.

Project activity plan includes four smart city pilot services/operations .Using these pilots as drivers, project will build capacity and perform scientific research in the area of smart city specific needs for communication, mobile systems and services. It also includes pilot implementation and utilization of distributed sensor systems for smart city services.

5.3 TRENDS AND DEVELOPMENTS

Looking at the five key-principles above and in the perspectives of the Future Internet Open Innovation landscape the Living Lab evolution over two decades may be summarized as follows (Table 5-2).

Key principles	From	To
Value Creation	Research and development experiments with the purpose to generate new knowledge and new artefacts (prototypes)	Also include "Innovation", where experimental processes are designed to also create new practical and substantial values and new businesses.
Influence	Users being studied as "human factors" (by researchers and industry)	Users being "human actors", taking active part and sometimes even are the drivers of activities and processes.
Openness	Low publicity experiments with/by invited partners	High publicity experiments with openness for any partner to contribute and participate.
Scale	Local experiments with limited groups of users/partner	Cross-border and cross-cultural experiments with large user groups and many partners
Sustainability	Single project/campaign missions, after which experimental environments and user/partner relations are essentially dismounted/disengaged	Continuous missions and partnerships where experimental environments and user communities sustain and mature, over time and in continuity to become valuable assets for new experiments, projects and campaigns.

Table 5-2: The Living Lab evolution

5.4 LINKAGES WITH OTHER COMMUNITIES

The Living Labs offer many diverse ways to test new and innovative services in their natural environment. The future internet community can use Living Labs for building and creating the services and applications that will enable the Future Internet to grow and justify itself.

The Living Labs form the Human centred innovation platform of choice for researching services and their production in everyday settings. The large user communities that can participate in the Living Lab projects and the diverse background of these user communities give advantages to the utility, reliability and validity of the results that are difficult to get with other forms of study. The methodologies used in Living Lab research are aimed at building and sustaining a cyclical process of enhanced interaction between the users, the researchers and the developers of the service or product under study. With this powerful interaction the Living Labs offer the tools that the future internet community needs for continuing and expanding the research.

Smart Cities can work with established Living Labs in their cities, but also enjoy the benefits that the growing network of Living Labs offer to create a wider base for testing the services and concepts that are developed within the framework of smart cities.

The common assets of the three different communities lie partly in the value that the open nature of the development and innovation strategies offers. The use of human centric development tools and the diversity of experiments that are done by Living Labs make cooperation with the Smart cities and Future internet Communities logical and without big obstacles.

5.5 EXPLOITING THE LINKAGES

Service development, validation and enhancement through user interaction is natural in Living Labs. This presents opportunities both to the Smart Cities and Future Internet Community to establish early versions of services, enabled by advanced (Future Internet based) technology platforms in real life settings and to test near to market technologies in a creative and inclusive environment. The benefits are for all involved clear and advantageous. The increased use of Living Labs in cutting edge technologies and applications offered by the Future internet and Smart Cities communities will enable the Living Lab Community to enhance its expertise in this field and give new impulses in the development of these services and technologies, and new impulses in collaboration models with smart cities and Future Internet stakeholders and facilities.

The trend towards a more pronounced role of users in Future Internet projects will contribute to building bridges with living labs activities. Equally the real life testing and validation platforms that are offered by Living Labs, combined with the cyclical and interactive nature of user driven open innovation that characterizes Living Labs will form important components of major testing and learning platforms for Future Internet Research.

6 MAPPING THE LANDSCAPE OF FUTURE INTERNET AND SMART CITIES

6.1 LANDSCAPE ELEMENTS

This chapter presents some initial views about creating a landscape map, which will be elaborated in next report versions. We will discuss bottom-up and top-down approaches. The landscape can be defined as a cloud of elements and topics characterizing the three communities composing the FIREBALL ecosystem: Future Internet, Smart Cities and Living Labs. Table 6-1 presents an overview of such elements. However, the landscape map does not consist only of such elements. It is also about relationships between elements, about complementarities and synergies. Also the elements and their interrelations are dynamically changing. A top down perspective will complement a bottom up view (elements). Table 6-2 proposes a high-level framework to identify each domain specified by aspects: assets and strengths, methodologies, actors, priorities, and value creation. The "horizontal" view may help recognizing the interrelations, synergies and complementarities for each of the aspects.

Living labs	Future Internet	Smart Cities
1. Living Lab origins	1. Future Internet genesis	1. Defining and understanding Smart Cities
2. Living Lab initiatives in the EU	2. FIRE research	2. Smart / intelligent cities origins
3. Living Lab initiatives - NORDFORSK	3. Future internet technologies	3. Digital cities
4. Living Lab initiatives globally	4. Future internet architectures	4. Cyber cities
5. ENoLL	5. Future internet applications	5. Intelligent cities
6. Living Lab methodologies in different sectors (health, energy, rural development)	6. Experimental FIRE facilities and user involvement	6. Smart City policy priorities in socio-economic development: health, energy, environment, education, business
7. Living Labs and smart city strategies	7. Technological developments and large-scale projects	7. Broadband city strategies
8. Living Labs and Future Internet-enabled services	8. Future Networks	8. Fiber optic deployment strategies
9. Living Labs, local alliances and authorities	9. Software and service architectures	9. Broadband technologies
10. Living Labs and ICT infrastructure	10. Internet of Things	10. Broadband infrastructure
11. Living Lab research	11. Networked enterprises	11. Cable broadband networks xDSL technologies
12. Living Lab innovation approach / perspective	12. Large-scale test-beds and experimentation facilities	12. Fiber optic broadband networks
13. Living Lab services provision	13. Emerging constituencies and collaborationships: FIA, ETP's, large-scale project consortia, national innovation agencies, Future Internet PPP (etc)	13. Wireless broadband networks
14. Living Lab service creation	14. FIRE and open innovation	14. Broadband networks mDSL
15. Living Lab service architectures	15. FIRE and users involvement	15. Broadband business models
16. Collaborative innovation ecosystems	16. Future Internet-enabled services for Smart Cities	16. Broadband regulatory and financial models
17. R&D open platforms	17. FIRE, security and privacy issues	17. Digital and intelligent cities concept to attract business interest
18. Collaborative R&D networks	18. FIRE legal and regulatory issues	18. Future Internet pilots in Smart city environments
19. Collective intelligence	19. FIRE and Living labs experimentation	19. Living Labs pilots in Smart City environments
20. Participatory foresight and futures techniques	20. FIRE and Smart cities innovation	20. Smart cities and open innovation ecosystems
21. Technology absorption networks	21. Web 3.0	21. Smart marketplaces / Central Business Districts
22. Knowledge spillovers	22. Open data API	22. Smart Health networks / applications
23. Collective learning	23. Open data intelligence	23. i-Universities and campus
24. Technology transfer	24. Semantic web	24. Intelligent incubators and technology parks
25. University –industry cooperation	25. Semantic mash-ups	25. Intelligent industry
26. Collaborative New Product Development	26. Semantic databases	

27. Crowdsourcing 28. Co-design / participatory innovation 29. LL good practice 30. Project Apollon, 31. Project Save Energy 32. LL and the CIP programme 33. Open platforms supporting LLs	27. Wireless sensors 28. Ambient intelligence 29. RFID 30. Cloud computing 31. Virtualisation of infrastructure 32. EU research on FIRE 33. New European initiatives, e.g. EFII/Future Internet PPP, EIT, ETP's, FP7 programme 34. Priorities within national programmes of research and innovation in Future Internet 35. FIRE and the death of the web	clusters 26. Smart traffic applications 27. Energy saving and optimization applications and districts 28. Smart energy grid 29. Water management monitoring and alert 30. Real time air quality monitoring and alert 31. Smart safety and emergency management 32. Intelligent city strategies 33. Smart city profiles 34. Smart city good practice 35. Smart / intelligent cities in Asia, US, EU 36. Smart / intelligent cities in the US 37. Smart cities performance measurement and benchmarking

Table 6-1: Elements of the landscape map

	Future Internet	Smart Cities	Living labs
Actors, constituencies	• FIA, ETPs • National and EU research organisations • ICT sector	• Cities, urban area authorities • Partnerships	• Cities, regions, innovation agencies
Priorities	• Advanced experimental facilities for R&D • Resolving future Internet challenges: routing, scalability, mobility etc.	• Quality of life and attractiveness of cities (health and care, infrastructure, social innovation) • Innovation, work, economic development	• Cities as platforms for ICT-based innovation • Accelerate SME innovation • Foster entrepreneurship
Resources and strengths	• Technology base • Degree of organization	• Clear city development policy priorities	• User centred innovation • Potential mediating role
Methodologies	• Testbeds and experimentation facilities	• Public-private partnering • Open innovation	• User driven innovation
Value creation potential	• Uptake of technologies in network infrastructure	• Create open innovation ecosystem	• Acceleration of innovation cycles

Table 6-2: Elements of the landscape map

6.2 LANDSCAPE MAPPING BASED ON ELEMENTS

The profile of each element identified in Table 6-1 will be defined by properties such as actors, processes, technologies, applications. Property categories should be common for all topics to enable mapping of interrelationships. Mapping the landscape thus will allow visualizing the relationships among the elements that emerge from their properties / topics. We can produce multiple 2-dimensional maps by selecting the respective axis (technologies / processes; actors / applications; etc.). See for instance the mapping of the term "New York" by the mapstan machine which used as reference websites that speak about New York.

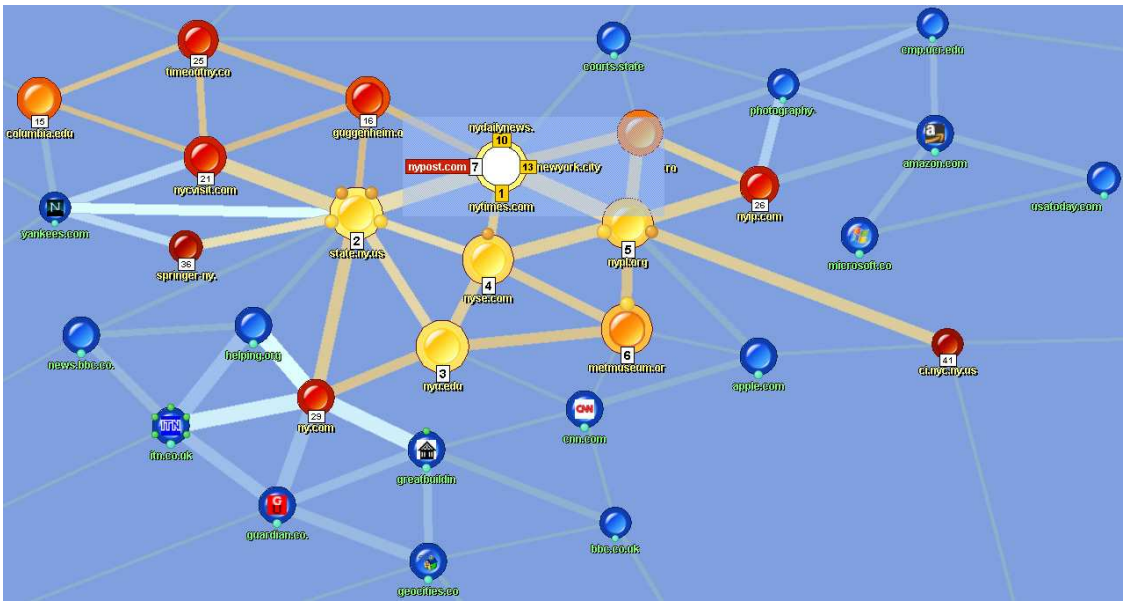


Fig. 6-1: Mapping "New York"

There are different ways to define the main elements of the Landscape:

(1) We may create of a corpus of reference to sustain the selection / definition of the main elements of the landscape. For instance, We may create an online library of about 100 documents (papers, books, reports) in each of the three major dimensions of FIREBALL (smart cities, Living Labs, future internet). The analysis of this literature may suggest which are the main subjects in each of the three FIREBALL dimensions.

(2) We may use online search, indexing and visualization tools. See for instance a document analysis of papers stored in the FIREBALL Literature and Background Documents folder at BSCW (http://www.ami-communities.eu/bscw/bscw.cgi/545087). Indexing "THE SMART CITY INFRASTRUCTURE DEVELOPMENT & MONITORING" using the online tool: **www.wordle.net** provides the following picture.

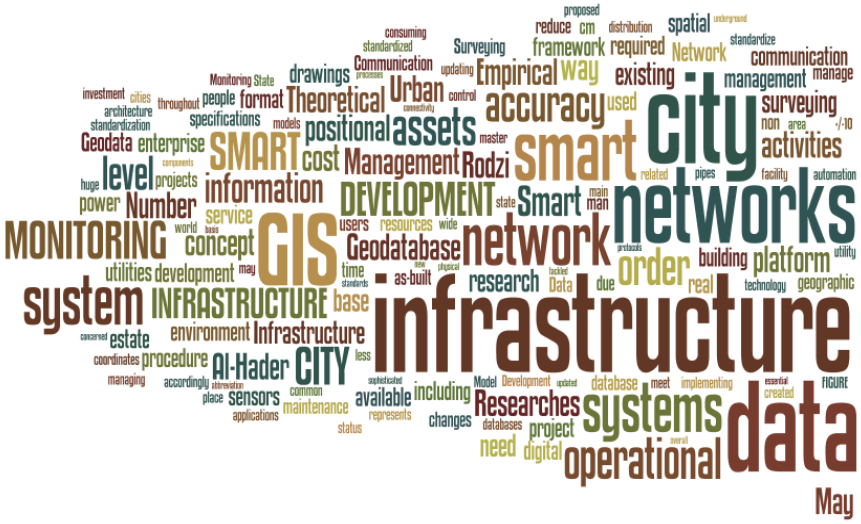


Fig. 6-2: Indexing Smart City Infrastructure Development

Another approach is website analysis. Indexing of the IBM site on Smart Cities (http://www.ibm.com/smarterplanet/us/en/sustainable_cities/ideas/) Using the online tool: **http://www.tocloud.com/**

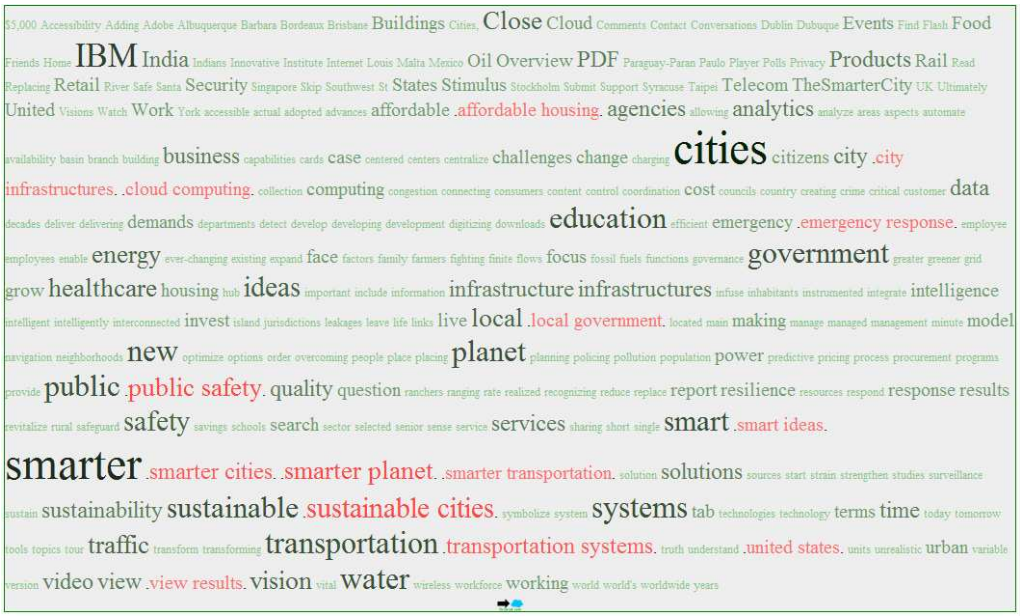


Fig. 6-3: Website analysis of Smart Cities

The above visualizations indicate a number of elements which characterize the discussion (landscape) about smart cities and sustain our selection of the FIRE – Living Labs – Smart Cities landscape. A richer yield will be produced taking into account the other two dimensions about Living Labs and Future Internet research.

6.3 STRUCTURING THE SMART CITIES LANDSCAPE: A LAYERED VIEW

The "Landscape" covers key dimensions of the (future) innovation systems of smart cities: technologies, applications, users and uses, methodologies, actors and policies. The landscape also embodies a map of opportunities for smart city innovations, and for collaboration models in smart city innovation ecosystems.

A top-down and systematic view of the landscape identifies and describes different landscape layers: city and urban development, innovation facilities and processes, networked applications and innovations, Internet technologies and services. For each layer, "sub-maps" can be created e.g. a map of technologies, map of city applications, and map of smart city policies. It is also important to describe the "vertical" relations across the layers.

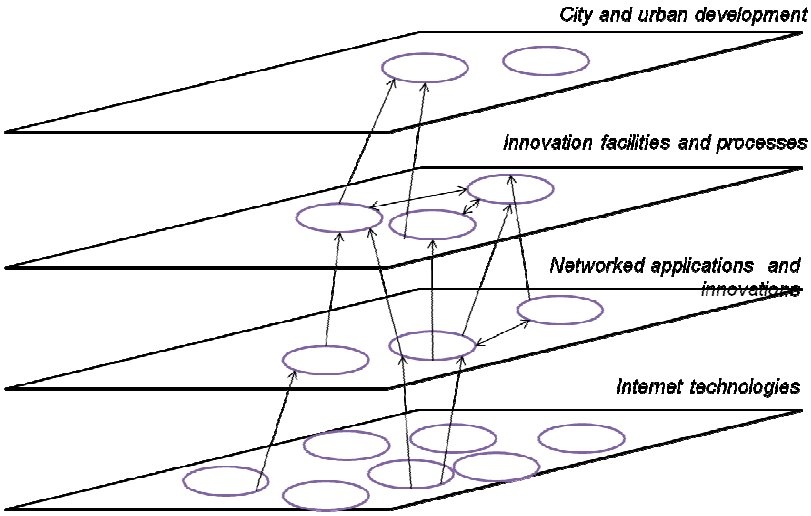


Fig. 6-3: Layered view of the landscape

6.4 SMART CITIES LANDSCAPE DYNAMICAL CHANGE

The landscape of smart cities and open innovation will change continuously, as changes are happening at every layer, e.g. new technologies, and new innovation policies. Drivers of change include:

- Generic trends, e.g. technological developments, demographic change, societal changes, regional developments.
- Actor strategies and policies. Many cities have developed explicit smart city strategies for urban development and open innovation to enhance attractiveness of cities for business and citizens.
- Sector specific trends related to demands and solutions in health, energy, government, manufacturing and other.

6.5 A ROADMAP FOR GUIDANCE TO POLICIES AND STRATEGIES

The "landscape" covers the interconnected key dimensions of the (future) innovation ecosystem of smart cities: technologies, applications, users and uses, innovation environments, actors and their policies.

The landscape embodies a map of opportunities as well: both opportunities for integrated methodologies (stemming from future internet research and experimentation approaches and living labs open innovation, as well as urban innovation policies) and opportunities for smart city innovations.

Complementary to the landscape is a roadmap for realizing the ambition of smart cities as innovation ecosystems. The roadmap presents the state of the art, trends and developments, and identifies gaps and bottlenecks or challenges regarding the transformation towards smart city innovation ecosystems, fostering a process of change and transformation towards realizing the vision of smart cities' socio-economic and cultural development.

The roadmap recognizes the dynamic and uncertain aspects of change in the smart cities' landscape, and connects push and pull developments. Fig. 6-4 visualizes the main elements of the roadmap, addressing demand issues, technology developments, and innovation ecosystem changes mediating between demand and supply.

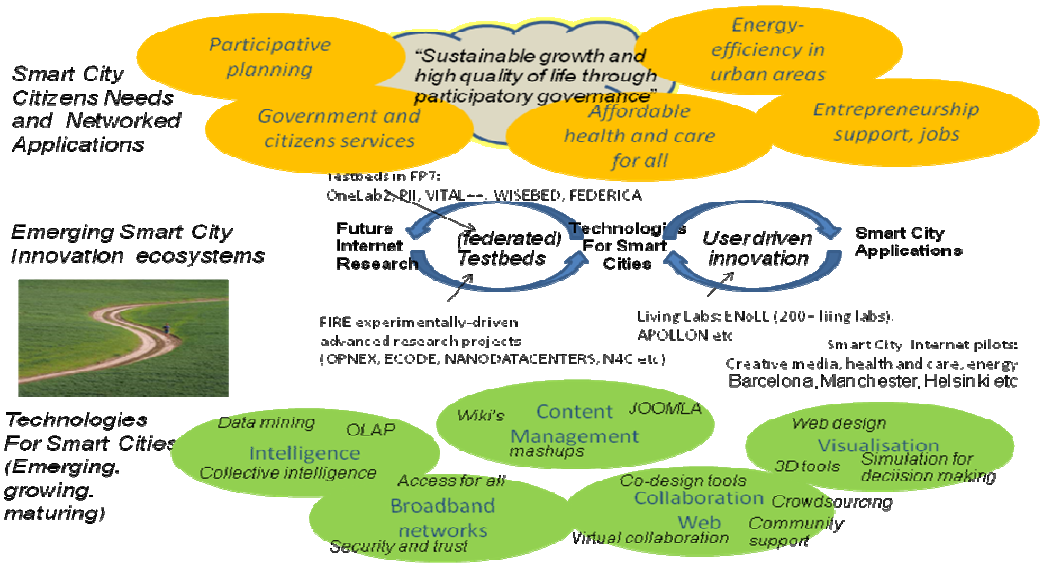


Fig. 6-4 FIREBALL roadmap concept

An initial view of the FIREBALL roadmap, which is to be elaborated in the next period through a dialogue with all stakeholders, is presented in Fig. 6-5.

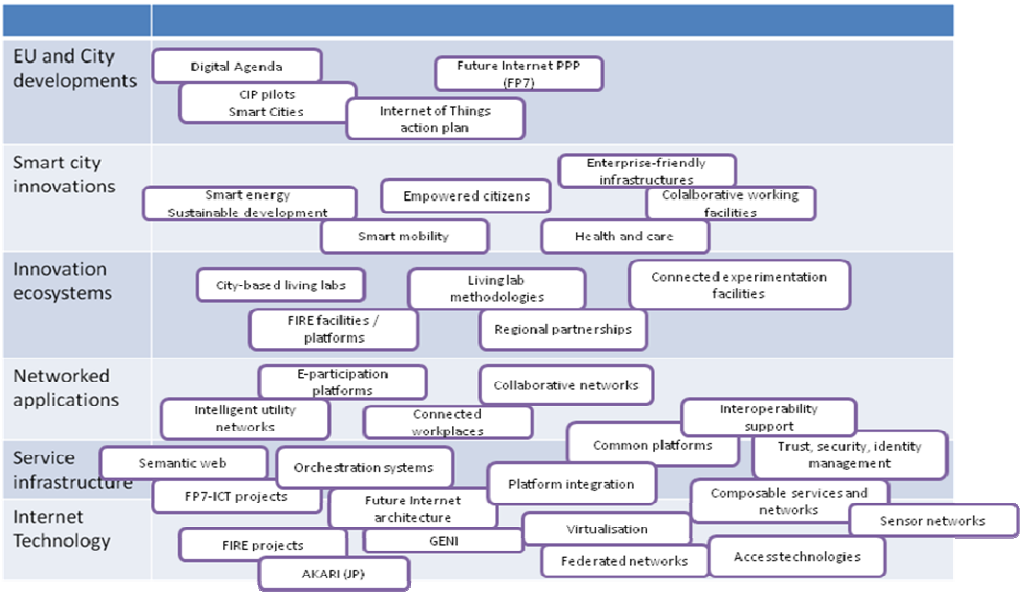


Fig. 6-5: FIREBALL initial roadmap

7 FRAMING SMART CITIES COLLABORATION ON THE FUTURE INTERNET

7.1 INTRODUCTION

Previous chapters have developed foundations of a methodological framework for collaboration among different constituents in Smart Cities. FIREBALL understands "collaboration" in two meanings (as presented at the FIA Conference, Gent, December 2011):

1) **Collaboration at the strategic level.** This level of collaboration is important from the perspective of setting up the innovation conditions. Actors from three communities may join strategically to define and achieve common objectives in research and innovation. One approach to that is to establish innovation ecosystems based on partnerships, covering urban and regional areas.
2) **Collaboration at the operational level.** This level of collaboration is important from the viewpoint of defining the collaboration processes. Actors from three communities are co-innovating based on sharing their resources (e.g. testbeds, know-how, user groups, methods) and build common facilities to achieve their joint innovation objectives.

7.2 COLLABORATION AT THE STRATEGIC LEVEL

We refer to D2.1 (M6) as well as to D2.2 (M8) for further details; see also this report Chapter 3. For each of the communities in the FIREBALL domain, D2.1 has analysed the key actors, their objectives, linkages to other communities, and benefits in exploiting the linkages. Through creation of longer term partnerships governed by public-private "business models", strategic forms of collaboration e.g. taking the form of innovation programmes may be implemented. The smart cities cases provide evidence for this approach (Annex).

Collaboration focus on sharing innovation resources and capabilities

A key priority within FIREBALL is to examine and explore models of collaboration among the three communities: Future Internet research and experimentation, Living labs, and Smart Cities. Such collaboration would imply collaboration within the innovation-ecosystem constituted by the interplay between the three constituencies. Some of the elements of collaboration models, including the linkages between constituencies, were mentioned in earlier chapters and here we take a more integrated view.

The facilities or resources in use by activities regarding the Future Internet, Living Labs and Smart Cities communities together constitute the technical infrastructure or resources of an urban innovation ecosystem comprising ICT companies, researchers and policy makers as well as other businesses and citizens. This ecosystem is strengthened by the determinants of the city value creation system such as infrastructure, actor networks, entrepreneurial conditions and innovative demand, as well as government policies. The collection of facilities or resources constitutes the basic infrastructure of innovation processes. A challenge is to create a strategic management approach to innovation ecosystems in which these resources are **aligned** in order to create synergies and complementarities from bottom-up. Managing innovation at the level of urban innovation ecosystems thus becomes a task of managing the **portfolio of resources** and fostering fruitful interlinkages.

Some of the key resources in the smart cities' innovation ecosystem, and the processes they facilitate, are the following (see Ballon et al. 2006; added: Innovation Community, Venture Lab).

- **Testbeds.** The role of testbeds is experimenting and testing of Internet technologies on dedicated platforms. System requirements dominate the validation process in testbeds (user requirements dominate living lab innovation). Main actors involved are researchers and business. Outcome of testbed processes is validated technology in the form of software and hardware components.
- **Living labs**. The role of living labs is to organize open innovation driven by users. Interactions involving software developers and end-users (citizens, business) proceed interactively and evolutionary.
- **Field Lab.** Field labs implement field trials is to test applications and solutions in practice, involving real user groups.
- **Prototyping platform.** This facilitates a process starting from user requirements and creating a software "model" of the final product or service. It can be seen as part of larger development process, resulting in proof of concept.
- **Social pilots.** An environment for introducing and validating mature solutions (products, services).
- **Innovation Community**. A community of citizens, domain experts, researchers, companies, stakeholders willing to meet and interact to create and shape innovative scenarios and service concepts.
- **Venture Lab**. Environment of business creation based on service and product concepts.

The outputs of these resources differ in several respects. Outputs of testbeds result in technologies that are adopted in the longer term. Outputs of prototyping and innovation community are used in upstream processes. Outputs of social pilots can be expected to be adopted on the short term. The "glue" linking these resources and processes is not or not always their outcome but **knowledge and information**.

The role of smart city innovation ecosystem management is to manage the portfolio of "innovation assets" made up of the different facilities and resources, through fostering the knowledge and information flows created and investing or disinvesting in those resources.

7.3 COLLABORATION AT THE OPERATIONAL LEVEL

Operational collaboration among Future Internet, Living Labs and Smart Cities initiatives and resources requires the definition of collaboration processes and infrastructures around a specific innovation activity. Partly these collaboration processes are generic, partly specific.

As an example of what we mean with operational collaboration, the **TEFIS Integrated Project i**n FP7-ICT, which is part of the FIRE portfolio, has elaborated a simple collaboration model for the purpose of developing content sharing applications (Fig. 7-1).

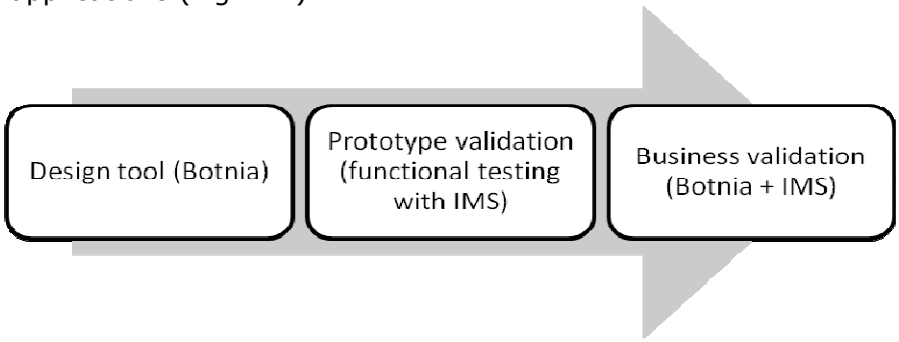


Fig. 7-1: Collaboration Framework of TEFIS (content sharing applications)

In the first phase, **Botnia Living Lab** is used as a design tool facility. The second phase of prototype validation utilises functional testing capabilities of IMS facility (IP Multimedia System). The third phase of business validation builds on joint use and integration of Botnia Living lab and IMS facility.

Other more complex, concurrent engineering based, configurations of using available facilities can be relevant for different and more complex use cases. Based on such "innovation-based" collaboration frameworks, which should be flexible models adaptable to situational context, a set of component processes can be identified and elaborated that govern the actual collaboration and define the "reference framework for common assets collaboration".

In what follows we are using some elements of the approach taken in the APOLLON project on cross-border living labs. Here, a key issue is how to support the process of creating and operating such living labs and orchestrating collaboration networks among different partners. To considerable extent this resembles the issues regarding collaboration in FIREBALL, at least at generic level.

Among the key components within the mentioned reference framework will be the following processes that are part of constructing collaboration across stakeholders for smart cities development based on using living labs and future Internet facilities:

- Finding partners, agreeing contracts for collaboration, setting up a collaboration network
- Establish roles, obligations, tasks, work plans for experimentation and testing
- Setup collaboration support for development and experiments team activities
- Identify facilities, know-how, human capital to be brought together in the project
- Define project and team composition
- Select and operate civic user groups for testing and validation
- Carry out product/service development activity based on user group brainstorming
- Manage and maintaining user communities and user engagement
- Prototype software solutions (e.g. using agile development approaches such as SCRUM)
- Moderate user-developer interactions in applications development and testing
- Field trials organisation and execution
- Technology testing in Future Internet testbed facility
- Societal or market-oriented pilots organisation and execution
- Handling of legal and IPR issues
- Evaluate experiment results and provide feedback to developers and users.

These processes seem to cover **four phases of the over-all innovation process** for smart cities development:

1) Setup of the innovation partnership (inception phase)
2) Plan and develop innovation projects (definition phase)
3) operate the innovation process (operation phase)
4) complete and terminate the innovation process (completion phase).

Inspired by the approach in APOLLON, table 7-1 presents the major phases, their definition and output, as a basis for structuring and guiding the innovation process for smart cities as collaboration between the different constituents in smart cities, Future Internet and Living Labs stakeholder communities.

Phase	Definition	Output
Inception	• Start up phase of collaboration • Find partners • Define primary goals and requirements.	Partners Initial agreement
Definition	• Define stakeholder and partner roles • Evaluate business case (benefits – costs) • Agree on contract details, IPR handling • Establish experiment infrastructure • Plan experimental activities and tools	Project plan Contract, IPR Infrastructure
Operation	• Co-innovation of product enhancements • Product and service testing • Expert collaboration • User experience observation	Experimental results Product improvements User satisfaction
Completion	• Evaluation of experiment • Evaluation of collaboration benefits	Lessons learned Good practices

Table 7-1: Phases in structuring the collaboration

Table 7-2 suggests a portfolio of major issues that should be covered in implementing the smart cities collaboration framework at operational levels, across the lifecycle of smart cities innovation ecosystem evolution. Covering these issues in more detail and finding strategies or solutions will be part of ongoing interactions with the main communities embodied in the FIREBALL project.

	Inception	Definition	Operation	Completion
Infrastructure and resources availability and access	Is infrastructure for collaboration and experimentation available, accessible	Has experimentation infrastructure been prepared, has access been agreed	Is technical experimentation platform and living labs facility operational	How can transfer of infrastructure and resources to owners be ensured
Collaboration and business model	Which partners are required Are partners willing to collaborate, under which conditions	Do benefits vs. costs, risks justify the collaboration	Is collaboration elaborated into specific collaboration processes during the experimentation	How are the collaboration benefits, costs and risks evaluated What are the lessons learned
Innovation project definition	Is the innovation project clear in terms of objectives, benefits	Is the innovation project clearly defined, prepared and planned	Is the innovation project well managed, monitored, implemented	Has the innovation project created results and benefits for stakeholders
Communities involvement and support	Do city, FI and LL stakeholders agree	Are City, FI and LL stakeholders involved	Are users, developers and other stakeholders involved	Have communities been satisfactorily involved and engaged

Table 7-2: Major issues in implementing the collaboration framework

7.4 OUTLOOK

The work on collaboration methodology for smart cities will be ongoing within FIREBALL. The concepts that we are proposing mostly have not yet been tested in practice. On the other hand it is very important to learn from emerging practice in collaboration (see the smart cities cases, and also D1.2 regarding common assets). By studying emerging examples and at the same time developing new concepts and discussing them with the various stakeholder groups we intend to propose a more mature set of collaboration methodologies for smart cities in the remainder of this project.

8 COOPERATION FRAMEWORKS FOR OPEN INNOVATION IN SMART CITIES

This chapter presents the FIREBALL vision concerning collaboration frameworks for smart cities. The text was published a contribution to the FIA 2011 book (Springer, May 2011), authors: Hans Schaffers, Nicos Komninos, Marc Pallot, Brigitte Trousse, Michael Nilsson, and Alvaro Oliveira.

8.1 INTRODUCTION

The concept of "smart cities" has attracted considerable attention in the context of urban development policies. The Internet and broadband network technologies as enablers of e-services become more and more important for urban development while cities are increasingly assuming a critical role as drivers of innovation in areas such as health, inclusion, environment and business [1]. Therefore the issue arises of how cities, surrounding regions and rural areas can evolve towards sustainable open and user-driven innovation ecosystems to boost Future Internet research and experimentation for user-driven services and how they can accelerate the cycle of research, innovation and adoption in real-life environments. This paper pays particular attention to collaboration frameworks which integrate elements such as Future Internet testbeds and Living Lab environments that establish and foster such innovation ecosystems.

The point of departure is the definition which states that a city may be called 'smart' "when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory government" [2]. This holistic definition nicely balances different economic and social demands as well as the needs implied in urban development, while also encompassing peripheral and less developed cities. It also emphasises the process of economic recovery for welfare and well-being purposes. Secondly, this characterisation implicitly builds upon the role of the Internet and Web 2.0 as potential enablers of urban welfare creation through social participation, for addressing hot societal challenges, such as energy efficiency, environment and health.

Whereas until now the role of cities and regions in ICT-based innovation mostly focused on deploying broadband infrastructure [3], the stimulation of ICT-based applications enhancing citizens' quality of life is now becoming a key priority. As a next step, the potential role of cities as innovation environments is gaining recognition [4]. The current European Commission programmes FP7-ICT and CIP ICT-PSP stimulate experimentation into the smart cities concept as piloting user-driven open innovation environments. The implicit aim of such initiatives is to mobilise cities and urban areas as well as rural and regional environments as agents for change, and as environments of "democratic innovation" [5]. Increasingly, cities and urban areas are considered not only as the object of innovation but also as innovation ecosystems empowering the collective intelligence and co-creation capabilities of user/citizen communities for designing innovative living and working scenarios.

Partnerships and clear cooperation strategies among main stakeholders are needed in order to share research and innovation resources such as experimental technology platforms, emerging ICT tools, methodologies and know-how, and user communities for experimentation on Future Internet technologies and e-service applications. Common, shared research and innovation resources as well as cooperation models providing access to such resources will constitute the future backbone of urban innovation environments for exploiting the opportunities provided by Future Internet technologies. Three perspectives are

addressed in this paper in order to explore the conditions for rising to this challenge (see Table 1).

Table 1. Three perspectives shaping the landscape of Future Internet and City Development

	Future Internet Research	Cities and Urban Development	User-driven Innovation Ecosystems
Actors	Researchers ICT companies National and EU actors	City policy actors Citizen platforms Business associations	Living Lab managers, citizens, governments, enterprises, researchers as co-creators
Priorities	Future Internet technical challenges (e.g. routing, scaling, mobility)	Urban development Essential infrastructures Business creation	User-driven open innovation Engagement of citizens
Resources	Experimental facilities Pilot environments Technologies	Urban policy framework Organisational assets Development plans	Living lab facilities: methodologies & tools, physical infrastructures
Policies	Creation of advanced and testbed facilities Federated cooperation Experimental research	City policies to stimulate innovation, business and urban development Innovative procurement	User-driven innovation projects Open, collaborative innovation

The first perspective of Future Internet research and experimentation represents a technology-oriented and longer term contribution to urban innovation ecosystems. Cities and urban areas provide a potentially attractive testing and validating environment. However, a wide gap exists between the technology orientation of Future Internet research and the needs and ambitions of cities. Hence, the second perspective is comprised of city and urban development policies. City policy-makers, citizens and enterprises are primarily interested in concrete and short-term solutions, benefiting business creation, stimulation of SMEs and social participation. While many cities have initiated ICT innovation programmes to stimulate business and societal applications, scaling-up of pilot projects to large-scale, real-life deployment is nowadays crucial. Therefore, a third perspective is the concept of open and user-driven innovation ecosystems, which are close to the interests and needs of cities and their stakeholders, including citizens and businesses, and which may bridge the gap between short-term city development priorities and longer term technological research and experimentation.

A key challenge is the development of cooperation frameworks and synergy linkages between Future internet research, urban development policies and open user-driven innovation. Elements of such frameworks include sharing of and access to diverse sets of knowledge resources and experimentation facilities; using innovative procurement policies to align technology development and societal challenges; and establishing open innovation models to create sustainable cooperation. The concept of open and user-driven innovation looks well positioned to serve as a mediating, exploratory and participative playground combining Future Internet push and urban policy pull in demand-driven cycles of experimentation and innovation. Living Lab-driven innovation ecosystems may evolve to constitute the core of "4P" (Public-Private-People-Partnership) ecosystems providing opportunities to citizens and businesses to co-create, explore, experiment and validate innovative scenarios based on technology platforms such as Future Internet experimental facilities involving SMEs and large companies as well as stakeholders from different disciplines.

This paper is structured as follows. Section 2 addresses challenges for cities to exploit the opportunities of the Future Internet and of Living Lab-innovation ecosystems. How methodologies of Future Internet experimentation and Living Labs could constitute the innovation ecosystems of smart cities is discussed in section 3. Initial examples of such ecosystems and related collaboration models

are presented in section 4. Finally, section 5 presents conclusions and an outlook.

8.2 CITY AND URBAN DEVELOPMENT CHALLENGES

In the early 1990s the phrase "smart city" was coined to signify how urban development was turning towards technology, innovation and globalisation [6]. The World Foundation for Smart Communities advocated the use of information technology to meet the challenges of cities within a global knowledge economy [7]. However, the more recent interest in smart cities can be attributed to the strong concern for sustainability, and to the rise of new Internet technologies, such as mobile devices (e.g. smart phones), the semantic web, cloud computing, and the Internet of Things (IoT) promoting real world user interfaces.

The concept of smart cities seen from the perspective of technologies and components has some specific properties within the wider cyber, digital, smart, intelligent cities literatures. It focuses on the latest advancements in mobile and pervasive computing, wireless networks, middleware and agent technologies as they become embedded into the physical spaces of cities. The emphasis on smart embedded devices represents a distinctive characteristic of smart cities compared to intelligent cities, which create territorial innovation systems combining knowledge-intensive activities, institutions for cooperation and learning, and web-based applications of collective intelligence [8, 9].

Box: A new spatiality of cities - multiple concepts

Cyber cities, from cyberspace, cybernetics, governance and control spaces based on information feedback, city governance; but also meaning the negative / dark sides of cyberspace, cybercrime, tracking, identification, military control over cities.

Digital cities, from digital representation of cities, virtual cities, digital metaphor of cities, cities of avatars, second life cities, simulation (sim) city.

Intelligent cities, from the new intelligence of cities, collective intelligence of citizens, distributed intelligence, crowdsourcing, online collaboration, broadband for innovation, social capital of cities, collaborative learning and innovation, people-driven innovation.

Smart cities, from smart phones, mobile devices, sensors, embedded systems, smart environments, smart meters, and instrumentation sustaining the intelligence of cities.

It is anticipated that smart city solutions, with the help of instrumentation and interconnection of mobile devices, sensors and actuators allowing real-world urban data to be collected and analysed, will improve the ability to forecast and manage urban flows and push the collective intelligence of cities forward [10]. Smart and intelligent cities have this modernisation potential because they are not events in the cybersphere, but integrated social, physical, institutional, and digital spaces, in which digital components improve the functioning of socio-economic activities, and the management of physical infrastructures of cities, while also enhancing the problem-solving capacities of urban communities.

The most urgent challenge of smart city environments is to address the problems and development priorities of cities within a global and innovation-led world. A recent public consultation held by the European Commission [11] on the major urban and regional development challenges in the EU has identified three main priorities for the future cohesion policy after 2013. It appears that competitiveness will remain at the heart of cohesion policy, in particular, research, innovation, and upgrading of skills to promote the knowledge economy. Active labour market policy is a top priority to sustain employment, strengthen social cohesion and reduce the risk of poverty. Other hot societal issues are sustainable development, reducing greenhouse gases emissions and improving the energy efficiency of urban infrastructure. Smart city solutions are expected to deal with these challenges, sustain the innovation economy and

wealth of cities, maintain employment and fight against poverty through employment generation, the optimisation of energy and water usage and savings, and by offering safer cities. However, to achieve these goals, city authorities have to undertake initiatives and strategies that create the physical-digital environment of smart cities, actualising useful applications and e-services, and assuring the long-term sustainability of smart cities through viable business models.

The first task that cities must address in becoming smart is to create a rich environment of broadband networks that support digital applications. This includes: (1) the development of broadband infrastructure combining cable, optical fibre, and wireless networks, offering high connectivity and bandwidth to citizens and organisations located in the city, (2) the enrichment of the physical space and infrastructures of cities with embedded systems, smart devices, sensors, and actuators, offering real-time data management, alerts, and information processing, and (3) the creation of applications enabling data collection and processing, web-based collaboration, and actualisation of the collective intelligence of citizens. The latest developments in cloud computing and the emerging Internet of Things, open data, semantic web, and future media technologies have much to offer. These technologies can assure economies of scale in infrastructure, standardisation of applications, and turn-key solutions for software as a service, which dramatically decrease the development costs while accelerating the learning curve for operating smart cities.

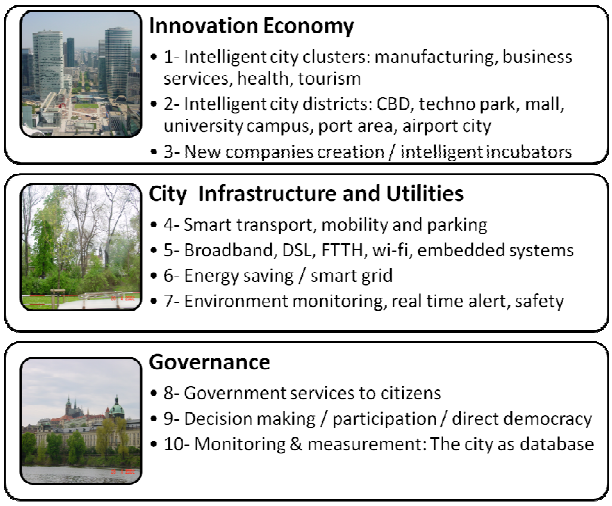


Fig. 1. Smart city key application areas

The second task consists of initiating large-scale participatory innovation processes for the creation of applications that will run and improve every sector of activity, city cluster, and infrastructure. All city economic activities and utilities can be seen as innovation ecosystems in which citizens and organisations participate in the development, supply and consumption of goods and services. Fig. 1 presents three key domains of potential smart city applications in the fields of innovation economy, infrastructure and utilities, and governance.

Future media research and technologies offer a series of solutions that might work in parallel with the Internet of Things and embedded systems, providing new opportunities for content management [12, 13]. Media Internet technologies are at the crossroads of digital multimedia content and Internet technologies, which encompasses media being delivered through Internet networking technologies, and media being generated, consumed, shared and experienced on the web. Technologies, such as content and context fusion, immersive multi-sensory environments, location-based content dependent on user location and context, augmented reality applications, open and federated platforms for content storage and distribution, provide the ground for new e-services within the innovation ecosystems of cities (see Table 2).

Table 2. Media Internet technologies and components for Smart Cities

Solutions and RTD challenges	Short term (2014)	Mid term (2018)	Longer term (2022)
Content management tools	Media Internet technologies	Scalable multimedia compression and transmission	Immersive multimedia
Collaboration tools	Crowd-based location content; augmented reality tools	Content and context fusion technologies	Intelligent content objects; large scale ontologies and semantic content
Cloud services and software components	City-based clouds	Open and federated content platforms	Cloud-based fully connected city
Smart systems based on Internet of Things	Smart power management Portable systems	Smart systems enabling integrated solutions e.g. health and care	Software agents and advanced sensor fusion; telepresence

Demand for e-services in the domains outlined in Fig. 1 is increasing, but not at a disruptive pace. There is a critical gap between software applications and the provision of e-services in terms of sustainability and financial viability. Not all applications are turned into e-services. Those that succeed in bridging the gap rely on successful business models that turn technological capabilities into innovations, secure a continuous flow of data and information, and offer useful services. It is here that the third task for city authorities comes into play, that of creating business models that sustain the long-term operation of smart cities. To date, the environment for applications and their business models has been very complex, with limited solutions available 'off the shelf', a lot of experimentation, and many failures. Cities currently face a problem of standardisation of the main building blocks of smart / intelligent cities in terms of applications, business models, and services. Standardisation would dramatically reduce the development and maintenance costs of e-services due to cooperation, exchange and sharing of resources among localities. Open source communities may also substantially contribute to the exchange of good practices and open solutions.

The current research on smart cities is partly guided by the above priorities of contemporary urban development and city governance. Large companies in the ICT sector, such as IBM, Cisco, Microsoft, are strongly involved in and are contributing to shaping the research agenda. EU research within the context of the FP7 and CIP programmes also aims at stimulating a wider uptake of innovative ICT-based services for smart cities, linking smart cities with user-driven innovation, future Internet technologies, and experimental facilities for exploring new applications and innovative services.

Technology push is still dominant in the actual research agenda. A recent Forrester survey states that smart city solutions are currently more vendor push than city government pull based. However, the survey points out that, "smart city solutions must start with the city not the smart" [14]. The positive impact of available smart city solutions on European cities has not yet been demonstrated, nor have the necessary funding mechanisms and business models for their sustainability been developed. Creating the market constitutes the first priority. Innovation ecosystems for smart cities have to be defined, in terms of applications, services, financial engineering and partnerships. This will help cities to secure funding, identify revenue streams, broker public-private partnerships, and open public data up to developers as well as user communities. As the major challenge facing European cities is to secure high living standards through the innovation economy, smart cities must instrument new ways to enhance local innovation ecosystems and the knowledge economy overall.

8.3 FUTURE INTERNET EXPERIMENTATION AND LIVING LABS INTERFACES

In exploring the role of Future Internet experimentation facilities in benefiting urban development as we move towards smart cities, we will succinctly summarise the role of experimental facilities and the experimentation process, as well as the potential role of the 'Living Labs' concept in enriching experimentally-driven research on the Future Internet. Within the context of the now emerging FIRE portfolio [15], the potential exists to support new classes of users and experiments combining heterogeneous technologies that represent key aspects of the Future Internet. The considerable obstacles of complexity and unfamiliarity that are faced when trying to explore the effects of new applications that bring future users the increasing power of the Future Internet have not yet been overcome. Issues that are being dealt with in the attempt of FIRE projects to move closer to the goal of a federated testbed facility, and which are also important in collaborating with smart city and Living Labs activities, are authentication and access to facilities; security and privacy as well as IPR protection; operation and research monitoring as well as experiment control; and the issue of defining and monitoring experiments in large-scale usage settings.

The portfolio of FIRE experimentation projects shows that users in such FIRE projects are mostly academic and industry researchers. End-user involvement and end user experimentation is beyond the current scope of FIRE, although some interesting initiatives in that respect have started such as the Smart Santander project (services and applications for Internet of Things in the city), the TEFIS project (platform for managing experimental facilities, among which Living Labs) and the ELLIOT project (co-creation of wellbeing, logistics and environment-related IoT-based services).

A comparison of the role of users in FIRE facilities projects compared to Living Labs is presented in Table 3. Importantly, FIRE projects typically involve users in assessing the impacts of technologies in socio-economic terms, whereas Living Labs projects aim to engage users in the innovation process itself. Also, the predominant approach of FIRE facilities is controlled experimentation, whereas Living Labs engage users in the actual innovation process (co-creation). The European Commission has voiced its support for stronger user orientation in the Future Internet facilities projects; not only users in terms of academic and industry researchers who will use these facilities for their research projects, but also end-users. Emphasis is on involving communities of end-users at an early stage of development to assess the impacts of technological changes, and possibly engage them in co-creative activities.

Table 3: User Role in FIRE and Living Labs

	Future Internet Experiments	Living Labs Innovation
Approach	Controlled experiments Observing large-scale deployment and usage patterns Federated testbeds	Both controlled and natural situation experiments User co-creation via Living Labs methodologies, action research Open, cooperative innovation
Object of testing	Technologies, services, architectures, platforms, system requirements; impacts	Validation of user ideas, prototype applications and solutions. Testing as joint validation activity
Scale of testing	Large-scale mainly	From small to large scale
Stakeholders	FI Researchers (ICT industry & academia)	IT multidisciplinary researchers, End-users, enterprises (large & SMEs)
Objective	Facilities to support research Impact assessment of tested solutions	Support the process of user-driven innovation as co-creation

In order to explore the opportunities and interfaces, we will now take a further look at Living Labs. The Web 2.0 era has pushed cities to consider the Internet, including mobile networks, as a participative tool for engaging citizens and tourists. Many initiatives have been launched by cities, such as Wikicity in Rome stemming from MIT's Senseable City Lab which studies the impact of new technologies on cities, Real-Time City Copenhagen, and Visible City Amsterdam. This collection of initiatives already looks like a "networked Living Lab" of cities for investigating and anticipating how digital technologies affect people as well as how citizens are "shaping" those technologies to change the way people are living and working.

Apart from the diversity of research streams and related topics for designing alternatives of the Internet of tomorrow, it becomes increasingly challenging to design open infrastructures that efficiently support emerging events and citizens' changing needs. Such infrastructure also creates many opportunities for innovative services such as green services, mobility services, wellbeing services, and playable city services based on real-time digital data representing digital traces of human activity and their context in the urban space. Environmental sensors measure parameters such as air quality, temperature or noise levels; telecommunication networks reflect connectivity and the location of their users; transportation networks digitally manage the mobility of people and vehicles as well as products in the city, just to give a few examples. Today, it is becoming increasingly relevant to explore ways in which such data streams can become tools for people taking decisions within the city. Promising applications and services seem to be emerging from user co-creation processes.

Recent paradigms, such as open innovation and open business models [16], Web 2.0 [17] as well as Living Labs [18], a concept originating from the work of William Mitchell at MIT and currently considered as user-driven open innovation ecosystems, promote a more proactive and co-creative role of users in the research and innovation process. Within the territorial context of cities, rural areas and regions, the main goal of Living Labs is to involve communities of users at an early stage of the innovation process. The confrontation of technology push and application pull in a Living Lab enables the emergence of breakthrough ideas, concepts and scenarios leading to adoptable innovative solutions. Some of the methodologies used in Living Labs innovation projects demonstrate a potential interface with FIRE experimentation approaches. In [19], a useful classification is elaborated of different platforms for testing and experimentation including testbeds, prototyping projects, field trials, societal pilots and Living Labs. In [20] a landscape of user engagement approaches is presented. Methodologies for Living Labs organisation, phased development and

process management integrated with user experiments within an action research setting have been developed and implemented in [21].

Altogether, Future Internet experimental facilities, Living Labs and Urban development programmes form an innovation ecosystem consisting of users and citizens, ICT companies, research scientists and policy-makers. In contrast with a testbed, a Living Lab constitutes a "4P" (Public, Private and People Partnership) ecosystem that provides opportunities to users/citizens to co-create innovative scenarios based on technology platforms such as Future Internet technology environments involving large enterprises and SMEs as well as academia from different disciplines. It appears that Future Internet testbeds could be enabling the co-creation of innovative scenarios by users/citizens contributing with their own content or building new applications that would mash-up with the city's open, public data.

8.4 EMERGING SMART CITY INNOVATION ECOSYSTEMS

As Table 4 illustrates, several FP7-ICT projects are devoted to research and experimentation on the Future Internet and the Internet of Things within cities, such as Smart Santander and, within the IoT cluster, ELLIOT. The CIP ICT-PSP programme has initiated several pilot projects dedicated to smart cities and Living Labs, some with a clear Future Internet dimension (Apollon, Periphèria, and to a less extent too, Open Cities and EPIC). Among the earlier projects with interesting aspects on the interface of Living Labs and Future Internet is C@R (FP6).

The Smart Santander project proposes an experimental research facility based on sensor networks which will eventually include more than 20,000 sensors, considered as IoT devices. The architecture supports a secure and open platform of heterogeneous technologies. The project is intended to use user-driven innovation methods for designing and implementing 'use cases'. Bus tracking and air quality (EKOBUS: a map of sensor data available on smart phone) as well as urban waste management are two of the use cases from the Smart Santander project.

Table 4: Examples of Living Lab Initiatives Related to Smart Cities, Rural Areas and Regions

Cities and urban areas	• Smart Santander (FP7-ICT, 2010). Internet services and sensor network in the city. www.smartsantander.eu • ELLIOT (FP7-ICT, 2010). Experimental Living Lab for Internet of Things. Three Living Labs are involved. http://www.elliot-project.eu/ • Periphèria (CIP ICT-PSP, 2010). Internet of Things in Smart City. www.peripheria.eu • Open Cities (CIP ICT-PSP, 2010). Public sector services. • EPIC (CIP ICT-PSP, 2010). Platforms for intelligent cities. • Apollon (CIP ICT-PSP, 2010). Domain-specific Pilots of Living Labs in cross-border networks, targeting city areas. www.apollon-pilot.eu
Villages in rural areas and regions	• Collaboration@Rural – C@R (FP6-ICT, 2006-2010). Six Living Labs in Rural areas using a common service platform. www.c-rural.eu • Networking for Communications Challenges Communities (N4C). Extending Internet access to remote regions. www.n4c.eu • MedLab (Interreg IVc). Living Labs and Regional Development.

The ELLIOT project (Experiential Living Lab for the Internet of Things) represents a clear example of Living Labs and Future Internet interaction, elaborating three IoT use cases in three different Living Labs. The first use case is dedicated to co-creation by users of green services in the areas of air quality and ambient noise pollution with innovative devices such as the "green watch" (http://www.lamontreverte.org/en/) and customised sensors being used by citizens. The second one addresses wellbeing services in connection with a hospital and the third focuses on logistic services in product development facilities with professional users. Its goal is to investigate evidence of the social dynamics of the Living Lab approach for the purpose of ensuring a wide and rapid spread of innovative solutions through socio-emotional intelligence mechanisms.

The green services use case takes place in the context of the ICT Usage Lab and within the Urban Community of Nice - Cote d'Azur (NCA). This use case involves local stakeholders, such as the regional institution for air measurement quality (Atmo PACA), the local research institute providing the IoT-based green service portal and managing the experiments (INRIA/AxIS), the Internet Foundation for the New Generation (FING) facilitating user workshops, and a local SME providing data access from electric cars equipped with air quality sensors (VULog) and a citizen IT platform (a regional Internet space for citizens in the NCA area). The objectives of the IoT-based green services use case are twofold: to investigate experiential learning of the IoT in an open and environmental data context, and to facilitate the co-creation of green services based on environmental data obtained via sensors. Various environmental sensors will be used, such as fixed sensors from Atmo PACA in the NCA area, fixed Arduino-assembled sensors by citizens, mobile sensors, such as citizen-wired green watches or sensors installed on electric vehicles. The backbone of the green services use case is an IoT-based service portal which addresses three main IoT-related portal services by allowing the user: 1) to participate in the collection of environmental data; 2) to participate in the co-creation of services based on environmental data; and 3) to access services based on environmental data, such as accessing and/or visualising environmental data in real time. Three complementary approaches have already been identified as relevant for the green services use case: participatory/user-centred design methods; diary studies for IoT experience analysis, and coupling quantitative and qualitative approaches for portal usage analysis. In this context of an open innovation and Living Lab innovation eco-system, focus groups involving stakeholders and/or citizen may be run either online or face-to-face.

The Periphèria project is among the Smart Cities portfolio of seven projects recently launched in the European Commission ICT Policy Support Programme. Their aim is to develop smart cities infrastructures and services in real-life urban environments in Europe. Actually, the Periphèria project forms a bridge between the Smart Cities portfolio of projects and the Internet of Things European Research Cluster (IERC) and can therefore be taken as a model of Smart Cities and Future Internet integration. At the core of Periphèria lies the role of Living Labs in constituting a bridge between Future Internet technology push and Smart City application pull, re-focusing the attention on "People in Places" to situate the human-centric approach within physical urban settings. People in Places becomes the context and the situation – including the relational situations between people and between people and spaces, infrastructures, services, etc. – in which the integration of Future Internet infrastructures and services occurs as part of a "discovery-driven" process. The Cloud is considered to be a resource environment that is dynamically configured (run-time) to bring together testbeds, applets, services, and whatever is relevant, available and configured for integration at the moment that the social interaction of People in Places calls for those services.

Participation is at the heart of this bottom-up approach to Future Internet technology integration, whereby Future Internet research adopts a "competitive offer" stance to prove its added value to users. Platform and service convergence is promoted by the use of serious games that engage citizens and users in the process of discovering the potential of Future Internet technologies and the possible sustainable scenarios that can be built upon them. Serious gaming thus constitutes a mechanism to enhance participation and transform individual and collective behaviour by working directly on the social norms that shape them; in addition, they constitute a monitoring and governance platform for increasing self-awareness of the changes brought about by the adoption of Future Internet technologies. Periphèria has identified five archetypal urban settings: (1) the Smart Neighbourhood where media-based social interaction occurs; (2) the Smart Street where new mobility behaviours develop; (3) the Smart Square where participatory civic decisions are taken; (4) the Smart Museum and Park where natural and cultural heritage feed learning; and (5) the Smart City Hall where mobile e-government services are delivered.

As an example (see Fig. 2), the City of Genova is experimenting with the Smart Museum and Park arena, with to the aim of blending the fruition of the city's natural and cultural heritage with safety and security in urban spaces. This approach draws on and integrates Future Internet technologies (such as augmented reality services for the appreciation of cultural heritage) with networks of video-cameras used to monitor public spaces. In addition, the integration of these services occurs in the Living Lab context where citizens contribute both to the definition and prioritisation of the cultural heritage in their city and also to an exploration of the privacy and security issues that are central to the acceptance and success of Future Internet services for the safety of urban environments.

Fig. 2. Genoa smart city experiments on Smart Museum and Smart Park

This example illustrates the central role of users and citizens in defining the services that make up a Smart City as well as the new sustainable lifestyles and work styles made possible by Future Internet technologies. In addition, it shows how the Future Internet is a mixture of technologies and paradigms with overlapping implementation time-frames. While the deployment of IPv6 networks may be a medium-term effort, other Future Internet paradigms such as cloud services and camera and sensor networks can be considered as already operational. The discovery-driven arena settings in Periphèria are guiding the development of Living Lab-convergent service platforms that bring these technologies together into integrated, dynamic co-creation environments that make up a Smart City.

These projects examples provide initial examples of collaboration models in smart city innovation ecosystems, governing the sharing and common use of resources such as testing facilities, user groups and experimentation methodologies. Two different layers of collaboration can be distinguished. The first layer is collaboration *within* the innovation process, which is understood as ongoing interaction between research, technology and applications development and validation and utilisation in practice. Cases mentioned above such as ELLIOT, SmartSantander and Periphèria constitute typical arenas where potential orchestrations of these interactions are explored. Still, many issues need to be clarified such as how the different research and innovation resources in a network, such as specific testing facilities, tools, data and user groups, can be made accessible and adaptable to specific demands of any research and innovation projects.

The second layer concerns collaboration at the territorial level, driven by urban and regional development policies aiming at strengthening the urban innovation systems through creating effective conditions for sustainable innovation. This layer builds on Michael Porter's concept of "national competitive advantage" [22] which borrows the 'national systems of innovation' thinking, which was originally developed by Chris Freeman. Following this thinking, the "urban value creation system" can be considered as being shaped by four determinants: 1) physical and immaterial infrastructure, 2) networks and collaboration, 3) entrepreneurial climate and business networks, 4) demand for services and availability of advanced end-users (see Fig. 3). Additionally, the value creation system in its conceptualisation by Michael Porter is affected by policy interventions aimed at stimulating the building of networks, the creation of public-private partnerships, and the enhancement of innovative conditions.

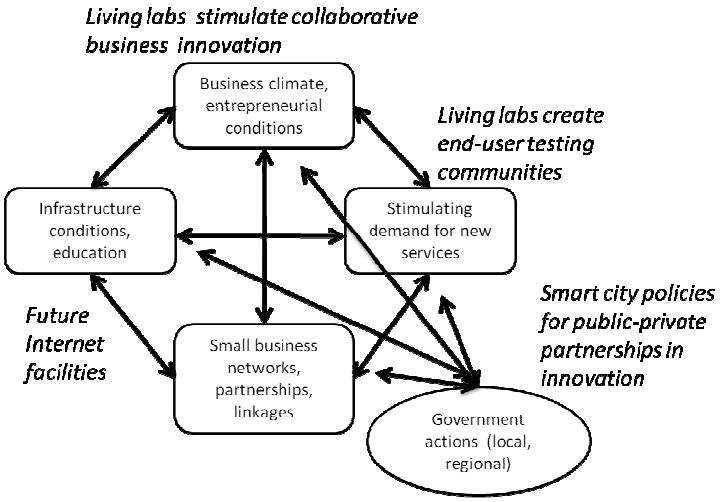


Fig. 3. Conceptualisation of smart city value creation and innovation system (based on Porter)

The challenge in this layer is to create a collaborative approach to innovation ecosystems based on sustainable partnerships among the main stakeholders from business, research, policy and citizen groups and achieve an alignment of local, regional and European policy levels and resources. The ELLIOT project is an example of a Future Internet research and innovation project embedded in regional and even national innovation policy. From the perspective of smart cities, managing innovation at the level of urban innovation ecosystems becomes a task of managing the portfolio of resources and fostering fruitful interlinkages. Smart city innovation ecosystem management aims to manage the portfolio of "innovation assets" made up of the different facilities and resources, by creating partnerships among actors that govern these assets, by fostering knowledge and information flows, and by providing open access to resources made available to users and developers.

8.5 CONCLUSIONS AND OUTLOOK

In this paper we explored the concept of "smart cities" as environments of open and user driven innovation for experimenting and validating Future Internet-enabled services. Smart cities are enabled by advanced ICT infrastructure contributed to by current Future Internet research and experimentation. Such infrastructure is one of the key determinants of the welfare of cities. Other determinants of the welfare of cities will be important as well: the infrastructure for education and innovation, the networks between businesses and governments, the existence of demanding citizens and businesses to push for innovation and the quality of services. Here we see a clear analogy to Porter's concept of national competitive advantage: the welfare potential of cities and urban areas.

The Living Labs concept represents a powerful view of how user-driven open innovation ecosystems could be organised. As a concept applied to smart cities it embodies open business models of collaboration between citizens, enterprises and local governments, and the willingness of all parties -including citizens and SMEs- to engage actively in innovation. The Living Lab concept should be considered also as a methodology, a model for organising specific innovation programmes and innovation projects and conducting innovation experiments. Whereas the last aspect has gained most attention, both levels and their interaction are important: *shaping* and *operating* the innovation ecosystem.

Based on an analysis of challenges of smart cities on the one hand and current projects in the domain of Future Internet research and Living Labs on the other, common resources for research and innovation can be identified, such as testbeds, Living Lab facilities, user communities, technologies and know-how, data, and innovation methods. Such common resources potentially can be shared in open innovation environments. Two layers of collaboration were distinguished that govern the sharing of these resources. One layer focuses on the actual resources within the Future Internet research and innovation process, the second layer addresses the urban innovation system. Several projects discussed in this paper provide evidence of collaboration models for sharing resources at both layers, e.g. the use of Living Lab facilities and methods in experimenting on Future Internet technologies, and the use of Living Lab methodologies for implementing innovation policies of cities.

The potential types and structures of these collaboration frameworks and the concrete issues to be resolved in sharing of research and innovation resources, such as governance, ownership, access, transferability and interoperability need further examination and also need development and piloting in future pilot projects. The current experimentation and innovation approaches used in some of the FIRE and Living Lab projects should be studied more closely in order to develop concrete examples of resource sharing opportunities. Initial examples of resource sharing appear in making user communities available for joint use with Future Internet facilities (e.g. the TEFIS project), and in making accessible Future Internet facilities for developing and validating IoT-based service concepts and applications through Living Labs approaches for smart cities (e.g. the SmartSantander and ELLIOT projects).

The Future Internet constitutes both a key technology domain and a complex societal phenomenon. Effective, user driven processes of innovation, shaping and application of Future Internet technologies in business and society are crucial for achieving socio-economic benefits. A key requirement emphasised in this paper is how, within an environment of open innovation in smart cities and governed by cooperation frameworks, the diverse set of resources or assets that constitutes the "engine" of ongoing research and innovation cycles can be made open accessible for users and developers.

8.6 REFERENCES

1. Kroes, N.: European Commissioner for Digital agenda, "The critical role of cities in making the Digital Agenda a reality". Closing speech to Global Cities Dialogue Spring Summit of Mayors Brussels, 28 May 2010.
2. Caragliu, A., Del Bo, C. and Nijkamp, P.: Smart cities in Europe. Series Research Memoranda 0048. VU University Amsterdam, Faculty of Economics, Business Administration and Econometrics (2009).
3. Eurocities: Strategic Policy Paper on Broadband in Cities (2010).
4. Eurocities: Cities and Innovation in Europe. Discussion paper (2010).
5. Von Hippel, E.: Democratizing Innovation. The MIT Press, Cambridge, Massachusetts (2005).
6. Gibson, D.V., Kozmetsky, G. and Smilor, R.W., (Eds): The Technopolis Phenomenon: Smart Cities, Fast Systems, Global Networks. New York, Rowman & Littlefield, (1992).
7. WFSC: Smart Communities. Online, http://www.smartcommunities.org/about.htm.
8. Komninos, N.: Intelligent Cities: Innovation, knowledge systems and digital spaces. London and New York, Taylor and Francis, (2002).
9. Komninos N.: Intelligent Cities and Globalisation of Innovation Networks. London and New York, Routledge (2008).
10. Chen-Ritzo, C.H, Harrison, C., Paraszczak, J., and Parr, F.: Instrumenting the Planet. IBM Journal of Research &. Development, 53.3, 338-353, (2009).
11. European Commission: Growing Regions, Growing Europe: Fifth progress report on economic and social cohesion. European Commission COM(2008) 371 final, (2008).
12. European Commission: Future Media Internet: Research challenges and road ahead. DG Information Society and Media, Luxembourg, Publications Office of the European Union (2010).
13. European Commission: Future Media Networks: Research challenges 2010. DG Information Society and Media, Luxembourg, Publications Office of the European Union (2010).
14. Belissent, J.: Getting clever about smart cities: New opportunities require new business models. Forrester for Ventor Strategy Professionals (2010).
15. European Commission, DG INFSO: Future Internet Research and Experimentation. September (2010).
16. Chesbrough, H. W. : Open Innovation: The New Imperative for Creating and Profiting from Technology, Boston, Harvard Business School Press (2003).
17. O'Reilly, T., Battelle, J.: Web Squared: Web 2.0 Five Years On. Special Report, Web 2.0 Summit, Co-produced by O'Reilly & Techweb (2009).
18. European Commission, DG INFSO: Advancing and Applying Living Lab Methodologies (2010).
19. Ballon, P., Pierson, J., Delaere, S. et al.: Test and Experimentation Platforms for Broadband Innovation. IBBT/VUB-SMIT Report (2005).
20. Pallot, M, Trousse, B., Senach, B., Scapin, D.: Living Lab Research Landscape: From User Centred Design and User Experience Towards User Co-creation. Position Paper, First Living Labs Summer School (www-sop.inria.fr/llss2010/), Paris, August (2010).
21. Schaffers, H., Garcia Guzmán, J., Navarro, M., Merz, C. (Eds.): Living Labs for Rural Development. Published by TRAGSA, Madrid (2010). Download: www.c-rural.eu.
22. Porter, M.: The Competitive Advantage of Nations. Free Press, New York (1990).

9 CASE STUDIES OF SMART CITIES

This chapter presents the approach to the development of smart city case studies, and summaries of the cases. The elaborated case studies can be found in the Appendix. For seven cities, smart city case studies have been developed: Helsinki, Oulu, Barcelona, Manchester, Lisbon and Thessaloniki.

9.1 OBJECTIVES OF SMART CITY CASE STUDIES

The key objective of the smart city case studies is to analyze and compare current and emerging policies regarding how smart cities are exploiting the opportunities of the Future Internet, how they are working with experimentation environments and living labs in this respect, and learn lessons of interest for smart city stakeholders. Specific objectives of the case study work are the following:

- Capturing the different understandings of the term "smart cities" by city stakeholders
- Finding out about the ambitions and expectations regarding smart cities
- Identification of the state of things as regards innovation management in cities, including the set of instruments, practices, policies, citizen involvement approaches etc.
- Identification of the state of things as regards ICT infrastructure, applications, technologies, experimental facilities, other innovation resources
- Identify current and emerging policies and strategies of cities to exploit the opportunities of the Future Internet and ICT applications
- Understand the diversity of policies observed in different cities
- Identify bottlenecks and gaps hindering successful implementation of smart city policies
- Identify the opportunities for collaboration and partnerships in order to exploit the opportunities of the Future Internet
- Identify the opportunities for optimizing the synergetic use of available resources and assets such as experimental facilities, living labs and user communities.
- Provide the information for assessment and benchmarking of participating cities.
- Prepare policy recommendations to boost smart city strategies and developments at EU level.

The case studies present an empirically-based and realistic picture. The smart city case studies will be published in a concise report aiming for wide distribution and visibility at upcoming events (FIA, Open Days, Eurocities events etc). The case materials will also form the core of a foreseen special issue on Smart Cities and Future Internet of the Journal of the Knowledge Economy (JKE).

The intended size of each case study might be either (1) about 5-6 pages or 2.500 words, abstaining from obvious descriptions and focusing on essential observations, specific analysis and policy conclusions, or (2) more extended review and analysis about 5.000 - 7.000 words, in the form of a JKE contribution paper, covering also aspects of literature, empirical survey findings, and discussion. Detailed descriptions of concrete examples with a distinctive contribution that could enrich the discussion will be appreciated.

9.2 CASE STUDY CHECKLIST FRAMEWORK

The following framework presents checkpoints and questions for desk research and semi-structured interviews. Interviews could be arranged with different types of stakeholders:

- Local governments, agencies
- Business associations
- Research organizations and agencies
- Innovation agencies
- Private initiatives
- Other.

In a first round of developing the cases, interviews may be limited to just a few persons.

The key aspects covered in the cases are the following:

1. Smart city concept and ambitions
2. Current situation
3. Management of the Smart City Initiative
4. Drivers and bottlenecks
5. Conditions established
6. Assets / resources
7. Innovation ecosystem characteristics
8. Future Internet opportunities
9. Success and failure factors

Below are specific questions and eventually respective sections that can be covered in the case studies. This is meant as a list of suggestions in the first place, to support desk research and interviews. Some limited overlap cannot be avoided as some of the topics will be approached from different angles.

How is the smart city concept currently adopted, and what are the ambitions and expectations

This question looks to the over-all overview of how the smart city concept has been adopted so far, and what the ambitions and expectations of smart city stakeholders are.

- How do city stakeholders understand and interpret the concept of "smart city", how are they defining or describing this concept (maybe in different terms)
- What are the key objectives associated to this concept and how are they translated to policy objectives and priorities
- What is the importance of the smart city concept as a policy concept
- What are the ambitions and expectations regarding the smart city concept
- Has a specific "unique" approach or model to smart cities adopted
- What is the relation between the Smart City concept and Innovation in the Public Services.

What is the current state of affairs of the city functioning as a "smart city"

This question looks at different aspects of state of the art, among which: broadband infrastructure and applications, online services, smart urban environments, policy initiatives as implemented, quality and strength of the innovation ecosystem, current innovation activities, and results achieved.

- What are the policies, programs, collaborations and partnerships, activities and initiatives related to smart cities as currently functioning
- How are they managed, as separate programs or as a common initiative.
- What are the current activities of the city on deploying and using broadband infrastructure and working on Internet-based applications targeting business and societal development
- Describe the current innovation ecosystem at city and urban level and how it functions to establish smart city objectives.
- What are the main results that have been achieved in terms of infrastructure, applications, wellbeing, healthcare, human capital, mobility, the local economy, etc.

What are the drivers and bottlenecks influencing the transformation towards a "smart city"

This question aims to identify the driving forces and bottleneck factors that influence the development towards smart city.

- What are the driving forces underlying the transformation towards a smart city. Think of stakeholder strategies, economic development perspectives.
- What are the bottlenecks hindering the transformation towards a smart city. Think of resources, budgets, lack of attention, adoption problems.

Which strategies, policies, infrastructures and other conditions have been established to stimulate the future transformation towards "smart city"

These conditions should be distinguished from actual results and achievements. Such conditions will be multidimensional:

- Existence of vision and strategy, policy programs, organizational capabilities related to smart cities.
- Resources and budgets committed to realize smart city programs in the near future.
- Existence of projects of ICT-based innovation to support smart city objectives
- Available broadband infrastructure, fiber optic and wireless networks, to enable smart city applications development.
- An innovation ecosystem at city and urban level stimulating the development towards smart city objectives.
- Awareness, engagement of stakeholders and actor groups, community building activities.
- Governance mechanisms that manage the initiative, describing if they are centralized or independent, maybe unrelated projects.
- Is there a conception of government as a platform or is it regarded as a service provider.
- Networking and cooperation mechanisms with other cities and initiatives, intention to reuse or collaborate in the development.
- Mechanisms in place for the participation of external actors such as SMEs, users, Open Source contributors or commercial companies.

Which resources and assets are available to facilitate the development towards a "smart city".

Assets include the human, technological and infrastructural assets (capital goods) that are underlying the smart city. Assets may include experimentation facilities, living labs, know-how and technologies, human capital, user communities, as well as the assets embodied in the existing innovation ecosystem. This question addresses the "common assets": the resources that

are available to facilitate, when combined and made accessible, the transformation towards smart city.

Asset type	Services offered
Network infrastructure	Provide opportunities to experiment and realize applications; city clouds; virtualization of computer infrastructure
Testbed facilities	Technology testing
Testbed methods	Testing and validation process
Living Lab facilities	User driven applications development
Living Lab methodology	User engagement, cyclic development, action research, data collection
Human capital	Expertise, know-how (Future Internet, applications, business)
User community	Availability of advanced users for experimentation and evaluation
Collaboration platform	Enabling interaction between users, developers, stakeholders
Technologies, know-how	Application opportunities
Public data / information	Information, applications
Policy resources	Access to funding opportunities, organizational capabilities, networking enablers, innovation policies and programs
Project development capability	Capability to initiate and develop Future Internet and Living Labs projects to support smart city objectives

Specific questions regarding assets:

- Which assets are available or in use
- What is the present role of these assets in the smart city innovation ecosystem
- What are the opportunities to create or enhance synergies in combining these assets in order to strengthen the smart city innovation ecosystem
- How mature are the assets mentioned

What are the characteristics of the innovation ecosystem facilitating the smart city

The smart city innovation ecosystem can be described in terms of the different elements of the urban innovation system and how these elements interact and create synergies to create value. What are the weak and strong points in the innovation ecosystem as regards the realization of smart city objectives? How is it actually functioning?

- Infrastructure conditions: broadband networks, but also educational system, research infrastructure
- Networks of collaboration between stakeholders; innovation community building
- Business climate, entrepreneurial conditions,
- Demanding citizens and companies as uses of advanced ICTs who are capable to organize the demand side
- Local government role as pro-active catalyser of innovation and network organizer
- Institutional reform: Decentralization of decision making; people involvement; turning citizens to services providers; intellectual property issues in Internet applications; supporting small companies providing future Internet services
- Existence of open platforms, connected or not to other cities.
- Participation in existing platforms, such as Google Maps, etc. commercial or not.

- Development of open solutions, open source or not or preference for commercial or ad-hoc solutions.

How are cities exploiting the opportunities of the Future Internet and how to enhance that

- What is the current state of affairs in exploiting the opportunities of the future internet
- What are the next steps foreseen
- What are the plans, programs to exploit the opportunities

What are the success and failure factors underlying the transformation towards a smart city; how should city governance change in order to facilitate the development towards a "smart city"

- What are the success and failure factors of smart city strategies and policies
- What have been the experiences, lessons learned on how to achieve success and avoid failure in transforming to a smart city.
- SWOT: what the strengths, weaknesses, opportunities and threats shaping the smart city strategy.
- What are the policies in place to facilitate the transformation process towards a Smart City.

The case studies are presented in the Appendix 1. Four of the cases, namely Manchester, Helsinki, Thessaloniki and Barcelona, have been published, in a revised form after a review process, in the Special Issue on Smart Cities and the Future Internet in Europe, of the Journal of the Knowledge Economy (April 2012). The next sections provide summaries and lessons learned of the seven case studies.

9.3 BARCELONA: FROM TRADITIONAL AGGLOMERATION TO METROPOLIS

In 2009, Barcelona came fourth in the ranking of Europe's best cities for locating business [7]. The extensive industrial operation and entrepreneurial structure helped Barcelona to become a knowledge-intensive economy. Knowledge is used as an engine for economic growth to support production and the generation of talent with more than 400 research centres. Barcelona is pioneering the Smart City concept, with various initiatives like 22@Barcelona district.

Barcelona urban policies and reforms are leading towards becoming a Smart City. Barcelona Smart City initiative aims to generate smart ideas in an open environment through fostering clusters and Open Data or developing proper living labs while directly involving citizens in the co-creation process of products or services.

Barcelona transformation into a Smart City leaded to ask the following questions:

- How does city hall manage transformation?
- What are the underlying drivers and bottlenecks for the transformation?
- What are the main obstacles faced by city hall?
- What are the necessary conditions to be established for the transformation?
- What are the assets/infrastructures required to become be a Smart City?

Barcelona Smart City model required as main driver the fostering competitiveness of the city. Other drivers are to promote innovation, create new channels of communication, facilitate access to information both locally and internationally and improve the efficiency of public services.

Figure 1. Conceptual model of Barcelona [1]

Barcelona Smart City is the physical environment providing the necessary infrastructure and town planning based on historical patrimony. The city knowledge economy is built with an industrial network and clusters creating a relationship space, social network between companies, institutions and city hall and citizens. This interaction of the citizens with this area and companies creates a knowledge society.

The main assets of Barcelona Smart City Model (see Figure 1) leaded to launch initiatives, namely: Smart Governance, Smart Economy, Smart Living and Smart People. Smart Governance is based on Open Data with information kiosks and maps providing a better access to government information. Barcelona Smart Economy is based on the creation of innovation clusters, and a triple helix concept with interacting companies, faculties and citizens for fostering innovation. The initiatives under Smart Living are targeting new technology adoptions that are mainly initiated by municipal police and tool developments for public transport. Finally, Smart People mainly involves training programs for digital literacy of the Barcelona City hall. To support these initiatives Barcelona use existing or new infrastructures; the 22@Barcelona innovation district; Corporate Fibre Optical Network; Wi-Fi mesh network; Sensors network and Public Wi-Fi network.

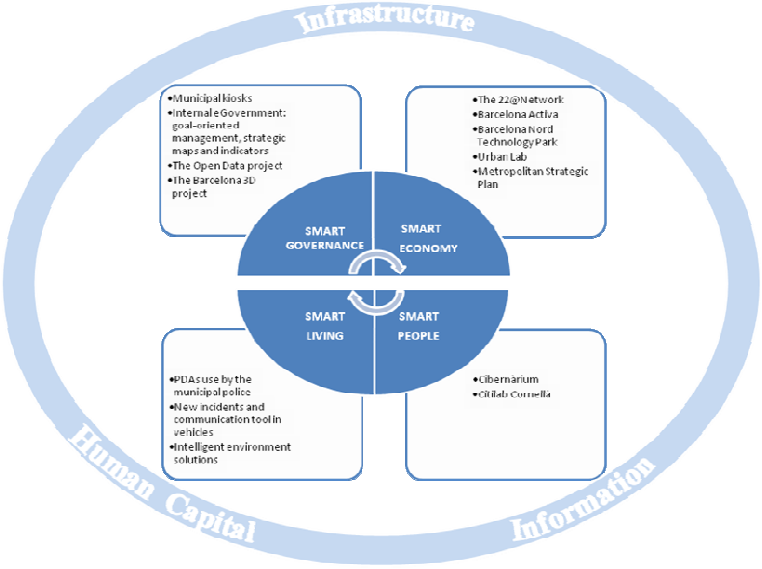


Figure 2. The main assets of Barcelona Smart City initiative Model [generated from 1, 4, 5]

Barcelona Smart City model foundations lay on three pillars, namely these are ubiquitous infrastructures, information and human capital. The goal is to provide citizens and enterprises with a powerful platform connecting city elements for an effortlessly interaction with each other and with their administration through electronic means. Optical fibre networks cover the city acting as a backbone to the installation of sensors for the development of intelligent solutions in cities.

Information coming from daily activity in the city is an invaluable asset that needs to be collected and interpreted, creating a Smart City information space that acts as the basis to deliver smart tailored services and better city management. There are two main information sources:

- Information coming from the city that involves sensors and city elements and Open Data (public sector information);
- Information coming from the citizens as digital footprint, social media and Crowd Sourcing.

The implementation of the Smart City is not only a concern of public administration as it should involve the human capital: population, innovation centres, companies and entrepreneurs. Faculties and society are knowledge producers, while companies and entrepreneurs generate new business opportunities. Cooperation among these actors seems to be the key for talent development.

Main Components of the Smart City Strategy of Barcelona

Barcelona Smart City concept is used as a strategic tool to encompass modern urban production factors in a common framework and foster competitiveness of the city. Barcelona Smart City Model components are:

- **Smart Districts:** The 22@Barcelona district supports the formation of urban research and facilitates a new working space among the Barcelona city hall, companies and institutes. This space is intended to foster research activities about the smart management of the urban space and e-services. The main objective is to sustain an area for the collaboration with companies and institutes for new product developments while improving the urban management. It also creates a space of personal relationships. It constructs an affiliation sensation to the community of 22@Barcelona and this also encourages feelings such as pride to live and work in 22@Barcelona district.
- **Living Labs initiatives:** 22@Urban Lab is another component for new infrastructures and services, inspiring companies to test and develop innovative solutions as products or services in any field: sensorization, urban planning, mobility, education. Living Labs are used as tools and processes for the creation of user innovation cooperatively in real life environments. It is employed for learning, conducting tests and research for the implementation of new technologies and services of organizations in large-scale real-life environments.
- **Infrastructures:** The traditional infrastructures are redesigned to ease the integration of ICT at all levels. This can take place either as a minor road renewal or a whole transformation of a major district such as 22@Barcelona or Sagrera for a model of territory adaption to the new needs. This major transformation involves infrastructures such as companies, institutions, specific spaces, universities, technological centres, incubators, residences, dissemination, entrepreneurs, and other services. The backbone of the smart city involves special public property infrastructure plans. This involves Wi-Fi and optic fibre, a new mobility plan, new heating and cooling systems, new energy networks and underground galleries.

- **New Services for the citizen:** A corporate optical fibre network to connect the main municipal buildings; a Wi-Fi mesh network to provide wireless connection to those municipal services and employees working at street level; sensors networks to manage a multivendor, multipurpose sensors network configured to be used by several providers; and a Public Wi-Fi network. Services created by citizens for the citizens, including also the professional arena, boosting cooperation between the several elements of civil life are grouped under Citizen to Citizen services. These services are based on public Open Data, representing the real social innovation and the real openness of a city.
- **Open Data:** These data involve territory, population, management and procedure indicators, urban environment and documental data. It is society's right to use this data, whether to brief themselves or for creating new services, increasing social value and perhaps also commercial value.

Benefits

Regarding the 22@Barcelona District, city hall created new employment opportunities, moved universities to the area, provided social housing, urbanized green areas and provided more efficient public services. It created more than 4.000 units of new housing with 25% at minimum rental, 55,000 jobs with over 1500 new companies, and new institutions, mainly in information and communication technologies and media industries. It has 10 universities and 12 R&D centres [5].

Private organizations gained from the use of leading-edge infrastructures, higher density of collaboration and networking. For instance, through the 22@Urban Lab, new products and patents were generated from commercial products that have been tested and validated at least in one city. This assures the viability of their solutions in a real environment while fostering innovation. Hence the Smart City model provides a higher rate of innovation, creativity and cohesion for both parties.

Challenges

Barcelona Smart City has faced the following challenges:

- Provide the appropriate infrastructure, deployment and management of Wireless Networks;
- Creation of triple helix, networks, clusters and collaborations: skilled human capital level was not enough to satisfy the needs of industry clusters. The level of local entrepreneurship was lower compared to any other country in Europe. Venture capital funding was not sufficient to attract firms and finance start ups. The number of large firms to lead innovation was low. In the business context, global connectivity of Barcelona was poorer compared to other European cities.
- Top-down approach in leadership leading to difficulties about local engagement and collaboration across departments;
- The planning and use of new products and services should be well integrated with the social and economic programs of the city in order to provide a real test environment;
- Intermediary organizations were used for facilitating the cross-departmental cooperation and clear definition of roles and responsibilities;
- Provide effective governance actions in the case of budget restrictions while sustaining urban growth with continuous development.

Lessons Learned:

- Barcelona and other cities need to proactively engage and collaborate with public and private organizations as well as with knowledge institutions;

- Cities should base their Smart City models on three main pillars, namely: infrastructure, human capital and information;
- The Smart City initiative should be a composition of various organizations and departments;
- Main obstacles are the management of the initiative, providing necessary infrastructures, and creation of collaborative networks;
- Both public and private sectors benefited from this initiative in terms of enhanced public services, innovation, business developments and a more collaborative system;
- As the main outputs of the Smart City model, Smart Services have been successfully implemented to boost cooperation, innovation and development;
- To sustain an effective urban management system, intelligent network technologies are required to drive economic growth, to support a sustainable green city and provide a better quality of public services.

9.4 THESSALONIKI: ADOPTING THE PARADIGM OF "INTELLIGENT CITY" BY PROMOTING SMART DISTRICTS

The case study on Thessaloniki highlights how a city is adopting the new paradigm of intelligent cities and how the deployment of broadband networks, smart urban spaces, web-based applications, and e-services is helping every district of the city to address its particular objectives of competitiveness and sustainable development. It describes an evolutionary course from digital to intelligent and smart city. The digital life of cities starts at the hyper space, but it soon becomes part of the social life and the physical environment of cities, empowering people and advancing citizen's capabilities by collaborative, collective, and embedded intelligence. An irreversible stream is driving the city from digital applications to smart ecosystems and intelligent places.

The knowledge economy of Thessaloniki is developing via two parallel processes: on the one hand by setting up innovation clusters and technology districts, such as the Technology Park of the Centre for Research and Technology, the Technopolis ICT business park, the Thermi and i4G incubators, the Alexander Innovation Zone, and on the other hand by deployment of broadband networks and web-based services for business, government, and citizens sustaining a new economy around the ICT sector. These two processes are not coordinated, the first being supported by public Research and Technology policy, while the second is progressing thanks to private investments being made by large telecommunication companies, Internet service providers (ISPs), and ICT companies. The process towards "intelligent Thessaloniki" highlights how these two fundamental processes of knowledge development complement each other, and how broadband networks, e-services, and smart environments sustain the main production and innovation ecosystems of the city.

Broadband access in Thessaloniki is provided by a number of operators, such as OTEnet, Vivodi, Telecom, "Tellas, Hellas On Line" (HOL) and Forthnet, with ADSL being the main standard. Most Internet providers use OTE's Bit Stream Network, which is the most extensive privately owned fibre optic network. ISPs lease ADSL connections to offer online services but they do not have access to OTE's network infrastructure. Additional broadband connectivity is offered by the GRNET fibre optic network that interconnects the city's universities, technical and research institutes to a wider academic and research institution's network. 3G coverage is very important doubling the Internet penetration. It is offered by three mobile telecommunications service providers in Thessaloniki. Wireless broadband is offered by many public organisations covering various city districts. These networks have been developed by local authorities, the Aristotle University, the Expo, the Port area, and other public or semi-public organisations. Non-profit initiatives operating on a community / collaborative basis also offer free wireless

broadband connections using cheap wireless technology for creating an open metropolitan network.

Web applications and e-services are running on broadband networks and concern the city's activities, its digital presence and functioning. Most of these applications come from bottom-up initiatives created out of the interest of their developers. However, seen as a whole they create a rich layer of digital services which is emerging from dispersed individual actions. Web based applications address the city as a whole, in contrast to applications related to its constituent objects, and deal with the representation of the city, the functioning of city sectors and districts, content aggregation by citizens, the provision of administration and social services, location-based services, management of city infrastructure and utilities (transport, power, water, broadband), decision making, city planning and consultation. Best known e-services are those related to administration offered by public authorities, mobility and transport services, and local e-commerce, advertisement and marketing. The most technologically-advanced ones and best integrated into the physical space of Thessaloniki are those relating to mobility (public transport, fleet management, route planner, intelligent road monitoring).

These bottom-up initiatives are coupled with top-down planning for turning smart the main productive districts of the city. "Intelligent Thessaloniki" is a strategy for deploying ICTs and web-based services in metropolitan Thessaloniki with the clear objective of strengthening the innovation ecosystems of the city and the new growth sectors of transport, commerce, education, and high-tech industry. This planning effort is blending ICTs and innovation at the city district level, with the aim to create smart city districts endowed with applications and e-services adapted to each city district that enable the mobilisation of collective intelligence and crowdsourcing for learning, innovation, digital marketing, and performance benchmarking. "Intelligent Thessaloniki" is focusing on most important districts of innovation and entrepreneurship within Thessaloniki. Applications and e-services vary from one city district the other. In the *Port area* and surrounding cluster, smart environments are focusing on competitiveness of the post vis-à-vis other ports, lowering operating costs, improving the quality of service, integrating freight transactions, and monitoring and benchmarking the operations of the Port. In the *Central Business District*, digital spaces are seeking to increase the number of visitors and the competitiveness of the CBD, to stop ground being lost to peripheral malls; to facilitate mobility and parking, as well as environmental monitoring and alerts. At the *University campus*, smart environments are targeting on the dissemination of research, the opening up of the University to the local productive fabric of the city, and the strengthening of collaboration with enterprises. In the *Eastern technology district*, smart environments are expected to facilitate the promotion of premises and to attract tenants, to provide online technology services, and to support new business incubation.

The development of broadband networks, digital applications, and smart districts in Thessaloniki provides some insights about the governance of the new digital - social - physical spatiality of cities. Similar processes are taking place in many cities all over the world combining individual bottom-up initiatives and targeted state-led top-down planning. The twin processes of city development - from below and above - are somehow replicated in the creation of the urban digital space and its integration with pre-existing social and physical spatialities. Major challenges to be addressed concern the characteristics of broadband networks balancing development costs and benefits, the digital skills gap and the ability of citizens and companies to master web-technologies and offer solutions over the net, the creativity gap with living Lab methodologies, social experiments, crowdsourcing, and open city platforms, and the entrepreneurship gap with successful business models for smart environments sustainability.

9.5 MANCHESTER: URBAN REGENERATION THROUGH DIGITAL DEVELOPMENT

The Manchester case study encompasses urban regeneration, digital development strategies and the knowledge economy. Manchester has gradually evolved towards the concept of smart cities. In the 80s, Manchester City Council embarked on a radical new approach to regeneration. A new Economic Development Department was established with a proactive approach to economic restructuring and social change towards Innovation in regeneration. Three thematic priorities were defined at that time, namely: set the focus on area and neighbourhood based working; develop a 'creative city' strategy demonstrating the economic importance of the 'arts and cultural industries'; encourage innovation through the development of Manchester Science Park and the recognition that ICT1 could play a significant role in creating new infrastructures and services and, consequently, future economic growth.

These three themes were at the heart of the new Economic Development Strategy for the City and remain at the core of Manchester's neighbourhood regeneration strategy twenty years later for generating sustainable economic growth and reducing dependency through tackling worklessness, inequalities and social exclusion. In 2011 the launch of the EU's Digital Agenda for Europe [2] provided a high level strategic framework for supporting the development of policies and actions to maximise the benefit of the Digital Revolution for all. As a consequence, cities and regions prepared "Local Digital Agendas" to set out their aspirations for change, while at the same time focusing on practical action and initiatives for delivering that change supported by digital technologies and a "user driven open innovation approach".

Manchester reviewed its own Digital Strategy and digital development priorities while focusing on three main issues, namely: ***digital inclusion*** for tackling the digital divide[2]; ***digital industries*** for building on Manchester's strengths in order to overcome the lack of business finance to support new investment and start-ups and the need for better access to skills and pathways to employment in the sector; ***digital innovation*** for generating investment for innovation and new infrastructures and working with the research community on Future Internet development to support Manchester as a 'Smart City' in areas such as smart energy, cloud computing and very high speed NGA[3] digital infrastructures (fibre and wireless), networks and services.

The Manchester Digital Strategy mainly addresses the concept of "Smart Citizens in Smart Cities", using digital technologies to promote community engagement, capacity building and social capital. To use the four level social capital model, namely: **creating a common vision** and **a sense of belonging** for all communities through imaginative uses of digital technologies to help to transform lives; **ensuring that diversity is appreciated and positively rewarded** through improved accessibility of digital technologies to support social networking; **engaging people from different backgrounds through the use of digital technologies** which enables them to have similar life chances; **encouraging strong and positive relationships** to be developed between people from different backgrounds in the workplace, in education and within neighbourhoods by using digital technologies to break down barriers and promote social cohesion.

[1] Information and Communications Technologies
[2] over 50% of households excluded communities no longer having or using copper based landlines
[3] Next Generation Access

Today, MDDA[1] continues to combine innovation through new initiatives, including the Manchester Living Lab, so that it can be the way by which **people and businesses can easily connect and collaborate** while providing **access** for ensuring that all local residents, plus those who come to Manchester to work, study or visit, have the most accessible and affordable ways to use the Internet through local access centres, NGA networks and wireless connectivity; **generating Business opportunities** for enabling existing digital businesses to safeguard existing jobs and create new ones, developing pathways into employment through training and skills programmes, including apprenticeships, supporting new start-ups and social enterprises opportunities and promoting new trading opportunities and promotional activities; **Capacity building** for using digital technologies to build social capital and to support community engagement so that there is real local benefit generated by innovation, which, in turn, increases digital inclusion, provides access to skills and jobs and improves the quality of life through green digital and open data initiatives, working in collaboration with local partners such as the Manchester Digital Lab (MadLab).

A number of examples of MDDA project development in these areas include: **'Fibre to the People'** – the Manchester Living Lab pilot project that started to roll out next generation access digital infrastructure; **Manchester 'Internet Hub'** – ensuring that Manchester can develop its 'Internet Exchange' capacity to be a globally competitive 'Internet Hub' based on enhancing connectivity across the city; **Low Carbon Open Data Network** – extending the wireless connectivity around the Corridor area to collect real-time environmental data using low-cost, low-power sensing equipment and providing open access to the data through a range of online services; **Smart Innovation & People** – a European project connecting up digitally supported community engagement initiatives in Manchester and four other European cities working in partnership with Peoples Voice Media's 'community reporters' project and the University of Manchester; **Green Digital Charter** – a European wide initiative to reduce the environmental impact of digital technologies and to develop innovative 'smart energy' projects, such as Internet based interactive smart meters, that can improve energy efficiency and get people involved in new and imaginative ways of reducing their personal and collective carbon footprints; **Digital and Creative Skills** – bringing together businesses in the digital and creative sectors, including through Manchester Digital, education and training providers, community networks and other major employers to develop more innovative ways for people to gain skills that can help them get access to jobs, set up their own businesses and get access to advanced learning opportunities through non-traditional routes, including apprenticeships.

Manchester ambition is to become a Digital City Test-Bed with an open innovation Living Lab for creating Future Internet next generation services and applications, such as **developing more efficient public services** - NGA is key to enabling city service providers to maximise the ability for citizens to self-serve and to provide efficient access to expensive specialist resources, such as expert medical care, using innovative new services such as telemedicine; **exchanging knowledge and expertise** - cities are ideally placed to mobilise and aggregate demand for NGA services for the Future Internet 'Smart City' and to provide the strong leadership required to make this happen. The 'Core Cities' network is currently working on an initiative to develop closer engagement between City Leaders, Government, Communications Service Providers and the Internet industry as a whole.

[1] Manchester Digital Development Agency

The Manchester City Region NGA initiatives are being developed in partnership by MDDA, which is part of Manchester City Council, and the Commission for the New Economy, working on behalf of the Association of Greater Manchester Authorities (AGMA) in the context of the City Region Pilot and the proposed 'Combined Authority'.

There are currently linked initiatives being developed:

- **The Corridor 'Living Lab' NGA pilot project**, aiming to connect 500 businesses and 1,000 residential users through a FTTP network. This will be an **access network testbed** enabling new business to business, business to consumer and community based applications and services to be developed as well as innovation in public service delivery in areas such as telecare/e-health, energy efficiency/smart energy, e-learning, smart mobility and flexible working;
- **The Manchester City Region NGA Initiative**, which is currently undertaking a feasibility study on the scope for market investment in new and innovative models of NGA delivery which would harness the advantages of the core network being developed in Manchester and extend this using all possible routes (e.g. Metrolink and other transport corridors together with Public Service Network development) across the whole of Greater Manchester, including those in the 'final third' rural communities and those in inner urban excluded from access by virtue of financial and other social barriers.

This covers not only existing projects being undertaken by City through the MDDA but also 'bottom up' grass roots initiatives being developed by local partners in collaboration with the MDDA. The 'Roadmap' aims to map existing work going on in the city region, which is relevant to the 'Smart Cities' agenda, and to identify how this fits into the future vision, the challenges and gaps which exist and the future solutions and innovation needs in terms of realising the targets and aspirations of the Manchester city region. The 'Roadmap' is seen as a first stage in the process of developing the Local Digital Agenda for Manchester and the Green Paper is in place to stimulate discussion and consultations so that these responses can be used to validate proposals for future work and that this will be able to inform the production and implementation of the Local Digital Agenda for Manchester. Some of the policies, as outlined above, are in place to facilitate and support the transformation process of Manchester into a 'Smart City', but there is still much to be done to ensure that the opportunities that the Future Internet can provide to a city region such as Manchester are fully exploited.

There are a number of specific lessons learnt from the Manchester's experience:

- The need to develop digitally enabled services that are based on the social, cultural and economic needs of the neighbourhoods, requiring the capture of user needs and involving users in the design and delivery of new services, the start of the co-production process;
- Stakeholders in the project, especially the public sector, need to demonstrate a long term commitment to community engagement and capacity building, and invest as much in the development of people's skills, confidence and aspirations as in the technology being deployed;
- The need to have an ongoing evaluation strategy that not only has the ability to identify weaknesses, and even failures, but also has the role of communicating these results directly into the strategic decision making process so that the project can accordingly adapt and evolve;

- The importance of developing real exemplars that push the boundaries of what people know and their expectations, so that people's imaginations are stimulated and horizons widened while this is communicated with all the power that Future Internet enabled communications can bring with the most effective social media and social networking;
- The potential for generating added value from innovation and new investment into the area while at the same time focusing existing investment within those locations and sectors that are most capable of delivering growth, in order to respond to the ongoing structural shifts in the economy towards knowledge industries, including Future Internet enabled services.

9.6 HELSINKI: TOWARDS A SMART CITY CLUSTER AND USER EMPOWERED INNOVATION

As the leading national expertise cluster, the Helsinki Region remains the strategic core of Finland's international competitiveness. Helsinki region is the economic heart of the Small and Open Economy (SMOPEC) of Finland. 'Helsinki Region' is both a fairly loose cross-municipal organization and a vaguely defined area surrounding the capital region, consisting of the City of Helsinki and 10-15 municipalities around it. Helsinki Region has no strategic planning instruments and decision-making bodies as such. However, collaborative arrangements for water management and public transport and various informal networks are grounds for active co-operation. For the metropolitan region to become and function like an effective 'Smart City' a change towards increased collaboration between the municipalities is needed. Helsinki, as a developing Smart City working to promote a Smart Region, does not endorse limiting smart solutions to its municipal boundaries, or to organizations that serve a single municipality. Removing boundaries between bureaucratic organizations is necessary within and across a competitive and agile smart region of the future. For the Helsinki Region to act effectively towards smart services it must provide platforms for innovation that are open to all municipal and regional parties with an interest in developing new products and services. The competition for applications cases shortly discussed below forms evidence of this (cross-municipal) collaboration in setting up an innovation platform around open data aiming at smart services for citizens.

As indicated, collaboration is of crucial interest. The first innovation strategy for the Helsinki Region shows the way forward for collaboration that will more efficiently harness the huge innovation potential of the metropolitan area. The future competitive strength of the Helsinki Region and its appeal as a strategic partner for the world's other leading knowledge hubs will depend on the Region's record of effective collaboration. In terms of Porter's concept of cluster, Helsinki region forms a strong innovation oriented cluster around mobile technology, based on favourable factor determinants such as high quality research and education institutes, a continuous demand for change and innovative services, a highly competitive business environment, and at the same time a strong innovation driven networks of businesses and with governmental actors.

For the Helsinki Smart City strategy the emergence of a mobile application cluster is a benefit and the resulting competition within the cluster is equally essential. The proximity of the cluster members, both geographical and cultural, supports the constant drive to innovate in order to grow. This gives a push to development of innovative ideas for the Smart City. The user and citizen's participation and demand provide a pull. By becoming a center of innovative and competitive firms a cluster attracts new firms to the area, creating economic growth. Within the Helsinki Region, this competitive-collaborative process is ongoing within IT, media, services, and particularly in the sector of mobile application development.

The City of Helsinki has stimulated the development of a Mobile Application Cluster through organizing competitions for innovative applications. The Smart City services that are developed in competitions benefit both the Mobile Application Cluster and the citizens. The function of the competition mechanism to encourage the development of new mobile applications utilizing Open Data is described with examples from the Helsinki Region. Porter's diamond model of determinants of national competitive advantage is used as a framework to describe the forces driving the ongoing developments towards the Mobile Application Cluster. In particular the paper explores the interaction between the cluster determinants of Porter's model with regard to the externalities made by the linkages between the parties in the emerging cluster. In the two competitions for Open Data applications that the paper discusses innovation is supported by a policy-like instrument: an urban competition on open data, which is driven forward through the Living Labs approach to innovation. The two competitions launched in the Helsinki Region are aimed at developing mobile applications by utilizing open data. This case study shows how a Living Lab functions as an innovation intermediary where the competitions are utilized in developing a Smart City.

9.7 LISBON: TOWARDS AN INTERNATIONAL HUB AND SUSTAINABLE CITY

Lisbon's goal towards becoming a Smart City is to improve the city's liveliness and quality of life, namely through the active involvement of the citizens in the city's governance model.

This strategy is set "to facilitate creativity, providing citizens, small enterprises, start-ups and civil organizations the tools needed to create, to innovate, to enable social innovation, centring the citizen as a co-producer/partner of the City"(source: Lisbon City Councillor Graça Fonseca(2009), "Lisbon Smart City", www.lisboaparticipa.pt).

The most important challenges addressed through the Smart City Initiative are entrepreneurship, enhancing the city's capacity to attract investors and promote the nurturing of new ideas and business models; urban management, improving the city's management structure, focused on the optimization of resources and smarter use of infra-structures and citizens participation, inviting citizen's to actively participate in the city's governance model.

Lisbon's path towards becoming a Smart City is at its very beginning. This fact hinders a thorough analysis of the effective impact. Nevertheless the achievements of this strategy so far have been very positive with the creation of the Lisbon Start Up, the launch of the Fab Lab initiative and public and private Co-Working centres. At the urban management level the strong effort in the improvement of the public transport system and the collection of real time data regarding energy use in public buildings and services allowed the optimization of infra-structures and the definition of intervention priorities. Finally user's involvement in the city's governance model has been successfully achieved with the Participatory Budgeting Initiative.

The work already developed, namely in the citizens governance area allows to acknowledge positive lessons that are the basis for this strategy's continuous improvement. Citizens are eager to participate, and a proof of this is the increasing participation in the Lisbon Participatory Budgeting initiative that started in 2008 with 1.000 citizens and achieved more than 17.000 participations in 2011. Despite the positive feedbacks a strong effort has to be put into the communication strategy, enabling different actors to interact and represent their role in the society. The Living Lab methodology is already a tool, being mostly applied in energy efficiency projects dealing with consumer behaviour. Energy efficiency projects are being developed both in residential and service buildings with savings between 9% and 20% in the residential sector and between 5% and

13% in service buildings. These positive results are incentives to the deployment of new projects and the addressing of new areas where the Living Lab methodology can be applied. The collection of real time data in service buildings and cooperative analysis with the building managers is another area where ICT as proven successful, arising new cooperation activities and new interaction patterns between energy managers and energy experts, opening the door for the implementation of new business models, focused on energy services and energy performance contracts. Entrepreneurial activities, taking advantageous of the assets created are flourishing, especially within the creative industry that already plays an important role in Lisbon's economy and can further be deployed in this sense.

Resources, education, information and confidence are the natural barriers still to overcome. Resources to deploy the mainstream of information and communication technologies applied to the most diverse environments, collecting and integrating data that allows optimizing processes and taking the most out of existing infra-structures. Education is at the heart of a Smart City: "We believe a city to be smart when citizens and visitors have the opportunity to make smarter choices." Education is crucial for citizens to understand the strategy and deploy useful, usable tools. Information, targeted at the different social and age communities and confidence on the common goal, on the overall strategy and on the actors involved.

9.8 OULU: A LEADING WIRELESS R&D HUB WITHIN THE GLOBAL INNOVATION ECOSYSTEM

Since early 90's the City of Oulu has been determined in developing working environments to expedite growth of businesses in the Oulu region. An active role in standardization of wireless and mobile technologies, remarkable investments in public wireless and mobile infrastructure and concrete collaboration with unique PPP programs, have all made Oulu a leading wireless R&D hub within the global innovation ecosystem. Intensive collaboration between companies, public sector and universities, so called "Triple-Helix" has been the base for co-operation for many years. The city of Oulu and Oulu region with its developing infrastructure forms an excellent urban living lab, a system and an environment where real-life user centric innovations flourish.

The City of Oulu has recognized the areas for development identified and presented in the digital agenda as important. For its part, the City of Oulu has worked actively to promote the various preconditions necessary to support a knowledge society. For instance *panOULU,* Oulu's wireless WLAN, has been realized as part of local municipal projects, as has *OmaOulu*, a 'citizen's portal' giving citizens free access to e-services. Within those municipal projects, a clear need has been identified to develop the skills and capacities of both citizens and municipal workers to participate in a knowledge society, in order to improve citizen knowledge of information security issues, helping to avoid security risks related to the use of e-services. Also, the development of skills increases citizens' trust in e-services, resulting in an increase in the use of those services.

In the course of just a few decades, Oulu has become among the most successful cities in northern Europe. In 2015, Oulu aims to be the most developed city in Finland and northern Europe as well; the "city of technology" will evolve into a centre of innovation. In this new strategy, the city states its intention to continue on its present path of strong growth, to multiply its efforts to attract companies based on high competence in different fields to the city, and to promote internationalisation by a significant increase of foreign employees. Oulu intends to gain a clear head start compared to other cities by being number one in terms of service provision and top-level education. For this purpose, Oulu is setting itself demanding challenges and tasks, with the aid of which the top position can be secured. Oulu is also the first city to define creativity and courage as being the most important among the values that guide its operation.

Besides creativity and courage, a sense of community and tolerance are emphasised.

The city of Oulu has strongly emphasized the importance of its innovation ecosystem. In 2007, the city created a national level working group to draw up a regeneration proposal for the Oulu innovation ecosystem in order to better meet the challenges of internationalisation of business and innovation. The short term goal was to establish a strategic partnership of Oulu Triple Helix development Alliance, later on called the "Oulu Innovation Alliance", including the City of Oulu, the University of Oulu, the Oulu University of Applied Sciences, the VTT Technical Research Centre of Finland and Technopolis. The activities focused on the creation of centres of excellence (e.g. centre of Internet Excellence, Centre of Wireless Communication) and the creation of an open ubiquitous city in Oulu. From the user community's point of view such a city appears as a smart urban space providing rich interaction between the physical, virtual and social spaces. From the R&D community's point of view the city appears as an open community test bed stimulating innovation, research and development of new services and applications. The test bed enables urban computing research in authentic urban setting with real users and with sufficient scale and time span. Fundamental hypothesis is that by deploying new pervasive computing infrastructure and new applications and services into the public urban space, a better place for people is made.

Oulu has aggressively developed its infrastructure which forms the core of what can be called an urban living lab where real-life user-centric innovations flourish. Oulu's living lab offers an environment for sensing, testing and piloting technological and social innovations. One example how City of Oulu drives for the Living Lab approach to obtain user-driven innovations is development of "test user community" tool in Tomorrow's Service Society project (EAKR/Council of Oulu Region). Test User Community tool "PATIO" (www.patiolla.fi) empowers ordinary people to experiment and contribute to development of new services or appliances. Another example is **development of learning environments**. How to renovate old schools or new school buildings to meet challenges of future learning? The Education Office in the City of Oulu is investing in future oriented thinking to develop learning environments to better match the learners and their needs. This foresight thinking is unique globally. Among the living labs created in the Oulu environment are OULLabs (Oulu Living Labs) and NorthRULL (Northern Rural Urban Living Lab). The applicability and benefits of Oulu's open ubiquitous city testbed has been demonstrated with many examples in collaborative industrial R&D and in engaging user communities. Some examples are the OmaOulu service giving citizens free access to e-services, the development of Future Schools and InnoLobby as a Learning Environment of the Future, the Smart Urban Spaces project and other.

It can be said that City of Oulu has been driving the Smart City ideas already from the early 90's. Many activities which have not been called at that time as a "smart city" or "Living Lab" have been done in co-operation with real end user, "an ordinary innovator". In early 2000, the City of Oulu advanced the catchword "Smart Oulu - Knowledge is the future" in the "Information Society City of Oulu" project. One of the examples of that project is the Smart Card (City Card) which was an ID-, access- punch- and payment card used by city employees and others involved to the project.

Even while there is an intensive collaboration between "Triple-Helix" stakeholders, it is still difficult to make all happen because of the different policies and priorities. The need to keep the "Smart City" architectural thinking continuously developing in terms of realizing plans towards results, combined with the need to continuously discuss and attract resources (time, people, facilities and money) sets the innovation ecosystem under pressure.

Available funding instruments and policies are not always supporting business development and spin-offs from research institutes. Policies have to be modified to enable to start commercialization of research results and help SMEs to do business with infrastructures developed with publicly funded projects. For example, in the future the public sector should be able to engage in innovative ways of procurement, so-called "early involvement process", when purchasing new e-services or software. In this process possible vendors will be taken into the loop in the early phase, to be able to avoid bidding but still taking care that everybody who would like to offer can do so.

Regional, national and international co-operation in developing Future Internet-enabled services have very crucial impact on the life of citizens. Citizens' (users) active participation in the economic activities plays an important role in the innovation process since citizens offer ideas and resources for innovation. Cities and Regions should therefore be fully involved in the process of governance and deployment of Future Internet services.

9.9 REMARKS ON THE CASES

The smart city cases demonstrate, besides the similarities as regards smart city visions, some different approaches to the concept of "smart city" as well. Clearly the cities covered are at different stages of maturity and have been developed under different circumstances and using different strategies.

It is also clear that the "smart city" is a strategy, not a reality yet. Several cities investigated, such as Oulu for example, are advanced in terms of technology infrastructure. However a smart city is more than technology and infrastructure; it is also a universe of smart applications and platforms which are empowering citizens in innovative ventures.

Formation of innovation districts, neighborhoods, and clusters are fundamental elements of a smart city strategy, because the city is a system of systems, and cities co-exist within cities with variable management capacity and institutional control. Formulating smart city strategies in terms of smart districts and clusters offers also an advantage for exchanging good practice and solutions from one city to another, as cities are made from the same set of standard districts (CBD, housing, industrial, commercial, university campus, port and airport hubs, recreation).

A smart city strategy involves many actors, organizations, communities, R&D, NGOs, clusters, and authorities. The strategy should achieve a common vision, flagship projects, collaboration and synergy. Top-down planning and bottom-up initiatives should complement each other.

Major challenges for successful smart city strategies deal with skills, creativities, user-driven innovation, entrepreneurship, venture capital funding, and management of intra-government rivalries.

The cases, however, do not provide detailed evidence on how cities are realizing their vision. This implies that there is a need for even deeper analyses and case-based research on the transformation towards smarter cities.

10 SMART CITIES LANDSCAPE AND ROADMAP TOWARDS STRATEGIC COLLABORATION

10.1 INTRODUCTION

The FIREBALL project develops a Smart Cities Landscape Roadmap aiming to outline potential pathways to the future of Smart Cities. This Landscape Roadmap has been contributed to the FISA Roadmapping working group. The contribution to FISA will be ongoing during 2011-2012.

The Roadmap forms the basis for a strategy towards developing sustainable collaboration across the three major communities: Cities, Future Internet and Living Labs. Whereas this deliverable (M12) focuses on the Landscape Roadmap, next activities will address the Smart City Collaboration Strategies for Implementing the roadmap.

10.2 FIREBALL ACTIVITIES IN FISA ROADMAPPING WORKING GROUP

FIREBALL has actively participated in FISA since October 2010:

- Member of the FISA Roadmapping working group, which prepares recommendations to the European Commission regarding FP8
- Proposed the roadmapping methodology, which is now used in FISA
- Co-organised several roadmapping workshops (Roadmapping workshop at FIA event, Ghent December 2010, and FISA Roadmapping workshop 31st March 2011, upcoming 3-4 May 2011)
- Prepared the Smart Cities Roadmap Framework.
- Member of the Editing Committee for the FISA Roadmap 2020.

The FIREBALL Roadmap results will be presented and discussed at the upcoming eChallenges 2011 Conference. A workshop will be organised for that event, and a conference paper is in preparation next section).

10.3 ROADMAP APPROACH: PAPER PREPARED FOR ECHALLENGES 2011 CONFERENCE

This section presents the accepted extended abstract of a paper which is currently in preparation for the upcoming eChallenges conference, October 2011, Aachen.

Cities and urban areas of today are complex ecosystems, where ensuring sustainable development and quality of life are important concerns. In such urban environments, people, companies and public authorities experience specific needs and demands regarding domains such as healthcare, education, media, energy and the environment, safety, and public services. These domains are increasingly enabled and facilitated by Internet-based applications, sensors and embedded systems, and infrastructures based on common platforms. Therefore, cities and urban environments are facing challenges to maintain and upgrade the required infrastructures and establish efficient, effective, open and participative innovation processes to jointly create the innovative applications that meet the demands of their citizens. In this context, cities and urban areas represent a critical mass when it comes to shaping the demand for advanced Internet-based services and experimentation in a large-scale open and user driven innovation environments.

Now that Future Internet driven network infrastructures and applications start becoming available, which potentially might bring economic and social benefits not only to research communities but also to Cities, it becomes all the more urgent to advance strategies that elicit their future needs and requirements from the perspective of user driven open innovation. Identifying these needs and requirements elicitation also informs ongoing research, experimentation and deployment activities related to Future Internet and testbeds, and helps to establish a dialogue between the different communities involved in the development of the future Internet and user-driven environments, to form partnerships, and to assess social and economic benefits and discovery of migration paths at early stages.

Smart Cities (a concept which is connected to notions of sustainability, empowerment and quality of life, enabled by modern ICTs) therefore need to develop strategies and migration paths regarding how they will make use of available Internet infrastructures, testbed facilities, applications and know-how, and how they will develop (public-private) partnerships for their access and exploitation. Informed by technological opportunities and cost-benefit assessments, cities should develop priorities regarding socially and economically desirable applications, based on strategic objectives regarding economic and social development of city areas. Gradually we will enter a situation where combinations of such assets will be selected and governed by a business model based on partnership. Common assets that might be useful in smart city strategies include Living Labs assets, Future Internet research and testing facilities, as well as methodologies, tools and user communities. A particular point of attention is how these assets can be made open accessible for users and developers, to stimulate experimentation and innovation and become part of the innovation ecosystems of cities.

The paper reports results from the FIREBALL Coordinating Action on adopting the living labs approach for Smart Cities and benefit from the opportunities of the Future Internet (FP7-ICT). The over-all objective of the paper is to provide a state of the art, vision and policy roadmap to support the ongoing transformation of cities towards "smart cities". To fulfil this aim, the paper will:

- Present a state of the art in the domain of "smart cities". Based on literature and cases we are able to provide an assessment and evaluation of the current maturity of cities in terms of "smart cities" measures, policies, infrastructure development, and e-services.
- Develop a framework for smart cities innovation roadmap, based on expected developments in technologies and societal needs. The innovation roadmap considers four dimensions of systems of innovation: technological change, business change, policy change and societal change.
- Derive policy conclusions to support the innovation policies and strategies of cities towards becoming "smart". These policies concentrate primarily on the creation of sector-based or district-based innovation ecosystems.

The methodology to underpin the Future Internet and Smart Cities roadmap is based on a mixture of literature research, cases and consensus workshops. Based on cases we will assess the current state of the art of smart cities in terms of maturity. Through our involvement in a wider iterative and participatory roadmapping activity (FIA Research Roadmap) as well as collaboration with the Eurocities network we are able to present initial validation results. Attention is paid to the empirical grounding of the roadmap and to the validation approach.

The roadmap methodology itself is based on four key questions: 1) what is changing in the domain of smart cities and future Internet, 2) what is the future vision for smart cities based on scenarios, 3) what are the challenges and gaps to be addressed for realizing the vision, 4) what are the foreseen solutions to the envisaged gaps and challenges. The roadmap is based on a two-dimensional mapping of layers and time periods. The vertical roadmap dimension considers

the following layers: technological change, business change, policy change and social change. The time dimension includes the short term, mid-term and longer term developments. In order to enhance the policy relevance of the roadmapping approach, we focus on the systemic character of innovations related to smart cities, which require processes of socio-technical change. To provide guidelines to this process, the roadmapping approach draws from systemic change literature to take into account several characteristics of systemic change relates to the transformation towards smart cities e.g. barriers, transitions and regimes.

A short Delphi exercise among the FIREBALL project partners is used to validate the conclusions of the roadmap. Participants are asked to assess whether the expectations described along the two dimensions of the roadmap are compatible to foresight studies and future research they are acquainted with.

The roadmap is grounded a series of ongoing changes that shape the emerging settings of smart cities. Many cities are increasingly pushing the deployment of broadband infrastructure for urban development, and are creating open networks. Cities are increasingly aware of the concept of "smart city" and actively developing strategies towards the goal of becoming "smart" and manage more efficiently city resources. Part of the development towards such smart cities is the co-creative development, testing and implementation of technologies and ICT-based applications in sectors such as health and assisted living, participative government, energy management, and new work environments. For example, future media research and technologies offer a series of solutions that might work in parallel to Internet of Things and embedded systems providing new opportunities for content management. Media Internet technologies is at the crossroads of digital multimedia content and Internet technologies, which encompasses media being delivered through Internet networking technologies, and media being generated, consumed, shared and experienced on the web. Technologies enabled by the functionalities of the Future Internet, such as content and context fusion, immersive multi-sensory environments, location-based content dependent on user location and context, augmented reality applications, and open and federated platforms for content storage and distribution, provide the ground for new e-services within the innovation ecosystems of cities. At the same time engagement of users and creation user driven innovation ecosystems forms an important precondition for success.

The paper draws policy-relevant conclusions and sets out strategy framework concerning the creation of innovation ecosystems which facilitate the transformation towards smart cities.

City authorities are undertaking initiatives and strategies that create the physical-digital environment of smart cities, actualizing useful applications and e-services, and assuring the long-term sustainability of smart cities through viable business models. To this end, key issues to master concern the main layers of a smart city strategy, including (1) infrastructure development combining wired and wireless networks, (2) embedded systems, sensors, agents functionalities, and data integration, (3) services development and new opportunities offered by open data and the semantic web, (4) technologies and user-driven environments for services and applications development, (5) business models for smart city viability, (6) monitoring and measurement methodologies.

The challenge is to address these issues taking into account emerging technologies, citizens' behaviours, and limitations of city governance institutions.

10.4 THE SMART CITIES ROADMAP

The process for developing the FIA research roadmap was developed at the roadmapping workshop at FIA Ghent (2011). The FISA approach proposed by FIREBALL centers around four key questions driving the roadmapping process:

- What is changing? What are the really significant changes that will take place between now and 2020?
- What is our vision for the future of Smart Cities and Future Internet?
- What are the gaps and challenges to realize the vision?
- What are solutions to those challenges, and what needs to be done in terms of concrete milestones?

Gathering these inputs is complex and there are many different kinds of inputs to be gathered - the framework that we have adopted reflects this and allows us to gather a variety of different contributions but to fit them into an overall framework.

What is changing

The first step of the roadmap process is to identify the emerging changes in the domain of Smart Cities and their innovation ecosystems, which represent the seeds of developments towards exploiting the opportunities of Future Internet and Living Labs. A summary of key changes that we have identified are:

- Increasing deployment of broadband infrastructure and creation of open networks and open data repositories
- Many cities are developing Smart City strategies, in the context of urban development, sustainable growth, revitalisation, and innovation districts
- Increasing participation and empowerment of citizens in societal issues, using social media and open data on a wider scale
- Increasing interest for wider scale testing of services and solutions e.g. energy efficiency, healthcare, environment monitoring, mobility
- Diversity of technologies for smart city applications is becoming rapidly available (mobile broadband, cloud computing, open data, smart devices, content management, Web 2.0)
- User driven open innovation in cities (e.g. crowdsourcing services based on sensor data) is gaining more attention
- All kinds of city managed data could become publicly available to promote crowdsourced services and bottom-up innovation (may also be misused)

Vision of the future

The second step is to develop a scenario representing the future of Smart Cities. Elements of such scenario are the following:

- Smart city digital innovations enable the forecast and management of urban flows and encourage collective intelligence within cities
- Smart enterprises, collaborative business networks, smart energy and health systems, social media and open data are key enablers for smart cities quality of life and sustainable growth strategies
- Future Internet successful development and uptake depends on cooperation along the value chain and user driven innovation to establish sustainable urban innovation ecosystems as "civic in-situ laboratories"
- Cities are a key driver of innovation in Future Internet enabled services and applications. City-based 4P innovation ecosystems develop across existing constituencies and resolve barriers in take up of Future Internet.
- Future Internet testbeds will be enriched by living labs approaches through user co-created applications and services
- Providing access to, and enabling sharing of common assets and resources owned by the different constituencies lies at the basis of these innovation environments.

Gaps and challenges

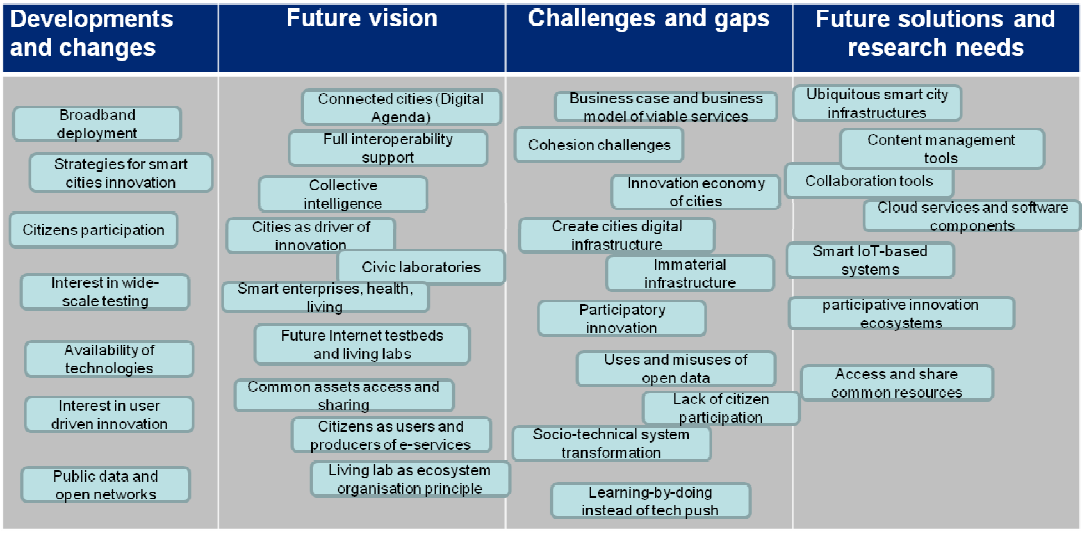
The third step is to identify the challenges to realize the future vision, and the gaps relative to the state of affairs in 2011.

- Smart city digital innovation for cohesiveness: competitiveness, inclusion, innovation and skills, employment and entrepreneurship, and for sustaining the innovation economy of cities
- Smart city digital innovation should address societal and urban challenges: energy efficiency, environmental quality, healthcare. Integrate designed and grassroots solutions
- Create the digital and immaterial infrastructure of smart cities and establish partnerships and business models
- Create rich environment of (fixed and mobile) broadband networks supporting digital applications: networks, sensors and devices, applications
- Create end-user driven and participatory innovation environment on city-wide scale based on sustainable partnerships and willingness to experiment and learn e.g. on cloud computing, Internet of Things, open data, semantic web, future media technologies
- Combine technology push and application pull approaches (e.g. end-user driven and learning-by-doing models). Consider cities as socio-technical systems and address socio-technical change from holistic perspective. Address potential new divides.

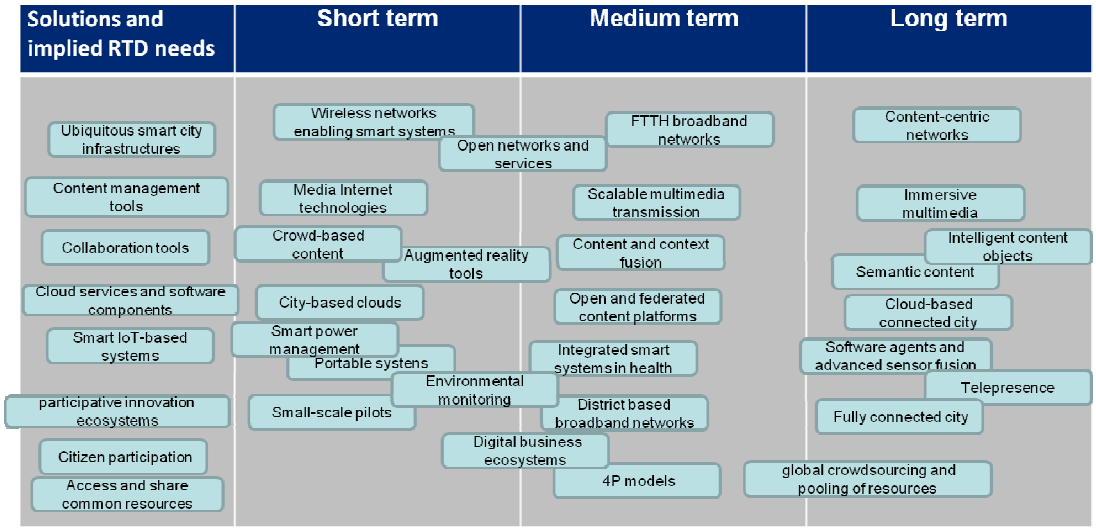
Solutions towards smart cities

- *Innovation ecosystems* based on integrating policies for urban development, revitalisation and digitisation, smart environments harnessing collective intelligence and user driven innovation, and experimentally driven Future Internet research.
- *Ubiquitous smart city broadband infrastructures*: smart city open network infrastructures and services, wireless sensor networks enabling smart systems, smart personal devices, open data infrastructures, cloud computing, public ambient interfaces, Internet of Things
- *Open city platforms* (`i-phone cities`) enabling the creation of products by citizens, including marketing and delivery
- *Technologies and components*: Content management tools; Collaboration tools; Cloud services and software components to build networked applications; Smart systems based on Internet of Things; semantic web and M2M communication
- *Enable the access and sharing to common assets:* open data repositories, experimentation facilities, and testbeds, user communities for validating new services, technology platforms and experiential know-how, IPR for open data
- *Simplification of programming languages,* enabling user-generated services and harnessing mass IT literacy

Summary Roadmap



Roadmap milestones



10.5 POLICY ROADMAP FOR SMART CITIES AND THE FUTURE INTERNET

This section includes parts of the paper published in eChallenges e-2011 Conference Proceedings: Komninos, Schaffers, Pallot: "Developing a Policy Roadmap for Smart Cities and the Future Internet". References are included at the end of the section.

The innovation roadmap methodology is based on [4] and considers four dimensions of upcoming trends: technological changes, business changes, policy changes, and societal changes. In elaborating the roadmap, we focus in particular on developments and impact of three main Internet-based technologies: cloud computing; real-world user interfaces of sensors, tags and RFIDs; and content of semantic web. The aim is to assess the expected effects of these technologies on smart city structures and operations, and the resulting changes on informational and cognitive processes of information collection and processing, real-time alert, learning, collective intelligence and problem solving, which characterize smart cities.

The Future Internet domain landscape comprises a great diversity of research streams and related topics for designing alternatives of the Internet of tomorrow. For example, the Internet of Things (IoT) is considered as a major research and innovation stream leading to create plenty of service opportunities in interconnecting physical and virtual worlds with a huge amount of electronic devices distributed in houses, vehicles, streets, buildings and many other public environments. Hence, a massive amount of data will be flowing over the Internet that should not decrease the overall service performance and satisfaction. In [5] it is proposed to examine the four key components of a real time control system: entity to be controlled in an environment characterized by uncertainty; sensors able to acquire information about the entity's state in real-time; intelligence capable of evaluating system performance against desired outcomes; physical actuators able to act upon the system to realize the control strategy. This perspective corresponds to new technology paradigm of embedded spatial intelligence and intelligent cities. The Institute for the Future [3] has also identified some major trends of the future Internet technologies on smart cities, which emerge, among others, from cloud computing, smart sensors and devices, and open data.

Cloud computing and smart cities

Cloud computing is based on several technology advances related to high-speed networks, virtualisation, and mainly standardisation of platforms and applications. However, "cloud computing is a new way of delivering computing resources, not a new technology" [6], providing computer services through the Internet and a series of new business models of outsourcing. The National Institute for Standards and Technology offers a stylized description of cloud computing as composed of five essential characteristics (on-demand self service, ubiquitous network access, metered use, elasticity, and resource pooling), three service models (software as a service-SaaS, platform as a service-PaaS, and infrastructure as a service-IaaS), and four deployment models: private, community, public and hybrid clouds [7].

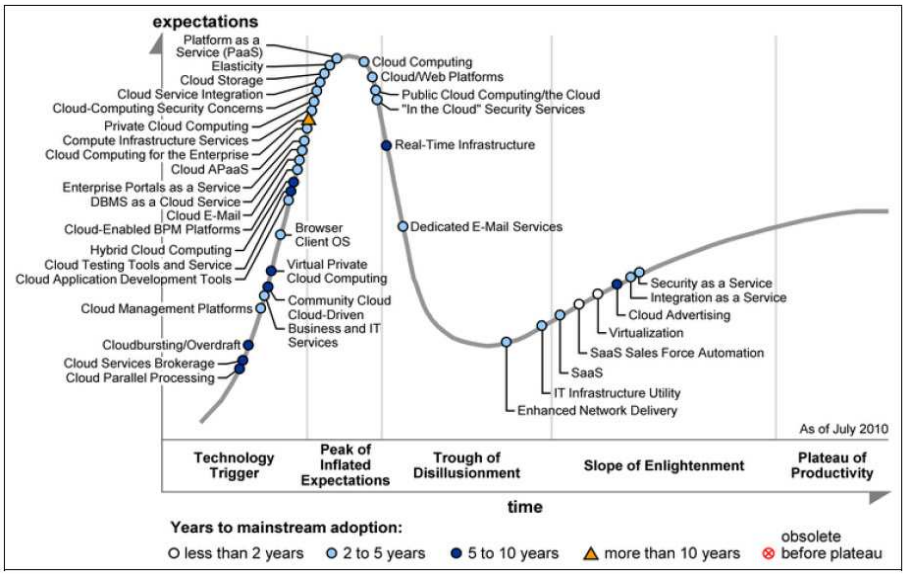


Figure 1. Gartner hype of cloud computing [8]

Foresight estimations about developments in cloud computing is given by the Gartner Hype Cycle for Cloud Computing [8], which is positioning 38 technologies of the field at different stages of the Hype Cycle. In this type of analysis, each Hype Cycle is composed of five stages representing the typical progression of an emerging technology: (1) "Technology Trigger" or technology breakthrough and product launch that generate significant interest of the press, (2) "Peak of Inflated Expectations" the phase of over-enthusiasm and unrealistic expectations, (3) "Trough of Disillusionment" of reduced press interest because technologies fail to meet expectations and quickly become unfashionable, (4) "Slope of Enlightenment" with experimentations about the benefits and practical application of the technology, and (5) "Plateau of Productivity" in which the benefits of technologies become widely demonstrated and accepted. Expectations about cloud computing are very high. Most technologies, however, are at the "technology trigger" stage, and cloud computing overall is at the peak of expectations, a few solutions are at experimentation stage, and none at the stage of demonstrated results. The time frame for these solutions is from 2 to 10 years, and only virtualisation and software as a service are closer to mainstream adoption.

Cloud computing and its impact on smart city solutions has been discussed in two forecast publications for 2020 [3], [9]. While in the short-term, cloud computing will be delivered by large commercial clouds, government G-clouds are promising models for (larger) cities, creating urban clouds that reduce IT costs, and providing platforms for small business applications and e-services. Cloud computing is opening also new possibilities in virtualisation of physical spaces and substitution by digital ones. Already because of global 2009 crisis many activities and networks, from R&D to markets, go virtual allowing companies and organisations to maintain operations in times of austerity, gaining flexibility and lowering fixed costs. It sustains new growth sectors of cities, which are now moving from manufacturing to services in the framework of a wider movement from products to services, as material and intangible infrastructures start being provided by the cloud.

Extremely important is the expected standardisation of smart city systems, platforms, and applications, which is necessary to provide on-demand self services. Standardisation will accelerate technology diffusion and learning curves as city administrations and their IT departments will become aware of proven solutions for the main districts and sectors of the city. We should expect a standardisation of platforms and applications in about 20 different domains of cities, related to typical city districts (CBD, manufacturing, housing, education), city utilities (transport, energy, water, broadband), and city management (administration, democracy, planning). Collaborative innovation ecosystems may emerge in these areas.

Real-world user interface, sensors, RFIDs and smart cities

Internet-of-Things including sensor networks and RFID is another important emerging strand. These technologies may overcome the fragmented market and island solutions of smart city applications and provide generic solutions to all cities. Examples of generic architecture include networked RFID tags (passive and active tags, mobile devices), sensor networks (multimodal sensors and actuators, built-in intelligent agents), and connected objects such as distributed intelligent systems, intelligent objects and biometrics [10]. A new round of applications, such as location aware applications, speech recognition, Internet micro payment systems, and mobile application stores, which are close to mainstream market adoption, may offer a wide range of services on embedded system into the physical space of cities. Augmented reality is also a hot topic in the sphere mobile devices and smart phones, enabling a next generation location-aware applications and services [8].

While the future uses of IoT technologies that will bridge the physical and virtual worlds are still largely a matter for speculation, there are estimations that they will bring significant economic benefits. The OECD policy guidance encourages research on economic and social impacts and foster business R&D encouraging technological neutrality, open global standards, and harmonization of frequency bands [11].

Embedded networks of sensors and devices into the physical space of cities are expected to enable a new type of spatial intelligence, advancing further the capabilities created by web 2.0 applications, social media and crowdsourcing. A real-time spatial intelligence having a direct impact on the services cities offer to their citizens. The concept of spatial intelligence of cities refers to mechanisms that make a city intelligent or smart and allows unifying those of "intelligent city" and "smart city" under a common field of study focusing on their underlying informational and cognitive processes (http://en.wikipedia.org/wiki/Spatial_intelligence_of_cities). Internet of Things brings us closer to the way William Mitchell [12] has described the intelligence of cities as residing in "the increasingly effective combination of digital telecommunication networks (the nerves), ubiquitously embedded intelligence (the brains), sensors and tags (the sensory organs), and software (the knowledge and cognitive competence)". Collective intelligence and social media has been a major driver of spatial intelligence of cities. Social media have offered the technology layer for organizing collective intelligence, with crowdsourcing platforms, mashups, web-collaboration, and other means of participatory problem-solving. Now, the turn to embedded systems highlight another route of spatial intelligence based on location accurate and real-time information. Smart cities with instrumentation and interconnection of mobile devices and sensors can collect and analyse data and improve the ability to forecast and manage urban flows, thus push city intelligence forward [13].

For this type of embedded spatial intelligence important is the development of Urban IoT platforms offering a common framework for ambient sensor networks as intelligent information infrastructure under universal ubiquitous sensor network architecture [14].

Semantic web, linked data, ontologies and smart cities

The OVUM report on smart cities [15] considers cloud computing and the IoT as fundamental layers of ubiquitous connectivity on which stands a layer of open public data and advanced analytics for fast-based decisions. The open standards trends have expended to government data and many agencies are providing access to datasets stimulating the creation of applications for information retrieval and decision making. Open data from various sources, government, sensors, citizens and businesses, offer opportunities for advanced analytics and intelligence to detect patterns, generate alerts, visualise information and predict trends.

In data-driven decisions, techniques for forecasting and predictive analytics are well established in many domains. What is relatively new is the semantic meaning provided by ontologies, like the Good-Relations annotator tool for creating rich RDF meta-data describing products or services and the introduction of HTML5. The cloud will offer additional functionalities for linked data as any object will be related to objects contained in the cloud. The semantic web is expected to breaks down barriers, merging data from different sources and presenting it in meaningful way. Social media based collaboration and collective intelligence can reach a higher level of efficiency and information accuracy.

Future media research and technologies offer a series of solutions that might work in parallel to Internet of Things and embedded systems providing new opportunities for content management. Media Internet technologies is at the crossroads of digital multimedia content and Internet technologies, which encompasses media being delivered through Internet networking technologies, and media being generated, consumed, shared and experienced on the web. Technologies enabled by the functionalities of the Future Internet, such as content and context fusion, immersive multi-sensory environments, location-based content dependent on user location and context, augmented reality applications; open and federated platforms for content storage and distribution provide the ground for new e-services within the innovation ecosystems of cities.

Engagement of users and user driven innovation are important preconditions for success. The Web 2.0 era has pushed cities to consider the Internet (including mobiles) as a more participative tool for engaging citizens and tourists. Many initiatives were launched by cities. It already looks like an example of several cities based Living Labs for investigating and anticipating how digital technologies will change the way people live in the city and their implications at the urban dynamics.

Altogether, Future Internet, Living Lab and Smart City form an intelligent innovation ecosystem comprising users/citizens, ICT companies, research scientists and policy makers. In this ecosystem, while the Future Internet represents the technology push, Smart Cities represent the application pull and Living Labs form the exploratory and participative playground in between the FI technology and Smart Cities' applications. In contrast with a testbed, a Living lab constitutes a 4P (Public, Private and People Partnership) ecosystem that provide opportunities to users/citizens to co-create innovative scenarios based on technology platforms such as FI technology environments involving large enterprises and SMEs as well as academia from different disciplines. It appears that Future Internet testbeds could be enabling the co-creation of innovative scenarios by users/citizens contributing with their own content or building new applications that would mash-up with city open public data.

A roadmap of Future Internet impact on smart cities

The above brief account on future Internet technologies and expected impact on cities allows defining an innovation roadmap towards smart cities. Many cities are increasingly pushing the deployment of broadband infrastructure for urban development, and are creating open networks. Cities are increasingly aware of the concept of "smart city" and actively developing strategies towards the goal of becoming "smart" and manage more efficiently city resources and addressing challenges. Part of the development towards such smart cities is the co-creative development, testing and implementation of technologies and ICT-based applications in sectors such as health and assisted living, participative government, energy management, and new work environments.

The roadmap summarized here is based on a two-dimensional mapping of layers and time periods. The vertical roadmap dimension considers the following layers: technological change, business change, policy change and social change. The time dimension includes the short term, mid-term and longer term developments. In order to enhance the policy relevance of the roadmapping approach, we focus on the systemic character of innovations related to smart cities, which require processes of socio-technical change. To provide guidelines to this process, the roadmapping approach draws from systemic change literature to take into account several characteristics of systemic change relates to the transformation towards smart cities e.g. regimes, barriers, transitions, and niches of novel solutions.

The innovation roadmap presented on Table 1a,b highlights a series of themes at the intersection of future Internet technologies and smart cities. Recurrently, at multiple sections of the roadmap appear the transition to the cloud, smart city pilots, and city-wide open platforms of embedded systems. These areas are of primary importance for city authorities all over the world that are deploying strategies for smart cities, e-infrastructure and e-services to address the contemporary challenges of competitiveness and sustainable development. Thus, the roadmap allows formulating some policy recommendations to city authorities for mastering the new interdisciplinary planning for intelligent / smart cities and the interlinked layers of digital technology, people-driven innovation ecosystems, urban activities and infrastructure.

REGIME	***Short term (2014)***	***Medium term (2017)***	***Long term (2022)***
Technological change *(Dominant designs, emerging technologies, interoperability)*	-CLOUD: Virtualisation -CLOUD: IaaS for smart cities	-CLOUD: Web platform -CLOUD: SaaS for smart cities - Content-context fusion	-CLOUD: PaaS for smart cities -CLOUD: Service integration
	-IoT: RFID -IoT: Speech recognition -IoT: Open data apps	-IoT: Multimodal sensors -IoT: Location aware apps,	-IoT: Urban IoT platforms -IoT: Cloud based large ontologies -Content-centric networks
Industrial change *(Networks of technology developers, lobbying, standardisation)*	-CLOUD: Large companies clouds, Google, MS, Amazon global clouds	-CLOUD: Large cities clouds	-CLOUD: Standardisation of smart city applications / services
	-IoT: Sensors into utilities and energy networks	-IoT: Alliances of large companies and major cities companies	-IoT: Large scale applications
Social change *(Behaviour, routines, values, preferences, demand, end-users)*	-CLOUD: Reduction of IT costs	-CLOUD: Security issues raised -CLOUD: Disaster management addressed	-CLOUD: Continuity of service -CLOUD: Learning curve
	- IoT: Experimental facilities -IoT: A few city pilots	-IoT: Multiple city pilots	-IoT: Large scale demand for sensor-based city infrastructure
Policy change *(Regulations, economic instruments, governance, agreements)*	-CLOUD: Transition white papers -CLOUD: Preparing to the cloud	-CLOUD: Pilots at city levels -CLOUD: Legal and regulatory reform	-CLOUD: Whole smart cities on the Cloud
	-IoT: Preparing to the IoT	-IoT: Regulations -IoT: Procurement	

NICHES of radical novelties	*Short term (2014)*	*Medium term (2017)*	*Long term (2022)*
Technological change	-CLOUD: SaaS -CLOUD: IaaS	-CLOUD: PaaS	
	-IoT: Experimental facilities -IoT: Open / linked data	-IoT: M2M in city environments	
Industrial change	-CLOUD: Private and hybrid clouds -CLOUD: Hosting of G city services	-CLOUD: SaaS and PaaS in the main domains of cities	
	-IoT: IPv6 and HTML5	-IoT: Smart gird / smart meters in cities	
Social change	-CLOUD: Pilot city applications in city utilities, districts, and gov	-CLOUD: Large scale demand of smart city applications and services	
	-IoT: Sensors for city environment alert	-IoT: Embedded city intelligence proof of concept	-IoT: Extended demand for sensor over city networks
Policy change	-CLOUD: Government roadmaps to G services -CLOUD: US reform of IT management	-CLOUD: Standards development and adoption	
	-IoT: China encouraging technologies for IoT	-IoT: FP8 IoT PPP -IoT: Harmonisation of frequency bands	

Table 1a,b: An innovation roadmap toward smart cities

TRANSITION TO CLOUD

Policy white papers about the transition to the cloud and IoT provide guidance to public agencies in view of the fact that these technologies are still evolving and have not yet fully addressed the issues of security and privacy. The recommendation is for concurrent streams of work, providing public agencies with guidance and documentation, development of services in less important areas initially and finally goes on full deployment of new technologies and business models. The recent report of Australian government [6] offers a global scan of public policies and programs addressing the transition to cloud computing in the US, UK, EU, Canada, and Japan. City authorities should also become aware that IoT solutions will increase dramatically the demand for broadband connections along the transition from connecting people to connecting things. Network interoperability and merging of network and media technologies, as well as mobile to mobile communication (M2M) become necessary to cover the broadband needs in the public space of cities.

SMART CITY PILOTS

In developing smart city solutions, city authorities have to become aware about a number of existing methods for involving the users, which are abundantly described in the literature, such as the Lead User, User Driven Innovation, User Centred Design and User Created Content, and User Co-Creation perspectives. The existence of a new technology stack of "cloud-IoT-linked data" does not guaranty automatically the development of new services based by these technologies. The recommendation is for adopting Living Lab, Open Innovation, and Web 2.0 product development perspectives, which promote a more proactive role of end users and citizens in services innovation, assuring the good coordination between technology offer by vendors and services demand by citizens and cities.

URBAN IOT PLATFORMS

Future Internet technology is a key driver for offering infrastructure, platforms and solutions for smart cities. However they don't assure a higher intelligence and problem solving capability unless they are integrated to a wider architecture of coordination among the physical, institutional, and digital spaces of cities. City authorities and leaders are called to master a series of smart city layers, including (1) infrastructure development combining wired and wireless networks, (2) embedded systems into the physical space of cities, sensors, smart devices and meters, (3) applications for data integration and city functions management, (4) e-services development and provision, (4) innovation ecosystems and user-driven environments for applications and services creation, (5) business models for smart city sustainability and viability, (6) monitoring and measurement scoreboards and methodologies, which offer higher spatial intelligence through their integration and coordination.

References

[1] Tselentis, G., Galis, A., Gavras, A., Krco, S., Lotz, V., Simperl, E., Stiller, B., Zahariadis, T. (2010). Towards the Future Internet - Emerging Trends from European Research. Retrieved from http://www.booksonline.iospress.nl/Content/View.aspx?piid=16465

[2] Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M., Oliveira, A. (2011). Smart Cities and the Future Internet: Towards Cooperation Frameworks for Innovation. In: J. Domingue et al. (Eds.), The Future Internet, Springer, pp 431-446.

[3] Townsend, A., Maguire, R., Liebhold, M., Crawford, M. (2011). A Planet of Civic Laboratories. The Future of Cities, Information and Inclusion. Institute for the Future.

[4] Könnölä, T. (2007). Innovation Roadmap: Exploring Alternative Futures of Industrial renewal. Working Paper submitted to the 2007 conference on corporate R&D, IPTS.

[5] Calabrese, F., Ratti, C., Kloeckl, K. (2009). WikiCity: Real-Time Location-Sensitive Tools for the City. Handbook of Research on Urban Informatics: The Practice and Promise of the Real-Time City, 390-413 pp. Published by IGI.

[6] Australian Government (2011) "Cloud computing strategic direction paper", Department of Finance and Deregulation.

[7] Mell, P. and Grance, T. (2011) The NIST Definition of Cloud Computing, NIST Special Publication 800-145.

[8] Gartner (2010) "Gartner's 2010 Hype Cycle Special Report Evaluates Maturity of 1,800 Technologies".

[9] Townsend, A., Soojung-Kim Pang, A., and Weddle, R. (2009) "Future Knowledge Ecosystems: The Next Twenty Years of Technology-Led Economic Development", Institute for the Future, IFTF Report Number SR-12361.

[10] Lemke, M. (2010) "Open innovation for future Internet enables services in 'smart' cities", CIP ICT-PSP Info Day, January, European Commission, DG Information Society and Media.

[11] OECD (2008) Shaping Policies for the Future of the Internet Economy, OECD Ministerial meeting on the Future of the Internet Economy, Seoul, Korea, 17-18 June.

[12] Mitchell, W., (2007), 'Intelligent cities' e-Journal on the Knowledge Society.

[13] Chen-Ritzo, C.H, Harrison, C., Paraszczak, J., and Parr, F,. (2009), 'Instrumenting the Planet', IBM Journal of Research and Development, 53 (3), 338-353.
[14] Hernández-Muñoz, J.M., Vercher, J.B., Muñoz, L., Galache, J.A., Presser, M., Hernández Gómez L. A., and Pettersson, J. (2011). Smart Cities at the Forefront of the Future Interne. In: J. Domingue et al. (Eds.), The Future Internet, Springer, pp 447-462.
[15] OVUM (2011) "Is your city smart enough?", OVUM publications.
[16] European Commission (2010). Future Media Networks: Research challenges 2010. DG Information Society and Media, Luxembourg, Publications Office of the European Union.

11 CONCLUSIONS AND FINAL REMARKS

The FIREBALL White Paper, April 2012, contains a synthesis of key results of FIREBALL. This chapter includes some of the conclusions and remarks of this White Paper as related to the work presented in D2.1.

This report has explored the landscape of "smart cities" as environments of open and user driven innovation sustained by Future Internet technologies and services. Smart cities are also seen as environments enabled by advanced ICT infrastructure for testing and validating current Future Internet research and experimentation. Overall, the smart city is built upon a triangle of "City" – "Living Labs" – "Future Internet" components.

Such social and technical infrastructure is one of the key determinants of the future welfare of cities. Other determinants of the welfare of cities are important as well: creative population, infrastructure and institutions for education and innovation, networks of collaboration between businesses and governments, the role of active and demanding citizens, businesses and authorities to push for innovation and quality of services. In this sense, there is a clear analogy to Michael Porter's concept of national competitive advantage: the welfare potential of cities and urban areas depending on factor conditions (human resources, capital, infrastructure, information), demand conditions, related and supporting industries and suppliers, strategy, and government.

The concept of "Smart City"

Based on a holistic instead of technology merely driven perspective on smart cities we consider necessary to revisit the concept of the Smart City itself. The concept of the smart city that emerges from FIREBALL can be summarized as follows:

The smart city concept is multi-dimensional. It is a future scenario (what to achieve), even more it is an urban development strategy (how to achieve it). It focuses on how (Internet-related) technologies enhance the lives of citizens. This should not be interpreted as drawing the smart city technology scenario. Rather, the smart city is how citizens are ***shaping*** the city in using this technology, and how citizens are enabled to do so. The smart city is about how ***people are empowered***, through using technology, for contributing to urban change and realizing their ambitions. The smart city provides the conditions and resources for change. In this sense, the smart city is an urban laboratory, an urban innovation ecosystem, a living lab, an ***agent of change***. Much less do we see a smart city in terms of a Ranking. This ranking is a moment in time, a superficial result of underlying changes, not the mechanism of transformation. The smart city is the engine of transformation, a generator of solutions for wicked problems, it is how the city is behaving smart.

We propose the following statements as clarifications to this concept:

- The Smart City concept is useful as a mobilizing concept. It is bridging between and bringing together various professional communities (urban development, innovation management, Internet technology, local policy). However the Smart City concept is not a reality: it is a future scenario, and even more an urban development strategy of how citizens are shaping the city in a continuous process of development and change.

- There are no common Smart City off the shelf solutions. The concept of Smart City has been adopted by technological solution providers and city marketing departments to promote the city and new solutions. To date, the smart city concept has been technology push. It has been interpreted mainly from a technology point of view and has inspired predominantly technology driven visions.
- There is a lack of attention (also in most of our Smart City case studies which we studied) to engagement and empowerment of citizens, SMEs and other entities realizing their needs or ambitions, and of how citizens are empowered to participate in urban development and social innovation in general.
- There is a need for much more than now working directly with or for citizens groups, SMEs, local governments, technology providers and other actors to develop, prototype and validate solutions that are really in the interest of cities and their citizens. There is a need to address the important topic of a societal view of smart cities, and to address the new theme of "social innovation". People need tools to be empowered in shaping their urban environment.

Technologies for smart cities

We found that the Future Internet domain landscape comprises a great diversity of research streams and related topics for designing alternatives for smart cities. However, most connected and influencing smart cities are the following technology streams:

Internet of Things (IoT) is considered as a major research and innovation stream leading to create plenty of service opportunities in interconnecting physical and virtual worlds with a huge amount of electronic devices distributed in houses, vehicles, streets, buildings and many other public environments. These technologies open up a new innovation technology paradigm of embedded spatial intelligence cities, emerging from cloud computing, embedded smart sensors and devices, and open data.

Cloud computing and its impact on smart city solutions has been discussed in many foresight studies and reports. While in the short-term, cloud computing will be delivered by large commercial clouds, government G-clouds are promising models for (larger) cities, creating urban clouds that reduce IT costs, and providing platforms for small business applications and e-services. Cloud computing is opening new possibilities in virtualisation of physical spaces and their substitution by digital ones. Extremely important is the expected standardisation of smart city systems, platforms, and applications, which is necessary to provide on-demand self services. Standardisation will accelerate technology diffusion and learning curves as city administrations and their IT departments will become aware of proven solutions for the main districts and sectors of the city.

Embedded networks of sensors and devices into the physical space of cities are expected advancing further the capabilities created by web 2.0 applications, social media and crowdsourcing. A real-time spatial intelligence is emerging having a direct impact on the services cities offer to their citizens. Collective intelligence and social media has been a major driver of spatial intelligence of cities. Social media have offered the technology layer for organizing collective intelligence with crowdsourcing platforms, mashups, web-collaboration, and other means of collaborative problem-solving. Now, the turn to embedded systems highlight another route of spatial intelligence based on location accurate and real-time information. Smart cities with instrumentation and interconnection of mobile devices and sensors can collect and analyse data and improve the ability to forecast and manage urban flows, thus push city intelligence forward.

Cloud computing and the IoT are fundamental layers of **ubiquitous connectivity** on which stands a layer of open public data and advanced analytics for fast reaction and real-time decisions. The open data trends have expended to government data and many public agencies are providing access to datasets stimulating the creation of applications for information retrieval and decision making. Open data from various sources, government, sensors, citizens and businesses, and linked data with semantic technologies offer opportunities for advanced analytics and intelligence to detect patterns, generate alerts, visualise information and predict trends.

However, for cities and their citizens and businesses, the Future Internet is an abstract concept and far away from reality. They are interested mostly in applicable solutions and in participating in planning and decision making, less in longer term technology innovation. However to some extent citizens and businesses are willing to participate in pilots aiming to develop and validate such solutions.

The urban ecosystem comprises different innovation and engineering cycles with different objectives, resources, timelines and different priorities from the side of the actors. These cycles should be distinguished although they are interacting, and should be monitored and gardened.

The longer term innovation cycle is represented by experimenting on new Internet technologies. Actors (often mentioned "users" however this is confusing) involved are mostly research institutes and larger technology companies. End-user participation to this cycle is generally not realistic. End-users may only participate to this cycle if there is a clear benefit for them. Targeted end-users will be the "lead innovators" within companies or wider professional communities.

The shorter time innovation cycle aims to develop, prototype and validate applications and solutions. Service innovation is a key goal of this cycle. In doing so these cycles will contribute to urban development and social innovation. End-user participation is natural for this cycle, but might not always be feasible. Targeted end-users may include lead innovators within professional communities, but also active citizens and businesses in domains such as energy efficiency, healthcare, government services and other.

Urban Innovation Ecosystems and Living Labs

The technology landscape represents a space of opportunities which must be aligned with the needs and ambitions of citizens and cities within urban innovation ecosystems. FIREBALL started with the perspective that developing towards a smart city needs three ingredients: cities, user-driven innovation environments such as living labs, and Future Internet technologies and related testbeds. Communities or stakeholders within the "urban value system" related to these ingredients fulfill different roles in making a smart city:

1. **Local governments** set challenges of competitiveness, inclusion and sustainability, and develop and implement policies for urban development and orchestrate the planning and decision process.
2. **Citizens and businesses** have an immediate interest in shaping their living and working environment. They may organize themselves in citizen interest groups or communities.
3. **Living labs** act as generators of ideas and innovative solutions through open innovation. It is a fundamental trend of smart cities that solutions have to be defined and implemented with the involvement of citizens, consumers and users.

4. **Research and technology communities** such as research institutes / laboratories offer technological know-how as well as facilities for technology testing.

The smart city cases undertaken in the framework of FIREBALL illustrate the opportunities for intensive collaboration among the various stakeholders and citizens involved in building the smart city innovation ecosystem, and several interesting practical examples are provided.

The Living Labs (or Innovation Labs, Urban Labs) concept represents a powerful approach to the organisation of user-driven open innovation environments. As a concept applied to smart cities, it embodies open business models of collaboration between citizens, enterprises and local governments, and the willingness of all parties -including citizens and SMEs - to engage actively in innovation. The Living Lab concept also provides a methodology and a model for organising specific innovation programmes/projects and conducting innovation experiments. Both aspects are important: living labs 1) *shaping* and 2) *operating* the urban innovation ecosystem.

The concept of open and user-driven innovation looks well positioned to serve as a mediating, exploratory and participative playground combining Future Internet push and urban policy pull in demand-driven cycles of experimentation and innovation. Living Lab-driven innovation ecosystems may evolve to constitute the core of "4P" (Public-Private-People-Partnership) ecosystems providing opportunities to citizens and businesses to co-create, explore, experiment and validate innovative scenarios based on technology platforms such as Future Internet experimental facilities involving SMEs and large companies as well as stakeholders from different disciplines.

However, in order to fulfil their promise as a key element of urban innovation ecosystems, many living labs should become mature and professional in terms of their "business process", service offering and capabilities to create networks and orchestrate collaboration among a wide diversity of actors (i.e. SMEs, citizen user groups, larger companies, policy actors, research laboratories).

Connected cities, connected infrastructures

FIREBALL has explored the concept of "common assets", a view of making accessible and sharing smart city resources such as network infrastructures, technologies, applications, know-how and services (See D1.2). The cases which we have elaborated mainly focus on making available these resources on a geographical area (urban environment, region). There is a need to explore the concept of connected cities in this respect: how can different cities in a region or in different regions get access to the services provided by assets or resources hosted elsewhere. What kind of new services can be foreseen building on this concept of common, geographically distributed assets, e.g. testbed and living labs services for nnovators in smart cities.

To some extent, projects dedicated to Future Internet experimentation and dedicated to Living Labs innovation may interact and even work together in hybrid models of which we have provided examples. Such models could be dynamically evolve over time, as "organisms" constituting the infrastructure of urban and regional innovation ecosystems.

Future Internet and Living Labs normally represent different cycles of innovation (see above) but there might be concrete interfaces and interactions. Concrete, practice-oriented projects should be elaborated in order to gain more insight and experience regarding the benefits and synergies, and regarding the integration of testbed and living lab methodologies.

A future vision for 2020: Internet infrastructures, services and applications will form the backbone of connected regional and urban, even transnational innovation ecosystems, fostering co-creative innovation and new business creation. This backbone connects the resources and enables the provision of and access to services independent of location.

Towards smart(er) cities

An important part of the FIREBALL effort focused on describing how cities in Europe are transforming their processes for becoming smarter (more intelligent) cities. This was done in composing showcases that illustrate smart environments, applications and solutions and through surveys and case studies in cities like Thessaloniki, Manchester, Helsinki, Lisbon, Oulu and Barcelona. Altogether, they illustrate both top down planning and bottom-up initiatives for the making of smart urban environments.

However, in the smart city initiatives studied, the socio-economic impact of these initiatives should become more evident. Throughout Europe there is a need for advanced monitoring methodologies and benchmarking scoreboards (such as the EU Innovation Scoreboard) to assess effectively and comparatively costs and benefits from investments in broadband infrastructure in cities, sensor networks, smart city platforms, e-services, and user-driven innovation initiatives over this tangible and intangible infrastructure.

Actors involved such as represented by FIRE, Living Labs and Smart Cities, and including businesses and local authorities, should develop terms of sustainable PPP-based collaboration to realize this vision. They should actively form alliances and partnership agreements. Such collaboration agreements should result into concrete projects targeting cities' problems and challenges in particular areas such as healthcare, social innovation, energy and water management, mobility and transport.

There is a need to link living labs, future internet research and commercial potential in order to create business impact and entrepreneurship. The recently initiated NSF I-Corps program is a good example, as it brings together the technological, entrepreneurial and business know-how to accelerate the exploitation of technologies. Another recent initiative is the Canadian Digital Accelerator for Innovation and Research (DAIR), initiated by CANARIE, which is a "digital sandbox" where high-tech innovators – SMEs - can rapidly design, validate, prototype and demonstrate new technologies for world markets[1]. Both Living Labs and FIRE will need to increasingly engage industrial actors and SMEs into the development of technologies and facilities, in order to tackle the identified challenges of knowledge transfer from research to business and research based entrepreneurship. This requires new forms of partnerships and even "business models" underpinning future sustainability.

[1] See: www.canarie.ca/en/dair. This program has started December 2011.

APPENDIX: SMART CITIES CASE STUDIES

1 SMART CITY CASE STUDY: THESSALONIKI

INTELLIGENT THESSALONIKI: FROM AGGLOMERATION OF APPS TO SMART DISTRICTS. Authors: Nicos Komninos and Panagiotis Tsarchopoulos, Aristotle University of Thessaloniki - URENIO Research

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Abstract

The new planning paradigm of "intelligent cities" is replacing the principles of smart growth and new urbanism which inspired urban planning during the last 20 years. The case study of ''Intelligent Thessaloniki" highlights how a city is adopting this new paradigm and how the deployment of broadband networks, smart urban spaces, web-based applications, and e-services help every district of the city to address its particular objectives of competitiveness and sustainable development. The paper examines the current state of broadband infrastructure and e-services development in the city of Thessaloniki, the strategy that has been established to stimulate the future development of the city with respect to smart environments and districts, and the gaps and bottlenecks influencing this transformation of the city. The conclusions stress that a new orientation of urban governance is needed to address the challenges of digital literacy, creativity in the making of smart environments, and business models for the long term sustainability of e-services.

Key words: Intelligent cities; smart cities; innovation ecosystems; strategy; smart districts; Thessaloniki

1.1 INTRODUCTION: INTELLIGENT CITIES, A NEW PLANNING PARADIGM

A news article of Haya El Nasser in USA TODAY under the title "Will 'intelligent cities' put an end to suburban sprawl?" had had an amazing spread over the Internet with hundreds of quotes by social media. The argument of El Nasser is that 'smart growth' is near the end of its shelf life, concluding a 20 years cycle as major urban planning model, and now 'intelligent cities' has become the new "darling lingo of planners" as it captures the essence of 21st-century technology that can help track how people use and live within the cities. This doesn't mean, she argues, that sustainability principles of smart growth and New Urbanism - the design movement driving smart growth with compact city, public transport, natural ecosystems preservation, passive architecture, and green energy solutions - have become obsolete, but intelligent cities as new planning paradigm can drive urban renewal more efficiently to sustainability. The connection of intelligent cities with urban renewal opens a new path for viewing every city and city district from a new perspective and consider how 'intelligent city' principles and strategies can sustain urban regeneration in terms of competitiveness, social, and environmental sustainability.

The new planning paradigm of intelligent cities (smart cities is the term mostly used in Europe) has been forged by academic research and experimental city projects. A series of books that appeared during the last 10 years reflect the evolution of thinking in this field and discuss the contribution of information technologies and the Internet on city development and planning, the city and the digital space, and the role of virtual spaces and digital ecosystems in enhancing innovation within 21st century cities. This literature clearly shows an evolution towards open digital platforms and ecosystems which operate within cities and enable citizens, enterprises and organizations to develop innovative, open, and collaborative attitudes; in other words becoming more efficient and intelligent.

Among the first publications that opened this new field was the book of Ishida and Isbister (2000) on technologies, experiences and future perspectives of digital cities, focusing on the way the information society, the Internet, and mobile computing create a virtual space over cities. This was a book devoted to digital cities and contained experimental city projects building platforms for communication, city representation, and city management. Based on an international symposium held in Kyoto, Japan, this collection of papers made clear the interdisciplinary perspective that brings together the necessary expertise for making digital cities. The digital cities symposium series offered also input for other two publications under similar titles, Digital Cities II (Tanabe, Van den Besselaar, and Ishida 2001), and Digital Cities III (Van den Besselaar and Koizumi 2005) discussing the concept of the digital city, politics, knowledge and data modeling, design, monitoring and evaluation, technologies and architectures, while presenting case studies and city experiments. The social, class, power, gender and ethnicity impact of information and communication technologies over cities and how new media in cities shape societies, economies and cultures was the focus of another influential publication on digital city spaces. "Cybercities Reader" (Graham 2003) contained cases from all over the world, Amsterdam, Lima, Jamaica, and Melbourne, highlighting different ways that the digital space was incorporated into cities, affecting all aspects of city life, economy, commerce, (tele)working, community, urban surveillance and control. Digital cities were also discussed in Aurigi (2005) focusing on economic regeneration and place promotion strategies sustained by electronically distributed services and participatory decision-making. Case studies of European cities were presented where urban processes were taking place via front-end information sites, 'digital cities', and digital networks. At the other side of the Atlantic, Laguerre (2006) explored the digitization of the American city, and how information technology practices in the Silicon Valley and San Francisco metropolitan area were re-organising social relations, global interactions and workplace environments.

However, the creation of digital spaces was not the only driver of contemporary city development. Another set of processes, equally powerful, fed urban change and new planning concepts. At the turn of the century some cities and regions in Europe, Japan and the USA, displayed an exceptional capacity to incubate and develop new knowledge and innovations. They offered a favourable environment for research, technology and innovation based on proximity spillovers, institutions for learning, social capital, and digital collaborative spaces. "Intelligent Cities: Innovation, knowledge systems and digital spaces" (komninos 2002) analysed three different spatial models for creating environments of innovation, based on spatial proximity and knowledge spillovers (industrial districts and clusters), learning institutions (innovating regions), and physical-digital innovation ecosystems (intelligent cities). A follow-up publication (Komninos 2008) explained the rise of intelligent cities with respect to the spread of global information and technology supply chains and user-driven innovation processes. The distinctive characteristic of intelligent cities was attributed to integration of three types of intelligence, human intelligence of the population, collective intelligence of institutions for collaboration, and machine intelligence of digital networks. The book described also the building blocks of intelligent cities with respect to collaborative physical-digital platforms sustaining networks for strategic intelligence, technology learning and acquisition, innovation, and product marketing and promotion.

The same concerns were reflected in the work of Yigitcanlar, Velibeyoglu and Baum (2008) which explored initiatives sustaining knowledge cities and techniques and processes for the successful integration of information technologies and urban knowledge-based development. Broadband economies (Bell, Jung and Zacharilla 2009) looked also at how city's information and

communication infrastructure and digital services sustained the innovation economy of cities. Based on experiences from the "Intelligent Community Forum" the authors tell the story of "Intelligent Communities" around the world, cities that deploy broadband networks to build local prosperity, global competitiveness, and social inclusion.

In more recent publications there is a turn to a more extended digital space, which is being created by wireless broadband networks, mobile devices, open platforms, and embedded systems into the physical space of cities. Aurigi and De Cindio (2008) looked at augmented urban spaces created by ubiquitous / pervasive computing, mobile devices, and wireless connectivity. This new intersection of physical and digital environments reshape cities with implication for the public sphere, community empowerment, and people-led urban planning. Leach (2009) looked at computer-aided techniques for experimental use of generative design tools and parametric modelling, and how cities might gain insights from digital platforms like "i-Phone" and offer open innovation and marketing environments to citizens and organisations.

The above literature and research, which offer a representative account of the evolution of thinking about the city and the digital space since 2000, seem sharing an holistic view of cities as integrated agglomerations of people, activities, infrastructures, digital networks, and e-services. However, cities are highly fragmented in terms of functions, propriety rights, institutional controls, and management capacities. Cities co-exist within cities or as IBM has described it cities are systems of systems (IBM 2010), even if we don't always see the intangible walls that smaller cities erect within urban agglomerations.

The present paper examines cities from this point of view of fragmented spaces and coexistence of parallel jurisdictions, controls, and development trajectories. It is based on the account of creating a digital space over the city of Thessaloniki, Greece and the strategy towards "Intelligent Thessaloniki" promoting smart city districts. However, in essence the paper describes how intelligent city strategies can help every city to address its particular and place specific objectives of competitiveness and sustainable development, using broadband networks, smart urban spaces, applications and e-services for collective intelligence, creativity, and innovation.

1.2 THESSALONIKI: THE TURN TOWARDS KNOWLEDGE AND INNOVATION

Thessaloniki is a 23 centuries city and in the course if its life came through a series of historic periods and cultures, Hellenistic, Roman, Byzantine, Venetian, Ottoman, and again Greek. The British historian Mark Mazower (2004) reconstructed in his book "Salonica City of Ghosts" the more recent history of Thessaloniki from 1430 to 1950, how this Mediterranean port city nurtured for more than 500 years a cosmopolitan blend of cultures and a mixture of Greek, Turkish, and Jewish populations. It should be expected that this long history brings in memories and landmarks of different "ghosts", but every period created also its own identity over the ruins of the previous ones. Landmark of the recent history is 1912 when the Greek army liberated the city from the Ottomans and Thessaloniki was annexed to Greece by the Treaty of Bucharest (1913). Since, a new city emerged almost from scratch with two major events marking the radical transformation towards contemporary Thessaloniki: the exchange of populations and the new city plan.

At the liberation of the city the total population of 160.000 was more or less equally distributed among three large ethic communities of Greeks, Turks, and Jews. This composition changed because of the exchange of populations between Greece and Turkey and the Jewish tragedy of the World War II. The Convention concerning the Exchange of Greek and Turkish populations was signed in 1923 in the framework negotiations of the Treaty of Lausanne. It was a compulsory population exchange between the two countries involving the moving of about 2

million people and the entire Turkish community of the Thessaloniki, while Greeks expelled from Turkey resettled in the city changing its demographics. Twenty years later, the Nazis deported most of the Jewish community of Thessaloniki and 50.000 Jews were killed in concentration camps and gas chambers. Few of them returned in Thessaloniki after the war while many emigrated to the USA and Israel ending a long history of bonds between the Christian and Jewish communities that started in 1492.

The new city plan was endorsed after the great fire of 1917 which destroyed most of the historic centre of Thessaloniki. The fire levelled almost the entire commercial district, all the shops, hotels and restaurants, entertainment and business premises, and ruined the heart of the old Ottoman city. The new city plan was designed by the Committee for the New Thessaloniki Town Plan with leading involvement of the British landscape architect Thomas Mawson, and mainly the French architect and urban planner Ernest Hébrard (Fig. 1). Out of the fire's ashes a new city was created, founded on market principles and purchasing power than ethnicity and religion. The fire-affected area was expropriated and the land owners received bonds which they could use to buy premises in open bids for plots of the new city plan. The new plan introduced also a functional organisation and division of the city, with commercial and tertiary activities in the centre, manufacturing and logistics at the west, and housing and garden cities in the east side; the city grid was aligned in orthogonal blocks and new infrastructure was built. Thus, a great socio-economic change took place based on the gendrification and occupation of the city centre by the most affluent residents, irrespectively of nationality and religion, and the functional reorganization of the city in which the city districts were defined by their working within an integrated whole. The Ottoman city with its ethnical and religious divisions was replaced by a western city based on the principles of market economy, pursuit of productivity, and functional specialisation.

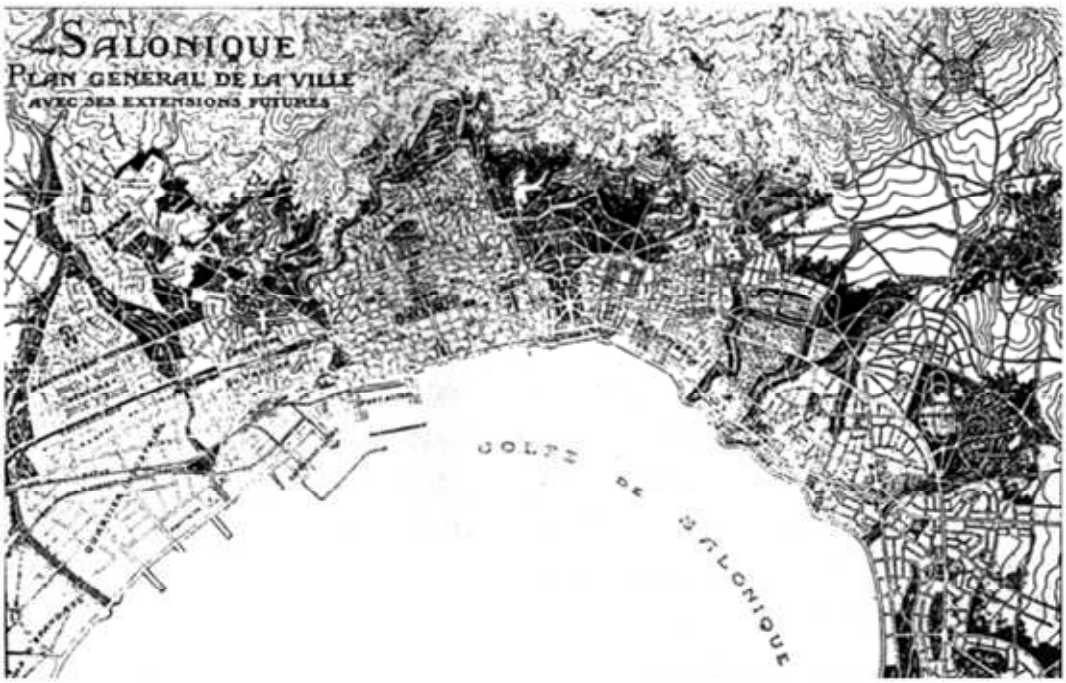

Figure 1: Thessaloniki, E. Hébrard Plan, 1917
Source: Karadimou (1985:228)

The post war economic development of Thessaloniki was characterized by intense industrial development. A large manufacturing complex was created in the Westside of the city composed of chemical, plastics, paper, textile, and food industries. Housing sprawl took place in the eastern part as foreseen by the Hébrard Plan. Internal migration inflows led to increases of population which is now close to 1 million inhabitants. However, during the last decade the industrial base of Thessaloniki has undergone major changes. Since 1997, the number of manufacturing establishments decreased by 42.7%, employment by 17.8%, and the value added by 3.1%. In contrast, the total value of production increased by 17.9% and sales by 18.4% as manufacturing became more capital intensive and integrated into global supply chains (Georghiou et al. 2009).

During the same period a net growth of services was observed. The tertiary sector responded better to international changes, quickly integrated organizational innovations and increased its share in employment and GDP. Within the tertiary sector, a dynamic core has been created by outward-oriented services that characterize the current development of Thessaloniki, such as tourism, ICT, health, higher education and research, business services, transport, and international trade. The research activity of Aristotle University, for instance, offers 6.500 new jobs for young scientists and researchers annually with a turnover of more than 50 million Euros, and a substantial part spent on the local market for supplies of materials and services. These new sectors are now considered as new growth engines contributing both to GDP and employment growth all around the EU (EC 2008).

In the 1990's a turn towards knowledge and innovation-led development became very clear. The concern for the development of knowledge-intensive activities and new technology districts is all-inclusive in Thessaloniki as it was understood that knowledge and innovation provide competitive advantages counter-balancing deindustrialization. The Greek knowledge economy is currently emerging in a small number of urban centres (Athens, Thessaloniki, Heraklion) where human skills, infrastructures, and resources for research and technology are co-located. The position of Thessaloniki as the second most important city of learning and innovation in the country is mainly due to higher education, public research, and knowledge intensive services. The 2009 data confirm that the innovation strengths of Thessaloniki are in human resources of higher education and public R&D.

Actually, the knowledge economy of Thessaloniki is developing by two parallel processes: on the one hand by setting new technology districts, such as the Technology Park of the Centre for Research and Technology, the Technopolis ICT business park, the incubators Thermi and i4G, the Alexander Innovation Zone, and a new economy formed around the ICT sector, and on the other hand by deployment of broadband networks and web-based services for business, government, education, mobility and other activities of the city. These two processes are not coordinated, the first being supported by the public Research and Technology policy, while the second is progressing by private investments of large telecommunication companies, Internet service providers (ISPs), and initiatives by the citizens and small ICT companies.

1.3 DIGITAL THESSALONIKI: AN EMERGING AGGLOMERATION OF APPS

By the term "Digital Thessaloniki" we characterise the development of broadband networks, smart spaces and applications, which create a fourth sector of digital infrastructure, e-services and utilities in the city. Main components of this new sector are broadband communication networks and web-based services running over the networks.

Broadband

Broadband access in Thessaloniki is provided by a number of operators, such as Otenet, Vivodi Telecom, Tellas, Hellas On Line (HOL) and Forthnet, with ADSL being the main standard. Most Internet providers use OTE's Bit Stream Network, which is the most extensive privately owned fibre optic network. This network includes (1) the copper cable used for telephony that link ADSL modems/routers at homes and offices with the local telephone centres ending at the DSLAMs, (2) the network linking DSLAMs to BBRAS routers, and (3) the network between the ISPs and the BBRAS routers. ISPs lease ADSL connections to offer online services but they don't have access to OTE's network infrastructure. This is changing with the liberalization of telecommunications, as the first part of the above network passes to the control of the ISPs. The typical download/upload speeds available over OTE's network are 2048/256, 4096/256, 8192/384 kbit/s and 24/1 Mbit/s (Fig. 2). Internet access is available thought a subscription to OTE's access and then through the preferred ISP. Broadband penetration is about 25% in the region of Central Macedonia and assumed higher in the city of Thessaloniki with average bandwidth 13,7 Mbps.

Additional connectivity is offered by the GRNET fibre optic network that interconnects the city's universities, technical and research institutes to a wider academic and research institution's network. Five points of presence (PoPs) are maintained within the framework of the network, Aristotle University of Thessaloniki, University of Macedonia, Higher Educational Institute Thessaloniki, Centre for Research & Technology, Hellas (CERTH) and Informatics and Telematics Institute (ITI), which constitute secondary nodes that are equipped with switches or optical add-drop equipments aggregating the customer's traffic.

The GRNET network, managed by the state owned limited company GRNET S.A., supports the electronic interconnection of academic and research institutions among themselves and with relative academic networks through its upstream provider GÉANT (the pan-European communications infrastructure serving Europe's research and education community). It provides wider coverage and much greater protential for 500.000 students and researchers who use it. The GRNET backbone network of dark fibre-optic cable (Wavelength Division Multiplexing – WDM technology at extra high speeds of 1-2,5 Gbps) has a total length of more than 8.000km. All the nodes are based on routers of Gigabit speeds and are interconnected with a network of 2.5 Gbps speeds over DWDM technology with leased wavelengths from the incumbent (OTE).

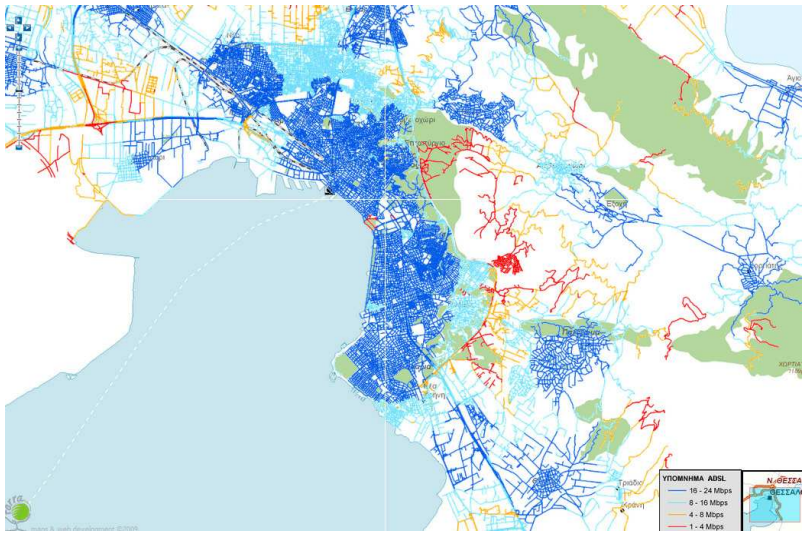

Figure 2: ALSL coverage and speeds at metropolitan Thessaloniki

Source: National Telecom Committee, http://mapsrv2.terra.gr/eettutilities/mapnew.aspx

Figure 3: 3G coverage in Thessaloniki

Source: http://client0.cellmaps.com/tabs.html#cellmaps_intl_tab:

3G coverage is offered by three mobile telecommunications service providers in Thessaloniki: Cosmote, Vodafone, and Wind. Speeds for both Wind Hellas and Cosmote providers are up to 24 Mbit/s download (HSDPA) and 5,72 Mbit/s upload, while Vodafone offers broadband speed up to 42,2 Mbit/s download (HSDPA). Beside the good coverage of the entire city (Fig. 3) 3G Internet use is still very limited at about 2,1% of the population only.

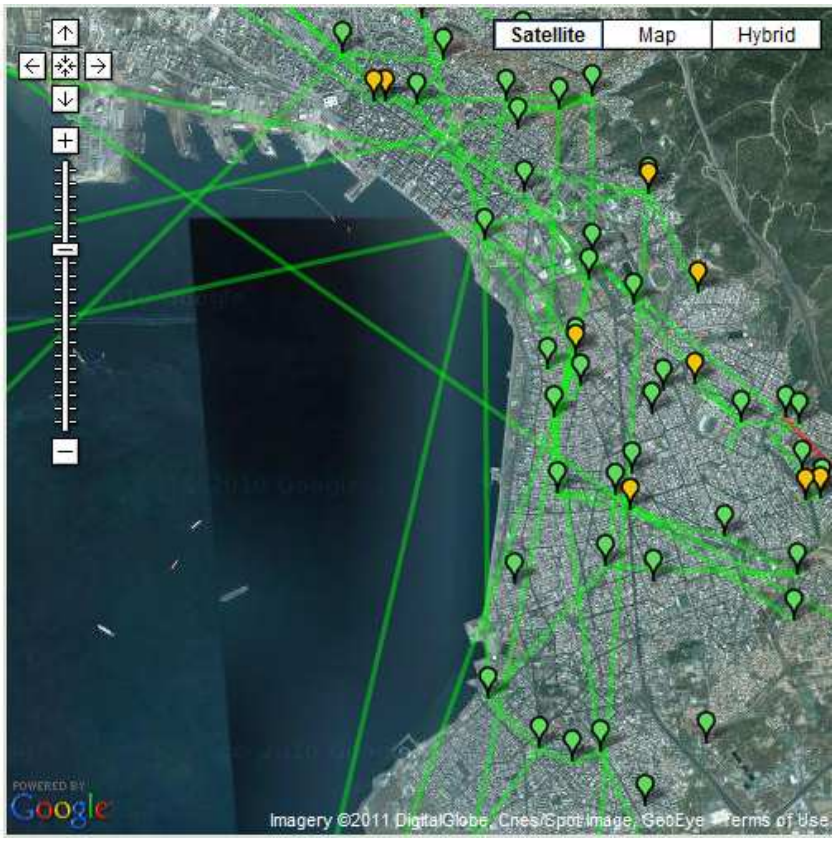

Figure 4: Wireless Metropolitan Network of Thessaloniki

Source: http://wind.twmn.net/?page=nodes

Wireless broadband is offered by many public organisations covering smaller areas. These networks have been developed by local authorities, the Aristotle University, the Expo, the Port area, and other public or semi-public organisations. The access points are operated at 2,4-2,48GHz and are compliant to 802.11b standard which has a maximum raw data rate of 11 Mbit/s and the 802.11g which extends the maximum raw data rate to 54 Mbit/s. A good example is the Wi-Fi network in the city of Thermi at the eastern part of metropolitan Thessaloniki. The Municipality has installed 13 Wi-Fi hotspots and the wireless network consists of Point-to-Multipoint and Point-to-Point links, succeeding in this way to cover wider areas which are characterised by either large numbers of visitors (commercial districts, archaeological sites, plazas, etc.) or lack of other broadband infrastructures (ADSL). The wireless network offers free internet access to the citizens. It also supports the development of services and applications such as VoIP (Voice over Internet Protocol) and VoD (Video on demand). The access points work with the following standards: The 802.11b standard, which has a maximum raw data rate of 11 Mbit/s and uses the same CSMA/CA media access method defined in the original standard. Due to the CSMA/CA protocol overhead, in practice the maximum 802.11b throughput that an application can achieve is about 5.9 Mbit/s using TCP and 7.1 Mbit/s using UDP. The 802.11g standard extends the maximum raw data rate to 54 Mbit/s or about 19 Mbit/s net throughput. The backbone network operates at 5,47-5,725GHz and has developed with PreWimax technology. The 13 Wi-Fi hotspots create small communication areas around localities of high accessibility, such as the Town Hall, the Mall, the Cultural Centre, the commercial Street, Technical Services, as well as the Cultural and Community Centres of adjacent communities in Triadi, New Redestos, New Ryssio, and Tagarades.

Non profit initiatives on community / collaborative basis offer also wireless broadband connections, such as the Salonica Wireless Network (http://www.salonicawireless.net/) and the Wireless Metropolitan Network of Thessaloniki (http://www.twmn.net/). With the use of cheap wireless technology they move away the barriers that telecommunications companies erect to prevent the creation of a really cheap metropolitan network. They use antennas mounted on rooftops and windows and the free radio frequency of 2.4GHz to create a free, local ownership, wireless backbone. The goal is to use open-source routing solutions to create an open and Wide Area Network with metropolitan coverage (Fig. 4).

E-services

Citizens, companies, and organisations located in Thessaloniki have developed a large number of applications and online services related to city's activities, digital presence, and functioning; from individual websites to more complex applications of content aggregation, location-based services, provision of online administration services, and community services to citizens. Most of these applications are bottom-up initiatives created by the interest and concern of their developers. However, seen as a whole they create a rich layer of digital services which is emerging from dispersed individual actions. The formation of this layer has characteristics similar to swarm intelligence and creativity, a "movement from low-level rules to high-level sophistication" (Gloor 2006; Jonhson 2001). It is a layer composed of applications which were given birth from the invisible hand of the digital market, operated by developers, sellers, buyers, and end users without central planning or coordination. A survey conducted by the authors of this paper, during January and February 2011, helped describing the major components and characteristics of this web-based Thessaloniki. The survey took place in three steps: definition of web applications which concern the city; identification and listing of e-services offered; and interviews with e-service providers.

The first step of the survey was about the definition of applications and e-services which determine the web presence and the web-based services of Thessaloniki. Here we have a problem similar to the "building vs. city": the city is composed of buildings, but "building" and "city" are different objects in terms of attributes and functions. Only relationships of proximity, agglomeration, collaboration, external economies, identity, governance, transform buildings and activities to cities and city districts. Thus, the web presence of a city is defined both by the **sum** (agglomeration) of web applications related to its buildings, monuments, infrastructures and activities, and by applications dealing with the city as a **system** of interconnected objects.

From this perspective, the following categories of web applications and web-based services can be considered that characterise Thessaloniki (and any city) as a whole, in distinction to applications related to its composing objects:

1. Applications which concern the representation of the city.
2. Applications for the provision of administration, social, community, safety, and environmental services to citizens.
3. Applications for the provision of services relying on spatial proximity (i.e. location-based services, local offerings and promotions of products and services).
4. Applications which rely on collaboration or collective intelligence of citizens (i.e. report of incidents, content aggregation).
5. Applications which concern an entire sector of economic activity of the city (all hotels in the city, entertainment in the city).
6. Applications which concern the function or management of a city district (university campus, Central Business District, etc.).
7. Applications which concern the use, functioning, and management of city's infrastructure and utilities (transport, power, water, broadband).
8. Applications for managing and controlling the development of the city (i.e. city planning, consultation, decision making).

The second step of the survey concerned the identification of web applications in Thessaloniki falling into the above eight categories. More than a hundred applications and online services were identified. A representative sample of them is given on Table 1 with the right column indicating the respective web address. Identification was based on expert opinion gathered by web developers, IT experts, website administrators, city managers, utility managers. A search on the web and search engines produced also a good yield. Digital applications have been developed in all domains of the city, from virtual guides of Thessaloniki to e-services for business, education, culture, utilities, transport, and city management.

Table 1: A sample of web-applications and e-services in the city of Thessaloniki

REPRESENTATION OF THE CITY	
Thessaloniki Street View	http://www.kapou.gr/
Thessaloniki 360^0 - Virtual City Guide	http://www.thessaloniki360.com/en/map/
City guide	http://www.e-leoforos.gr
BUSINESS ACTIVITY	
HELEXPO Thessaloniki	http://www.helexpo.gr
Thessaloniki Port Authority	http://www.thpa.gr/
Thessaloniki Industrial Estate - Land offerings	http://www.etvavipe.gr/(6019544444953489)/ecPage.asp?id=133&nt=18&lang=1
Thessaloniki Technology Park – Online technology transfer services for companies	http://www.thestep.gr/active.aspx?mode=en{54bbe145-5987-4897-843b-22fd99a3fb51}View

Association of ICT companies - Market intelligence	http://www.urenio.org/bi/
Restaurants in Thessaloniki	http://www.tavernoxoros.gr/
Hotels in Thessaloniki	http://www.booking.com/city/gr/thessaloniki
Groupon, Thessaloniki	http://www.groupon.gr/deals/thessaloniki
Golden Deals, Thessaloniki	http://www.goldendeals.gr/deals/thessaloniki/current
HIGHER EDUCATION	
Aristotle University Research Committee Online services	http://www.rc.auth.gr/ http://researchvalue.net/
Aristotle University of Thessaloniki VPN and online services	http://web.itc.auth.gr/portal/content/view/18/191/
University of Macedonia Information and Consultation	http://www.uom.gr/index.php?newlang=eng
Higher Educational Institute Thessaloniki Online services	http://www.teithe.gr/modules/content/index.php?id=4
School of Engineering - Research Portal	http://rp.web.auth.gr/rp/index.html
CULTURE AND TOURISM	
Regional Guide of Central Macedonia	http://cultour.lab.rcm.gr/
Science Centre and Technology Museum "NOESIS"	http://www.noesis.edu.gr/index_en.php
Thessaloniki events	http://www.saloniki.org/index_gr.htm
Thessaloniki blogs	http://www.thessalonikiblogs.gr/
MOBILITY	
O.A.S.Th - Route Planner	http://www.oasth.gr/routes/routeDetaileng.php?line=61&ml=12
RCM - Ring road information system	http://rrits.lab.rcm.gr/
Mobility Service Center of Municipality of Kalamaria	http://www.kemdkalamarias.gr/Default.aspx
Macedonia Intercity Bus Station	http://www.ktelmakedonia.gr/en/content/show/tid=135
Thessaloniki Airport - Ticket Reservations	http://www.thessalonikiairport.gr/tickets/
Bike sharing	http://www.easybike.gr/
Radio Taxi White Tower	http://www.radiotaxi.gr/
UTILITIES	
Water supply organisation	http://www.eyath.gr
Meteorological services	http://www.meteo.gr/cf.asp?city_id=1
Recycling in Thessaloniki	http://www.anakyklosi.gr
CITY GOVERNMENT	
Syzeuxis: Telematic Services	http://www.syzefxis.gov.gr/node/34
Municipality of Thessaloniki	http://www.thessaloniki.gr
Thessaloniki Municipality Geoportal	http://gis.thessaloniki.gr
Municipality of Thermi	http://www.dimosthermis.gr/
Municipality Ampelokipon	http://www.ampelokipoi.gr/
City of Kalamaria - Business services	http://www.kalamaria.gr/index.php?option=com_content&task=category&sectionid=28&id=13&Itemid=244&lang=en

Many different kinds of applications were identified, related to cyber, digital, and smart city concepts (see Box 1). Though their number is not that large as the number of all digital objects related to Thessaloniki (i.e. all the websites having IP in the city), they represent a significant amount of applications, which define the web presence and online services emerging by multiple actions and initiatives of the city's population and organizations.

Box 1: Cyber, Digital, Intelligent, and Smart Cities

Cyber cities, from cyberspace, cybernetics, governance and control spaces based on information feedback, city governance; but also meaning the negative / dark sides of cyberspace, cybercrime, tracking, identification, military control over cities.

Digital cities, from digital representation of cities, virtual cities, digital metaphor of cities, cities of avatars, second life cities, simulation (sim) city.

Intelligent cities, from the new intelligence of cities, collective intelligence of citizens, distributed intelligence, crowdsourcing, online collaboration, broadband for innovation, social capital of cities, collaborative learning and innovation,

Source: Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M., Oliveira, A. (2011)

Most known e-services to citizens are those related to administration services offered public authorities, mobility and transport services, and local e-commerce, commercial advertisement and marketing services. Most advanced technologically and better integrated into the physical space of Thessaloniki are those of mobility (public transport, fleet management, route planner, intelligent road monitoring). Interviews with managers of these systems provide information about their development and operation.

OASTH (www.oasth.gr) is the Organisation of Urban Transportation of Thessaloniki. It is a legal entity governed by private law representing approximately 2.000 small shareholders. The Organisation employs a personnel of 2.400 who move on a daily basis the buses of the Organisation, servicing the wider metropolitan area of Thessaloniki via 68 bus lines. In the period 2005-2010 OASTH invested about 5 million Euros in satellite fleet management and online services connecting all the 600 buses and 3500 bus stops of its network.

The system includes many different digital services:

- GPS based fleet management providing with real time information about the position and working conditions of every bus. Every 20 seconds or 150 meters the bus sends its position traced by GPS.
- Acoustic information inside the buses informing the public about next stop, which is activated automatically by GPS data.
- Digital displays on 220 most used bus stops, informing about the timing, direction, and arrival of buses. Displays are connected to fleet management and the information they provide is accurate and real time.
- Route planner for selecting best routes in terms of distance covered or time spent with respect to starting and ending points of a route. The user can find arrival times of routes at bus stops by selecting the route, the direction and the stop of interest.

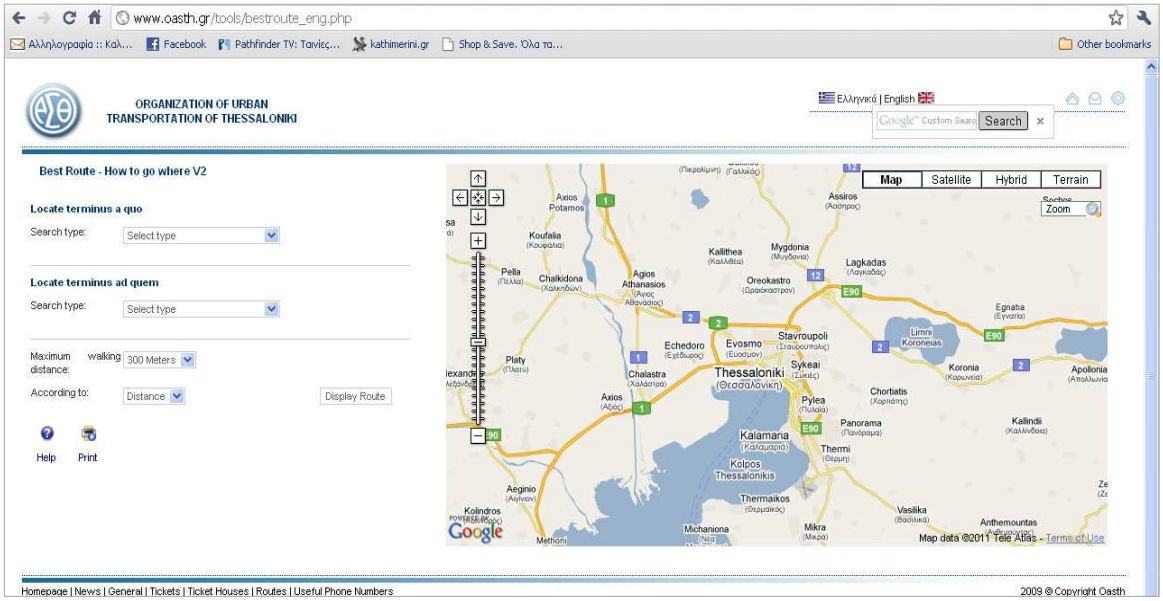

Figure 5: Route planner. Source: http://www.oasth.gr/tools/bestroute_eng.php

The development of the system was subcontracted to external vendors. Data entry and route update is made internally by the Organization. Data and applications are also maintained by the Control Centre on internal servers. The bus stops where displays were placed were selected by local authorities. Initially displays were supplied with power from photovoltaic panels, but these were vandalised or stolen. Bus stops provide also acoustic information for the blind.

The system offers information to 500.000 people that daily use the services of the Organization. The added value to end users is through better information on the route (bus stops), inside the buses with acoustic update of next stop, and on the web or smart phone with the route planner. Online fleet management is lowering maintenance costs of the fleet and quicker response in case of working failures or accidents.

The **Information System for the Thessaloniki's Eastern Ring Road** (http://rrits.lab.rcm.gr/) is another application in the same field. It is an intelligent transportation system which serves citizens' mobility by providing real time information on traffic conditions and advanced incidents' detection and management on the ring road of the city.

The ring road is among the most important infrastructures of the city with more than 100.000 moves per day. Currently the system covers a length of about 12.5 km in each direction of the Eastern Ring Road of Thessaloniki. The service is offered free of charge by the Regional Authority of Central Macedonia**.**

The system comprises three components:

- The wireless network which combines IEEE 802.11 (Wi-Fi) and IEEE 802.16 (WiMAX) and connects the smart devices placed on the Ring Road (cameras, sensors, displays), transferring information about traffic conditions in the Control Centre.
- The devices on the ring road, which comprise 5 variable message signs and a closed television circuit with 8 cameras which can be rotated and 9 fixed cameras. Cameras are equipped with image detection and processing equipment for recording and analysing traffic data.
- The Traffic Control Centre where data are stored into servers and the software is installed. The Advanced Transportation Management System (ATMS) software from NETworks © is used.

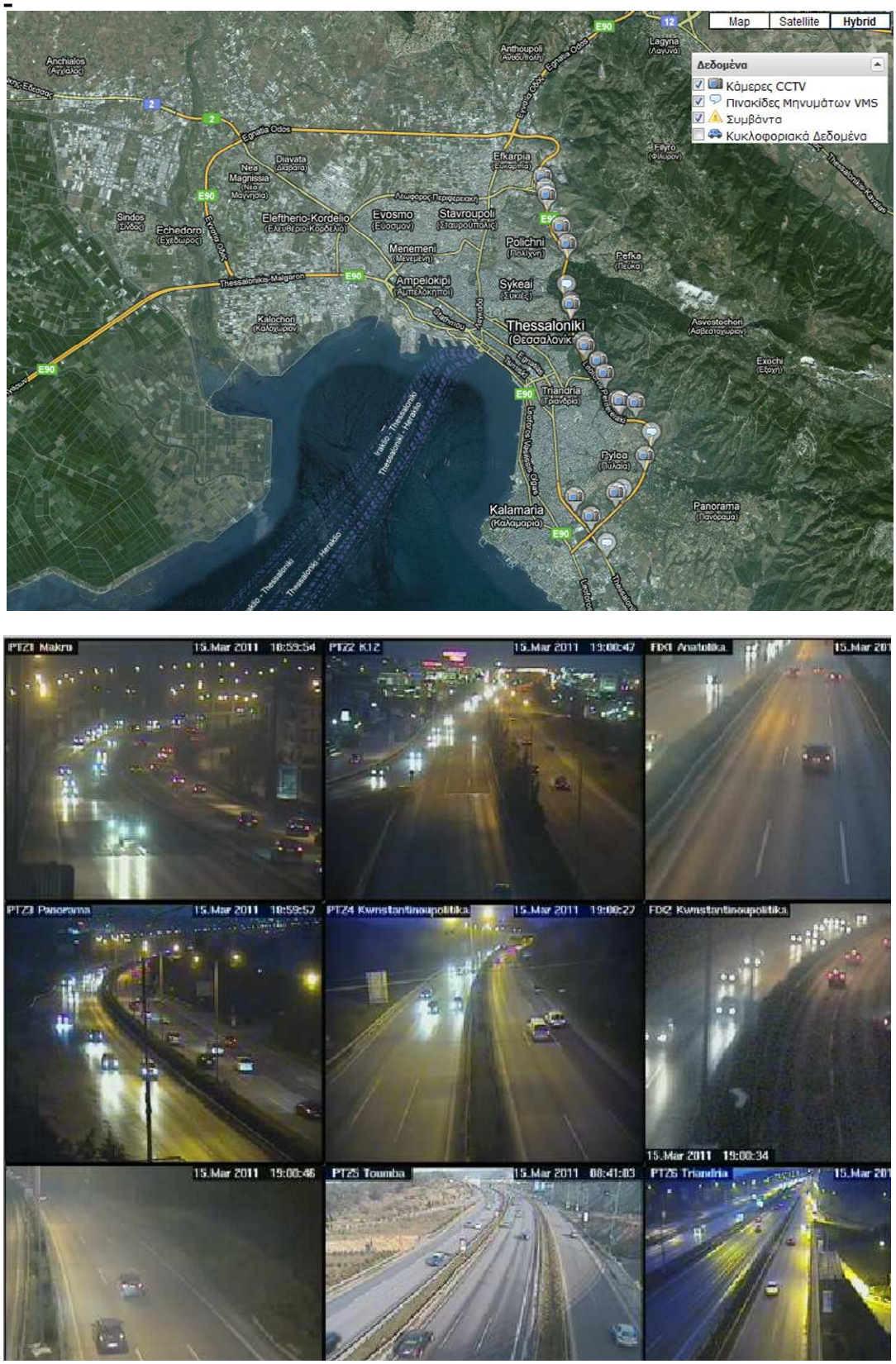

Figure 6: Rind Road Intelligent transportation system.

Source: http://rrits.lab.rcm.gr/

Data from cameras pictures, message signs, incidents and traffic rates is also available through the internet (http://rrits.lab.rcm.gr/). The user should have a web browser or a smart phone in order to use the service. The data is refreshing every 2 minutes due to bandwidth constrains of the wiresless network. A Control Centre gathers information from cameras about traffic conditions and incidents. Traffic loads are displayed with different colours for low (green), mid (yellow), and high (red) traffic. The system suggests messages to appear on the variable message signs, but the controller has to validate these suggestions before appearing on the Ring Road displays.

Funding for the design and development was given by the Operational Program of the Information Society and the total budget was 1,4 million Euro. Infrastructure, wireless network and software were developed by a consortium of providers including ICT companies, transport consultants, developers, and academic research labs of Aristotle University and the Institute of Transport - CERTH.

Thessaloniki 360 (http://www.thessaloniki360.com/en/) is a virtual guide of the city. It was created by the *Little Planet Image Services* as a web guide of the city. The intention of developers was to offer an advertisement platform and create customised configurations to advertise city companies and organizations. Particularly important is the quality and aesthetic value of the representations of the city, especially the night panoramic views. There are three applications on the platform:

Address finder and driving directions, with a usual structure of point of origin and destination, drop down lists, and directions given by car or foot. Specific itineraries are drawn for both pedestrians and drivers along with the estimated duration of the journey.

Tourist information map, covering the entire city with geolocated information. Places of interest are given in 10 categories: Media (Radio stations, Magazines, Sports newspapers, Newspapers); Shopping (Shops, Markets, Malls); Arts (Galleries, Theater Stages, Cinemas); Going out (Restaurants, Clubs, Café, Bars); Public Sector(Citizen Service Centres, Fire departments, Police departments, Taxation Offices, Hospitals, Post Offices, Consulates); Hotels (1 to 5 stars); City Views (Streets, Squares, Buildings); Events(International Bookfair, Song festival, Helexpo, Film festival, Biennale); Site seeing (Statues, Museums, Landmarks, Exhibition halls, Theaters, Churches); Life in the City (People, Everyday life, Happenings).

Virtual tour, with interactive city 360° panoramas. The visitor can discover monuments and landmarks, explore the history, culture and city highlights. More than 350 parts of the city are presented, city views, shopping, going out, etc. New material is constantly added and the area covered is being extended so as to gradually include sites outside the city that are considered important and can be reached from the city.

Impact

This survey on broadband and web-applications available in Thessaloniki reveal very little about the impact of digital Thessaloniki on the city growth and citizens well-being. It is certain that there is an impact, which can defined as a series of incremental and local improvements of various city systems, infrastructure, and activities: react quicker in the case of incident on the ring road; find the best route for travel from one place to another; make a transaction online; pay online a parking ticket; place online a demand for a governmental service; inform authorities about an incident; learn about cultural events in the city; find a hotel or a restaurant; learn the city better; share a bike; buy with a great discount, and so on and so forth.

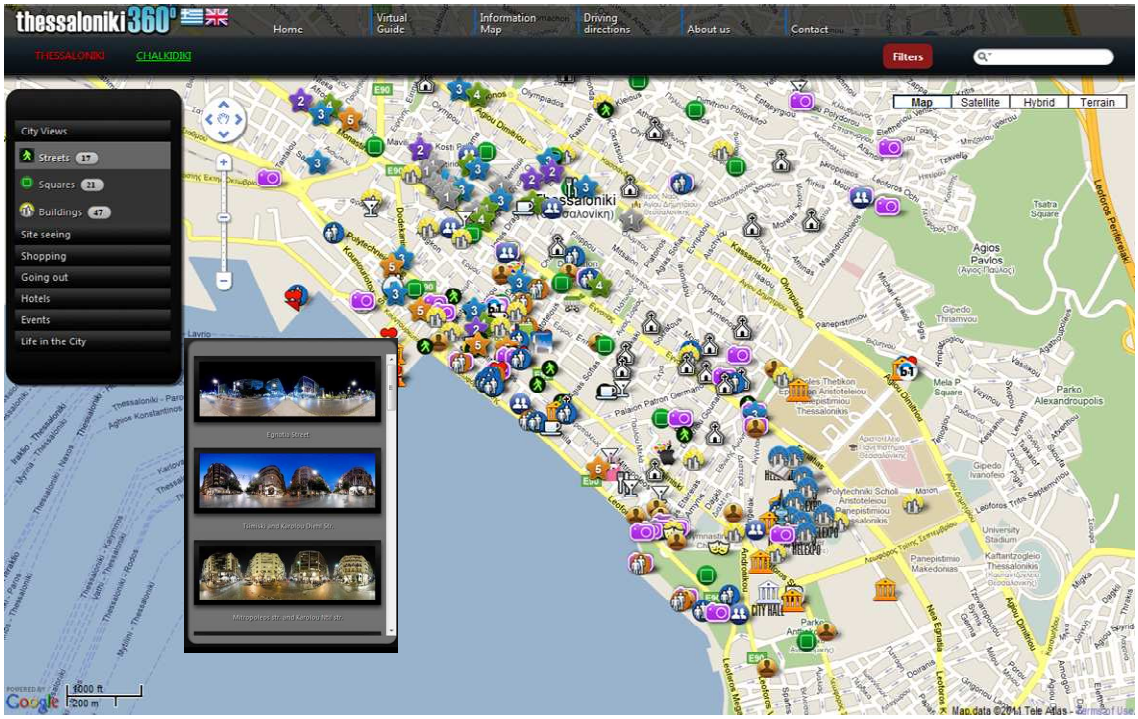

Figure 7: Thessaloniki 360

Source: http://www.thessaloniki360.com/en/map/

These fragmented outcomes are inherent into the way systems and applications have been development by bottom-up, decentralised actions, without a comprehensive plan about digital Thessaloniki. Also, it is hard to say whether a higher order is emerging from the local events and improvements. Impact measurement and analysis have not realised by any authority. However, some indications appear about systemic effects in three fields of the urban life in Thessaloniki.

A more competitive city with higher information and learning capacity is being created. Digital Thessaloniki with its hundreds of applications is sustaining the growth of the ICT sector in the city. A cluster of ICT companies has already been developed including more than 200 companies. It is the same cluster that funded and created the Technopolis Business Park in eastern Thessaloniki, a throughout private initiative. New employment and new company formation in this sector profited also from the concentration of demand about digital applications and networks.

Less traffic, less CO2 emission, less road load is realised because of less mobility. Online transactions are reducing the needs for physical mobility of inhabitants. Physical mobility is replaced by online transaction in relationships of citizens with public authorities, as more and more administration services are offered online; in relationships with banks as most operate online stores and transactions systems; in booking and ticketing for travel and recreation.

A more friendly city to the visitor or tourist is being created as much information about the city and its characteristics, monuments, recreation and cultural resources become available online. This is particularly important for a city with a large tourist sector and employment in hotels and restaurants depending from incoming visitors.

Table 2: Use indicators

	Alexa Traffic Rank	Traffic Rank in GR	Sites Linking In	3 month change	Google page rank
OASTH	239,063	1,497	167	+7%	6
Eastern Ring Road	650,459	5,011	92	-17%	7
Thessaloniki 360	3,107,547	60,907	20	-10%	3

Monitoring is needed to define the level of positive effects and valuate the benefits of digital Thessaloniki. Even organisations managing digital systems do not dispose data about the use of systems and users satisfaction. Some indications about impact estimation comes from Alexa and Google traffic ranks. Monitoring and impact analysis together with more elaborated vision about the contribution of digital technologies in the life of the city are among the first priorities for the immediate future.

1.4 INTELLIGENT THESSALONIKI: TOWARDS SMART INNOVATION DISTRICTS

The real challenge of digital platforms and applications developed over cities is to address the contemporary urban challenges of competitiveness, inclusion, and sustainable development. "Intelligent Thessaloniki" is a new approach towards these objectives of urban competitiveness and sustainability.

"Intelligent Thessaloniki" is a strategy for developing open public broadband networks, smart environments and web-applications in metropolitan Thessaloniki with the clear objective to strengthen the innovation ecosystems of Thessaloniki and the new growth sectors of transport, commerce, education, and high tech industry. This new approach was initiated in 2008 from the collaboration of the Ministry of Development, the Regional Authority of Central Macedonia and Aristotle University of Thessaloniki. The General Secretariat of Industry in the Ministry of Development commissioned the design of an innovative programme of entrepreneurship and development in the framework of the National Strategic Framework of Reference 2007-2013. "Intelligent Thessaloniki" was proposed by URENIO Research of Aristotle University in cooperation with the Region of Central Macedonia. Actually, the Municipality of Thessaloniki has taken the lead as agency for implementation having a strong support from all stakeholders in the city and wide coverage from the media[1].

The planning method adopted for "Intelligent Thessaloniki" was based on consultation with the authorities of the city and its main districts. The solutions proposed were based (1) on good practices internationally in the development of intelligent cities, (2) the results of the consultation with the city stakeholders, and (3) the available funding framework and constraints. Prior to consultation a survey took place to record available infrastructure and e-services, examine complementary solutions, and avoid duplication.

The planning objectives of "Intelligent Thessaloniki" reflect the conviction that smart environments can improve substantially the innovation ecosystems of the city, opening the local economy to global supply chains and markets and

[1] http://www.voria.gr/index.php?module=news&func=display&sid=41334
http://grblogs.gr/post/eufiis-thessaloniki
http://www.aftodioikisi.gr/dhmoi/dimos_thessalonikis/10349

enabling participatory innovation processes driven by citizens and inhabitants of the city. All planning objectives are blending ICTs and innovation, as well as the creation of smart environments supporting innovation, namely:

1. Sustain the development of new growth sectors and the main districts of economic activity of Thessaloniki with broadband networks, smart environments and web-based applications.
2. Develop new applications and e-services adapted to each city district to enhance its functioning and specific objectives. These media enable the mobilisation of collective intelligence and crowdsourcing for learning, new services development, digital marketing and promotion, monitoring and benchmarking each district.
3. Create smart city districts with strong local connectivity based on locally open broadband networks, mainly Wi-Fi and WiMAX, and embedded systems of sensors, smart meters, RFID, QR codes, and actuators.

These objectives point out a double concern: On the one hand to sustain the activity of each city district and innovation capability with broadband networks and smart environments, and on the other to differentiate this integration of innovation and ICTs from one city district to another. The intention of using publicly open broadband, embedded systems RFIDs, and sensors, marks also a step towards the Internet-of-Things and the management of innovation within open and smart collaborative environments.

"Intelligent Thessaloniki" is focusing on selected districts and islands of innovation and entrepreneurship of Thessaloniki, in which broadband networks, sensors, and web-applications are deployed. Priority districts include (1) The port of Thessaloniki, (2) the Central Business District and shopping centre of the city, (3) the campus of the Aristotle University of Thessaloniki, (4) the technology district of eastern Thessaloniki, and (5) the area of the airport.

In these city districts and ecosystems of products and services, a wide range of digital applications and services are proposed that improve innovation and entrepreneurship, including:

- The development of networks, wired and wireless, to provide broadband and access to services
- Provision of free Internet to users and business
- Development of intelligent environment of sensors for real time information processing and alert
- The development of digital services to businesses / organizations in each district such as market and technology watch, capacity building and acquisition of technology, new product development, digital marketplaces, and monitoring and benchmarking
- Training services for the involvement of end-users and business organizations to content development social networks.

Applications and e-services vary from one city district the other. In the **Port area and surrounding cluster,** smart environments are expected to enhance the competiveness of the post vis-a-vis other ports, lowering operation costs, improving the quality of service, integrating freight transactions, monitoring and benchmarking the operations of the Port. In the **Central Business District**, digital spaces are sought to increase visitors and the competitiveness of CBD, stop losing ground from peripheral malls; facilitate mobility and parking, environmental monitoring and alert. In the **University campus**, smart environments are expected to facilitate the dissemination of research, the opening of the University to the local productive tissue, and the strengthening of collaboration with enterprises. In the **Eastern technology district**, smart environments are expected to facilitate the promotion of premises and attraction of tenants, the provision of online technology services, and support new business

incubation.

The design of networks, systems and applications in each district is extremely specific to the character of the district. The concern is to integrate the activities of each district with processes and rules ensuring its optimum operation and a set of digital applications that enhance collaboration and effectiveness. All systems are revaluated from the point of view of additional functionality they offer to the respective community.

Figure 7: Smart districts reorganizing the city of Thessaloniki

Source: "Intelligent Thessaloniki"

In the Port District, i.e., the design of network infrastructure takes into account the radiocoverage of existing networks (Wi-Fi/ WiMAX) in the port area, the optimization and expansion of these networks, installing new antennas, links, and routers, central management of all wireless and wired links, determination of independent physical subnets and subnet bridges, design of servers installation depending on the applications, and design of an RFID and cameras network. Over this extended network, new services are designed to offer additional functionality and performance to the entire **Port Community**. To this end, a series of applications and platforms are to be developed, selected from the consultation with this Community.

Figure 8: Districts of Intelligent Thessaloniki: Port area, CBD, University campus, Technology District

Source: "Intelligent Thessaloniki"

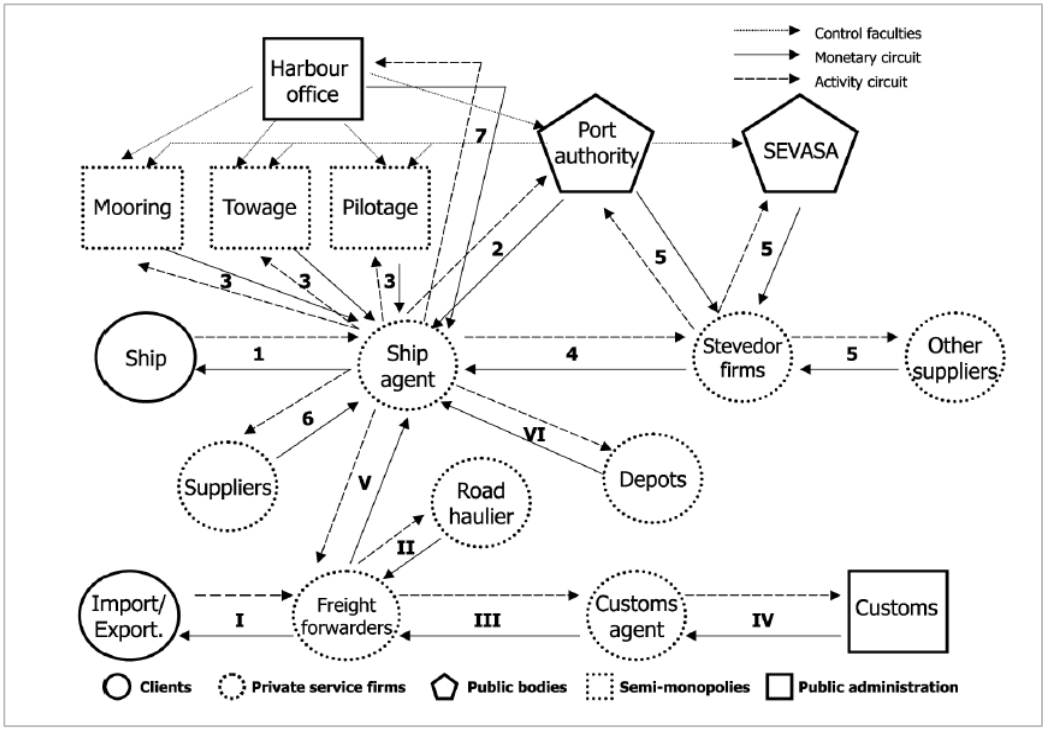

Figure 9: Representation of a Port Community

Source: Cuadrado, Frasquet and Cervera (2004)

Strategic intelligence is a collaboration platform for the continuous improvement of the Port practices and competitiveness, including the analysis of the Thessaloniki port characteristics, competition from ports in southern Europe, creation of a community of strategic intelligence group by administrators, employees and partner organizations, crowdsourcing solutions and improvements, and elaboration of Port strategic orientations collaboratively.

Port Community - Freight is a system providing communication and cooperation of all members involved in the cargo operation of the Port. The maximum return on the loading / unloading of containers and their handling at the port requires the close cooperation of numerous agencies and groups. The freight community platform is based on Internet, Intranet, wireless communication, and RFIDs, connecting ships, machines, operators, and personnel. All parties in the transport chain can cooperate on-line, including Local Liner Agents, Ship Operating Agents, Hauliers, Rail Operators, Tally Companies, Service Providers, Repair companies, Container Terminals, Port Authorities, Administration, Customs, Importers / Exporters.

Intermodal Freight Transportation is a system covering the transfer of a cargo in a container or vehicle, using multiple modes (rail, ship, truck, etc.) without having to mediate cargo handling when changing vehicle. IFT includes technologies that improve the safety of cruise ships at a port, including the approach to port and technologies that enable efficient tracking and tracing of cargo during transport from the port to the consignee.

Port Community - Passenger ensure continuous and adequate information to passengers, informing the traveling public and citizens, allowing on-line ticketing, monitoring and cancellation of tickets at the entrance to the ship, smart safety based on biometrics tracing, and e-commerce.

Benchmarking performance is a platform comparing the activity of the Port with their competitors or other ports which are considered to be excellent; comparing the services that the Port offers (pilotage, towage, mooring, loading and unloading, supply, customs clearance, administrative control, storage and distribution of goods, intermodal transport, and other added value operations of finishing, packaging, labeling) with respect to criteria for selecting one port against another, i.e. infrastructure quality, logistics, time, costs, and safety.

In all these new services, the same architecture will be implemented combining the creation of a group of actors for each service, the definition of processes and rules for the delivery of the service, and the development of online platforms, applications, and smart environments facilitating and guiding the new service. Communities of users are in focus. Intelligence will be generated by workflows that combine collaboration, institutional rules, and IT support and coordination.

All these new services are very specific to the Port district. Different set of applications and services is foreseen in the other districts of "Intelligent Thessaloniki".

Implementation of "Intelligent Thessaloniki" is foreseen by stages and on per district basis. An open call for drafting and implementing detailed plans for the Port area and the Central Business District is expected this year. Vendors will be selected on the basis of the solutions they will offer, the added value of solutions to the respective district, development costs, and sustainability business models proposed. Much of the infrastructure and applications are expected to be hosted on the cloud.

1.5 GOVERNANCE CHALLENGES OF INTELLIGENT CITIES

Bottom-up and top-down making of digital spaces over the cities mark the development and planning of 21st century cities. It is a process of historical dimensions equal to the creation of institutional mechanisms for city management and planning (master plans, land use regulation, urbanisation control, welfare city programs) which were adopted during the 20th century. However, this new orientation poses new challenges to city government related to the creation of the digital spatiality of cities, and integration of the digital into the pre-existing physical and institutional spatialities for more effective, inclusive, and environmentally sustainable cities.

The survey on the development of broadband networks, digital applications, and smart districts in Thessaloniki informs about these new governance challenges. Similar processes take place in many cities all over the world[1] combining individual bottom-up initiatives and state-led top-down planning. The twin processes of city development - from below and above - are somehow replicated in the creation of the urban digital space.

Creation of digital spatiality of cities: Gaps to bridge

The creation of a digital space over cities can be represented by four concentric rings each one having specific characteristics and functionality. At the centre are the broadband network, wired and wireless infrastructure and communication protocols enabling communication and connectivity of various devices. Then comes a ring of web technologies enabling data processing, elaboration, visualisation and web-based collaboration. The third ring is composed of applications at different domains of the city; at least twenty different domains of cities can be identified as potential fields applications related to the economy, city infrastructure and utilities, quality of citizens life, and city governance. The outer ring is composed of e-services as a few applications will be adopted by the market and offered on a regular basis as service.

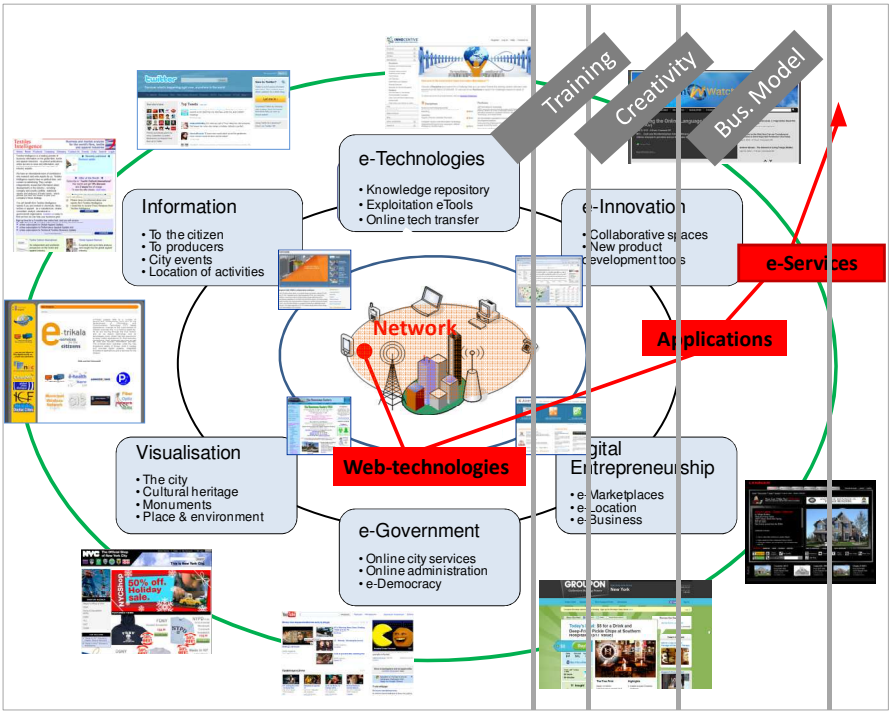

Figure 10. Digital spatiality of cities: Four rings - three gaps

[1]The estimation of the Intelligent Community Forum (http://www.intelligentcommunity.org/) speaks about 500 experiments of intelligent city strategies around the world.

The deployment of this complex digital edifice does not emerge spontaneously, but it comes from meticulous planning and development. In the first place, decisions about the characteristics of the network have to balance costs and benefits. All cities would wish the high bandwidth of a FTTH network, but networks always comply with traffic. VDSL solutions, for instance, might be more appropriate at medium term, reducing investments in networks and increasing the effort on applications and e-services. The critical question is how the network is used and which services are offered on the network. Here come a series of gaps which cities have to overcome.

The ***digital skills gap*** concerns the ability of citizens and companies to master web-technologies and offer solutions over the net. We have seen in Thessaloniki that a major part of the digital spatiality has been created by bottom-up initiatives. Most applications presented on Table 1 rely on local capabilities of companies, organisations and citizens to master web technologies. The larger the digital skills gap is, the smaller is the involvement of citizens in digital, smart, and intelligent city solutions. Primary importance for bridging this gap is to promote training of the LAMP stack composed of free, open source software, such as the Linux operating system, Apache HTTP Server, MySQL database, and Perl/PHP/Python programming languages. This stack offers a great number of advantages such as easy to code, easy to deploy web applications, low cost and ubiquitous hosting as most web hosts offer PHP and MySQL services[1].

However, learning and mastering web-technologies does not lead spontaneously to applications, as a ***creativity gap*** separates web technologies and applications. As learning grammar and syntax of a language doesn't make a writer, equally learning programming languages does not make someone successful application developer. Platforms like the iPhone and Android document this gap as the toolbox of technologies lead to thousands applications with different degrees of complexity, novelty, and success. Bridging the creativity gap between technologies and applications should be a priority for city governance to take advantage of latent skill among the city population. Living Lab methodologies, social experiments, crowdsourcing, and open city platforms for creating and promoting applications may offer good solutions to this end and mobilize creativities of the entire population of the city.

A few digital applications will finally turn to e-services, as an ***entrepreneurship gap*** takes place between digital applications and services. Here, the critical issue is to find a successful business model and the initial investment needed to turn an application to e-service and offer it on the market. The question is quite simple: who is going to pay for the service and at what cost? A recent survey of Forrester Research identified eight alternative engagement models that ensure the viability of IT initiatives: External investment; Revenue-generating or cost-cutting; Revenue-sharing and public-private partnerships; Capacity reselling; Agreements to pool resources and share infrastructure; Leasing and financing; Barter or in-kind exchange; Data monetization (Belissent, 2010). Each city has to experiment with such business models and identify which are suitable for each type of services and applications.

Integration of the digital: workflows and skills

Creating a digital spatiality is not the only challenge of contemporary city governance. The digital space with all its components and functionalities has to integrate with the pre-existing physical and institutional spatiality of cities. Integration makes media solutions part of city's infrastructure and offers additional problem-solving capabilities. Integration is the motor of the spatial intelligence of cities, combining the strengths of the digital spatiality with the community of the city, and its institutional endowment.

[1] http://en.wikipedia.org/wiki/LAMP_(software_bundle)

The survey and case study in Thessaloniki revealed two different trajectories of this much desired integration. In the case of the Port, for instance, integration takes place as the Port community take advantage of IT and web applications to work more efficiently, increase the competitiveness and the quality of service of the Port. Digital spaces complement directly the community of the Port improving established processes and workflows. Simplification and re-engineering introduce innovations in processes and services. Intelligence and problem solving evolves because of more efficient and cost-reducing workflows. On the other side, we observe an indirect integration as knowledge spillovers and public policies for smart environments disseminate digital learning and know-how within the city. The urban environment becomes a platform for skills creation and digital education of the city's population. Intelligence evolves because of more educated and skilled people.

Both forms of integration create advantages either way: the digital improving the physical and institutional dimensions of cities; and city environments and proximity enhancing the digital culture of the population.

References

Aurigi, A. (2005) Making the Digital City: The Early Shaping of Urban Internet Space, Ashgate.

Aurigi, A., and De Cindio, F. (2008) *Augmented Urban Spaces* , Ashgate.

Belissent, J. (2010) "Getting clever about smart cities: New opportunities require new business models" Forrester for Ventor Strategy Professionals.

Bell, R., Jung, J., and Zacharilla, L. (2009) Broadband Economies: Creating the Community of the 21st Century, Intelligent Community Forum Publications.

Cuadrado, M., Frasquet, M. and Cervera, A. (2004) "Benchmarking the port services:

a customer oriented proposal", Benchmarking: An International Journal, Vol. 11 No. 3, pp. 320-330

El Nasser, H. (2011) "Will 'intelligent cities' put an end to suburban sprawl?", USA TODAY 28 January 2011. Online http://www.usatoday.com/news/nation/2011-01-28-cities28_ST_N.htm.

European Commission (2008) Growing Regions, Growing Europe: Fifth progress report on economic and social cohesion, European Commission COM(2008) 371 final.

Georghiou, C., Komninos N., Martinidies, G., Martzopoulou, N. Sefertzi, E., Tramantas, K. (2009) Hybrid Innovation and the Future of Industry in Thessaloniki, Thessaloniki: Giahoudis Publications.

Gloor, P. (2006) Swarm Creativity: Competitive advantage through collaborative innovation networks, Oxford: Oxford University Press.

Graham, S. (ed.) (2003) *The Cybercities Reader*, London: Routledge.

IBM, 2010, 'A vision of smarter cities: How cities can lead the way into a prosperous and sustainable future', IBM Global Services.

Ishida, T., and Isbister, K. (eds) (2000) Digital Cities: Technologies, Experiences, and Future Perspectives, New York: Springer.

Johnson, S. (2001) Emergence. The connected lives of ants, brains, cities, and software, New York: Scribner

Kakderi, C. and Kourtesis, A. (2009) 'Local e-governance applications in support of entrepreneurship policy: the case of Thessaloniki metropolitan area', Int. J. Innovation and Regional Development, Vol. 1, No. 4, pp.423–442.

Karadimou, A. (1985) "Redesign and rebuilding of Thessaloniki after the great fire of 1917", PhD dissertation, Aristotle University of Thessaloniki.

Komninos, N. (2002) *Intelligent Cities: Innovation, knowledge systems and digital spaces*, London and New York: Taylor and Francis.

Komninos, N. (2008) *Intelligent Cities and Globalisation of Innovation Network***s**, London and New York: Routledge.

Laguerre, M. (2006) The Digital City: The American Metropolis and Information Technology, Palgrave Macmillan.

Leach, N. (ed.) (2009) Digital Cities AD: Architectural Design, Wiley.

Mazower, M. (2004) Salonica City of Ghosts: Christian, Muslims, and Jews 1430-1950, London: Happer Perennial.

Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M., and Oliveira, A. (2011) "Smart Cities and the Future Internet: Towards Cooperation Frameworks for Open Innovation" FIA 2011 (forthcoming).

Tanabe, M., Besselaar, P.V., Ishida, T. (2001) Digital Cities II: Computational and sociological approaches, New York: Springer.

Yigitcanlar, T., Velibeyoglu, K. and Baum, S. (2008) Creative urban regions: harnessing urban technologies to support knowledge city initiatives, IGI Global.

Van den Besselaar, P. and Koizumi, S. (eds) (2005) Digital Cities III. Information Technologies for Social Capital: Cross-cultural Perspectives, New York: Springer.

2 SMART CITY CASE STUDY: OULU

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2.1 INTRODUCTION

The concept of the **smart city** as the next stage in the process of urbanization has been quite fashionable in the policy arena in recent years, with the aim of drawing a distinction from the terms digital city or intelligent city.

Its main focus is still on the role of ICT infrastructure, but much research has also been carried out on the role of human capital/education, social and relational capital and environmental interest as important drivers of urban growth.

Since early 90's City of Oulu has been determined in developing working environments to expedite growth of businesses in Oulu region. The active role in standardization of wireless and mobile technologies; remarkable investments in public wireless and mobile infrastructure and concrete collaboration with unique PPP programs, have all made Oulu a leading wireless R&D hub within the global innovation ecosystem. Intensive collaboration between companies, public sector and universities, so called "Triple-Helix" has been base for the co-operation for years.

The city of Oulu and Oulu region with its developing infrastructure forms an excellent urban living lab - a system and an environment where real-life user centric innovations flourish.

This document elaborates current situation of the City of Oulu in this context.

2.2 DEFINITION OF SMART CITY CONCEPT

Urban performance currently depends not only on the city's endowment of hard infrastructure ('physical capital'), but also, and increasingly so, on the availability and quality of knowledge communication and social infrastructure ('intellectual and social capital'). The latter form of capital is decisive for urban competitiveness. It is against this background that the concept of the "smart city" has been introduced as a strategic device to encompass modern urban production factors in a common framework and to highlight the growing importance of Information and Communication Technologies (ICTs), social and environmental capital in profiling the competitiveness of cities. The significance of these two assets - social and environmental capital - itself goes a long way to distinguish smart cities from their more technology-laden counterparts, drawing a clear line between them and what goes under the name of either digital or intelligent cities.

Smart cities can be identified (and ranked) along six main axes or dimensions. These axes are: a smart **economy**; smart **mobility**; a smart **environment**; smart **people**; smart **living**; and, finally, smart **governance**. These six axes connect with traditional regional and neoclassical theories of urban growth and development. In particular, the axes are based - respectively - on theories of regional competitiveness, transport and ICT economics, natural resources, human and social capital, quality of life, and participation of citizens in the governance of cities.

A city can be defined as 'smart' when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic development and a high quality of life, with a wise management of natural resources, through participatory governance [1].

2.3 DIGITAL AGENDA

By digital agenda is here meant the EU communications and knowledge society policy guidelines, legislative policies, and programs that help to ensure conditions for economic growth—based on information and communications technology—in the EU. Behind the success of the EU in the last five years has been the effective use of information and communications technology; the goal of the EU's joint digital agenda is to enable comparable development in the future.

The digital agenda contains seven areas of development to be pursued.

The City of Oulu has recognized the areas for development identified and presented in the digital agenda as important. For its part, the City of Oulu has worked actively to promote the various preconditions necessary to support a knowledge society. For instance *panOULU*—Oulu's wireless WLAN—has been realized as part of local municipal projects, as has *OmaOulu*, a 'citizen's portal' giving citizens free access to e-services. Within those municipal projects, a clear need has been identified to develop the skills and capacities of both citizens and municipal workers to participate in a knowledge society. Better skills and competence means we can improve citizen knowledge of information security issues, helping to avoid security risks related to the use of e-services. Also, the development of skills can increase citizens' trust in e-services, resulting in an increase in the use of those services.

One of the most central challenges facing public administrations is to improve the interoperability of information systems, enabling much more efficient service production and better development of service production. *Interoperability* and *data portability* would remove the need for the manual transfer of information between systems and organizations. By automating manual procedures, we can improve how efficiently organizations act and—in turn—use the released resources to perform more productive tasks and improve the efficacy and effectiveness of service production. Such improvements are critical to the success of the EU as a region.

In improving interoperability, it is important to bring together different players to determine needs and standards. Through cooperation, we can more effectively influence the openness of systems and solutions; the same principles apply to the creation of a uniform digital marketplace. In a traditional economy, high-quality transport connections play a significant role in regional development. A comparable trend is evident in the digital world: fast data connections allow us to develop new *types* of service and are key to promoting the use of digital services (for instance for use in long-distance employment, in improving conditions for the elderly living at home, and in providing broadband TV). Finland faces a challenge in the low population density of regions outside southern Finland, regions in which sufficient commercial conditions may not exist to offer the necessary data network infrastructure. A similar challenge is being encountered by member states that are behind in information and communications technology. For that reason it is important that the matter has been raised and identified for development on the agenda.

Investment in a high standard of education and in comprehensive research and product development is considered one of Finland's success factors. Finland is known for its technological innovations, but the technical possibilities offered by those innovations have often been under-used. This means that various parties have failed in the production of digital services; in other words, the technological possibilities have been left unused. According to the current trend, society is moving towards the development of e-services and for that reason it is important that further investments into the development of the applications of new technologies be made in the EU region. Through such applications, we might

genuinely support the pursuit of solutions to those challenges identified in the digital agenda.

A clear need exists for the EU's common digital agenda. Moreover, it is vital that the various different players and their needs at an EU level are drawn together to serve the development of the entire EU region and above all to ensure that the EU remains involved in global development. In pursuing a solution to the problem of an aging population, we need cooperative action and concrete measures by which the objectives of the digital agenda may truly be achieved. Also, in the process of concretizing that digital agenda, we must acknowledge that a sufficient infrastructure—fast, secure data networks and internet connections—must exist before the other areas of development on the agenda can be addressed [2].

2.4 STRATEGY

In the course of just a few decades, Oulu has become the most successful city in northern Europe. In 2015, Oulu wants to be the most highly developed city in Finland and all of northern Europe. The city of technology will evolve into a centre of innovation.

In its new strategy, the city states its intention to continue on its present path of strong growth, to multiply its efforts to attract companies based on high competence in different fields to the city, and to promote internationalisation by a significant increase in the number of foreign employees. Oulu intends to gain a clear head start compared to other cities by being number one in terms of service provision and top-level education.

Oulu is setting itself demanding challenges and tasks, with the aid of which the top position can be secured. Oulu is also the first city to define creativity and courage as being the most important among the values that guide its operation. Besides creativity and courage, a sense of community and tolerance are emphasised [3].

Oulu's vision to 2015

Oulu is the most viable urban community in northern Europe, with the most high-standard services in Finland based on residents' needs, and a well-balanced economy.

Oulu is a city of people and firms with global network contacts, providing an innovation environment based on top-level competence for a variety of actors.

Oulu is an international, multicultural, tolerant city with a pleasant living environment and ecologically sustainable operational principles.

Key elements of Oulu's strategy

- The key objective of the city strategy is to create a good, attractive and enjoyable living environment for residents and to provide the most highly developed services in Finland, combined with a well-balanced economy.
- The basis of the strategy is a creative, enjoyable urban environment, consisting of a whole made up of several elements: competence and capability, technology and creativity as well as a tolerant, multi-value urban community.
- The aim is to create an innovation environment of the highest international standard for companies, based on the integration of education, research and product development into a network which is actively built and maintained by the city.
- This gives firms already operating in the Oulu region power to develop, creates growth potential for new companies and attracts foreign experts and firms to the region. In addition, it provides room for diversification and expansion for different branches of business.

- The goals of the strategy are long-term development targets. Their fulfilment calls for regional networking as well as for more extensive networking on an international level.

City of Oulu's development approach and development programs are derived from the strategy for the city of Oulu. Development programs have been identified as critical success factors of strategy implementation.

2.5 INNOVATION ECOSYSTEM

Strategy for creating a competitive environment

City of Oulu placed 04/06/2007 a **national level working group** to draw up a **regeneration** proposal for the Oulu-based **innovation ecosystem**. Regeneration target for innovation ecosystem is the ability to better meet the challenges of internationalization, in particular business and generating the new applied knowledge.

The Working Group proposal of Oulu Innovation Environment vision for 2015 is as follows;

Oulu is a Northern European vibrant, inspiring, comfortable and globally interconnected, educational-, research-, business- and residential community. The City of Oulu plays a significant role in developing this community.

The working group prepared a short and long term objectives to achieve the vision. Short-term goal is a strategic partnership model of Oulu Triple Helix Development Alliance. Latter called as the Oulu Innovation Alliance (OIA).

Development of infrastructure

The Oulu Innovation Alliance (OIA) agreement has been formed between the City of Oulu, University of Oulu, Oulu University of Applied Sciences, VTT Technical Research Centre of Finland and Technopolis. It is headed by a joint management team, whose task is to decide on common strategic policies and initiate concrete measures for development.

The OIA has prepared a development plan for the next few years with various measures to be implemented by the parties. Operational development plan covers the structures of cooperation, excellence and internationality, innovation, environment and financial resources. In addition, proposals are made for the City of Oulu to further develop the innovation environment ecosystem.

Development of concept for Oulu Innovation Centers of Excellence, Strengthening of Internationalization and definition of City of Oulu role in the innovation ecosystem as a developer are couple of examples of the topics listed in the OIA development plan.

Developed innovation centers of excellence are;

- Center of wireless communications (CWC)
- Center for Internet Excellence (CIE)
- Welfare technology (CEHT)
- Water technology (CEWIC)
- Clean air technology (SkyPro)
- Business know-how knowledge (MAIGBE)
- Center for Printed Electronics (PrintoCent)

From the physical infrastructure point of view objective is to introduce a visible change on the society by building a functional prototype of an open ubiquitous city in Oulu. From the user community's point of view such a city appears as a smart urban space providing rich interaction between the physical, virtual and social spaces. From the R&D community's point of view the city appears as an open community test bed stimulating innovation, research and development of new services and applications.

The test bed enables urban computing research in authentic urban setting with real users and with sufficient scale and time span. Such studies are important because real world systems are culturally situated, and cannot be reliably evaluated with lab studies detached from the real world context. By deploying a system for a sufficiently long time "in the wild" we can establish the technical and cultural readiness and the critical mass of real users needed for determining whether the system can be deemed '(un)successful' [Greenberg & Buxton 2008].

Fundamental hypothesis is that by deploying new pervasive computing infrastructure and new applications and services into the public urban space we make it a better place for people. Proving the hypothesis either true or false calls for holistic understanding and addressing of urban informatics. As Paulos and Jenkins [2005] stated, the single main research challenge of urban computing is to understand how the future fabric of digital and wireless computing will influence, disrupt, expand, and be integrated into the social patterns existent within our public urban landscapes.

An approach to inclusive and sustainable city

Development programs of City of Oulu

City of Oulu's development approach and development programs are derived from the strategy for the city of Oulu. Development programs have been identified as critical success factors of strategy implementation and are in match to the digital agenda of EU containing seven areas of development.

The City of Oulu has recognized the areas for development identified and presented in the digital agenda as important. For its part, the City of Oulu has worked actively to promote the various preconditions necessary to support a knowledge society. For instance development programs; **Coping and well-being-, Urban culture development-, Information management-Employment policy- and Oulu Climate Change Program** are well aligned with the digital agenda.

Knowledge of citizens and equality are the key factors together with sustainable development in "Future Service Society" and "Information Society" programs and other development programs listed above.

Development programs are monitored and evaluated as part of the city's annual operational and financial planning and evaluation.

Living Labs in Oulu region

The city of Oulu with its aggressively developing infrastructure forms an excellent urban living lab - a system and an environment where real-life use-centric innovations flourish. Oulu's living lab offers an environment for sensing, testing and piloting technological and social innovations.

Definition of the living lab activities in the Oulu region innovation ecosystem is part of the national level working group proposal where City of Oulu plays a significant role. City of Oulu actively promotes intensive collaboration between companies, public sector and universities. This so called "Triple-Helix" has been base for the co-operation for years and well supports and is aligned with the ERDF strategy.

Operational strategy of Northern Finland ERDF is to increase competitiveness and innovation of the North of Finland, promote business growth, improving accessibility and strengthening of the attraction factors.

The living labs in Oulu region promotes the regional ERDF development program objectives by bringing innovative solutions to new operating environments and the development and creation, providing services and developing processes and technologies for their exploitation.

One example how City of Oulu drives for the Living Lab approach to obtain user-driven innovations is development of **"test user community"** tool in Tomorrow's Service Society project (EAKR/Council of Oulu Region). Test User Community tool "PATIO" (www.patiolla.fi) empowers ordinary people to experiment and contribute to development of new services or appliances.

Another example is **development of learning environments**. How to renovate old schools or new school buildings to meet challenges of future learning? The Education Office in the City of Oulu is investing in future oriented thinking to develop learning environments to better match the learners and their needs. This foresight thinking is unique globally.

The work is based to national and regional curriculum as well as strategies of the City. It has been carried out through ten Smart Schools network, which has their individual development Projects going on. Beside this network there are big development projects where it is possible to develop mobile learning, game-based learning, 3D and more personal learning environments either physical or virtual.

The work is carried out in co-operation between public, research and business sector operators. Based to Finnish Education system it is possible to create new business opportunities for new innovations in learning and new kind of business solutions.

This kind of change demands time and first effects we are able to seen in two or three years or when new learning environment and residential area have been built.

Development of **Social and Health Services** in City of Oulu is based on the strategies of City of Oulu and the needs of implementing new products and services into the public health care sector. A special effort is put to organize social welfare and health services to the citizens.

The latest healthcare center in the City Of Oulu was established January 7th 2008. In addition to the normal services of healthcare center, Technology Healthcare Center Oulu offers product testing and analyzing services to companies and research institutes. This service is called TT Kaakkuri, product testing service.

In product testing service professional health care personnel and product test specialist creates an individual test program tailored for customers' needs.

Living Labs strengthen the position of City of Oulu in international and national competition, and thus helps in restructuring the economy by increasing innovation, competitiveness, and promoting business growth.

OULLabs (Oulu Urban Living Labs, www.oullabs.fi)

OULLabs is established to support companies and developers to further utilize the existing infrastructures and networks. OULLabs brings together Living Labs, companies, public sector, social user groups and individual users for co-creation of user-centric appliances and services and to expedite growth of businesses.

OULLabs forms an active environment which drives co-creation of user-centric services supported by tailored research, development and solution creation.

OULLabs acts as a "one-stop-shop" testing and test bed service provider with project and resource management. It also offers marketing and communication services for members and opens a window of opportunity to national and international projects.

Test user community "PATIO" is a key element in obtaining user-driven innovations to empower ordinary people to experiment and contribute for the Future Internet.

The focus of the OULLabs is in ICT, eHealth, Education and Smart Cities. Network has been built for companies who want to test their ideas, products or services in authentic environments and with authentic users.

NorthRULL (Northern Rural Urban Living Lab, www.northrull.fi)

NorthRULL is the northern-Finnish Living Lab network whose primary objective is to strengthen, particularly in Northern Finland, living conditions, the economy and welfare in key thematic areas, which are currently producing new services, tourism, health and welfare. Development will be specifically to take advantage of ICT opportunities provided by both NorthRULL network added a multidisciplinary approach. NorthRULL is a network of universities and colleges to produce new innovative solutions all of Northern Finland.

Living laboratory model reflects a new user-centered innovation system, in which people / users / customers are at an early stage, to produce new and innovative solutions based on inter-disciplinary research and information and communication technologies.

2.6 EXAMPLES OF USE OF ENVIRONMENTS

Applicability and benefits of our open ubiquitous city test bed has been demonstrated with a number of examples in collaborative industrial R&D, in academic research, and in engaging the user community. Some of the examples are presented here.

Use by city

OmaOulu – service, www.omaoulu.fi

In May 2008 the City of Oulu opened the OmaOulu portal to citizens. OmaOulu is a website through which citizens can use the city's electrical service and the service offered by the other functions centrally. OmaOulu promotes citizens' ability to benefit from the latest technology in technological know-how.
OmaOulu portal brings together the City of Oulu e-services now and in the future. Users can easily create an own customized site, where they can access to the preferred services. Service content offerings include currently a variety of community services and integrated the city of Oulu existing online services, e-mail, photo album etc. Registering for the service is free of charge.
OmaOulu portal has been developed with a user centric procedure. OmaOulu is intended for all citizens. Citizens are encouraged to actively contribute to service development to define a new kind of service channels as well as possible services. The OmaOulu portal is intended to become so easy that even a less experienced internet user would be able to manage their affairs and take advantage of features provided by the service.

Development of Future Schools and InnoLobby

InnoLobby as a Learning Environment of the Future was carried out as a part of the School of the Future program, which consists of numerous development projects (www.edu.ouka.fi/sof). As a part of the product development, an environment similar to Living Lab and Demo center was designed for one school and the surrounding community.

The aim was to find solutions for the development of learning environments and to connect traditional and virtual learning environments, as well as to build a 21st century learning environment where people can be thought using various pedagogical models. The idea of the environment was to showcase the School of the Future ideology and concepts. It was to create, within a functional framework, an innovative unit where lighting, audiovisual environment, furnishing, technology as well as the multi-functionality of space and learning environment would be carefully planned. The space was to be a model for the future development of learning environments and later renovation and building projects.

The outcome of the project was a model and experimental space of the 21st century learning environment, where teaching can be carried out using various methods. The new learning environment has a positive impact on students' school satisfaction and learning motivation as well as teachers' ability to cope at work; it is also a place for collaborative working techniques.

The model may be scaled to fit similar projects, both renovation and new construction projects. The new learning environment will also be a place of interest for visitors and a benchmark for similar projects elsewhere in Finland as well as overseas.

The implementation of InnoAula is based on architectural surveys carried out in six schools that set out to find solutions for the future learning environments. As the drafts were being drawn, it was already decided that one of the construction projects would be carried out. It was InnoLobby, and the project was implemented by external funding.

The transformation of the traditional school environment into a 21st century learning environment is implemented:

1. by raising awareness
2. through change
3. Embedding a new operational culture.

During the School of the Future Program two new school building has being built. The next new school buildings are under planning process. To support this future oriented thinking there is also Smart School network and development projects inside the individual schools in the City of Oulu.

Based to development work for physical learning environment a new kind of virtual learning environment (VLE) has been built. It has been made by using realXtend technology. This is a virtual 3D learning environment called TOY. The pilots in test users are running in the piloting schools.

Smart Urban Spaces (SUS)

The City of Oulu aims to understand and support the development of new technologies by testing and implementing them in public sector service packages. Technological advances can result in significant improvements to the quality, efficiency, and usefulness of public services—and in higher productivity and a keener competitive edge for local businesses and research institutes. City of Oulu administrators act as defining bodies in the renewal of service processes, offering local organizations opportunities to test innovations in a real-life environment. Pilot prototypes are built around real-life development needs, use existing ICT solutions, and are planned to be as cost-effective and accessible as possible.

Whether a pilot project will lead to permanent new practices is not always apparent, but at the very least, public sector solutions offer new perspectives and possibilities to producers and suppliers.

Public sector solutions also function as a vital reference for businesses in European markets.

Smart Urban Spaces is a European-wide (Eureka ITEA2-IP-08010) effort to develop compatible urban services that are easy to use, making use of mobile technology and ubiquitous IT. The focus is on context-based services and local services usable through mobile devices.

These services and interoperability characteristics will be prototyped and validated over a first kernel of European cities [4].

Examples of SUS projects in City of Oulu

Solutions to Support learning

A suite of new services to improve learning through a growth in motivation, including hybrid books, e-media sharing platforms, and sports games...

Smart Daycare

Real-time monitoring of the attendance of children in daycare centres and of staff working hours will enable an optimal use of resources and form a basis for the hourly-based daycare units of the future.

Mobile Work Support

A Mobile automation of the logging and transfer of work hours by city mobile workers for approval and for use in payroll systems.

Mobile City Services / City Card Services

The NFC-enabled city card, a turnkey solution allows cities to serve citizens through mobile channels, linking those citizens to services, tickets, coupons, and more.

Use by companies

World-Class R&D Hub Offering Leading Edge Know-How

The Oulu region has strong ICT competence in ICT and the largest regional R&D expenditure per capita in Finland. In the late 1990's the Wired Magazine ranked Oulu as the number three 'silicon valley' in the world.

In Oulu continuous cooperation and communication between the research and business community is widespread and can be seen as a one of the keys to the region´s success. Those involved with Oulu mention such things as its excellent research and piloting infrastructure, great connections, as well as interesting, challenging clients.

Great effort is put to maintain Oulu as an internationally acknowledged center for innovation. The Oulu Innovation Alliance (OIA) agreement is one example of far reaching and yet concrete investments made to build and develop business in Oulu.

Not only a strong will but firm actions to support the flourishing networking between research and business parties keep Oulu competitive and result in the best possible R&D environment for multiple business sectors. Living Lab approach is one of the concrete actions made to support this way of thinking.

UMA pilot (2006). Nokia's first public UMA (Unlicensed Mobile Access) pilot was conducted atop our testbed in June-September 2006 in collaboration with DNA (local ISP), the City of Oulu and the University of Oulu. An UMA-enabled dual-mode handset was configured to access GSM core services over unlicensed wireless network (panOULU WLAN) if it was available, otherwise licensed cellular network is used. The purpose of the pilot was to evaluate the functionality of the UMA technology in real-world setting where a city-wide WLAN network was available. About 60 UMA-phones were distributed to the City of Oulu personnel, who used the phones for three months, totaling 1.03 million seconds of online time in the panOULU WLAN.

Mobile IP pilot (2006-2007). Mobile IP is a mobility management protocol standardized by the IETF. A Mobile IP pilot was conducted in Oulu by the City of Oulu, Fujitsu Services and Secgo Software (later acquired by Birdstep). The City's mobile workers were equipped with laptops that provided transparent and seamless connectivity in a multi-access network. The laptops were furnished with various network interfaces and Mobile IPv4 client for mobility management. The panOULU WLAN was configured to be the preferred wireless connection if no fixed connection was available. The successful one year long pilot started in September 2006 and eventually led to the City of Oulu purchasing a production system a year later.

Use by Projects and research groups

Wireless networks in City of Oulu

MediaTeam of University of Oulu presents a unique urban computing test bed for studying the utilization of ubiquitous computing technology in the public urban space of a city center. The test bed comprises of a wide range of pervasive computing infrastructure and different middleware resources. They demonstrate the applicability and benefits of the test bed in evaluating technology pilots and prototyping new ubiquitous services in real-world urban setting. They conclude with a discussion on the challenges in deploying this kind of a large-scale test bed in a public urban space.

The long-term goal of test bed is to provide open horizontal resources for building incremental functional prototypes of a future ubiquitous city. There networked computing devices are seamlessly embedded into the urban space, turning it into a smart space providing different interaction modalities with the physical, virtual and social spaces. The utilization of ubiquitous computing technologies in urban space is studied by the multidisciplinary field of urban computing. It is driven by two important and related trends, urbanization and increasing deployment of pervasive computing infrastructure in the urban areas [5].

panOULU WLAN

panOULU is a large multi-provider wireless network (IEEE 802.11) provided by a public-private partnership. The network comprises of two parts, 'CITY' and 'REGION'. The 'CITY' comprises of two types of WLAN zones, the campus networks of five public organizations (City of Oulu, University of Oulu, Oulu University of Applied Sciences, VTT Technical Research Centre of Finland, and Pulmonary Association Heli) and the panOULU subscriptions sold by four ISPs (DNA, Elisa, LAN&WAN, Netplaza). panOULU subscription is an ISP product, which allows any organization to acquire panOULU WLAN hotspot into its premises to enhance image and customer service. The topology also includes a simple approach for integrating mobile APs (e.g. in buses) into the same IP subnet. The 'REGION' subnet comprises of the WLAN zones covering key public locations in eight nearby townships, which are connected to the core via a layer 3 router.

The WLAN zones total currently ~1200 access points, of which ~500 reside

within a 1 km radius of the city center of Oulu. From the user's point of view the APs appear as one large uniform network with SSID 'panoulu'. The APs provide both indoor and outdoor coverage in places deemed relevant for public access. The city center and its immediate surroundings are blanketed with a WLAN mesh network, but otherwise the coverage is provided in a hotspot manner.

In its coverage area the panOULU network provides open (no authentication or registration) and free (no payment) wireless Internet access to the general public equipped with a WLAN device. Excluding the blocking of outgoing port 25 (SMTP), which is required by the Finnish legislation, there are no limitations or restrictions on the use of the network. Currently, about 20000 WLAN devices use the network every month so that 25-40% of them are visitors and about 30% are WLAN phones.

The large coverage combined with the open and free access make the panOULU WLAN network a valuable R&D resource, as well. The network has been employed by numerous R&D pilots and research projects. The panOULU WLAN is also used by the municipality for streaming feeds from video surveillance cameras and controlling digital parking guidance signs.

In a historical note, the panOULU WLAN fulfills Weiser's vision on ubiquitous infrastructure from the late 1980's: public access points provide shortrange wireless connectivity on license-free spectrum, which allows the user's wireless devices to communicate with the surrounding smart space.

panOULU BT and WSN

BT network is a cluster of Bluetooth APs around downtown Oulu. A BT AP provides open and free connectivity to Bluetooth devices. It effectively establishes a WPAN (Wireless Personal Area Network) hotspot for providing services within the wireless coverage of few tens of meters in range. Since we know the location of the AP, we can also reliably estimate the location of the user to provide context-aware services. We are in the process of expanding the network with additional AP's, which will be using the panOULU WLAN for their backhaul connectivity.

Wireless Sensor Network network will be a cluster of WSN AP's around downtown Oulu. The AP's conform to the IEEE 802.15.4 specification and have dual radios (868MHz, 2.4 GHz). An AP provides open and free multi-hop half-duplex connectivity with the 6LoWPAN protocol stack, the light-weight version of the IPv6 protocol stack intended for low-power devices.

Large public displays, Ubi-Displays

We are deploying two different types of large public displays, UBI-displays and UBI-projectors. They provide large visual capacity for representing information and realizing visual interfaces to the ubiquitous city. Thus, they play a very important role in creating visible artifacts of the new pervasive infrastructure – 'seeing is believing'. The UBI-displays are large interactive public displays installed on street level. The first phase installation deployed in summer 2009 comprises of six indoor displays in public buildings and six outdoor displays in the city center. The indoor displays are movable and have one 57" Full HD LCD panel in landscape orientation. The outdoor displays are installed permanently on streets and they have two adjacent LCD panels. The displays are equipped with various accessories such as Internet connection, quad core control PC, 500 MB RAID1 disk, two overhead video cameras, NFC/RFID reader, and loudspeakers. They also contain panOULU WLAN, BT and WSN access points. The UBI-projectors are implemented with data projectors on large surfaces. First two UBI-projectors will be deployed at the City Theatre in spring 2010.

HIP pilot (2008). HIP (Host Identity Protocol) is a security and mobility protocol standardized by the IETF. HIP-based distributed user authentication architecture was empirically evaluated in the panOULU WLAN network by the WISEciti (Wireless Community Services for Mobile Citizens) project in 2008. A HIP proxy was installed in the network for establishing connections with HIP-enabled mobile clients. The proxy authenticated clients, provided terminal mobility and encryption of user data over unprotected wireless links.

2.7 SMART COOPERATION

City of Oulu is participating on the implementation of the eServices and eDemocracy project (SADe) launched by the Ministry of Finance, which is related to eServices in public administration and their development plans. The target of the project is to cover all essential services of citizens and businesses with electronic transactions by 2013. The aim is create a single client interface for different parties providing public services for citizens and businesses. The aim is also develop the entire public administration information systems interoperability. SADe project includes seven electronic communication service package, in which the selection is weighted by the municipality productivity-enhancing projects [6].

The SUS City Council (11 European cities) aims to create an inter-city discussion platform to promote interoperability and develop the first set of European urban service standards for application architecture interoperability and for the coherent access of services in Europe.

The key role of the SUS City Council is to plan interoperable pilots, to share best practices, and to build and enlarge the initial network of "interconnected" cities. New city services will be based on an efficient combination of all the best available mobile, context-aware technologies. Services should be interoperable, available both locally and in other European cities.

Finland and France have agreed to create a joint road map of internal digital economic markets. The cooperation initiative for the creation of a joint France-Finland digital road map was drew up. The cooperation group has completed a joint plan aiming to concentrate particularly on European solutions to issues identified as potential barriers to the digital economy. Solutions are needed for—among other challenges—intellectual property rights for electronic communication, and on how to deploy NFC near field technology.

City of Oulu drives sharing the best practices and European interoperability with international partner cities in deploying the Future Internet serves.

2.8 CONCLUSIONS

It can be said that City of Oulu has been driving the Smart City ideology already from early 90's. Many activities which have not been called at that time as a "smart city" or "Living Lab" have been done in co-operation with real end user, "an ordinary innovator". Early 2000, City of Oulu was using slogan "Smart Oulu-Knowledge is the future" in "Information Society City of Oulu" project. One of the examples of that project is the Smart Card (City Card) which was an ID-, access-punch- and payment card used by city employees and others involved to the project.

Despite of intensive collaboration between "Triple-Helix" stakeholders elaboration of the "Smart City" architectural thinking to cover analyzes, research and continuous development of working methods together with needed resources (time, people, facilities and money) sets the innovation ecosystem under enormous pressure.

Available funding instruments and policies are not always supporting business development and spin-offs from research institutes. Policies has to be modified to be enablers to start commercialization of research results and help SMEs to do business with infrastructures developed with publicly funded projects.

In the future, it should be possible to do (the city of Oulu acquisition strategy development), innovative procurement without competitive bidding process with such as the various business associations through so-called early involvement principles.

Regional, national and international co-operation in developing Future Internet-enabled services have very crucial impact on the life of the citizens. Citizens' (users) active participation in the economic activities plays an important role in the innovation process since citizens have become sources of innovation. Cities and Regions should therefore be fully involved in the process of governance related deployment of Future Internet services.

Smart City is much more than technology!!

2.9 REFERENCES

- Wikipedia
- Oulu's adoption of Europe Digital Agenda 2020
- Strategy of City of Oulu
- Smart Urban Spaces home page www.smarturbanspaces.org
- Open Urban Computing Test bed, MediaTeam Oulu, University of Oulu
- Ministry of Finance, SADe Services and Project Report 2009

The following pages present a paper from Timo Ojala: "Open Ubiquitous Oulu: Open Community Testbed for Urban Computing".

2.10 OPEN UBIQUITOUS OULU: OPEN COMMUNITY TESTBED FOR URBAN COMPUTING

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Introduction

This paper provides a non-exhaustive overview of the Open Ubiquitous Oulu pursued by the UBI (UrBan Interactions) research program in close collaboration with the City of Oulu and industry. The 6.5 MEUR UBI program comprises of a number of research projects funded by the Finnish Funding Agency for Technology and Innovation (Tekes), the Academy of Finland, the ERDF, the City of Oulu and industry. The multidisciplinary program coordinated by MediaTeam Oulu research group at the University of Oulu brings together research groups from five different universities in Finland, Japan and Portugal, not just computer scientists and engineers, but also architects, cultural anthropologists, artists and designers.

Motivation

Urban computing is an emerging interdisciplinary research field which considers public urban spaces as potential sites for ubiquitous computing. Urban computing is driven by two important and related trends, urbanization and rapid deployment of computing infrastructure in the urban space. Urban computing studies the use of pervasive computing resources in public urban spaces. The vision of modern urban landscape is currently undergoing what might be considered the greatest and most radical change since the advent of computing. New technological innovations introduced in the very fabric of urban space allow for a deeper connection between the city and its inhabitants, making the hidden layers of social, economical and political processes, tensions, and flows both transparent and visible in ways that were never possible before. The introduction of pervasive computing resources in urban spaces and the possibilities enabled by them have been compared to the invention of aerial photography. It allowed a non-constricted view of the city, its flows of people and goods, its excrement of waste, its blood flow if you will. Urban computing, as the trend of building pervasive computing capabilities as integral part of urban spaces is called, allows for an even more detailed view, which might be compared to the invention of the microscope. With the new capabilities brought by the introduction of heterogeneous sensor devices and interactive I/O channels, the physical fabric of cities is waking up and becoming aware of itself [Townsend 2008].

While urban spaces offer the greatest opportunities and strongest demands for ubiquitous computing, yet urban design has not featured significantly in the ubiquitous computing systems research. There is no fundamental theory, knowledge base, principled methods nor tools for designing and building ubiquitous systems as integral elements of the urban landscape [O'Neill 2006]. It's clear that the successful employment of the new technology in the urban setting calls for a multidisciplinary approach, plain technology-driven engineering is simply not enough. Urban computing encompasses a wealth of research that needs to be taken into account when designing and deploying new technologies. Multidisciplinary research collaborations are crucial to comprehending social life and creating technologies that can augment it in positive ways. For example, grasping the many aspects of public spaces that make them legible to the inhabitants is critical to understanding the diverse needs of their inhabitants [Williams & Dourish 2006]. However, despite the new possibilities of enriching the experience of the city for its inhabitants through this new technology, we have yet to discover the 'killer' applications that would really bring the experience of the city to the next level. Researchers in different fields have

begun the search from different starting points, often framing the urban environment as wrought with difficulties and problems to overcome with the new technology [Bassoli 2007].

Objective

Our objective is to introduce a visible change on the society by building a functional prototype of an open ubiquitous city in Oulu. From the user community's point of view such a city appears as a smart urban space providing rich interaction between the physical, virtual and social spaces. From the R&D community's point of view the city appears as an open community testbed stimulating innovation, research and development of new services and applications.

The testbed enables urban computing research in authentic urban setting with real users and with sufficient scale and time span. Such studies are important because real world systems are culturally situated, and cannot be reliably evaluated with lab studies detached from the real world context. By deploying a system for a sufficiently long time "in the wild" we can establish the technical and cultural readiness and the critical mass of real users needed for determining whether the system can be deemed '(un)successful' [Greenberg & Buxton 2008].

Our fundamental hypothesis is that by deploying new pervasive computing infrastructure and new applications and services into the public urban space we make it a better place for people. Proving the hypothesis either true or false calls for holistic understanding and addressing of urban informatics. As Paulos and Jenkins [2005] stated, the single main research challenge of urban computing is to understand how the future fabric of digital and wireless computing will influence, disrupt, expand, and be integrated into the social patterns existent within our public urban landscapes.

Strategy

Our strategy towards realizing the open ubiquitous city is illustrated in Figure 1. The principal idea is to engage an iterative cycle of technology-led and application-led research [Rehman & Sharp 2005], together the deployment of open pervasive computing infrastructure at downtown Oulu which is the unique dimension in our strategy. The technology-led research is carried out because it is interesting or challenging from a purely technical perspective, producing new technology and knowledge. The technology-led research and the pervasive computing infrastructure open up new opportunities for the application-led research. It produces novel prototype applications and services, which are empirically evaluated either in labs or in authentic urban settings. The evaluation provides valuable feedback and creates new requirements to the technology-led research and the computing infrastructure.

We argue that the lack of visible and lasting results (in terms of applications) in urban computing is partly due to the lack of dedicated, shared and pervasive computing infrastructure in the urban space. Successful public spaces are mixtures of activities and applications, which purposefully combine physical and virtual spaces. They link places and context, consciously avoiding the "anything, anytime, anywhere" paradigm. Doing this in practice requires permanent local infrastructure, which for business reasons is often deployed as closed verticals. We wish to challenge this by deploying new pervasive computing infrastructure at downtown Oulu, which is provided as an open horizontal testbed to the community.

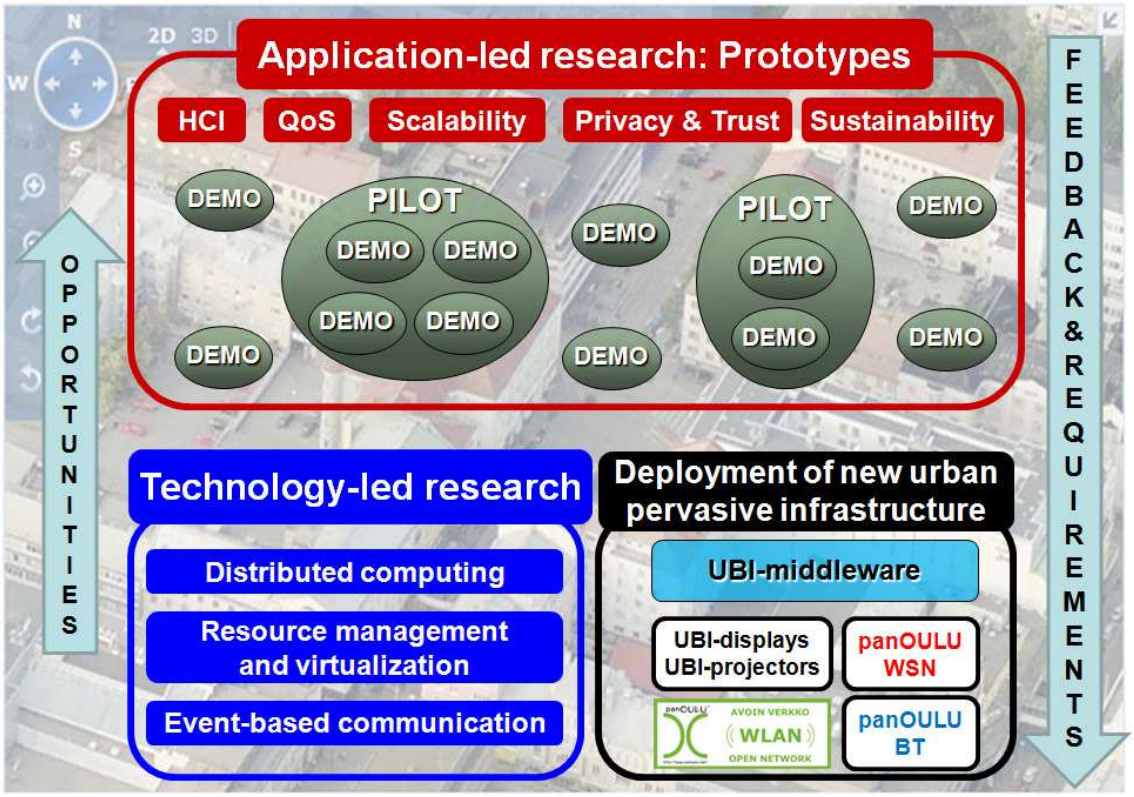


Figure 1. Our strategy towards realizing the open ubiquitous city.

The application-led research is driven by the domain-specific problems of urban computing such as HCI, QoS and scalability. We approach them by deploying two types of urban computing "proof of concept" prototypes, DEMOs and PILOTs. A demo is a short-lived small-scale evaluation of new technology, service concept or user interface paradigm. A DEMO is often implemented using rapid development process, and empirically evaluated in form of small user test either in laboratory or real-world setting. Successful functionalities from the demos are integrated into PILOTs, functional large-scale prototypes of the future ubiquitous city. They are subjected to longitudinal evaluation by the general public in real world settings. The empirical evaluation of DEMOs and PILOTs quantifies the benefits brought to the chosen application domain. The evaluation generates feedback and requirements to the technology-led research and the computing infrastructure to be taken into account in the next iterative design cycle. The DEMOs and PILOTs also play a very important role in showing in a very concrete manner to the people and to the community what can be done with leading-edge technology.

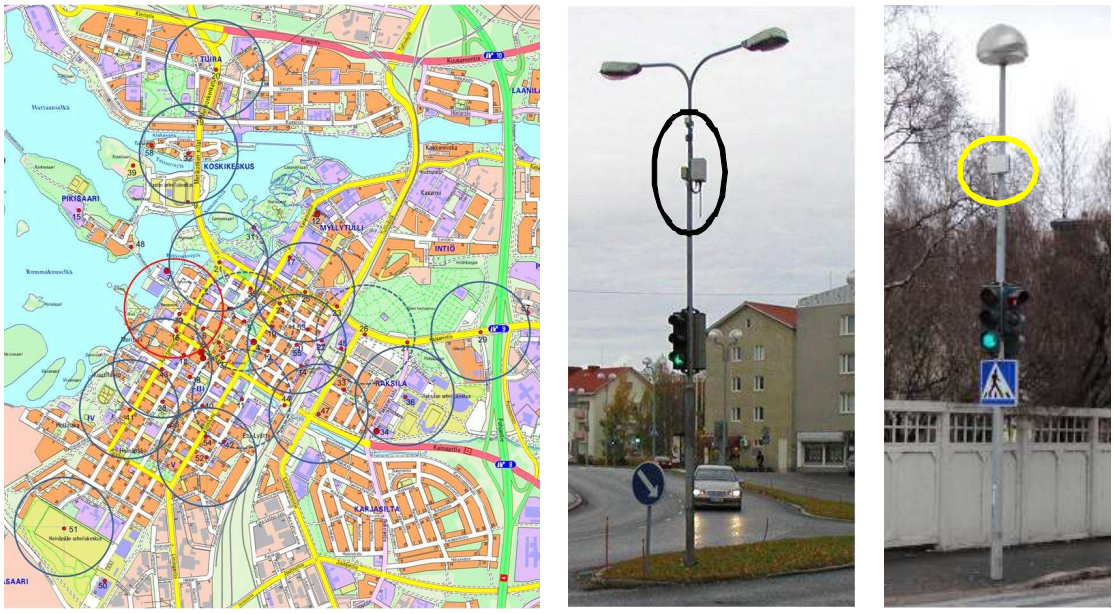
Infrastructure

We have invested lots of resources into infrastructure allows us to deploy a wide range of applications and services in authentic urban setting for use by real people. The infrastructure comprises of a wide variety of computing resources deployed across the City of Oulu, including panOULU WLAN/BT/WSN networks, UBI-hotspots and UBI-projectors, and assorted middleware resources.

panOULU WLAN is a city-wide WiFi network provided by a consortium of nine municipalities, four public research and education organizations and four ISPs. The network currently has ~1270 IEEE 802.11 AP's, of which ~500 reside within 1 km of the city center. While the downtown Oulu is blanketed with 60 mesh AP's providing outdoor coverage, elsewhere AP's are deployed in hotspot manner. The AP's provide open (no authentication) and free (no payment) wireless Internet

access to general public without any limitations. The network is typically used by ~25000 devices every month of which a significant proportion belongs to visitors.

panOULU WSN is an IP-based wireless sensor network comprising of 13 ER (edge routers) across the city (Figure 2(a)). The ER's are equipped with an IEEE 802.15.4 radio on the 868 MHz band and the 6LoWPAN protocol stack. 12 ER's are installed inside the WLAN mesh AP's (Figure 2(b)), so that the mesh AP provides enclosure, power and IPv6 connectivity. One ER is placed inside an UBI-hotspot. An ER has about 500 m line-of-sight range with 1 mW transmission power.



(a) (b) (c)

Figure 2. (a) Locations of panOULU WSN ER's around downtown Oulu; (b) panOULU WLAN AP and WSN ER installed in traffic light; (c) panOULU BT AP installed in traffic light.

panOULU BT is a network of 30 Bluetooth AP's (each equipped with three BT radios) scattered across the city center. 18 AP's are installed in traffic lights (Figure 2(c)) and they use the panOULU WLAN for Internet access. Additional 12 AP's are placed inside the UBI-hotspots. All AP's sniff bypassing BT radios and the real-time traces are used for modeling pedestrian and vehicular flows and networks. Further, the 12 AP's inside the UBI-hotspots are used for distributing multimedia content to mobile devices over BT connectivity.

UBI-hotspots (Figure 3(a)) are effectively interactive public displays embedded with other computing resources such as two cameras, NFC/RFID reader, panOULU AP's and high-speed Internet access. Currently, 12 hotspots are deployed, six double-sided outdoors at the walking street area at the heart of the city and six single-sided indoors in key public buildings. A hotspot alternates between two states. In passive broadcast state the whole screen is allocated for the UBI-channel, a digital signage service. In interactive state the screen is split between the UBI-channel and the UBI-portal, which can embed effectively any web service found in the public Internet. The UBI-portal provides access to a wide range of interactive services such as service directories, games, a street gallery of new media art exhibitions, sending of an UBI-postcard, and uploading of personal photos and videos. All interaction events such as face detections and launches of services are logged for reporting and research purposes. The **UBI-projectors** are high performance data projectors producing large scale projections to the wall of the City Theatre.

Figure 3. (a); UBI-hotspot; (b)UBI-projectors at the City Theatre.

These heterogeneous computing resources constitute a large distributed system which is virtualized by the **UBI-middleware**. It hides the differences and internal communication between underlying computers and provides open and standardized interfaces into the underlying resources. These APIs allow the research community, the general public and the SME's to develop their own applications and services atop the UBI infrastructure. We argue that while an infrastructure like this is absolutely necessary to take the city from 'sleeping' to 'sentient', we ourselves cannot presume to foresee all the possibilities created by the new infrastructure. Thus open and transparent access to the infrastructure is crucial in finding the applications that will make the new infrastructure irreplaceable to the people living in the city.

Example Use Cases

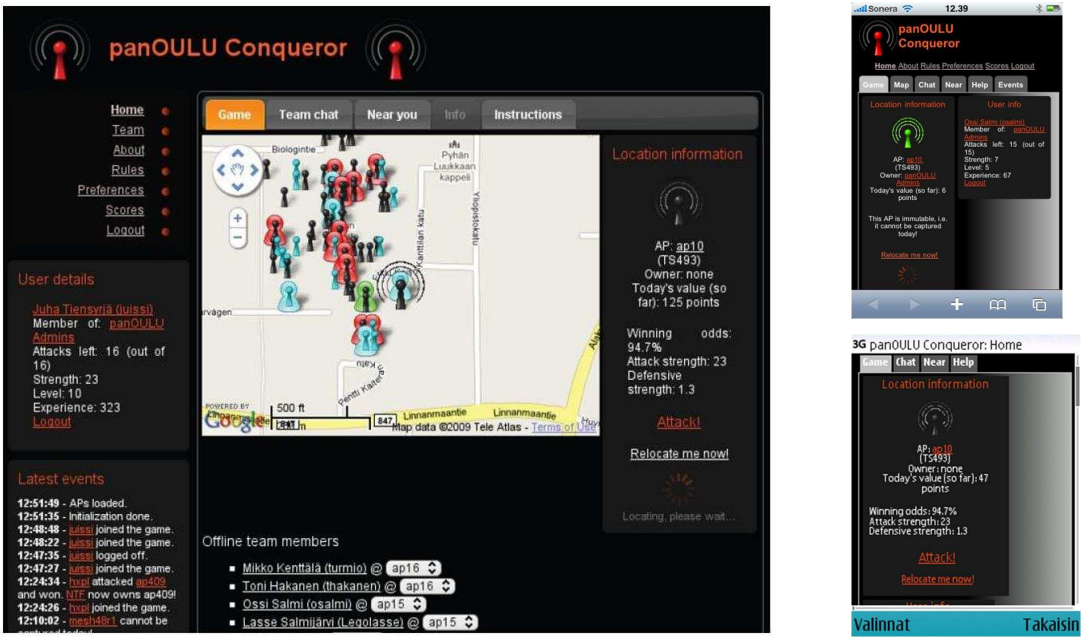
We demonstrate the applicability and benefits of our open ubiquitous city testbed with a number of examples in collaborative industrial R&D, in academic research, and in engaging the user community. See related publications for detailed descriptions of the cases.

UMA pilot (2006). Nokia's first public UMA (Unlicensed Mobile Access) pilot was conducted atop our testbed in June-September 2006 in collaboration with DNA (local ISP), the City of Oulu and the University of Oulu. An UMA-enabled dual-mode handset was configured to access GSM core services over unlicensed wireless network (panOULU WLAN) if it was available, otherwise licensed cellular network is used. The purpose of the pilot was to evaluate the functionality of the UMA technology in real-world setting where a city-wide WLAN network was available. About 60 UMA-phones were distributed to the City of Oulu personnel, who used the phones for three months, totaling 1.03 million seconds of online time in the panOULU WLAN.

Mobile IP pilot (2006-2007). Mobile IP is a mobility management protocol standardized by the IETF. A Mobile IP pilot was conducted in Oulu by the City of Oulu, Fujitsu Services and Secgo Software (later acquired by Birdstep). The City's mobile workers were equipped with laptops that provided transparent and seamless connectivity in a multi-access network. The laptops were furnished with various network interfaces and Mobile IPv4 client for mobility management. The panOULU WLAN was configured to be the preferred wireless connection if no fixed connection was available. The successful one year long pilot started in September 2006 and eventually led to the City of Oulu purchasing a production system a year later.

HIP pilot (2008). HIP (Host Identity Protocol) is a security and mobility protocol standardized by the IETF. HIP-based distributed user authentication architecture was empirically evaluated in the panOULU WLAN network by the WISEciti (Wireless Community Services for Mobile Citizens) project in 2008. A HIP proxy was installed in the network for establishing connections with HIP-enabled mobile clients. The proxy authenticated clients, provided terminal mobility and encryption of user data over unprotected wireless links.

panOULU Conqueror (2009) (http://conqueror.panoulu.net). panOULU conqueror is a pervasive location-aware multiplayer game for the panOULU WLAN. In the game teams of players score points by conquering real-world access points (APs) of a large city-wide municipal wireless network. The game is pervasive so that whatever the players and other users of the network do in the real world changes the all-encompassing game world. The game is also location-aware so that the players are positioned at all times by the network (not by user device), and the players' locations matter in scoring points and in conquering and defending APs. The game is implemented as a web service (Figure 4) so that a general purpose WLAN device such as a laptop or a smart phone equipped with a web browser is sufficient for playing the game - no dedicated game software or hardware is needed. The game was empirically evaluated with a four-week long tournament involving 96 players in 31 teams. The players found pervasiveness, location-awareness, social interaction and addictivity as the best parts of the game. The main finding was that location-awareness combined with a rather modest level of pervasiveness can go a long way in creating engaging gaming experiences.



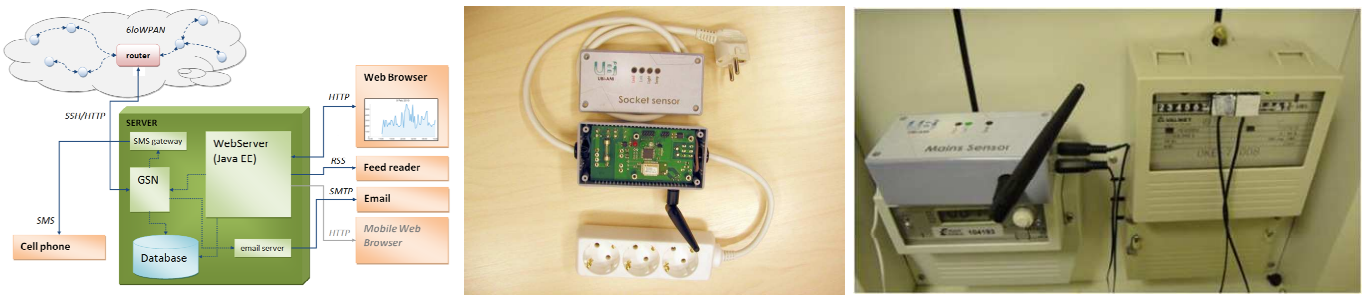
(a) (b)

Figure X. panOULU Conqueror web UI's: (a) Desktop; (b) Mobile (full UI in iPhone above, stripped down UI in Nokia N95 below).

UBI pilot 2009/2010. The UBI Pilots 2009 and 2010 corresponded to the longitudinal evaluations of the UBI-hotspot versions 1 and 2, respectively. Both versions offered varying portfolios of interactive services, including map based service directories, news, games, street gallery of new media exhibitions, user-created content, etc., available to the general public on 24/7 basis. Some services incorporate a hybrid user interface where the large display provides a public UI and a personal mobile UI provides a private UI. Research data was collected with various methods, including logging of quantitative usage,

questionnaires, observations and interviews of hotspot users, and an online survey to Oulu businesses. A common criticism targeted at many studies on interactive public displays is that their evaluation usually takes place in artificial lab environments and for short periods of time. Our hotspots represent the largest longitudinal studies on the usage of interactive public displays by real users in authentic urban setting to date. They have revealed a number of factors that lab studies do not necessarily take into account: user sampling, location, curiosity, novelty, and weather. These substantial differences have led us to question the validity of lab studies in this domain. However, the external validity of our research comes with a substantial cost and a number of challenges. The greatest challenge in our deployment has been maintenance, as a substantial amount of our resources has been used to make sure that the system behaves as expected and to troubleshoot faults. Another challenge is economic viability, ensuring that the hotspots become self-sufficient. To cover the operational expenses of the hotspots we have generated revenue from commercial use of the hotspots earning about 220000 EUR so far. However, the commercial user conflicts with research objectives: a given capacity sold for example to digital signage has to be delivered which constrains the screen layout and the interaction model. Thirdly, the discipline as a whole lacks standardized metrics for evaluating the success of such systems. In other words, despite the availability of huge volumes of quantitative and qualitative data on the usage of the hotspots, it is challenging to measure their actual impact on the community.

UBI-AMI pilot (2010). The UBI (UrBan Interactions) research programme developed the UBI-AMI system for real-time metering of energy consumption at homes using multi-hop IP-based wireless sensor networks. The architecture of the UBI-AMI system comprises of three functional building blocks (Fig. TODO(a)). Sensors equipped with IEEE 802.15.4 radios in multiple 6LoWPAN networks measure the loads and turn on/off devices connected to the sensors. Each network has a router collecting packets from multiple sensors over a multi-hop mesh topology, i.e. a sensor is able to forward packets of other sensors. Central UBI-AMI server receives packets from the routers, stores the data in a database and creates different representations of the data. User can browse the measurement data with a web browser and subscribe to RSS feeds summarizing the data. Further, the user can control the sensors and subscribe to email/SMS alerts based on load measurements. The UBI-AMI system was assessed by longitudinal user evaluation in seven households in the Oulu region in 2010. The evaluation confirmed that visibility to both the aggregate load and appliance level loads in a home is very useful functionality that has an impact on how people use electric appliances. The UBI-AMI system shows that IP-based wireless sensor networks and web provide a very potent technology platform for implementing such functionality in a cost-effective, reliable and standardized manner, in contrast to the many proprietary solutions on the market.



(a) (b) (c)

Figure. (a) UBI-AMI architecture; (b) Socket sensor; (b) Mains sensor.

1st International UBI Summer School 2010 ((http://www.ubioulu.fi/en/UBI-summer-school-2010**).** We utilized our testbed in researcher training by

organizing the 1st International UBI Summer School 2010 in Oulu, Finland, on May 31 - June 4, 2010. It comprised of six parallel workshops that enrolled 72 students from 20 countries via an open international call. All students attended a number of joint events, including a poster session where students presented their background and ongoing research, the opening plenary where each workshop was introduced and the closing plenary where each workshop presented their results. Each workshop had its own curriculum and activities, which included theoretical presentations by the instructor and practical projects conducted in groups of 3-5 students. Each workshop was assigned a liaison researcher who was intimately familiar with local arrangements including the testbed resources and could offer assistance when necessary. Several 'development' UBI-hotspots were available at the summer school site to support application development and testing. The opportunity to deploy an application on the public 'production' UBI-hotspots in the city center was also offered, in case any project would get that far. The six workshops utilized the testbed in varying degree. For example, Prof. Anind Dey's (CMU, USA) "Real World Context Aware Systems" workshop produced both functional prototypes and conceptual designs of new services. Prof. Vassilis Kostakos' (University of Madeira, Portugal) "Urban Social Networks Analysis" workshop collected BT traces to model and visualize pedestrian, vehicular and social networks in the city.

We have organized challenges to make our testbed available to the greater user and R&D community and to stimulate the innovation of new services.

National UBI Challenge 2010 ("**UBI-haaste 2010" in Finnish) (**http://www.ubioulu.fi/UBI-haaste**).** The national UBI Chllange opened in Feb 2010 challenged both individuals and organizations to innovate and implement new services to the UBI-hotspots. The objective was to stimulate open user-driven innovation and development of new commercial services to the UBI-hotspots. 4000 EUR grant was awarded to each proposal selected for implementation by a local expert jury. Further, the service deemed most successful of those deployed on the UBI-hotspots would receive an additional grant of 2000 EUR and a high end smart phone. Participation was stimulated by a raffle of a high end smart phone between all entries. By the submission deadline in May 2010 we received nine valid proposals, of which the jury selected three for implementation: Battleship (game proposed by two local exchange students), Diversus Oulu (interactive multimedia art piece proposed by a local freelancer artist couple) and UBI Mixer (interactive music mixing application proposed by an SME). Eventually, Battleship and Diversus Oulu were successfully deployed on the UBI-hotspots.

1st International Open Ubiquitous City Challenge 2010-2011 (http://www.ubioulu.fi/en/UBI-challenge). The "UBI Challenge" prepared together with a number of leading international experts on ubiquitous and urban computing challenges the global R&D community to design, implement, deploy end evaluate novel applications and services in real-world setting in the City of Oulu, Finland. The motivation of the international challenge is to stimulate global research collaboration on urban informatics in a very concrete manner, provide the international R&D community with an opportunity to transfer ideas from labs into real-world urban environment, make our testbed available to the international R&D community, and support developing metrics for evaluating urban computing infrastructure and applications in real-world setting. Participation was encouraged by advertising that up to five proposals would be invited as finalists for deployment in Oulu, receiving up to 10000 EUR grant and a full paper in the MUM 2011 proceedings (subject to regular peer review by selected members of the challenge jury). The program of the MUM 2011 conference to be held in Beijing, China, in Dec 2011, will have a special session dedicated to the challenge, including presentations by the finalists and the presentation of the awards to the winner(s). 11 written proposals were submitted

by the Nov 2010 deadline, three from Finland, six from Europe and two outside Europe. The international jury invited four proposals into the final. All four proposals were submitted by European university teams, who will arrive in Oulu at the beginning of June 2011 to finalize the implementation and deployment of the service by the beginning of July. Empirical evidence will be collected in July-August for reporting in September. Further, the jury's Oulu-based members will meet and assess the finalists in-situ. Each finalist has been assigned a dedicated liaison researcher to serve as the primary technical contact point. As the first task the liaison researchers provided the finalists with detailed technical, content related and cultural assessments of the proposals in the light of our own knowledge and experiences of the open ubiquitous Oulu. The finalists are provided with remote access to virtual UBI-hotspots for development and testing purposes.

Oulu Open Hack (2010) (http://ouluopenhack.posterous.com/). We participated in the organization of the Oulu Open Hack in November 2010. The 24-hour event solicited hacks in three categories: open, QML and UBI. Two "lightweight" UBI-hotspots were taken to the hack site at the CIE premises of the CIE. Two hacks were submitted to the UBI category, an adaptation of the HeiaHeia service and an adapatation of the FourSquare service.

SELECTED REFERENCES

1. Kukka H, Kruger F, Kostakos V, Ojala T & Jurmu M (2011) Information to go: Exploring in-situ information pick-up in the wild. 13th IFIP TC13 Conference on Human-Computer Interaction (INTERACT 2011), Lisbon, Portugal, to appear.
2. Ojala T & Kostakos V (2011) Driving innovation in urban computing with a community testbed. First Workshop on Pervasive Urban Applications (PURBA 2011), San Francisco, CA, USA, to appear.
3. Ojala T, Kostakos V & Kukka H (2011) It's a jungle out there: Fantasy and reality of evaluating public displays "in the wild". CHI 2011 workshop on Large Displays in Urban Life - from Exhibition Halls to Media Facades, Vancouver, BC, Canada, to appear.
4. Ojala T, Kukka H, Heikkinen T, Lindén T, Jurmu M, Hosio S & Kruger F (2011) Engaging citizens and community with the UBI-hotspots. In: Foth M, Forlano L, Gibbs M & Satchell C (eds.) From Social Butterfly to Engaged Citizen – Urban Informatics, Social Media, Ubiquitous Computing and Mobile Technology to Support Citizen Engagement, MIT Press, forthcoming.
5. Ojala T, Närhi P, Leppänen T, Ylioja J, Sasin S & Shelby Z (2011) UBI-AMI: Real-time metering of energy consumption at homes using multi-hop IP-based wireless sensor networks. 6th International Conference on Grid and Pervasive Computing (GPC 2011), Oulu, Finland, to appear.
6. Ojala T, Orajärvi J, Puhakka K, Heikkinen I & Heikka J (2011) panOULU: Triple helix driven municipal wireless network providing open and free Internet access to the community. 5th International Conference on Communities & Technologies (C&T 2011), Brisbane, Australia, to appear.
7. Heikkinen T, Lindén T, Ojala T, Kukka H, Jurmu M & Hosio S (2010) Lessons learned from the deployment and maintenance of UBI-hotspots. Proc. 4th International Conference on Multimedia and Ubiquitous Engineering (MUE 2010), Cebu, Philippines, 1-6. (Paper acceptance rate 29%)
8. Hosio S, Jurmu M, Kukka H, Riekki J & Ojala T (2010) Supporting distributed private and public user interfaces in urban environments. Proc. Eleventh Workshop on Mobile Computing Systems and Applications (HotMobile 2010), Annapolis, MD, USA, 25-30. Best Presentation Award.
9. Hosio S, Kukka H, Jurmu M, Ojala T & Riekki J (2010) Enhancing interactive public displays with social networking services. Proc. 9th International Conference on Mobile and Ubiquitous Multimedia (MUM 2010), Limassol, Cyprus, article no. 23.

10. Hosio S, Kukka H & Riekki J (2010) Social Surroundings: Bridging the virtual and physical divide. IEEE MultiMedia 17 (2), 26 - 33.
11. Ojala T, Kukka H, Heikkinen T, Lindén T, Jurmu M, Kruger F, Sasin S, Hosio S & Närhi P (2010) Open urban computing testbed. Proc. 6th International Conference on Testbeds and Research Infrastructures for the Development of Networks & Communities (TridentCom 2010), Berlin, Germany, 1277-1288.
12. Ojala T, Kukka H, Lindén T, Heikkinen T, Jurmu M, Hosio S & Kruger F (2010) UBI-hotspot 1.0: Large-scale long-term deployment of interactive public displays in a city center. Proc. Fifth International Conference on Internet and Web Applications and Services (ICIW 2010), Barcelona, Spain, 285-294. (Paper acceptance rate 31%)
13. Ojala T, Valkama V, Kukka H, Heikkinen T, Lindén T, Jurmu M, Kruger F & Hosio S (2010) UBI-hotspots: Sustainable ecosystem infrastructure for real world urban computing research and business. Proc. 2nd International Conference on Management of Emergent Digital EcoSystems (ACM MEDES 2010), Bangkok, Thailand, 196-202.
14. Tiensyrjä J, Ojala T, Hakanen T & Salmi O (2010) panOULU Conqueror: Pervasive location-aware multiplayer game for city-wide wireless network. Proc. 3rd International Conference on Fun and Games (FNG 2010), Leuven, Belgium, 157-165.
15. Kukka H, Kruger F & Ojala T (2009) BlueInfo: Open architecture for deploying web services in WPAN hotspots. Proc. 7th IEEE International Conference on Web Services (ICWS 2009), Los Angeles, CA, USA, 984-991.
16. Kukka H, Ojala T, Tiensyrjä J & Mikkonen T (2008) panOULU Luotsi: A location based information mash-up with XML aggregator and WiFi positioning. Proc. 7th International Conference on Mobile and Ubiquitous Multimedia (MUM 2008), Umeå, Sweden, 80-83.
17. Ojala T, Hakanen T, Salmi O, Kenttälä M & Tiensyrjä J (2008) Supporting session and AP mobility in a large multi-provider multi-vendor municipal WiFi network. Proc. Third International Conference on Access Networks (ACCESSNETS 2008), Las Vegas, NV, USA, 89-101.

3 SMART CITY CASE STUDY: HELSINKI

Authors: Hendrik Hielkema and Patrizia Hongisto (Aalto University). This chapter has been published in the Journal of the Knowledge Economy, April 2012.

Abstract

This article discusses how Mobile Application Clusters can be developed through competitions for innovative applications. The Smart City services that are developed in competitions benefit both the Mobile Application Cluster and the citizens. The function of the competition mechanism to encourage the development of new mobile applications utilizing Open Data is described with examples from the Helsinki Region. Porter's model of determinants of national competitive advantage is used as a framework to describe the forces driving the ongoing developments towards the Mobile Application Cluster. In particular the paper explores the interaction between the cluster determinants of Porter's model with regard to the externalities made by the linkages between the parties in the emerging cluster. In the two competitions for Open Data applications that the paper discusses innovation is supported by a policy-like instrument: an urban competition on open data, which is driven forward through the Living Labs approach to innovation. The two competitions launched in the Helsinki Region are aimed at developing mobile applications by utilizing open data. The paper shows how a Living Lab functions as an innovation intermediary where the competitions are utilized in developing a Smart City.

Keywords: Open Data, Competition, Living Lab, Smart City, Mobile Application Cluster, Regional Development

3.1 INTRODUCTION

In the present global economy the importance of regions as centers of knowledge and innovation is growing. The proximity of actors within an industrial sector works in favor of cluster formation, more so in agglomerations with a certain critical mass. The importance of metropolitan areas highlights the need for local, regional, and national government to support initiatives that focus on city-regions as clusters of innovation.

In line with the European Commission goals to develop Europe's cities' competitiveness by enabling services with high degrees of personalization and efficient modern infrastructures [25], the Finnish governmental organizations are using Living Labs as a policy instrument to stimulate innovation, ideation, development and delivery of citizen-centric services. The Finnish Ministry of Employment and Economy is implementing the Demand and User-driven Innovation Policy as stated in the Framework and Action Plan of 2010 [31]. This paper discusses how using a Living Lab to organize competitions on Open Data applications enables the implementation of those objectives and impacts the economic, business and industry driven agglomerations.

Innovation research that focuses on user-centric collaborative approaches explores how ideas and experiences of the users are brought to the developers. [4] By creating a space for dialogue between the users and developers valuable information is created and shared [18] Living Labs contribute to the development of new concepts and new knowledge on open innovation [8] [9] and can act as innovation intermediaries for regional innovation [1].

Smart Cities and Boundaries to Integrated Services

Metropolitan areas are becoming increasingly important in providing services to their inhabitants as well as their visitors. Removing boundaries between municipalities and municipal organizations helps to create new integrated services. In this article, what is meant by 'Helsinki Region' is both a fairly loose cross-municipal organization [12] and a vaguely defined area surrounding the capital region, consisting of the City of Helsinki and 10-15 municipalities around it. Helsinki Region has no strategic planning instruments and decision-making

bodies as such. However, collaborative arrangements for water management and public transport and various informal networks are grounds for active co-operation. The activities of the Helsinki Region assembly are described at www.helsinkiregion.fi.[1]

This paper looks into developing mobile applications and services utilizing data from the municipal organizations in the Helsinki Region. These services make the city smarter and the mobile citizens are better served. In Helsinki's case for the metropolitan region to become and function like an effective 'Smart City' a change towards increased collaboration between the municipalities is needed. Helsinki, as a developing Smart City working to promote a Smart Region, does not endorse limiting smart solutions to its municipal boundaries, or to organizations that serve a single municipality. Removing boundaries between bureaucratic organizations is necessary within and across a competitive and agile smart region of the future. For the Helsinki Region to act effectively towards smart services it must provide platforms for innovation that are open to all municipal and regional parties with an interest in developing new products and services. The competition cases discussed in this paper are evidence of this (cross-municipal) collaboration in setting up an innovation platform around open data aiming at smart services for citizens. By opening up data and enabling startups to use public data at no costs different actors have stakes involved and are in agreement on creating new chances for business opportunities in the form of new services and new applications [20].

Living Labs

Since the mid-90ties the concept of Living Lab research has been gaining momentum as a valuable tool for researchers, social innovators and companies [1] [13]. Territorial Living Labs have been established in several European regions as a tool for co-creation of services with the involvement of citizens by the public and private actors in the area [26]. Living Labs also operate successfully in Brazil, South Africa, and China[2].

Actively supported by local and regional government, as well as through governmental funding for RDI (research, development and innovation) projects, Living Labs have been established in and around Helsinki Region. Their functions are diverse, but all are basing their activities on the principles of User Driven Innovation (UDI). For Living Labs UDI functions as the basis for co-creation of knowledge. What they assume on citizen- and human-centric innovation and prototyping of services and products by developers together with users. User driven innovation is at the basis of Living Lab research. The Living Lab concept focuses on testing with users in their natural environment and is centered on the users of the product and service under investigation. Conference papers, book chapters and journal articles have been published exploring the possibilities of Living Lab research experiments [2] [4]. The use of Living Labs has been valuable in developing new products and services in eHealth, Energy Saving, Citizen Participation in Government, Manufacturing and many other fields [19] [24] [26]. Living Labs are especially suitable for service and product testing by SMEs [5] and regional development [27].[3]

[1] Helsinki Region, as used in this paper needs to be distinguished from the larger territory of the Helsinki-Uusimaa region (province) which is governed by its council as a regional authority.

[2] For a list of the Living Labs in Brazil and China that are members of the European Network of Living Labs (ENoLL) please see www.openlivinglabs.eu; for the Living Labs of Southern Africa see www.llisa.org.za and www.llisa.net.

[3] The European Union has chosen Living Labs as one of the main tools to bring the objectives of the CIP, FP and other programs to reality (EU 2009). European Union Brochure, 2009, online at http://ec.europa.eu/information_society/activities/livinglabs/docs/brochure_jan09_en.pdf

There is a tradition of Living Lab research in Finland and various types of organizations – Universities, city or region owned development agencies, companies and SMEs have established Living Labs in the Helsinki Region area. The municipalities use Living Labs for economic development and societal activation in energy issues, or service provision in health care of the elderly, preventive care, or urban living. Several Universities of applied science conduct research in Living Labs at the edge of science and practice. Companies such as NOKIA, or Philips, use Living Labs as user-centered hubs for ideation and product development and national research institutions use Living Labs as platforms for innovation. These living labs focus on bringing users with their knowledge, ideas, and experiences together with the developers of new services and products to increase the quality and usability of the services and products created. Collaboration with local small and medium sized companies is actively sought and managed, while entrepreneurship is enhanced at service and design 'factories' through new collaboration models at the newly merged Aalto University.

Living Labs for Smart Cities

In essence Living Labs can be seen as a social artifact like a university or a sports club. Bringing people, organizations and ideas together to form a shared understanding and create both individual and joint outcomes. This is done in many forms, with specific objectives and audiences. In the context of Helsinki Region the various Living Labs form a basis for creating a shared vision and a platform for collaborative projects bringing in the users with their ideas, experiences and enabling the business community to develop the products and services that are of most interest to the public.

Strengths	Weaknesses
Enables User Participation Government / Industry /People Partnership (PPPP) High Quality educational system at all levels, Number of engineers is highest in Europe and second highest worldwide per capita	Living labs are a relative expensive tool for UDI Living Lab experiments are time consuming Predominantly homogeneous society Mismatch between governmental strategy implementation and SMEs expectations on development and commercialization
Opportunities	**Threats**
Many platforms for user-driven innovations, Living Lab communities, dense local IT company competition Attractiveness of the area and of the educational system has increased multinational workforce	Path dependence in service solutions guided by technology push Financial crises constraining even more the already limited availability of venture capital Lack of experience in competing for VC at global level

Figure 1 SWOT Analysis of Living Labs for Smart Cities

In the above SWOT table, Figure 1, the strengths, weaknesses, opportunities and threats of utilizing Living Lab styled research platforms for development by SMEs and governmental organizations is summarized. To illustrate how a Living Lab as an innovation intermediary creates value to the Helsinki Region and enhances the innovation potential of its networks the competitions HSl Open and Apps4Finland are presented in this paper. We show how the use of a Living Lab brings all the various parties together and opens opportunities for the developer community.

Smart Cities make use of the possibilities created by Internet and Future Internet technology. We consider that Helsinki Region can be a model of a Smart City for the push it gives to development of new technologies within a multi-leveled infrastructure and towards the creation of new business sectors. In this paper we show that in the Helsinki Region everything needed to create, develop, test and market new ideas and new technologies, is present.

Outline of the Paper

The paper consists of five chapters. After having introduced the Living Lab concept and its link to Smart Cities, in chapter 2 we frame the Mobile Application Cluster using the cluster model by Michael Porter, the so called diamond shaped model. The determinants of the model allow us to examine the role of competitiveness within and outside the cluster for enhancing development of the Mobile Application Cluster towards new applications and services through Open Data. Chapter 3 presents the examples of Open Data Competitions. Chapter 4 discusses the Open Data competition environment from the point of view of the determinant factors of the competitiveness model. The conclusion in chapter 5 sums up the impact for the development of the Mobile Application Cluster and the benefits for the Smart City and the citizens of the Helsinki Region.

3.2 MOBILE APPLICATION CLUSTER

Clusters and their Determinants

Porter urges us to look at specific industries and industry segments to explain the competitiveness of nations [21] regions and cities [22] His framework includes a diamond shaped model with the determinants for competitive advantage. As shown in Figure 2 the determinants of a given cluster are "Factor Conditions, Demand Conditions, Firm Strategy, Structure and Rivalry, and Related and Supporting Industries". In our paper we are using this framework to visualize how the development of the Smart City Cluster in Helsinki Region is driven by the central role of a Living Lab as an Innovation Intermediary.

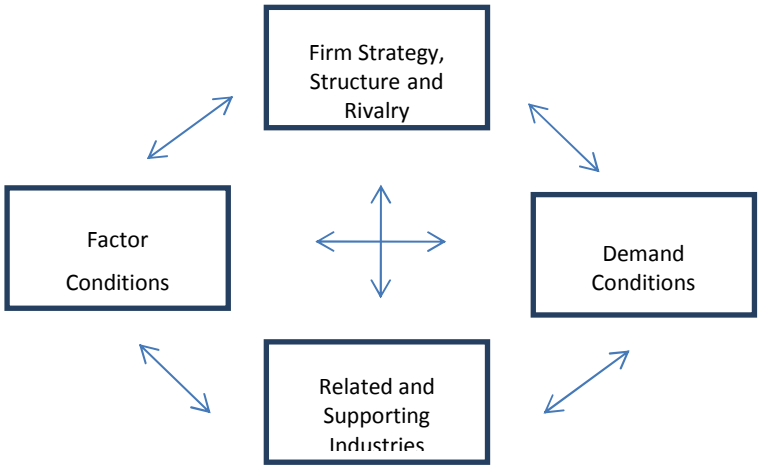


Figure 2, Determinants of National Competitive Advantage [22]

The determinants inside the diamond enable and promote the creation of clusters of competitive industries [21]. The benefits of clustering strengthen the motivation, or the incentives, for industrial partners to collaborate with the other, usually competing, actors in their environment. The linkages between various sections of the diamond form spillovers and enable externalities to emerge. These benefits are seen as positive externalities that any actor, public or private, can achieve with the other cluster members and thus benefit its own as well as the other members' learning processes.

Externalities are effects of a firm outside the boundaries of that firm. The consequences of a firm's existence and actions are a force that influences the very environment that a firm operates in. Not all externalities are under control of a firm. Both positive and negative externalities exist and certain externalities can have both positive and negative effects.

The various determinants in the diamond model (Figure 1) are elements of an environment that drives competitiveness. In this way the linkages within the cluster are creating the sustainability and growth opportunities, as well as the societal benefits, that stem from a competitive industrial cluster. Describing Porter's cluster concept [6] accurately states that a cluster works as "… a group of business enterprises and non-business organizations for whom membership within the group is an important element of each member firm's individual competitiveness" [6].

For the Helsinki Smart City strategy the emergence of a mobile application cluster is a benefit and the resulting competition within the cluster is equally essential. The proximity of the cluster members, both geographical and cultural, supports the constant drive to innovate in order to grow. This gives a push to development of innovative ideas for the Smart City. The user and citizen's participation and demand provide a pull. By becoming a center of innovative and competitive firms a cluster attracts new firms to the area, creating economic growth. Within the Helsinki Region, this competitive-collaborative process is ongoing within IT, media, services, and particularly in the sector of mobile application development.

When applying the lens of Porter's determinants, however, we need to be aware of certain limitations. Martin and Sunley [16] take a critical view of the concept of clusters. They identify two key limitations to the theory. Firstly, the concept is seen as too elastic and unable to provide a universal and deterministic model on how agglomeration in industry activities is related to regional and economic growth. Secondly, the definite link between high-growth industries and various forms of geographical concentration does not prove that the concentration is the main cause of the success and can account for variation in economic growth. Martin and Sunley [16] consider the cluster as defined by Porter to be a construct that can be used to describe the phenomenon, rather than show its causal links.

The criticism from Martin and Sunley [16] is aimed at encouraging cautiousness in applying Porter's cluster concept due to the fact that his cluster theory has become the standard in the field. Deriving implications for policies, setting policy agendas, and serving as foundation for innovation policies from Porter´s diamond has prevailed during the nineties and has been commented widely. As a tool to recognize certain elements that drive innovation and economic growth, Porter's competitiveness model remains valid in its descriptive character. Clusters are not limited to definitions [16], or clear limitations in actors, but rather they indicate agglomerations of organizations whose present actions benefit from the geographical and cultural proximity they are able to make use of. Therefore our attempt to apply the model to Smart City studies emphasizes how Smart Cities are able to create uses for their setting and for their own benefit, rather than predicting and defining Smart City attributes and defining Smart Cities.

Elements of the Mobile Application Cluster

A regional cluster in mobile technology is emerging in the Helsinki Region. Developments in the mobile industry, government policies and economic development initiatives, give the Helsinki Region the structure of a "Porter styled" competitive cluster. We see clustering increasingly more important whilst keeping pace with emergence of open innovation [3]. In the Helsinki Region clustering and openness both belong to the driving concepts of the local innovation system. While the emphasis on open innovation involving companies, universities, users (citizens) and government can be attributed to the Living Labs in the Helsinki Region, clustering has been less often noticed, or discussed. We suggest that the Helsinki Region developments contain all the "ingredients" that leads to what [10] called an innovation system.

In the following, Porter's competitiveness model is used as a lens to see the Helsinki Region mobile technology cluster. In order to examine the relation between industry clusters determinants with the Smart City concept in the case of the Helsinki Region we need to pay specific attention to how the municipal governmental organizations function as providers of Open Data, thus enabling the emerging cluster. In particular we are interested in how the Living Lab provides companies with access to citizen involvement and to collaborative elements for creation of products and services, thus illustrating some externalities resulting in a benefit for a Smart City as a whole.

Competitiveness attributes

FACTOR CONDITIONS

Finland has developed the critical production factors related to the Future internet and mobile technology to a high level. In the Helsinki region this development is particular strong and provides an underlying infrastructure that enables the development of the Mobile Application Cluster. The availability of broad band internet is a legal right. The rollout of 3G mobile internet is complete and available at very low cost. The fourth generation technology LTE, capable of 80 Mb/s is available in the Helsinki Region since December 2010. The telecom operators that have invested in these networks are enabling a new level of mobile internet with its related services, [17] thus building a new industry to emerge.

The Success of NOKIA over the past 20 years has given rise to a strong industrial concentration of firms in this sector. As a result, game development is one of the fastest growing industries in the Helsinki Region [7], other examples are media technologies, and electronics such as the industrial measurement sector, or safety technologies. There is a large skilled workforce with a specialized knowledge in Mobile Technology and Future Internet Technology. Universities in the Helsinki Region have been catering to the demands of the Mobile Industry for this time and have developed specialist and applied knowledge, by ways of collaboration between academia and companies.

This has already given rise to a strong group of growing companies as well as start-ups in the IT sector, some of which like F-Secure have scaled to global operating businesses. Others, like Rovio, famous from the mobile App hit "angry birds" are aggressively expanding. Helsinki is chosen by Wired Magazine [30] as one of the Hottest Startup capitals of Europe for Information Technology startups. Which of the determinant factors are establishing the Smart City / Region as an ecosystem in which companies can start and grow? Interestingly a dense diversified local IT cluster has been facilitated by a change in the dominant single driver of the IT industry in Finland.

In the dynamic market of smart phone technology Nokia has lost much of its prominence. Consequently, the decision to no longer continue with Nokia's own mobile operating systems Symbian and Meego, but to focus on Windows Phone Operating system (WP7), resonates strongly. Although a large part of the Nokia specialists will redirect their work to focus on WP7, a landslide shift in focus is taking place within the corporate giant Nokia. The current changes in the structure and operations of NOKIA "liberate" a significant portion of the local (though multinational) workforce for new and innovative startups that can experiment with new business forms and be agile in responding to the changing market demands. A growing number of startups in the Helsinki region are using the market channels of Apple's iTunes as well as alternative mobile phone platforms to distribute their products and services.

DEMAND CONDITIONS

There is a continuous demand for change and innovative services from different actors in the Helsinki Region. Firstly, driving this demand are innovation system initiatives undertaken by the national government to stimulate the need for collaborative solutions, such as the Demand and User-driven Innovation Policy presented in October 2010 by the Ministry of Employment and the Economy [31].

Adoption of mobile technology has been always high in Finland. Proud of being a frontrunner in the GSM domain the people of Finland have been keen on future developments of services that are made possible by these technologies. For example, the Finnish banking sector was one of the first widely using online banking, and public transportation in the Helsinki region has mobile ticketing since 2001 [15]. Today this trend is evident in the increasing use of mobile internet. Many organizations are embracing the new possibilities; Mobile Television broadcasting [28] and Mobile Banking [23], are examples of the continuous development in Mobile Services.

The government is taking an active role in the continuous improvement of services provided via mobile technology. The Demand and User-driven Innovation Policy [31] outlines how lead users and early adopters can be utilized in the commercialization phase of new products.

FIRM STRATEGY, STRUCTURE AND RIVALRY

Helsinki Region is the economic hearth of the Small and Open Economy (SMOPEC) of Finland. A SMOPEC operates in an international competitive environment and the firms within a SMOPEC are confronted with fierce competition from each other and from competitors abroad. The typical SMOPEC ICT firm faces tremendous pressure to sell its products or services to a global market [11]. To be able to grow competitive firms ICT-start-ups, software start-ups in particular, adopt specific strategies in management and marketing that enable them to become born globals. These strategies are partly in response to the intense local competition, but more importantly they enable them to become the global player they aspire to be. The growing availability of robust Open Source software development tools and environments such as MySQL, developed in the Helsinki Region (Wikipedia), attracts communities of interest and paves the ground for potential start-ups as born globals. Open Source which not only dramatically reduces the costs associated with launching software products, but also allows competition and collaboration to include actors beyond to regional cluster. These aspects increase both knowledge resources and standardization as elements capable of scaling novel service applications to meet global market needs.

Luostarinen & Gabrielsson [14] recognize that it is essential to trace the source of resources, capabilities, and skills beyond the boundaries of the firm. The search for competitive advantage of a Smart City Cluster needs to extend to interest groups local, or open source, external advisors and strategic value chain members, as well as to universities, local services agencies, and governmental bodies. These resources and capabilities are easily transferred between the firms, thus the competition for players in the Helsinki region is considerable. For born globals the rivalry is intense and acute, the timeframe from establishment to globalization is in average 2.1 years only [14]. In their work Luostarinen and Gabrielsson [14] conclude that born globals use efficiently the opportunities to create networks, to enter partnerships, and to build up alliances. To them the characteristics of an SMOPEC are used to strengthen resources by using the resources of chain members.

As example to illustrate the necessity of agile management is the company Rovio, the creators of the successful "angry birds" mobile game. The "angry birds" game was their breakthrough and forced them to change their management strategy from only the development of mobile games to organizing the exploration of the brand "angry birds".

RELATED AND SUPPORTING INDUSTRIES

To create value and profit from their investments, the mobile application developers depend on the usage of the available infrastructure, such as 3G networks, by citizens. In the value chain the infrastructure takes a central role, but needs to be supplemented with contextual and relevant applications for the end user. The providers of services that utilize these mobile networks are creating value for all partners in the chain.

According to a survey of the Finnish Games industry the overall turnover in the Finnish Game industry is expected to grow with 60% in 2011 compared to 2010 [7]. The Finnish Games Industry is strongly focusing on online and mobile games, for 61 % of the companies this is their primary market [7].

The various levels of government are also supporting the development of innovative services. While examples of pre-commercial public procurement fostering such innovations are still rare, Helsinki Region is moving forward initiatives that fuel relations between industry, government and citizen. One initiative is opening up public sector information for use by application developers. The goal of this initiative is to enable application developers to build specific services that make use of the data held by the governmental parties and create value for the emerging market and the citizens.

Helsinki Region Competitions for Open Data Applications

HSL OPEN

To stimulate the development of Smart City applications by local developers and to drive the growth of the Mobile Application Cluster the Helsinki Region municipalities have decided to use competitions as an instrument to realize the policy. The municipalities and several related public organizations are opening up their databases with information and make the data available at no costs for the public. This data can be utilized by applications so that developers can add relevance and value to the information.

The first set of data to be made publically available is the data of the public transportation network. The Helsinki region has an extensive public transportation network that includes busses, trains, trams, the metro, and boats. Every day about 700.000 people use the public transport of the Helsinki Region. To run such a complicated service several kinds of data are used in planning and monitoring the vehicles. This data is now made available to developers. All data concerning timetables, both for public transportation lines and individual stops, disruptions (in real time) and planned changes are available online. The busses, trams, trains and metro trains have been equipped with GPS locators and their location information is made available via internet.

This is done to give application developers the ability to create novel applications for the public transport system of the Helsinki Region. To stimulate the utilization of Open Data the transit authorities together with a city run Living Lab have initiated a competition. Several Application Program Interfaces, (APIs), were given to the public and attention in the media generated interest. Anyone interested could create an application for iOS, Android or Symbian mobile phone systems.

The competition was organized by the Living Lab named Forum Virium, owned by the municipality of Helsinki. Forum Virium, established 2005, has been instrumental in implementing the innovation policy of the city of Helsinki. During the OpenData competition, which was held during the first half of 2011, a total of 51 applications were submitted to the jury for consideration. More important than awarding a price has been the interest that was raised by the competition. By making data available with these APIs the organization got programmers and SMEs thinking about making such services. The stimulating effects are visible now. A search online of applications using the Helsinki Region Public Transportation Data reveals a collection of different mobile applications.

APPS4FINLAND

To follow up on the project a new competition was started subsequently by the Living Lab. This competition, Apps4Finland, makes data available originating from more sources in the local and regional government. Categories of data in this competition include environmental data and spatial information, a wide variety of statistics, Health and welfare statistics, the results of population surveys, traffic and location services. The Apps4Finland competition has four categories of eligible entries, applications, visualization series, ideas, and data.

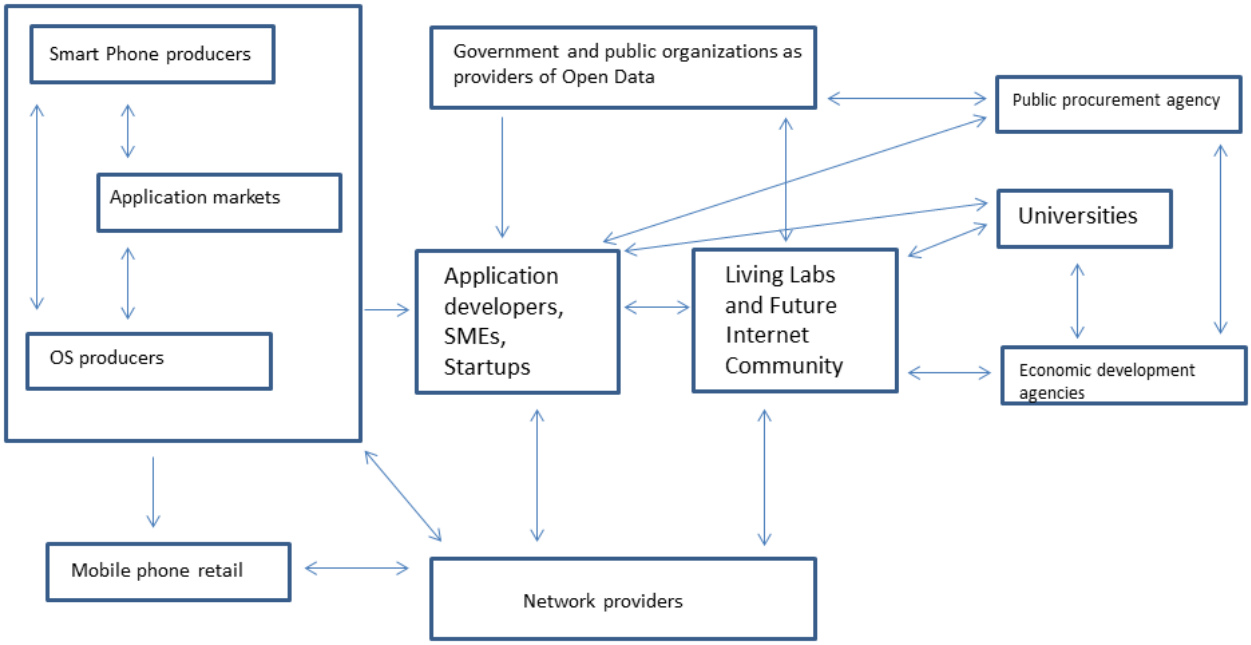
The applications category is for working applications, which will be freely available during the competition and for two months after closing. The visualization series is for innovative ways to visualize data from one or more of the public services. The ideas category is for concepts and unrealized applications, while the data category is for opening more data to the public, as well as for innovative ways in cleaning or converting the data. Over 140 submissions were done in the various categories and prizes were given to the winners.

Helsinki Living Lab Driving Innovation

THE MOBILE CLUSTER

The central role of the Living Lab as innovation intermediary demonstrates the function it takes in the innovation ecosystem. Figure 3 illustrates the actors and their relations in the context of the competitions. As an intermediary with experience in user driven innovation the Living Lab provides the critical link between the providers of the Open Data, the related organizations, and the developer community.

The role of the OS and Smartphone builders is limited to providing a marketplace. The role of the government is visible in several of the actors and key incentives: in the provision of the Open Data and APIs, in the role as purchaser of services, as a supporting partner, and as owner of the Living Lab collaborative network and facilitation.



competitions projects. As an innovation intermediary they take the role of orchestrating actor, providing support and feedback to the different parties. By taking a central, leading role in the promotion of development of applications, the Living Lab creates a space for innovation, and a playground for 'rivalry'. By providing the APIs and the media attention to the participants of the competition the Living Lab drives their usage forward. Making the APIs available offers the developers of the applications the chance to learn about the types of data available in the Open Data initiatives.

The experience of participating in the competition is an asset for future development of the Smart City Cluster. The value chain of a developed application runs through several different actors in the local as well as extended Smart City environment. For example, an application is made by a local developer, but sold over to the application market, bringing revenue for the developer and the owner of the application market. Every extra application adds value for both the mobile phone producers and the network operator as it increases the usability of their products and service. The provider of the Open Data benefits from every service that utilizes their data and brings more relevance for the public.

Extending the product range of the primarily games driven developers community to building services based on public data will complement the existing range of products and increase the scope and focus of the entire industry.

The Cluster determinants

To demonstrate how the different participants in the competitive environment that forms the Mobile Application Cluster using the Open Data we now consider the various Porterian Cluster determinants from Figure 1.

Factor Conditions

The most significant production factors for the Mobile Application Cluster are the skilled workforce in the region, and the availability of the Open Data. The value of this data, paid for by taxpayers, is considerable and constitutes a source of wealth. The Open Data is becoming a new impulse for competitiveness for the region providing the data. Regions that have a high availability of Open Data will have benefits over those regions that do not. These benefits can become very valuable for those developers who are able to utilize Open Data in the best way supporting services that create value for citizens and private or public actors. In making this data public the government and the Living Lab enable a new type of value creation.

As important as the available Open Data is the skilled workforce mobilized by the competition. By giving them a challenge in the form of the competitions they are stimulated to start thinking about the topic. To create this awareness the Living Lab uses the local media and the internet. The new technologies, often understood better by the young and inventive, offer chances that only they see.

The developers that take up the challenge are rewarded with competition and the chance to be the winner. Competition is a driver for the innovative and the entrepreneurial to demonstrate their capabilities. Competition helps in improving the services from a "good enough level" to the best level. The Helsinki Region has many startup companies that are looking for platforms to shine, for channels to demonstrate their prowess and to bring their services to attention of the wider audience.

Demand Conditions

Demand for the applications that are utilizing Open Data is growing with the media attention for it. The increasing ownership of smartphones and the new services that the possibilities of Open Data applications bring give rise to new services. By starting the competition with begin and end dates for submission the Living Lab creates a demand to finish the application on time. The opportunity to demonstrate to the general audience and the competitors is an chance that is unique and any media attention a significant bonus.

Firm strategy, Structure and Rivalry

The competition opens possibilities for many startups and individual developers to shine on a public stage and attract attention to their abilities. The fact that all applications use available Open Data forces the developers to be innovative in the way how they deal with the data. The winner of the competition and the winners in the market will be those who are able to utilize Open Data in the most user friendly, relevant, and attractive way. The Living Lab in its role of innovation intermediary enables developers to closely collaborate with users and get direct feedback.

The applications that are developed during the competitions stay property of the developers. They are able to sell them to the general public once the competition is over. The sales channels of mobile applications, online markets such as iTunes and Ovi Store enable the creators of mobile applications to sell their developed services without major investments in distribution and allow for practically unlimited up-scaling of the use of the applications. The success of Rovio, a successful firm from the Helsinki region, well known for their "Angry Birds" mobile games, has set an example for many start-ups on how to utilize the new markets for mobile applications.

Related and Supporting Industries

In the competitions the Living Lab is the center of a network of related industries that all benefit from the development of the applications and the establishment of a new industry in mobile applications. The network operators see an increase in the usability of their mobile networks and will benefit from this. The government creates a new channel to provide indirect services to the citizens. By supporting the competition they are able to support the development of the Smart City and help creating future internet applications. The builders of smart phones see their product increase in value with every additional application. The markets for mobile applications get more valuable and these externalities are created with the end user in the center.

3.3 CONCLUSIONS

In this article we have shown how Living Labs in their role of innovation intermediary can facilitate the collaboration between the various actors in the Mobile Application Cluster. By bringing challenges to the developer community and supporting the resulting applications in the media they drive the use of Open Data and further the Smart City development. Through using the innovative capacity of the participants in the competition they are able to raise awareness to the new possibilities that are offered by the Open Data. The new startups and the growth of the SMEs in the emerging Mobile Application Cluster in Helsinki Region is evidence of the strength of the Smart City. New firms, able to take full advantage of the new market channels and changing business environment of mobile applications, create a new industry around Open Data

By creating a space where the benefits are most tangible the Living Labs promote the smart city concept and drive the development of the Future Internet. The externalities of proximity in geographical and cultural respect are improved by strengthening the links between firms, the various government organizations and all other actors in the cluster. The emergence of the Mobile Application Cluster in the Helsinki Region is used to create value adding resources for all participants in the Living Lab network. The developments in mobile internet, Open Data, new channels for delivery of services and the growing ownership of smart phones all offer chances for start-ups.

The two competitions described in this paper are examples of how a Living Lab drives the development of an emerging Mobile Application Cluster, how the potential available in the region is released for application development and how it is utilized by the creation of innovative products and services. By demonstrating the benefits of collaborative networking it shows how Living Labs as innovation intermediaries can support the policy goals of the government.

The Future Internet development depends on the cooperation of innovative firms, government, the infrastructure controlling organizations and the input from the users. All these different actors collaborate in the network around the Living Lab, co-creating value for themselves and each other.

References

[1] Almirall, E. (2008). Living Labs and innovation, roles and applicability. Special Issue on Living Labs. The Electronic Journal for Virtual Organizations and Networks, 10.

[2] Ballon, P., Pierson, J., Delaere, S. (2005). Test and experimentation platforms for broadband innovation: Examining European practice. The 16th European Regional Conference by the International Telecommunications Society, Porto, Portugal.

[3] Chesbrough, H. (2003) Open innovation: the new imperative for creating and profiting from technology. Harvard Business Press.

[4] Eriksson, M., Niitamo, V.P., Kulkki, S., Hribernik, K. A. (2006). Living Labs as a Multi-Contextual R&D Methodology. The 12th International Conference on Concurrent Enterprising: Innovative Products and Services through Collaborative Networks, ICE2006. Milan, Italy.

[5]Fahy, C., Ponce de Leon, M., Ståhlbröst, A., Schaffers, H., Hongisto, P. (2007). Services of Living Labs and Their Networks. In: eChallenges 2007, Den Haag, Netherlands.

[6]Feser, E J. (1998) Old and new theories of industry clusters. In Steiner, M. (ed.) Clusters and Regional Specialization On geography, Technology and Networks. Pion Limited.

[7] FGI, Finnish Game Industry, report 2010-2011. (2011). http://hermia-fi-bin.directo.fi/@Bin/34de04bc32ba0a5853ab27ba8245322f/1316871591/application/pdf/928763/Finnish%20Games%20Industry%202010-2011.pdf Accessed 24 September 2011.

[8] Følstad, A. (2008). Living labs for innovation and development of information and communication technology: A Literature Review. Special Issue on Living Labs. The Electronic Journal for Virtual Organizations and Networks. Vol. 10.

[9] Følstad, A. (2008). Towards A Living Lab for the development of Online Community. Special Issue on Living Labs. The Electronic Journal for Virtual Organizations and Networks. Vol. 10.

[10] Freeman, C. (2002). Continental, National and Sub-National Innovation Systems. Complementarity and Economic Growth. Research Policy, 31(2).

[11] Gabrielsson, P., Gabrielsson, M. (2004). Globalizing internationals: business portfolio and marketing strategies in the ICT field. International Business Review 13(6).

[12] Helsinkiregion.fi http://www.helsinginseutu.fi/hki/hs/The+Region+of+Helsinki/City+information+and+statistics/Helsinki+Region+Statistics Accessed 9 September 2011.

[13] Katzy, B., Klein, S. (2008). Editorial Introduction, Special Issue on Living Labs, The Electronic Journal for Virtual Organizations and Networks. 10.

[14] Luostarinen, R., Gabrielsson, M. (2006). Globalization and Marketing Strategies of Born Globals in SMOPECs. International Business Review, Vol. 48(6)

[15] Mallat, N., Rossi, M., Tuunainen, V., Öörni, A. (2008). An empirical investigation of mobile ticketing service adoption in public transportation. Personal and Ubiquitous Computing. 12 (1).

[16] Martin, Ron & Sunley, Peter. (2003) Deconstructing Clusters: Chaotic Concept of Policy Panacea?. Journal of Economic Geography. Vol. 3(1).

[17] Munoz, M., Rubio, C.G. (2004) A new model for service and application convergence in B3G/4G networks, Wireless Communications, IEEE, 11(5).

[18] Nonaka, I., Toyama, R., Konno, N. (2000). SECI, Ba and Leadership: a Unified Model of Dynamic Knowledge Creation, Long Range Planning, 33(1).

[19] Oliveira, A., Fradinho, E., Caires, R., Oliveira, J., Barbosa, A. (2006). From a successful regional information society strategy to an advanced living lab in mobile technologies and services, Proceedings of the 39th Hawaii International Conference on Systems Sciences, IEEE.

[20] Poikola, A., Kola, P., Hintikka, K.A. (2011). Public Data, an introduction to opening information resources, Finnish Ministry of Transport and Communications, April 2011.

[21] Porter, Michael E. (1990) The Competitive Advantage of Nations, Harvard Business Review, March-April.

[22] Porter, Michael E. (2000) Location, Competition, and Economic Development: Local Clusters in a Global Economy. Economic Development Quarterly, 14(1).

[23] SAMPO, 2011, http://www.sampopankki.fi/en-fi/Personal/online-services/Pages/mobile-services.aspx Accessed 24 September 2011.

[24] Santoro, R., Marco, C. (2009). Living Labs in Open Innovation Functional Regions. Proceedings of the 15th International Conference on Concurrent Enterprising 2009, Leiden. The Netherlands

[25] Sargsyan, G. (2011) Social Economic Impact of Open Service Innovation (OSI), Final report for DG INFSO Study SMART2009-0077.

[26] Schaffers, H., Cordoba, M.G., Kallai, T., Hongisto, P., Merz, C., Van Rensburg, J. (2007). Exploring business models for open innovation in rural living labs. 13th International Conference on Concurrent Enterprising, Sophia-Antipolis, France.

[27] Schaffers, H., Guzman, J.G., Merz, C. (2008). In Action Research Approach to Rural Living Labs Innovation. In: eChallenges 2008, Stockholm, Sweden.

[28] Sonera, 2011. Press release, http://www.medialab.sonera.fi/workspace/SoneraCNNPR.pdf. Accessed 24 September 2011.

[29] Wikipedia, http://en.wikipedia.org/wiki/MySQL Accessed 02 October 2011.

[30] Wired magazine at http://www.wired.co.uk/magazine/archive/2011/09/european-startups/helsinki Accessed 11 September 2011.

[31] Työ- ja Elinkeinoministeriö. (2010). Demand and User-driven Innovation Policy, Framework and action plan, Publications of the Ministry of Employment and the Economy, August 2010.

3.4 ANNEX: SOME ADDITIONAL OBSERVATIONS ON HELSINKI SMART CITY

Collaboration, the only feasible way forward for the Helsinki Metropolitan Area

To succeed in a competitive world Finland and the Helsinki Metropolitan Area must be able to create new innovations and exploit them more effectively.

The first innovation strategy for the Helsinki Region shows the way forward for collaboration that will more efficiently harness the huge innovation potential of the metropolitan area. Regionally, nationally and internationally there is a pressing need for collaboration to generate added value. The future competitive strength of the Helsinki Region and its appeal as a strategic partner for the world's other leading knowledge hubs will depend on the Region's record of effective collaboration.

Helsinki Region will determine the competitiveness of the whole of

Finland

The public policy of developing Finland's other regions has diverted too much attention away from the Helsinki Region in recent years. Revenue transfers and the continuing debate on relocating various public functions away from the Finnish capital indicate that the Helsinki Metropolitan Area has not been the focus of national policymaking.

Radical new partnerships, not least between the Helsinki Metropolitan Area and the State, will be needed to restore the leading national and international status of the Helsinki Region. National innovation policy must acknowledge the principle that the future competitiveness of Finland can be based only on pre-eminence, specialisation and reinforcement of strengths. As the leading national expertise cluster, the Helsinki Region remains the strategic core of Finland's international competitiveness

A four-pillar strategy for Innovation:

1. Improving the international appeal of research and expertise
2. Reinforcing knowledge-based clusters and creating common development platforms
3. Reform and innovations in public services
4. Support for innovative activities

High educational standards, a fi rm grounding in science and technology and a long track record of cooperation between the private and public sectors have laid the foundations for developing innovative products and services in the Helsinki Region. As open environments for development, learning and interaction, development platforms reinforce strategically important areas of expertise and competitiveness in the Helsinki Region. Designing, implementing and developing such platforms is an excellent objective for the common business development policy of the cities.

Development of Platforms at the Core of Future Cluster Building

Helsinki Region seeks to become an internationally interesting and commercially competitive, versatile development platform based on cutting-edge expertise with a unique competence profi le. This platform will foster the development and exploitation of innovative products, services and operating formats.

By combining the powerful expertise clusters of the Region, these world class development platforms may also increase the appeal of the Helsinki Metropolitan Area to foreign investors.

The Helsinki Metropolitan Area must build its future competitive edge not only on its own areas of expertise, but also on the strengths of Finland as a whole. The Helsinki Region has both a unique opportunity and a national duty to evolve into an international attractive innovation environment that will ensure that the entire expertise portfolio of Finland is displayed and marketed.

Action proposal for Living Labs: A national Living Lab Finland

Forum should be established to serve as an open idea platform and co-ordinating body between all of the various living labs in Finland.

The cities should convene a high level enterprise-led steering group to direct the further evolution of existing development platforms and collaboration between them, to supervise implementation of projects at the planning stage, and to design entirely new platforms for the Helsinki Region.

The development platform is still a fairly new and therefore little known operating format. Open and interactive follow-up work will be needed to confirm the common objectives, functions and evolutionary requirements of development platforms both in the Helsinki Metropolitan Area and nationally. Mutual synergy and interaction between various areas of expertise and development platforms must also be enhanced by combining projects into dynamic packages using the structures that have arisen in the work of centres of expertise.

National funding of research and innovation must allow for the evolutionary needs and prospects of the Helsinki Metropolitan Area as a nationally and internationally important development platform environment.

The conventional format for project financing will be unsuitable when establishing and maintaining development platforms in practice.

Living labs Development

Some living labs or pilot communities are already operating in the Helsinki Region, and their status as future environments or "real life laboratories" for research, development and learning has yet to be confi rmed.

Collaboration between various living labs should also be increased. Noteworthy examples of current living labs include Helsinki Virtual Village in the city's Arabianranta district (part of the European Union IntelCities programme seeking to reinforce the information society), the joint New media culture centre of M-Cult and HIIT, and the Maunula project focusing on local community development.

Future living labs in the Helsinki Region include the Suurpelto initiative in Espoo, the Kolmiosairaala hospital project in the Meilahti district of Helsinki, and the Well Life Center in Espoo co-ordinated by Laurea University of Applied Sciences, which forms a living lab in combination with the senior citizens' centre in the Kustaankartano district of Helsinki. The cluster project for digital content and services in Pasila also includes a living lab.

The Dimes association – Digital Media

Service Innovations Finland Dimes is an association founded by Nokia, TietoEnator, TeliaSonera, Elisa, Finnet and the Finnish Broadcasting Company – YLE to promote the conversion of Finnish technological expertise into services and successful business operations combining expertise in the Oulu, Tampere and Helsinki region.

"Dimes offers a way of finding, developing and testing service innovations. We are constantly on the lookout for signs of market upheaval and focusing development projects on exploiting the opportunities that these provide. Broadly based collaboration ensures that due consideration is given to regional strengths and our sights remain focused on international competitiveness," explains Dr Yrjö Neuvo, Senior Vice President and Technology Advisor, Nokia Plc.

Forum Virium coordinating Helsinki Region Living Labs

Forum Virium Helsinki is a business-based and –driven cluster of actors whose mission is to promote the development of digital services. It is also an impartial test bed for ideas and actors, collecting large companies and growth companies, leading development projects and opening connections to international markets. The cluster actors closely participates in real test environments in the Helsinki Metropolitan Area and designs Lansi-Pasila and Forum Virium Cneter to be built there. The aim is to create better services and increasing business on the basis of solid comptence.

Source: Introduction for Innovation strategy of Helsinki

Public Data Information – Open Regional Data

The Helsinki Region Infoshare project aims to make regional information quickly and easily accessible to all. The data may be used by citizens, businesses, universities, academies, research facilities or municipal administration. The data on offer is ready to be used freely at no cost.

The data published during the project is mainly statistical, giving a comprehensive and diverse outlook on different urban phenomena, such as living conditions, economics and well-being, employment and transport. A good proportion of the data material offered by the project is GIS based.

The project includes building a web service for fast and easy access to open data sources. Users can download information and use it in decision-making, utilise it in their applications, or develop entirely new services based on the information, to name just a few examples.

Behind the project is the vision that making public data readily available to all increases the residents' knowledge and insight into their region. This in turn improves the civic activity abilities of the public. Open access to information can also lead to new services and businesses in the area, and it may also advance research and development.

Goals in a nutshell

- To develop an extensive network consisting of all those in the Helsinki region who are in possession of basic information pools and materials. The members of the network produce, maintain, share and develop the data pools in cooperation, following common guidelines.
- To open up the data pools of the network for everyone. The data in the pools will also be ready to be further processed or utilised in IT applications. Data is available free of charge and in an easily usable form.
- To build a web service through which the data can be easily found, downloaded and utilised. The web service is also used to encourage the producers and users of the data to cooperate more closely.

- To pilot an open data activity model and its implications to both the producers and end users of the data. To learn by doing and sharing the learned lessons, too.

Policy instruments in place in Helsinki (PreCo and Innovative City)

PreCo and Innovative City® as Innovative funding solutions boosting innovation in the Helsinki- Uusimaa region toward a Smart City

Apart from the well-organised platform and co-ordination among the stakeholders, innovative funding solutions are also needed to boost both RDI and innovation commercialisation. In the next section, the PreCo on Pre-Commercial Public Procurement (EU-funded initiative) and Innovative City® (City of Helsinki and Aalto Unversity) will be introduced as the examples of methods developed.

Enhancing innovation in pre-commercial public purchasing processes (PreCo)

Pre-commercial procurement (PCP) is described in the European Commission's communication with the title Pre-commercial Procurement: Driving innovation to ensure sustainable high quality public services in Europe (Brussels, 14.12.2007 COM 2007:799 final).

Pre-commercial procurement projects are still rare, at least that is as text book cases. PCP is used in complex product-service systems and in thematic fields such as health, elderly and social care. Mixed elements from Public-Private Innovation, Market Dialogue, PCP and Commercial regular Procurement are used in these areas.

PreCo Project raises awareness of pre-commercial procurement (PCP) and addresses the barriers in public sector Participatory RDI. PCP is defined as an approach for acquiring Research and Development services which enable public procurers to:

- share the risks and benefits of designing, prototyping and testing of new products and services with the suppliers and other stake-holders, such as the end-users
- create the optimum conditions for wide commercialization and take-up of R&D results through standardization and/or publication
- pool the efforts of several procurers.

The overall objective of PreCo is to support public authorities in undertaking pre-commercial procurement actions which stimulate innovation and citizen participation. For this propose, the project will establish a thematic network for the development and the adaptation of European wide models, frameworks and policy recommendations in two main areas: eHealth and eEnergy.

The thematic network will contribute to the Lisbon strategy goals by fostering growth and innovation. It will further develop synergies with other policies, and stimulate, encourage and facilitate the participation of SMEs and civil society organizations in the activities of public purchasing processes. The network will bring together a wide range of stakeholders including public authorities and relevant support actors, in order to encourage practical co-operation, exchange of experiences and knowledge on PCP.

A co-ordination action PreCo is funded by the FP-7 program of the European Commission aiming to ”Enhancing Innovation in Pre-commercial Public Purchasing - Processes”:

• Consists of ten partners from seven EU countries, lead partner and co-ordinator Culminatum Innovation Ltd Oy (Finland)

Objectives of PreCo:

- Benchmark: Collecting and analysing best practices
- Facilitate discussion between procurers and suppliers.
- Establish a thematic network of experts on PCP.
- Identify a common ground for guidelines, policy recommendations and PCP strategies which are to be delivered to the Commission by the end of 2011.
- Joint events and public PreCo website www.preco.share2solve.org

Procure R&D in steps (solutions, prototypes, test series) aims to reduce the risk and give SMEs a chance:

- Grow size of tasks gradually; make bridge from ideas to first test products; Procurer = SME First Customer Reference
- Risk-benefit sharing with Suppliers; Less risks to the Procurer: commercialization opportunity to the supplier
- Competing development with multiple Suppliers; Better value for money (US Defence Report: in-development competition reduces first unit acquisition cost with 20-30 %)
- Sharing R&D costs with other Procurers

Innovative City® Program

The Innovative City® Program is an urban innovation tool owned by the City of Helsinki and Aalto University and was launched by the City of Helsinki and the Helsinki University of Technology in 2001. Today, this cooperation continues and develops with Aalto University from 2011 onwards.

The climate change and the growing global competition between cities are the major motives for this cooperation. The Innovative City® Program aims at producing sustainable urban innovations through multidisciplinary R&D cooperation:

- The City of Helsinki has highlighted the cooperation with the universities as one of the main factors for its future success
- University researchers get the opportunity to use the urban area as a living laboratory
- For companies, the city is a potential customer

Innovative City® Program promotes R&D cooperation in areas where the City of Helsinki and Aalto University has mutual interests. Co-operation themes during the years 2006-2010 included:

- Future Urban Transport
- Senior Citizens
- Sustainable Constructing
- Urban Housing

Operation Model of Innovative City® Program:

- Maps the cooperation interests of the City of Helsinki and Aalto University
- Coordinates the call for research initiatives
- Develops procedures that support R&D cooperation and communication
- Searches for entirely new forms of co-operation

Results: the Innovative City® Program has been working with some 150 project initiatives, 34 of which have been financed and launched. The total project funding amounts to about / around 16 million Euros. Projects are mainly three year R&D -projects with many co-operation partners and produce both academic results and innovations which benefit urban dwellers in Helsinki and have also international potential (glocality).

Organization: the Innovative City® Program organization forms a coordinated network of leaders and specialists that creates a free-form and interactive knowledge and communication channel between the cooperation partners. The Board consists of the mayors of the city and rectors of the university. It convenes once a year and makes decisions regarding the cooperation's long-term directions and focus points. The Steering Group consists of directors of the city and professors of the university. It convenes 5-6 times a year and represents the cooperative partners' expertise from different knowledge areas. Program team and research coordinators are in charge of development of operational and research work in the program.

The results of the Questionnaire after the Smart Cities event 18/11/2010

In your opinion, what are the new insights/concepts in innovation management that are gaining momentum in your City Hall/ Regional Government?

Most of the respondents identified the new insights/concepts in innovation management that are gaining momentum as innovation as participatory process with citizens and the city/regional government shifting from being an effective service provider to triggering innovation, also according to the participants the government needs to boost its internal innovation capabilities and the use of ICT technology for City Planning/Management and shifting from being an active platform manager rather than service provider.

1. Innovation as participatory process with citizens (9 responses)

2. Government shifting from being an effective service provider to triggering innovation (8 responses)
3. Government needs to boost its internal innovation capabilities (8 responses)
4. Use of ICT technology for City Planning/Management (7 responses)
5. Government shifting from being an active platform manager rather than service provider (6 responses)
6. Open the vendor selection process to both multinational and small foreign SMEs (4 responses)
7. Government increasingly adopting proven solutions from regonized vendors (1 response)

In which sectors is the Smart City concept more visible in your City/Region, both in terms of existing or planned projects?

Most of the Smart City concepts were seen in transportation and mobility as well as ICT related services and energy management.

1. Transportation and mobility (10 responses)
2. ICT related services (7 responses)
3. Energy management (6 responses)
4. eParticipation (4 responses)
5. eGovernment (4 responses)
6. Other: City economy (1 response)

What are the new instruments/mechanisms in innovation that your City Hall/Regional Government is adopting?

Most of the new instruments/mechanisms that were identified were Living Labs, open data and Public and Private Partnerships.

1. Living Labs (13 responses)
2. Open data (10 responses)
3. PPP (9 responses)
4. Trials (participatory trials) in City Spaces (5 responses)
5. Co-creation exercises with citizens (5 responses)
6. Joint ventures with companies (4 responses)
7. Participation in Open Source Developments (4 responses)
8. Open service platforms (3 responses)
9. City services (2 responses)
10. Crowdsourcing (1 response)

4 SMART CITY CASE STUDY: BARCELONA

Authors: Tuba Bakici, Esteve Almirall (ESADE). A modified version of his chapter has been published in the Journal of the Knowledge Economy, April 2012.

Smart city concept spreads across the world and became a cultural phenomenon since it involves everyone and their future from presidents to infants. It is a new approach for constructing brighter futures by urban centers that includes stable sturdy infrastructures, renewable energy, two-way data flows, participation of citizens in management, efficiency in internal government services, competitive and innovative businesses and increase life quality.

Over than 200 U.S. cities have smart city projects on their agenda (O'Connell, 2008). Across Europe, Amsterdam, Stockholm and Lyon are some of the main frontrunners but certainly not the only smart cities on the horizon (Davis, 2010). Barcelona is also robustly moving in the smart city direction.

4.1 SMART CITY CONCEPT AND AMBITIONS

But, what is a Smart City for Barcelona city hall? As a general concept, Smart City is referred as the safe, secure environmentally green, and efficient urban centre of the future with advanced infrastructures such as sensors, electronics, and networks to stimulate sustainable economic growth and a high quality of life (Hall, 2000; Caragliu, 2009).

City of Barcelona defines Smart City as a high-tech intensive and advanced city that connects people, information and city elements using new technologies in order to create sustainable greener city, competitive and innovative commerce and an increase life quality with a straightforward administration and maintenance system of city.

Smart City Barcelona is a collaborative movement among its corporations (retail), academic institutions, government authorities and the residents of Barcelona, aimed at becoming a reference program for economic engine and urban development. Together, they are developing smart projects the city to foster the competitive profile of city.

The main objectives of the Smart City model in Barcelona are Smart Services that has different nature and purposes to manage the city in a better way. These services aimed to include municipal advanced public services targeted to citizens and business, services for citizens made by citizens and business, and new city management tools. These services should serve as a boost for cooperation between the Council, civil stratum and the professional arena.

4.2 CURRENT SITUATION AND INNOVATION ECOSYSTEM CHARACTERISTICS

In certain districts Barcelona pushes its limits toward an effective and sustainable city by transforming from industrial area into a home of new innovative companies. This, specifically, is the 22@Barcelona district project, but that is just one of many projects within the Barcelona Smart City plan, which includes a series of projects that will add value to companies and cities. 22@Barcelona district is a true living lab for new infrastructures and services with a collection of about 14 pilots in various domains such as Environment, Mobility, and Telecom. Project along the neighborhood began in 2001 and has run for over 10 years on the district. It involves projects aim to create a sustainable living, working and mobility with advanced infrastructures. This district embraces clusters of ICT, Media, Energy, Design and Biomedical with a triple helix case. Here new business culture is promoted based on collaboration between companies, universities and the public sector for innovation.

Recently Barcelona City involved in Open data movement with Open Data project, opening its government information to the access of everyone. These data involves territory, population, management and procedure indicators, urban environment and documental datum. It is the society's right to use, whether to brief themselves or for creating new services, increasing the social value and perhaps, also the commercial value.

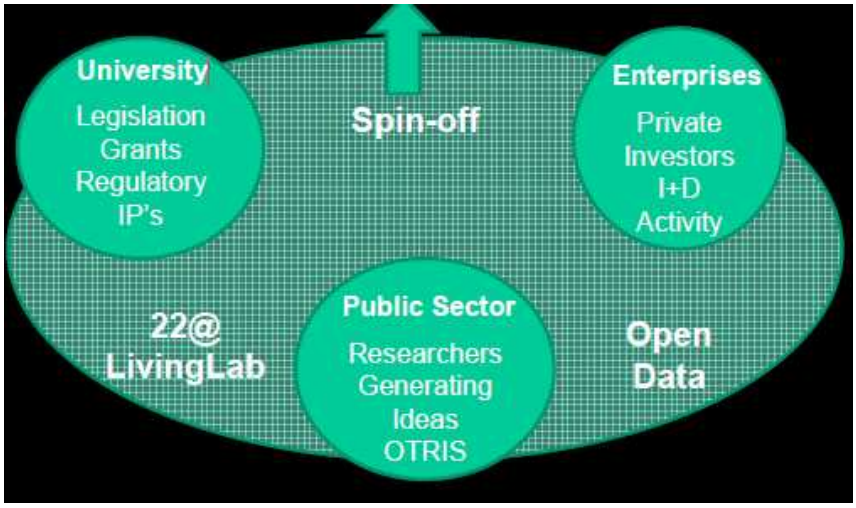


Figure 1: Triple Helix Model of Barcelona (Batlle)

Defining Barcelona's future as a smart city, the government has embarked on a massive model to build up the necessary infrastructure. However the aim is not just evolving Barcelona from its strong industrial legacy to a productive and profitable knowledge-based economy but an improvement of the quality of life for its citizens. It would also allow a better way of the delivery of public services from transportation to education, and healthcare.

Other Smart City projects in Barcelona include: a corporate fiber optical network to connect the main municipal buildings; Wi-Fi mesh network to provide wireless connection to those municipal services and employees working at street level; sensors networks to manage a multivendor multipurpose sensors network configured to be used by several providers; Public Wi-Fi network.

4.3 MANAGEMENT OF THE SMART CITY INITIATIVE

The management of the Barcelona Smart City model is composed of various organizations and departments. These mainly involves 22@Barcelona agency which was responsible for urban planning, such as new infrastructures and refurbishing preexistent ones. Together with 22@Barcelona agency, Promoció Econòmica (Economic Promotion) was responsible of attracting economic capital to the region. There are two governmental departments that are also involved in the management of Barcelona Smart City model. These are Mobility department that is responsible for the mobility plan of public and private transport and control and Environment department that in charge of environmental issues. Finally, Institut Municipal d'Informàtica (IMI, Municipal Institute of Information Technologies) that provides IT services to the municipality also involved in the management process. Thus all these organizations work in coherence and collaboration in order to run the Smart City model successfully in Barcelona.

4.4 DRIVERS AND BOTTLENECKS

There are various drivers for Smart city model in Barcelona but among all fostering competitiveness of the city is the leading one. Smart city initiated to promote innovation, create new channels of communication, facilitate access to information on local and international and improve the efficiency of public services.

The city Barcelona benefited from Smart city model with enhanced public services, access to knowledge, and a networking system while taking notice of its citizens' demands to meet their needs. For instance with 22@ Barcelona District, city hall created new employment opportunities, moved universities in the area, provided social housing, urbanized green areas and better efficient public services. It has created more than 25,000 jobs with over 900 new firms (Leon, 2008). This also allowed the real application of projects with the feedbacks from citizens.

Nevertheless as in any other city, Barcelona faced with certain challenges such as providing exact and paramount infrastructures, deployment and management of Wireless Networks, creation of triple helix, networks, clusters and collaborations.

In the case of 22@ Barcelona District, the research of Leon (2008) highlighted five major challenges that city hall faced: 1) the skilled human capital level was not enough to satisfy the needs of industry clusters, 2) the level of local entrepreneurship was lowest compared to any other country in Europe, 3) Venture capital funding was not sufficient to attract firms and finance start ups, 4) number of large firms to lead innovation was low, 5) in business context global connectivity of Barcelona was poorer compared to other European cities.

4.5 CONDITIONS ESTABLISHED

The foremost upshots of the Smart City model in Barcelona, Smart Services is grouped according to their target and producer. First one is the Internal Government services. These services aimed at making public workers tasks easier and giving useful information to city managers that can help taking better management decisions and evaluate policies. These services boost the cooperation between the several stratums of public workers in order to acquire efficiency and efficacy.

Secondly services aimed at making the citizens daily life easier and more comfortable, offering more and better services, offering updated information in a proactive way and fostering citizens' participation in the city management daily life is grouped under Government to Citizen/Business services.

Finally services created by citizens for the citizens, including also the professional arena, boosting cooperation between the several elements of civil life are grouped under Citizen to Citizen services. Services based often on public open data representing the real social innovation and the real openness of a city.

4.6 ASSETS / RESOURCES

To accomplish the initiated objectives, the Barcelona Smart City model foundations lay on three pillars, namely these are ubiquitous infrastructures, information and human capital.

Ubiquitous infrastructures

The city needs to be equipped with advanced infrastructures to evolve the Smart City concept from pure theory to reality, providing citizens and enterprises with a powerful platform to connect city elements and let them interact effortlessly with each other and with their administration through electronic means. Stable sturdy infrastructures, from optical fibre networks covering the city acting as a backbone to the installation of sensors, are the key for the development of intelligent solutions in cities.

Information

Information is the raw material to fuel innovation factories. Information coming from daily activity in the city is an invaluable asset that needs to be collected and interpreted, creating a Smart City information space that acts as the basis to deliver smart tailored services and a better city management. Several sources have been identified being the following the most important ones to construct the concept of the Smart City:

- Information coming from the city:
  - Sensors and city elements
  - Open Data = Public Sector Information
- Information coming from the citizens:
  - Digital footprint
  - Social media
  - Crowd Sourcing.

Human capital

Actors actively participating in the daily activity of the city are the ones that really could make a city smarter. The implementation of the Smart City is not only a concern of public administration but also it should involve population, innovation centres, companies and entrepreneurs.

Faculties and society are knowledge producers, while companies and entrepreneurs generate new business opportunities. Moreover, public administration can generate growing environments that should push a growing, sustainable and progressive dynamic. In this sense, cooperation between these actors seems to be the key for the development of a suitable environment for talent development.

To sum up, a Smart City should be able to "activate" smart ideas generation itself in an open environment, may it be through, for instance, fostering clusters or developing proper living labs directly involving citizens in the co-creation process of products or services.

4.7 CONCLUSION

Smart city concept in Barcelona is used as a strategic tool to encompass modern urban production factors in a common framework and foster competitiveness of city. Barcelona initiated Smart City model as it expected an effective urban management like any alternating city that grow. To sustain an effective urban management, intelligent network technologies are required to drive economic growth, sustainable green city and a better the quality of public services. The flourishing outcomes of this transformation to be a smart city in Barcelona can be clearly observed such as in the 22@ District or successful implementations of other various projects.

References

O'Connell, L. (2008) Exploring the Social Roots of Smart Growth Policy Adoption. Social Science Quarterly, 89, 5: 1356-1372.

Davis, K. (2010) The Rise of the Smart City. POWERGRID International, http://www.renewableenergyworld.com/rea/blog/post/2010/01/the-rise-of-the-smart-city

Hall, R.E. (2000) "The Vision of a Smart City", (Brookhaven National Laboratory, USA), 2nd International Life Extension Technology Workshop, Paris, 28th September

Caragliu, A. (2009) "Smart cities in Europe", (Politecnico di Milano), Chiara del Bo (Università degli Studi di Milano) and Peter Nijkamp (VU University), Research Memorandum 2009-48

Slides of Barcelona City Council, Joan Batlle

Leon, N. (2008) Attract and connect: The 22@Barcelona innovation district and the internationalization of Barcelona business. Innovation: management, policy & practice, 10: 235–246

5 SMART CITY CASE STUDY: LISBON

This case study has been contributed by Joana Fernandez (Lisboa E-Nova) with support of Jean Barroca (Alfamicro) and Idália Torres (ISA).

5.1 THE CITY OF LISBON

Lisbon is the capital and largest city of Portugal. Evolving over 84.7km^2, the city owes its character to the Tagus River, the city's most important ecosystem, around which some of the most important developments and requalification strategies lay ground.

Its municipality, which matches the city proper excluding the larger continuous conurbation, has a population of 489,562 (2008), while the Lisbon Metropolitan Area in total has around 2.8 million inhabitants, and 3.34 million people live in the broader agglomeration of Lisbon Metropolitan. Its economic output, standard of living, and market size, allow the Lisbon region to be considered the second most important financial and economic centre in the Iberian Peninsula. The Lisbon region is the wealthiest region in Portugal. It produces 36,6% of the Portuguese GDP (2007). It is also the political centre of the country, as seat of government and residence of the Head of State.

5.2 LISBON SMART CITY CONCEPT

Lisbon's vision for its future is set on the strengths of the city today and the opportunities still to enrol on the deployment of Lisbon's potentialities for the future.

Lisbon's challenges for the future start with the goal of becoming:

- an international hub for world scale companies, benefiting from the bridge Lisbon represents between Europe, Africa and America;
- a pole for creativity and innovation, acknowledging that the creative industry already accounts for 6% of Lisbon's employment rate and can further represent an important asset in Lisbon's economy;
- a city with a prospering atmosphere for entrepreneurs, incubator for new ideas and business models;
- a dynamic city for exhibitions, events and cultural activities, listening and learning from experienced partners the ways to better exploit its resources;
- a center for excellence in investigation and R&D, recognizing the fact that Lisbon is Portugal's biggest university pole,
- a sustainable city, focused on achieving excellence in the efficient use of its resources, bearing in mind the compromises assumed within the Covenant of Mayors and the city's energy-environment strategy that sets ambitious targets for the energy, water and materials consumption; and
- an inclusive city for its citizens, fostering a cooperative environment between the local authorities and the citizen.

According to Molly Webb, "leaders need to incorporate creativity from unexpected places" (source: www.guardian.co.uk/sustainable-business/smart-cities-clean-technology, 7th of December 2011) and that's the Smart Lisbon project main goal: "to facilitate creativity, providing citizens, small enterprises, start-ups and civil organizations the tools needed to create, to innovate, to enable social innovation, centring the citizen as a co-producer/partner of the City"(source: Lisbon City Councillor Graça Fonseca(2009), "Lisbon Smart City", www.lisboaparticipa.pt).

The Lisbon Smart City Strategy is designed as part of the city's response to the challenges and opportunities faced by the city. Especially addressing Lisbon's entrepreneurial potential and the need to attract investors and nurture new ideas and business models, Lisbon's need to improve the city's management structure, focused on the optimization of resources and smarter use of infra-structures and invite Lisbon's citizens to actively participate in the city's governance process, the Lisbon Smart City Strategy is based on three essential pillars:

- **Building spaces**: The Municipality sets as its role to provide open innovation spaces to the public, namely initiatives such as Co-Working spaces and Fablabs. These spaces intend to foster creativity, benefiting from the co-existence of competences and join of efforts toward a common goal;
- **Fostering entrepreneurship**: Lisbon should position itself as a privilege city for the launching of new business projects, namely in the creative industries, information and communication technologies and several other areas. Benefiting from different competences and promoting interaction platforms between cooperating stakeholders that can be essential in the successful launch of new enterprises. Examples of such initiatives were the TEDx Lisboa, the Sillicon Valey in Lisbon, Ignite, Lisbon Talks, among others. Additionally, a strong effort has been put through creating business incubators for start-ups as well as joining assets and promoting synergies between actors, motivating the market's creativeness to deploy new services and functionalities, creating added value business lines that can further grow to new start ups.
- **Useful tools**: Create useful tools for the city, improving its quality of life is the challenge and the basis for making available a wide variety of data sets so that citizens can co-create new, economical valid projects for the city. This goal is presently being undertaken with the Open Data Lx project, where sets of data, from information regarding the city's services to data regarding administrative process is already available to the citizen.

Lisbon, like any European capital, faces several challenges. The most important challenge is to improve the city's liveliness and quality of life, namely through the active involvement of the citizens in the city's governance model. Lisbon's Municipality model towards Lisbon as a Smart City bases itself on the principle that citizens, institutions, companies and public services are to work as partners in the deployment of innovative services and products at the city scale.

The Municipality should act as a promoter for innovation, development and investigation, setting the grounds for stakeholders to meet and dynamically work towards a greater project, maximizing the use of the available resources and competences. To this end a strategy should be set aiming to pull the citizens to cooperate, not only listening to their voices, but operationalizing the ideas into valid projects, bridging ideas in straight cooperation with the developers. The Municipality's role is to set the necessary conditions for the scientific, economic and social development of the city, providing the adequate environment for startups, placing innovation at the heart of Lisbon's strategy to improve life quality.

Within this concept, the Lisbon Smart City case will be presented in different areas:

- Technology infrastructures;
- Spaces for user participation and open innovation;
- Tools, actions and assets for user driven open innovation and citizen participation;
- Market opportunities and entrepreneurship fostering actions;
- Sustainable Mobility.

5.3 LISBON SMART CITY INITIATIVES

Technology Infrastructures

BROADBAND NETWORK

Portugal has today the second-highest penetration rate for high-bandwidth services in Europe, after Belgium. It started with a coaxial network developed by cable TV company, TV Cabo which then updated it using fiber to the cabinet (FTTC) technology and DOCSIS 3.0 cable modems. Other operators later introduced fiber to the home (FTTH) systems using a Gigabit passive optical network (GPON) architecture.

The main approach to bringing high bandwidth to the public has been FTTH, taking a high-capacity fiber-optic cable into each household, which now results on possible download speeds up to 2.5Gbit/s and upload speeds of 1.25Gbit/s per optical port in the central office, capacity that is then shared between up to 64 clients on the same passive optical network. FTTH has taken off rapidly in Portugal, with subscriber numbers increasing from 14,500 in 2008 to 237,000 on the fourth quarter of 2011. The Portuguese government has announced a plan to wire all of the 3.9 million homes in Portugal with a fiber-optic connection by the end of 2017, while the city of Lisbon has at this moment high speed internet connections with almost 100% coverage.

Spaces for user participation and innovation

LIVING LABS

Lisbon Smart city strategy bases its governance model in citizens' cooperation and co-creation of services and functionalities that increase spaces comfort and livingness. Mostly in the energy efficiency area, Lisbon has enrolled on several projects based on users' behavioural transformation regarding energy use. Lisbon's strategy towards energy efficiency bases itself on the constant knowledge of the city's consumptions and loop back to decision makers and citizens on these values, so pro-active measures can be placed in action. Within the maximum you can only quantify what you can measure and you can only manage what you can monitor, the use of information and communication technologies (ICT) is crucial for the effectiveness of this cycle and for a broader efficiency of the actions and projects developed.

Service Buildings

According to Lisbon's energy matrix (data form 2001), service buildings are responsible for 34% of Lisbon's total energy consumption. From all the costs involved in a building life cycle, construction, occupation and dismantling, occupation presents by far the most consuming period of the building's life.

The building management is crucial to assure a good energy performance. Focusing the management dimension, Lisboa E-Nova (Lisbon's Municipal Energy-Environment Agency) promotes the **Remote Manager project**, oriented towards buildings electrically supplied in medium voltage. EDP's (Portuguese Utility for Electricity) makes it available for medium voltage supplies real time consumptions through telemetry readings in the consumption point. This data, reported every fifteen minutes, is available to the owner of the medium voltage supply contract and can be critically analysed through the Remote Manager tool. This tool defines the consumption profile of the building and associates it with the different pricing periods, allowing the building manager to have a clearer view of the buildings bulk consumption. This is essential to assure the least costly interaction with the tariff in place for each hour and to transfer power charges according to this strategy, smoothing the building's consumption peaks.

The building's management directly links to how the building is used. Engaging the building users in the adoption of more energy efficient actions can represent energy savings from 5% to 15% (source: European Commission "SMART 2020: Enabling the low carbon economy in the information age" and "ICT for a Low Carbon Economy Smart Buildings") The use of active monitoring systems with real time data presentation is one of the measures to engage users in behaviour change. Within this context, the **SAVE ENERGY** project brought to Lisbon a pilot experience running in the Lisbon's Municipality most important services' building, Campo Grande 25. In one of the building's blocks several smart meters were installed, allowing users to know in real time the electricity consumptions registered in the several consumption circuits: lights, ventilation and plugs. Additionally to the availability of real time consumptions, other awareness actions like energy efficiency tips applets, workshops on energy efficiency and use of smart metering appliances at home were also organized. The results indicate higher awareness on energy and energy efficiency issues, adoption of energy efficient behaviours and energy consumption reductions around 5% in plugs and lights.

Behaviour transformation can be successfully achieved in younger generations, more open to change in their still not too strict habits. The MIT Portugal Programme in a partnership with the National Laboratory Civil Engineering (LNEC) and the Social Sciences Institute (ICS) promotes the **NetzeroSchool** project. The project's goal is to compare the behaviour change that evolves from the interaction at schools through a structured programme oriented towards energy efficiency, with a more residential oriented approach where real time consumptions are available online, GooglePowermeter, for dwellers to check. The school where this project is based is the Vergilio Ferreira school, that will not only be the house for the projects dedicated to students education, but also the focus for the 60 families that will be selected for the real time measurements and data availability.

Residential Buildings

APOLLON is a project dedicated to leveraging current experiences and on-going investments to supplement cross-border pilots with best-of-class methods for setting up, developing and operating sustainable networks of Living Labs.

The project consists of four cross-border Living Lab experiments: Homecare and Independent Living, Energy Efficiency, eManufacturing and eParticipation. These will focus on validating the added value of a cross-border Living Lab network, both in terms of small and medium enterprises (SMEs) gaining access to new markets, as in terms of achieving collaboration breakthroughs in the development of pan-European domain-specific solutions.

The Energy Efficiency experience taking place in Lisbon focuses in the residential framework. For this, smart meters were be installed in several dwellings enabling households validation and citizens empowerment for an active role in energy saving. The pilot is a residential block with 356 dwellings and 18 spaces reserved for commercial activity, where dwellers mobilized for the installation of a micro generation system and the adoption of energy efficiency measures. The installation of smart meters and active engagement of users with information and dissemination campaigns will promote not only behaviour change but also validate a new area of business strongly promoting local level SME innovation and creating European level synergies to these companies in scaling their market reach in ICT enhanced energy efficiency domain.

CO-WORKING

"Co-working is sharing a working environment with independent professionals and micro-companies. They also share the feeling of not standing any longer the isolation of working at home!" (source: coworklisboa.pt)

The co-working concept acknowledges private professionals needs in launching new business. The aim is to share a working space with other professionals, benefiting from the synergies of using a common space, both in terms of the lower costs associated and the relations and contacts network that arises from these joint ventures.

In Lisbon, the first private co-working space opened in 2010, offering both individual booths and booths for micro companies up to four workers. From this first initiative others have joined, fruit of the receptivity of these shared spaces within Lisbon's entrepreneurial community.

The Lisbon Municipality acknowledges the interest of these initiatives and is now promoting a publicly owned co-working space. Combining the requalification process of the *Forno do Tijolo* market with the creation of new functionalities in this space, the Lisbon Municipality project is to offer the city a new co working space, responding to the growing need for working spaces within a rotation regime and a low cost rent. These spaces will be available for entrepreneurs, especially young professionals in the creative industries area, in a clear bet to support these industries as a motor to the economic, social and cultural development of Lisbon.

Tools, actions and assets for user driven open innovation and citizen participation

PARTICIPATORY BUDGETING

Lisbon has a strong tradition in the participatory decision making processes. The most visible initiative is the Participatory Budgeting, which allows the population to decide the activities in which the municipality should invest 5 million euros, 5% of the Municipality's total annual budget for investments. This is an essential component in the Municipality's strategy and has already been recognized as a best practice in urban governance by UN-Habitat.

Implemented in 2008, Lisbon was the first European city to organize the Participatory Budgeting, a new governing model that gives the population the power to propose projects, analyse the candidacies and vote for the projects they believe comply with the city's needs. The projects are analysed and structured so to allow the population's evaluation and vote. The Municipality is responsible for the implementation of the most voted projects up to this amount. The guidelines for this process are approved in the letter of principles, an open methodology that foresees the yearly evaluation of the methodological procedure and consequent redefinition according to the expertise gained from the previous editions. In three years the number of citizens participating in the Participatory Budget has rose from 1000 people in 2008 to 11.500 in 2010 and 17.900 in 2011. A participant characterization identifies the average age of the online participants, between 26 and 45, having a university education and the participants at the participatory assemblies mainly over 65 years old, mostly with the basic educational degree. In 2011 five projects were the selected, mainly aiming at the city's requalification, namely the requalification of Mouraria and the University City Campus.

A pilot experience was successfully launched in 2011, exclusively open to schools, named the Scholar Participatory Budgeting and is expected to continue in the following years, in a clear engagement process focused on youngers needs.

OPEN DATA

Lisbon Municipality's Open data project started in 2010 with the aim of bringing into the local realm a national project on public administration data the www.dados.gov. The project started with a close partnership with AMA – The National Agency for Public Administration, who already publishes a wide set of data regarding the city of Lisbon in the most diverse areas. The Lisbon Municipality's idea was to make this data available in a more local focused project, combining it with data exclusively available at the local level, both collected from public and private entities. The objective is to allow the citizens to consult and construct new services and functionalities based on this data, creating projects with an added value at the local scale.

The first sets of data have just been made available as the Open data Lx portal just opened to the public on the 19th of December 2011. Some of the applications already developed are the Lisbon 360º, an application available for smartphones that allows seeing, in connection to google maps, where are the nearest restaurants, pharmacies, sigh seeing spots, etc, benefiting from already available functionalities at google maps as the distance from our location and preferable routes. In connection to this application the Municipality as also made available historical information on monuments form the Municipal Archives, which can now be easily consulted with this application. Another application using the data available from AMA relates to the Citizens Stores. The application was developed for smart phones and identifies the nearest Citizen Stores, the working schedule, services available, average waiting time for each service and store classification according to the citizens' questionnaire.

Sets of data regarding energy use and renewable energy technologies are already available, namely the Baixa Pombalina solar potential assessment, the location of the electric vehicles charging points, and more are expected to be available in the upcoming months.

Market opportunities and entrepreneurship fostering actions

Lisbon's innovative ecosystem allowed the proliferation of smart devices and the deployment of effective gains derivate from data assessment and exhaustive analysis, creating disruptive opportunities and possibilities for new services and significant savings through more intelligent systems and devices. These factors have modified the way the population interacts with the world, fostering efficiency, productivity and energy gains. Therefore thousands of smart applications and devices using M2M communications and traditional IT systems are being developed, in order to reduce consuming and enhance quality of life.

Like all cities Lisbon faces several challenges.

One of the city's main challenges is the transport system, which has revolutionized the logistics and distribution sector, as well as the citizens' mobility patterns, yet causing disruptive effects on cities air quality due to the associated local gases emissions. Acknowledging this, cities have launched several projects aiming at identifying the best strategies to mitigate the negative effects from the transports systems maintaining the commodities these system represent nowadays. The electric vehicles platform arises from the efforts that have been persecuted in this field. Several European cities have now enrolled in the deployment of electrical charging networks, in order to promote citizens adoption of electric cars. The roll out to electric vehicles opens a whole new world for ICT integration, namely smart meters, with bi-directional functionalities in order to manage electricity supply to the vehicles or the inverse situation when the vehicle can restore electricity back to the grid in peak hours, approaching the production and supply chains. Also, the interface of electrical vehicles with renewable energy sources for electricity production, namely solar and wind power, allows the integration of decentralized production on to the grid, planning for electricity availability in coordination with mobile storage sources. All these viable connections are only possible due to ICT and advanced monitoring and communication systems. Also within the urban transport system, railways represent an existing infra-structure that can further be exploited and optimized, improving traffic capacity and management, namely in the logistics sector.

The energy consumption, the interaction between energy consumption, economic development and demographic growth, it's another challenge for every big city. Smart Grids and meters deployment are the perfect channel to massive energy savings, connecting millions of houses, creating self managed systems that coordinate energy consumption and production, and advise consumers how to reduce costs. The opportunities arising for the roll out of smart meters in residential buildings are acknowledge by the market and dynamic projects addressing the scale up of the benefits, namely triggering energy efficiency and addressing the smooth in energy production/consumption, are being set in almost every European country.

Ageing population with growing heath care needs are also a challenge that the Healthcare sector is addressing, more and more, through the deployment of monitoring systems. There are several opportunities regarding the use of remote equipment's to monitor health parameters, RFID patient identification, positioning and drug management, among others. These opportunities can be further enhanced by the interaction with the transport systems, specialized health care units and special health care institutions.

In all these cases it's important to identify the location of a person or asset. This can be made through a navigation or positioning system, to advice people for specific environments or tracking and managing flows of people and assets in transportation and logistics. This can be achieved combining different technologies like GPS, RFID, etc.

The monitoring of the urban environment is also one area of opportunity for the deployment of ICT equipment. Monitoring the local conditions through sensors to identify temperature, humidity, wind and air quality in several sectors, like industry, offices, public buildings, private houses, etc. allows a more precise response of the local services to local conditions. With all the new infrastructures and range of possibilities, the acceptance of this kind of technologies is much easier. A key feature for the adoption of this technology is the easiness to install and use. Also the deployments of pilot actions in this field allowed to test and identify the best methodologies and practices in the gather, analysis and use of this data. The most important and valid variables have been identified, as well as the partnerships, the problems and solutions and the communication means that generate the most feedback from users. Its' now understood that further work needs to be done in the creation of specialized expertise in the capture, store, analyse and use of these valuable amounts of information, promoting the creation of innovative solutions in order to avoid equipment multiplicity, incompatible systems, the rejection of legacy systems and the interface to guarantee security, value, privacy and trust to data provided and acquired.

Lisbon has the potential to be a true open eco-system for these technologies to develop, creating several networks and applications (personal, home, enterprise, private and public) that aim to contribute to the interoperability of systems. It's important to leverage this approach to evolve in the dynamics of the ecosystem and its applications. For this its' essential to develop and install wireless sensors, analytic software and improve processing power to better manage those resources.

These cloud-based systems are an important asset in improving energy management systems and so contributing to increase energy efficiency, reduce gas emissions and offer new services and functionalities to users offering operational software for city management in all levels like water and energy consumption, traffic, facilities, offices, residential buildings, safety and security, etc.

Developing Internet applications offers tremendous perspectives for every socioeconomic sector, due to the facility to access and use data. All co-creation platforms aim to promote users involvement and have been empowering users and their ability to intervene in products and services development. To this end social networking has played an essential role allowing for greater data mobility and crowdsourcing initiatives that boost the innovation process.

All these technologies and developments have been implemented with users, so every development on product and service its closer to the user's needs and of course produced at lower cost and facing higher acceptance by users.

The involvement of public authorities was a major improvement in Lisbon as it enabled very different experience with citizens, leading to higher acceptance rates of these technologies and to a more progressive cooperation between public authorities, private entities and users.

This innovative ecosystem of projects has had major market advantages like:

- Break the first barrier to applications and devices and their potential benefits;
- Bring large scale social benefits, and ease the long term technological burden, beyond gains;
- Create bridges between different technologies and legacy systems;
- Pre competitive collaboration;
- Interact externally with end users, society, investor, legislators, etc.;
- Identify future applications, research and development;
- Mitigate barriers for adoption;

- Identify strategic directions and influence regulation and standardisation with policy-makers;
- Investigate market size and business opportunities;
- Encourage investment, and capacity of funding bodies to direct their programmes.

In a city like Lisbon, with this new growing ecosystem, it will be easier to promote projects like:

- Smart Manufacturing: application in Industries;
- Smart Platform: logistics and supply coordination;
- New Innovation networks for future internet applications;
- Smart Service: healthcare, government, smart grid, water supply, city security infrastructures.

All these new innovations and infrastructures make Lisbon a perfect city to create excellent opportunities to build world class ICT infrastructures, smart sensing and smart application systems and a reliable and safety security system. This approach will enable new, richer and potentially disruptive services that will become widely embedded across the way we do business, live, and interact.

LISBON START-UP

The Lisbon Start Up project was launched by the Lisbon Municipality in the beginning of 2012, as a result of a proposal to the Participatory Budgeting, supported by the Montepio Investment Bank and IAPMEI. The Start Up Lisbon is a project incubator that fosters entrepreneurship and supports entrepreneurs to deploy their market innovative ideas.

The Start Up Lisbon is set with the following mission:

- Facilitate the creation and development of entrepreneurial activities through the combination of infrastructures and specialized support services;
- To develop a pre-incubation program, development of the business model through guided tutorials with specialized professionals, specific and restricted training, organization and promotion of networking events and complementary activities;
- Deploy an incubation program, specialized consultancy and guided support with mentorship;
- Provide an adequate space to business initiative, from 10m^2 to 40 m^2, fully equipped with office furniture, telecommunication infrastructure, acclimatization, security and cleaning at a competitive price for new born companies.

The Lisbon Start Up Lisbon intents to set the impulse for new innovative ideas to step forward and find the necessary support to develop market viable business, actively promoting Lisbon entrepreneurship and economic development.

FAB LAB

Fab Lab is a municipal initiative driven from the need to create public spaces where innovators and entrepreneurs can benefit from a low cost prototyping environment, having access to peers from different areas of action, joining efforts in the testing of virtual ideas on a small scale approach. These digital manufacture laboratories are constituted by low cost rapid prototype machinery, controlled by computers, which allow the creation of new products.

The Fab Labs concept was created by the Center for Bits and Atoms (CBA), from the Massachusetts Institute of Technology (MIT) and are nowadays connected through the Fab Labs network that shares information from Fab Labs at a world wide scale. Fab Labs are the first step to industrial hardware, allowing new forms of "personal fabrication", overpassing mass production commercialization through user fabric.

Lisbon's Municipality Fab Lab will be hosted at the *Forno do Tijolo* market complementing the co-working initiative. This industrial experimentation site will allow professionals to test and validate their ideas with a low cost budget, enabling the promotion of new products and business models.

LISBON ACADEMY

Lisbon is the house for several universities. As such, one of the main focuses of master and doctoral thesis is Lisbon and the challenges it constantly faces. Also, one of the main difficulties when addressing Lisbon in each study is accessing the needed data and getting in contact with the relevant stakeholders. Benefiting from these privilege sources of knowledge and studies, the Lisbon Municipality decided to organize the Lisbon Academy, a privilege network for strategic partnerships between the Municipality and the Universities to develop investigation studies on the themes and practical questions that challenge the city.

The goal is to benefit from the scientific knowledge and investigation to answer some of the questions that are addressed in Lisbon's environment, benefiting from the living environment Lisbon represents. Yearly the Municipality launches themes that should be addressed in investigation and research thesis. Universities are to further develop the theme and present proposals. To acknowledge the best studies a prize is also associated to this initiative to promote innovative responses to the challenges faced by Lisbon.

Sustainability Mobility

ELECTRIC MOBILITY

Portugal is implementing the first countrywide EV charging network, which includes more than 1300 charging points across the Country (MOBI.E project), with Lisbon having the most prominent position in it with 687 charging points. The first set of electric vehicle charging stations was inaugurated in 2010 and currently more than 500 points are operating within Lisbon, fully available to the public.

Within its basics service, Lisbon and other cities charging points are interconnected within a unique platform MOBI.E with multiple interfaces (web, iphone, android), which presents the location and status of each charging point (occupation and existing pre-reservations), distances between points, translated into real time distance according to traffic and battery needs.

The project's goal is to further develop and implement innovative functionalities that mobilize the electric vehicle charging points as crucial infra structures in Lisbon's sustainable mobility strategy. Users will be called to identify and test new functionalities along with the universities and SMEs, in a user involvement strategy that relies on active cooperation between different actors. Nevertheless, electric vehicle owners are not the ones to exclusively involve in the project. The user involvement strategy will go beyond the early adopter, focusing also on laggards in order to motivate their participation and engage them in the development of services that may attract and persuade them to adopt electric vehicles.

The first sets of data regarding this network are available and present the location of the charging point, through GPS coordinates and street number, number of available plugs and classification within Lisbon's parking solutions. A wider set of functionalities are to be available as soon as the national network implements a global solution for the management of the plugs.

PUBLIC TRANSPORTS

The most important means of public transport entering in Lisbon are railway, bus and ferries. Urban transport in Lisbon is promoted mainly by CARRIS (public bus) and METRO (subway). CARRIS has the exclusive concession of the road public transport services inside the city of Lisbon and the exploitation is presently held by 749 buses and 57 trams that allow the movement of more than 234.371 million passengers a year.

Aiming at offering innovative services to its' clients, CARRIS launched in 2001 a service that allow citizens to know the time for the next bus in real time, **CARRIS by the minute**. Every bus is equipped with a route sensor that reports to the central station informing its exact location. From here the central communicates to the bus stops the time that will take for each bus to arrive at the stop. This information is presented in a public display placed in almost every bus stop. Additionally this information is also available online and through the sms service.

CARRIS strategy to reduce its passengers commuting time is complemented by the existence of internet services in some of CARRIS buses. The **Net bus project** was launched in September 2010 and offers passengers a free connection to internet services, allowing to access business or pleasure functionalities while enjoying their bus ride.

Another area of development in the public transport segment is carsharing. CARRIS recently implemented the **MobCarSharing** project, an initiative that promotes the use of a "public transport" individually. The project allows the passenger to rent a car online and use it for the time and route desired parking it in one of the CARRIS carsharing parks once it finishes. In the future all the cars will be equipped with GPS, allowing not only to know the car's location every instant for security reasons, but also to monitor the routes for which this service is mostly used, providing valuable data in terms of the definition of new bus routes and the systems own management with the definition of new parks and renting services.

The management of parking spaces is under the responsibility of the municipal parking public company, EMEL. This company launched in 2010 the Smart parking project. The basis of this is an electronic device that is connected to a rechargeable card, which allows drivers to pay exactly the time their car is parked in one of EMEL's parks. The **SmartPark** device is connected once the driver parks the car and is disconnected once he gets back to the vehicle, charging to the rechargeable card the amount of payment for the parking space. With this new equipment drivers can save money and time in their parking spaces.

After several decades in which Lisbon's public transport users could only benefit from monthly integrated tickets a revolutionary electronic ticketing scheme was implemented in the 90's. It comprises the use electronic cards in all public transport services which, amongst other capabilities, allow users to buy their tickets in any ATM machine and decisively contributed to the creation of new tariffs for specific groups. The **Lisboa Viva is a "smart card"** with an embedded chip and antenna that works by approaching the card, without contact, to a validator, at the stations "entry" channels. The system reads and validates the data loaded in the chip and, in the case of valid data, enables the access to the networks that use this card. This integration technology aims to enlarge this concept by developing ticketing systems that cover all the modes of transport including private transport, bikes, public transport and vehicle electric charging. This innovative measure has the ambition to "approximate" car users from the use of public transport and soft modes, suggesting their interchangeable use.

BICYCLES LANE NETWORK

"After some years of public debate, in late 2007, the Lisbon Municipality started to implement a strategy for bicycles. The main goal was to rapidly increase the number of commuters' cyclists in order to create a new class of users that could express confidence to new potential ones. Thus, with low public financial resources, the municipality intended to overlap the bicycles lane with the city's ecological green structure, creating a friendly bicycle paths network together with green corridors, connecting fragmented green spaces and covering main parts of the city, including access to important public transport interfaces as well as more representative educational and office equipment. This first step, a more than 6.0 M.€ investment effort, partly financed by National and European funds and also with Public and Private Companies partnerships, resulted on almost 40km of cycle paths including more than 40 public bike parks and two specific bicycle-pedestrian bridges, was focused on city flat areas, whose result is now changing mentality about bicycle and how it is an effective commuting alternative.

In a not so confident city regarding bicycle use as a daily transport, it was essential to potentiate users, reinforcing the creation of recognizable specific infrastructures to entrust early adopters for the bicycle option. On a time that the 'state of art' points different typologies for bicycle infrastructure according to car traffic speed, 30km/h zones will be defined allowing bicycles to spread into and from neighbourhoods. Nevertheless the perception of the number of cyclists in town points to a positive expectancy about a healthier future for bicycle Lisbon mobility. " (in Sá Fernandes, J.; Castro, J.; Mata, D.; Camolas, J.; 2011; Lisbon's Green Cycle Strategy 2007-2010: How can strong public commitment made it possible)

In 2009 transport related projects were the most voted in the Participatory Budgeting project, headed by an ambitious investment in cycle lanes across the city.

5.4 LESSONS LEARNED

Lisbon's path towards becoming a Smart City is at its very beginning. Nevertheless positive lessons have already been acknowledge and are the basis for this strategy's continuous improvement. Defined as part of the overall development strategy that enables the city to respond to its challenges and opportunities, the Lisbon Smart City strategy especially focuses the dimensions of entrepreneurship nurturing, urban management and citizens' engagement in the governance process.

So far, the results from the Lisbon Smart City strategy have been very positive with the creation of the Lisbon Start Up, the launch of the Fab Lab initiative and public and private Co-Working centres. At the urban management level the strong effort in the improvement of the public transport system and the collection of real time data regarding energy use in public buildings and services allowed the optimization of infra-structures and the definition of intervention priorities. Finally user's involvement in the city's governance model has been successfully achieved with the Participatory Budgeting Initiative.

Citizens are eager to participate, though a strong effort as to be put into the communication strategy, enabling different actors to interact and represent their role in the society. The Living Lab methodology is being applied in the consumer behaviour area, with energy efficiency projects being developed both in residential and service buildings. The results are very positives with savings between 9% and 20% in the residential sector and between 5% and 13% in service buildings. These positive results are incentives to deployment of new projects and to addressing new areas, where the Living Lab methodology can also be successfully applied. Entrepreneurial activities, taking advantageous of the assets created are flourishing, especially within the creative industry that already plays an important role in Lisbon's economy and can further be deployed in this sense.

Resources, education, information and confidence are still the barriers to overcome. Resources to deploy the mainstream of information and communication technologies applied to the most diverse environments, collecting and integrating data that allows optimizing processes and taking the most out of existing infra-structures. Education is at the heart of a Smart City: "We believe a city to be smart when citizens and visitors have the opportunity to make smarter choices." Education is crucial for citizens to understand the strategy and deploy useful, usable tools. Information, targeted at the different social and age communities and confidence on the common goal, on the overall strategy and on the actors involved.

5.5 CONCLUSIONS

This paper identifies the main pillars of the Lisbon Smart City strategy: **building spaces, fostering entrepreneurship** and developing **useful tools**. The pillars are an integrated approach to the city's objectives for its near future, to be an international hub for world scale companies, a pole for creativity and innovation, a city with a prospering atmosphere for entrepreneurs, an incubator for new ideas and business models, a dynamic city for exhibitions, events and cultural activities, a center for excellence in investigation and R&D, a sustainable city focused on achieving excellence in the efficient use of its resources and an inclusive city for its citizens, fostering a cooperative environment between the local authorities and the citizen.

Projects are being developed all over the city in all fronts, in a vibrant cooperation between public authorities, private entities, universities and R&D centres, associations and local agencies, centred in enhancing the city's quality of life and involving the citizen as an active voice, involved in the creation and decision process.

The city's goal to foster innovation and nurture new ideas sets on projects developed towards enabling a closer contact between entrepreneurs and business world, fostering social networking and providing the necessary conditions for new ideas and business concepts to flourish in an innovation environment. Examples of such projects are the Fab Lab Lisbon, the Co-working Centres, the Start Up Lisbon and the Lisbon Academy Initiative. Users are at the centre of the innovation process and the Living Lab concept is already a tool, being mostly applied in energy efficiency projects dealing with consumer behaviour. The Participatory Budgeting is an exemplar initiative on how users have a voice on the city's needs and can assess interesting projects for the city's development. On sustainable mobility ICT represents a great asset in developing new solutions and functionalities that facilitate users' adoption of collective transports, soft mobility means and more local friendly technologies as the electric car.

Lisbon is setting its path towards being a true open eco-system where ICT systems have the potential to be adopted at the most different levels of usage and engage public authorities, private entities and the citizens, onto the city's route for becoming a smart, sustainable city.

6 SMART CITY CASE STUDY: MANCHESTER

This case study has been contributed by Dave Carter (MDDA). A modified version has been published in the Journal of the Knowledge Economy, April 2012.

6.1 OVERVIEW

In the late 20th century cities like Manchester, seen as the 'original, modern' world industrial city, faced serious challenges in terms of how to respond to the massive economic restructuring that was taking place. On the one hand Manchester needed to respond to the highest rates of unemployment and social exclusion seen for more than 50 years, while, at the same time, the city wanted to develop innovative and practical solutions which could bring real economic and social benefits to local people. The impact of even more rapid technological change, referred to as the emerging 'information society', which started to impact from the 1980s onwards, exacerbated this dilemma, accelerating the process of restructuring so that within urban areas new economic growth increasingly sat side by side with extremes of poverty, unemployment and other forms of social exclusion. This case study looks at the ways that Manchester, and key players from the city region, including the public sector, business, education and the community sector, responded to this, and how those responses over the past 25+ years created new ambitions and aspirations for the city and its citizens. The conclusions focus on the concept of the 'Smart City' and Manchester's ideas on creating a more inclusive, creative and sustainable city, including through the imaginative use of digital technologies, applications and services and a commitment to open innovation and the co-production of new and innovative services.

6.2 INNOVATION IN REGENERATION: A PROACTIVE APPROACH TO ECONOMIC AND SOCIAL CHANGE

In the mid-1980s Manchester City Council embarked on a radical new approach to regeneration. A new Economic Development Department was established and work was commissioned to bring together people with new and innovative ideas, from research bodies, business, trade unions, the voluntary sector and the wider community, to advise the City Council leadership on how to tackle economic restructuring and the consequent impacts which were resulting in massive levels of unemployment, poverty and alienation. Out of those discussions, which also included many 'heated debates' on priorities, a number of practical proposals emerged in the late 1980s (1987-89), including:

- There should be more of a focus on area and neighbourhood based working, devolving intervention to local areas and encouraging cross-sector working where the public sector would work on a more proactive basis with local communities, businesses and other public sector bodies, e.g. health;
- The idea of a 'creative city' emerged, demonstrating the economic importance of the 'arts and cultural industries', such as the idea that Manchester should look to cities such as Amsterdam and Barcelona as '24 Hour Cities' for inspiration and practical ideas for new initiatives;
- Innovation being identified as another key theme, acknowledging the lack of a coherent collaboration strategy with higher education in particular and the need to address this with some practical initiatives such as the development of Manchester Science Park (MSP) and the recognition that information and communications technologies (ICTs) could play a significant role in creating new infrastructures and services and, consequently, future economic growth.

These three themes were at the heart of the new Economic Development Strategy for the City and provided the foundation for the City Council's new 'Economic Initiatives Group (EIG)' focusing on local (neighbourhood focused) action, creative industries and technology and innovation. They are still at the core of Manchester's neighbourhood regeneration strategy twenty years later, underpinning the two core objectives of the City Council, namely generating sustainable economic growth and reducing dependency through tackling worklessness, inequalities and social exclusion.

In 2011 the launch of the EU's Digital Agenda for Europe [2] provides a high level strategic framework for supporting the development of *"a flourishing digital economy by 2020" …* through … *"policies and actions to maximise the benefit of the Digital Revolution for all"*. As part of this local action is being encouraged so that cities and regions produce "Local Digital Agendas" to set out their aspirations for change, while at the same time focusing on practical action and initiatives which will deliver that change supported by user driven open innovation through the use of digital technologies.

This comes at a time when Manchester is reviewing its own 'Digital Strategy', originally produced in 2008, and its current digital development priorities focusing on three main issues:

- digital inclusion: continuing to tackle the 'digital divide' because, even though people generally have increasing access to the Internet and digital services, inequalities persist with large sections of excluded communities no longer having or using copper based landlines (over 50% of households in some parts of Manchester) and, consequently, having limited or no access to the 'digital world' and where access to skills and jobs in the digital economy is still a very real challenge;
- digital industries: building on Manchester's strengths as the largest and most dynamic cluster of digital and creative businesses outside of London to support further sector based growth, particularly through the independent Manchester Digital trade association (www.manchesterdigital.com) , finding ways to overcome barriers to growth, such as the lack of business finance to support new investment and start-ups and the need for better access to skills and pathways to employment in the sector;
- digital innovation: generating investment for innovation and new infrastructures and working with the research community on Future Internet development to support Manchester as a 'Smart City' in areas such as smart energy, cloud computing and very high speed next generation access (NGA) digital infrastructures (fibre and wireless), networks and services.

This review is starting with the production of a Green Paper, entitled "Smart Cities: creating an inclusive and sustainable knowledge society: A Local Digital Agenda for Manchester", the first draft of which was produced for consultation in November 2011. This was the result of six months work in consulting with local stakeholders and partners, following a workshop organised by Manchester Knowledge Capital and the Manchester Digital Development Agency (MDDA) in March 2011, together with a range of discussion held with partners in the EUROCITIES Knowledge Society Forum – KSF (www.eurocities.eu) , European Smart Cities projects and the European Network of Living Labs – ENoLL (www.openlivinglabs.eu) . Following a further three months consultation period with stakeholders and partners, local, nationally and internationally, the Local Digital Agenda for Manchester is being published in Spring 2012. It will outline priorities and an action plan for realising a digitally enabled and empowered Smart City, both in the short term and to 2020 and beyond.

6.3 DRIVING CHANGE IN MANCHESTER: FROM TELEMATICS TO A NEW DIGITAL AGENDA

Manchester's experiences in urban regeneration and digital development over more than 25 years

In the late 1980s when the City's new Economic Development Department was formulating its priorities for action to drive economic change technology was largely seen as something that was neutral and passive, a product of economic change rather than a catalyst for that change. Information and communication technologies (ICTs), or telematics (the convergence of telephony and informatics), were not particularly seen as being central or even that important to economic growth. There were examples in other parts of Europe, however, as well as in North America, where the power of micro-computing was being linked together with the 'plain old telephone system' (POTS) to create the first open networks that were more widely available outside of universities, the wider research community and the military.

Manchester was particularly influenced by developments in Scandinavia and Germany, where 'X25' networks were providing the first open access email and conferencing systems, such as the 'GeoNet' system in Germany with its email, fax and telex gateway in the UK, and the Electronic Village Halls in Denmark and Sweden taking ICTs out to local communities to support rural development and with links to one specific community project in the UK, the Notting Hill Information Technology Education Centre (ITEC). Manchester commissioned research from the Centre for Employment Research (CER) at Manchester Polytechnic (now Manchester Met University – MMU) to review these developments and to make recommendations about how such developments could be used to support economic development and social inclusion in Manchester.

In spite of some advice CER received, such as that 'there would be no commercial access to the Internet for at least 10 years', this was in 1989, the report was very positive and Manchester embarked on a proactive strategy of encouraging some of the pioneers of this early use of 'telematics' to bring their skills and infrastructure to Manchester. This resulted in the move of Poptel (the UK's first worker cooperative Internet Service Provider), working in partnership with GeoNet, to Manchester with the 'Manchester Host' computer communications and information system. The Manchester Host was launched in 1991, the UK's first locally based, globally accessible public access system offering email, bulletin boards and on-line databases, focusing heavily on community based users and information providers, as well as working with business and the public sector. In this way the early roots of digital development in Manchester were as much the result of grass roots initiatives as the City Council's strategic commitments.

A network of Electronic Village Halls (EVHs) was set up in local neighbourhoods in Manchester in 1992, providing access to ICTs and (pre Web) Internet services and Manchester City Council was one of the first UK local authorities to have a website in 1993. In 1994 a new community based organisation was established, the Manchester Community Information Network (MCIN), to support capacity building work in local areas and with the voluntary and community sector (NGOs) generally, enabling them to produce electronic content and to make that accessible via the Web and associated on-line networks. At the same time Manchester Science Park (MSP) became the home for the first 'Internet Exchange' outside of London, still the only facility of this scale and capacity outside of London, and this is a key asset in Manchester's continuing development as a digital city.

Consolidating Manchester's digital capacities in the 21st century

As Manchester considers its priorities for the coming period, taking in to account the potential impact of the third generation of Internet development, the 'Future Internet' based on innovations around 'cloud' computing, the 'Internet of Things', open data and the 'semantic web' [3], local experience to date has created a firm foundation for future work. As a recent report commissioned by the MDDA [4] to review Manchester's 'Internet Hub' capacity said:

"That such an open infrastructure approach works for Manchester is evident in the history of the digital sector and the process that led to Manchester becoming the foremost Internet hub in the UK outside of London. Manchester attracted some of the earliest Internet service providers who saw potential in strong local market awareness – to some extent the result of public sector intervention. Those ISPs created a market for Internet transit and hosting services that attracted investment by carriers and led to the creation of hosting businesses like Telecity, a hugely successful Manchester start-up. The same ISPs spawned a growing number of web design and software businesses that took advantage of the new market opportunities. Those in turn increased further the demand for hosting and transit capacity, and the city council joined others in promoting an initiative to establish MaNAP, the first significant Internet exchange outside London. The peering activity around MaNAP and the increasing number of carriers who chose facilities in the Science Park as their point of presence led to falling Internet transit costs. This increased the attractions of Manchester as a centre for digital businesses, increasing demand for hosting, and so on in a virtuous growth spiral.

Three factors were critical in bringing this about:

- The role played by SMEs as innovators and market creators, and their need for open infrastructure to support a competitive supply chain and offer opportunities to add value.
- The early emergence of the hosting facilities at the Science Park as a 'meet me' point for carriers to bring connectivity, overcoming the problem of 'where shall we meet?'.
- The leadership role played by the city council and the universities, in creating awareness through projects like the Manchester Host, in the creating the first hosting facilities on the Science Park, and in the creation of MaNAP."

In the 1990s the work of the technology and information society team within the City's Economic Initiatives Group continued to focus on developing a balance between traditional 'high tech' (largely 'technology push') innovation and 'accessible tech' (largely 'demand stimulation') open innovation. In the latter case it was again grass roots initiatives, such as those driven by the voluntary sector (NGOs), which were particularly innovative using digital technologies to develop networks of creatives, electronic arts initiatives and e-enabled community activities from the bottom up. The early digital business networks coalesced into the Manchester Digital trade association, launched in 2001, and largely survived the 'dot com' boom and bust, but there was a growing recognition by this time that accessibility to digital technologies had to be improved significantly if any competitive edge developed by the city was to be sustained. This meant not only improved networks and services for business but also for all local residents, especially those who, in spite of economic growth during the late 1990s, were still socially excluded, and for public sector services.

In 1996 the Manchester Telematics Partnership was launched as a local innovation networks, bringing together business, research, public bodies and community based organisations, focusing on digital development. This was very much influenced by the continuing work that Manchester was doing with other European cities, which provided growing evidence of the need for more proactive approaches to investing in digital infrastructure and services. Firstly, through Telecities, of which it was a founder member and hosted the founding conference

in 1993, and more widely through EUROCITIES where the late Councillor Brian Harrison, the first Chair of the City's Economic Development Committee in the 1980s, went on to be chair of the EUROCITIES Economic Development Committee (1996-98). The experience of other bottom up developments, such as the community based digital networks and infrastructures in Amsterdam (through its Digital City project 'Digitale Stad' in 1994 and the Waag Society MediaLab), Barcelona (with the Barcelona Community Network – BCN), Bologna (with its citizens community network) and Stockholm (with its municipal fibre company – Stokab), convinced senior decision makers in Manchester to take a much wider look at this agenda and how it could benefit Manchester, building on the second great digital revolution, the coming of broadband and the 'always on' availability of the Internet and Web services.

Current debates at the time (late 1990s) tended to focus on the more optimistic view that e-services will be able to empower citizens and provide for their full participation in an emerging 'digital democracy', while there was concern that continuing inequalities, especially at a spatial level, were ignoring the realities of power which could be seen to support, what was called at the time, "an information aristocracy", with elite access, rather than an effective 'digital democracy'. It was felt then that if there is not full accessibility to the new digital infrastructures and services for all citizens then the outcome will simply reinforce existing patterns of inequalities with 'information haves' and 'have nots' in our communities. This is still seen as a real challenge to realising the idea of a 'Smart City' today. Manchester's experience during this period, i.e. from the mid 1990s to the mid 2000s, was that capacities and capabilities needed to be built up amongst local innovators, entrepreneurs and small businesses (SMEs) and that one important factor in achieving this was public investment in key enabling facilities such as Manchester Science Park and other local innovation incubators. This is a key reason why Manchester continues to balance 'top down' strategic initiatives with 'bottom up' grass roots development, through local user networks, such as the Manchester Digital Lab (MadLab – www.madlab.org).

6.4 OPEN ACCESS IN THE DIGITAL ECONOMY: FROM THE LEGACY OF THE COMMONWEALTH GAMES TO AMBITIONS FOR MANCHESTER IN THE GLOBAL DIGITAL 'PREMIERSHIP'

Innovation and technology in urban regeneration: the experience of East Manchester

Manchester's work to date on technology and information society issues is based on the premise that urban regeneration is an essential prerequisite for tackling social exclusion and economic restructuring. Cities across the world face similar challenges in terms of finding coherent and effective policies and strategies that will enable them to deal with rapid industrial restructuring. They aim to support and sustain economic growth, connecting the opportunities created by economic growth with the needs of their citizens, in spite of the volatility of global markets, especially in terms of the current economic crisis. The emergence of the information society added new complexities to this process, on the one hand adding to the speed and scale of change while on the other hand providing new tools and processes which can be used in order to mitigate the impact of that change.

Manchester has experienced new economic growth developing side by side with persistently high levels of unemployment, poverty and social exclusion. It has the fourth highest rate of multiple deprivation (apart from parts of Merseyside and London) and the highest rate of child poverty in the UK. This "tale of two cities" syndrome (as it has been referred to) threatens to undermine the longer term sustainability of economic development and growth. It is in this context that Manchester's work on the information society and 'digital development'

continued to be an important cross-cutting theme within its City-Region Economic Development Strategy and Action Plans. The central aim is that digital technologies should be used to increase citizens' access to skills, jobs and services and support greater participation in civic life, including in the regeneration process itself.

Manchester is the UK's second largest metropolitan area outside of London, with a population of over 2.5 million in the Greater Manchester city-region. At its core is the City of Manchester, the first industrial urban area in the world and the 'original, modern' city. Alongside the city's transformation from industrial to knowledge economy is the legacy of high levels of unemployment and poverty from the experience and impact of the economic restructuring of the 1970s and 1980s. Much of this legacy is concentrated in the traditional industrial manufacturing area of the city, in East Manchester, once home to more than 100,000 its population had declined significantly, to less than 30,000 people by 2000.

East Manchester was, and is, a regeneration challenge of regional and national significance [5]. An area of 1,100 hectares situated immediately east of Manchester's City Centre, East Manchester presents an opportunity for regeneration on a scale and diversity almost unprecedented in an English city. There are unique opportunities for the renaissance of the area as a focus for the knowledge-driven economy of the twenty-first century. These opportunities have been generated by there being a range of regeneration initiatives focusing upon East Manchester to address many of the physical, economic and social problems in the area. These, in turn, build upon the stimulus provided by a buoyant economy within Manchester and the major investment attracted through the staging of the Commonwealth Games in 2002 and related legacy projects. The strong commitment by government to the success of cities and to tackling the most acute areas of deprivation is also a key factor driving this impetus, as is the partnership working between generated between the local community and local and national government.

A major influence on Manchester's approach to digital development and, most recently, on work on the concept of the 'Smart City', is the experience gained in East Manchester where the City Council formed an Urban Regeneration Company (URC), New East Manchester (NEM) Ltd, a public-private-community partnership operating on a not-for-profit basis. An online community network, run in partnership with local citizens organisations and representatives, known as "Eastserve" was established there in 2001. This was the location for the Commonwealth Games in 2002, which brought much needed investment and new facilities and resources in to the area, which had been the major industrial area of the city for more than 100 years until industrial restructuring brought factory closures, massive unemployment and environmental degradation over a 25 year period up to the late 1990s.

Manchester first Living Lab initiative – 'Eastserve'

The 'Eastserve' initiative was one of a range of legacy projects, where the investment attracted by the Commonwealth Games, including the City of Manchester Stadium (subsequently the home of Manchester City Football Club – MCFC, and now renamed as the Etihad Stadium), would continue to have positive impacts in supporting local residents to gain skills and access to employment, including through ICT projects. Even in 2001 many residents in the East Manchester area used cheap mobile phones rather than fixed telephone lines. The initial survey work undertaken by the area regeneration partnership (in 2001) revealed that more than 25% of homes no longer used landlines. This led to changes to the initial aims and objectives of the project which had been to provide PCs to households with dial-up Internet access. This meant that a system of wireless broadband connectivity was required which then enabled households to access the Internet and on-line services.

More than 2,000 of the area's homes were Internet enabled through wireless broadband Internet connections, as well as 17 local schools, eight "UKOnline" community access centres and 10 public access points in libraries and other centres. They all connected to a 100Mbps licensed wireless backbone linking four tower blocks around the East Manchester area from where bandwidth is distributed over a wireless network. Schools and public buildings receive an online community service, developed by Eastserve, and relay it to other residential locations. These locations are grouped in clusters and communicate with one another wirelessly via a radio dish antenna connected to a wireless bridge.

Underpinning this approach was the provision of micro-loans through the local Credit Union which enabled people to buy computer equipment which, because they were paying for it, increased the 'value' that they put on this and enhanced their sense of ownership over the process and its results. Many of the people involved had never saved before or, in some cases, did not have bank accounts, so the project also had a positive impact on the Credit Union, increasing membership from a few hundred to some two thousand people.

At the time this was one of the largest community based all-wireless broadband networks in Europe and the largest community regeneration initiative using digital technologies in the UK. In spite of being one of the poorest areas in the city, the take-up of broadband the area is far higher than the city-wide rate and residents are using their new skills to improve their access to training and jobs. In one of several evaluation studies of the impact of the project it was shown that Eastserve users are:

- more aware of job opportunities
- want access to more training
- more likely to seek work
- more likely to take part in other educational opportunities
- more likely to be looking for new challenges
- more interested in running their own businesses.

Over 40 per cent of residents have now had basic ICT training because of EastServe, more than double the rate of most areas in the City, and 20% of these were moving on to extended courses which provide opportunities for accreditation, again more than double rates for initiatives in other parts of the city.

Learning the lessons from the work in East Manchester influenced thinking about how to extend this and develop similar initiatives in other parts of the city, around the idea of the Manchester Living Lab, and how to develop a city wide strategy for what was now termed 'digital development' with continuing support both to and from local grass roots initiatives.

6.5 THE MANCHESTER DIGITAL STRATEGY: FROM LOCAL DIGITAL ACTION TO THE MANCHESTER LIVING LAB

Digital development supporting neighbourhood regeneration as a starting point for a 'smart city'

In 2002 Manchester hosted the world's second largest sporting and cultural event, the Commonwealth Games, and following this there was a city wide review of all of the City Council's services and structures. One result of this was that the City Council decided to change the way it delivered its Economic Development Strategy, focusing future work in strategic initiatives in defined Area Regeneration Partnerships and in sector initiatives. This led to the Technology and Information Society Team in the Economic Initiatives Group becoming the core of the new Manchester Digital Development Agency – MDDA (www.manchesterdda.com), set up as a city region wide initiative in 2003 with the mission:

"To make Manchester a leading world class digital city, having one of the most competitive broadband infrastructures in Europe, attracting and sustaining investment in ICT and e-commerce across all sectors of the economy, generating new businesses, developing new learning cultures, promoting social inclusion and providing all residents with the skills and aspirations to play a full role in the information society." [6]

In 2005 the Government published the UK Digital Strategy [7], which included proposals for a UK "Digital Challenge" where local authority led partnerships would be invited to put in innovative proposals for accelerating digital development at a local level. The MDDA was responsible for coordinating a response to this, working in partnership with other public sector bodies, including the other municipalities in the city region, other public sector bodies, business and the voluntary and community sector. In January 2007 Manchester City Council submitted the ONE-Manchester Partnership Digital Challenge proposal [8] to Government with plans for developing: *"universal, affordable next generation broadband access" which "is essential to connect all residents and businesses of the Manchester City-region to the social, educational, informational and economic opportunities they deserve".* This established the foundation for the creation of a Manchester Digital Strategy with a vision of creating the city-region as *"the most advanced 'next generation' connectivity in the UK, providing a sustainable base for high growth business, innovation, transformational public services and an inclusive knowledge society"*.

The thinking at that time was that Manchester, as the 'original, modern' city, faces many challenges in sustaining its economic growth and in connecting the opportunities created by this growth with the needs of local residents, maximising local benefit. Not least of these challenges is the way that ever accelerating developments of digital technologies are creating what has been referred to as a digital "paradigm shift" in the global economy. Various terms are being used to describe this – the "Web 2.0" world, "wikinomics" [9] and the new "long tail" [10] economic world where millions of micro-businesses and e-traders create as much economic wealth and opportunity as the traditional large corporate companies. Another challenge for Manchester was how best to continue to balance the strategic priorities of the City Council with the ideas and demands coming from service users and the wider community, including SMEs generally and the digital and creative sectors specifically.

The ONE-Manchester Digital Challenge proposals aimed to capitalise on this and to set out a 'route-map' for a third wave of development which would use the very latest digital technologies to support further economic growth, tackle the digital divide and create inclusive sustainability. This led to the development of Manchester first specific Digital Strategy [11], approved by the City Council in March 2008, with proposals for a 'Next Generation Digital City' aiming to make Manchester a world-class exemplar of how to lead this third wave around four main themes:

a) sustaining economic growth, especially through the digital/creative sector, new micro-businesses, digital social enterprises and creating e-traders;

b) promoting digital inclusion, ensuring that all residents can access the on-line services, technologies and applications that they need;

c) continuing to transform public services through innovative uses of digital technologies;

d) promoting inclusive sustainability where digital technologies are used more innovatively to support sustainable energy communities, intelligent buildings, teleworking, improved mobility, telecare and a greater quality of life generally.

Digital collaborations through Living Labs: networked city to networking city

The new Digital Strategy combined, firstly, continuing engagement and outreach work with innovation 'actors', both through new institutional networks, such as 'Manchester Knowledge Capital (M:KC)' [12], and through the networks of SMEs and community organisations, and, secondly, the lessons being learnt from experience in East Manchester. This provided the basis for a lot of new thinking and ideas which, in turn, enabled a new stage of digital development in the city.

This was happening at the same time as Manchester's work within EUROCITIES had brought it into contact with the network in Helsinki which was working with the MIT Media Lab [13] to develop the idea of Living Labs[1]. During the 1990s Manchester was successful in a number of EU funded projects, coordinated through Telecities and EUROCITIES, including:

- the European Digital Cities project (FP4);
- the INFOCITIES project (TEN-Telecom);
- the Intelligent Cities ("IntelCities") project (FP6).

One of the consistent partners in much of this work was the City of Helsinki, and their partners from Nokia and VTT, were also involved. Having seen and understood what they were doing with their Living Lab concept, i.e. getting research out of the research labs and into the hands of real people in local neighbourhoods, there were clearly a number of parallels with the work going on in East Manchester. As well as being a very good basis for knowledge exchange these collaborations also convinced the Helsinki network to talk to their European partners, including Manchester, about launching a European Network of Living Labs. Manchester joined in with this at the beginning in 2005 and then became a founder member of the network when it launched in 2006.

[1] Living Labs grew out of an initiative in 2000, following the ideas of Bill Mitchell at MIT, by Nokia Research Labs, the VTT Finnish national research centre and Helsinki City Council to find new ways of trialling and testing ICT products and services through mass participation of users. The University of Salford had long been collaborative partners with VTT and invited Manchester City Council to join a new EU collaborative research project called 'Intelligent Cities' in 2001 which was subsequently funded by the EU's 6th Framework Programme (FP6). As a result of the project a European Network of Living Labs (ENoLL – www.openlivinglabs.eu) was established in 2006 with the Manchester Living Lab as one of the first 20 members. There are now more than 200 Living Labs in the network.

The Living Labs 'movement' is driven by the idea of user-driven open innovation, where users are involved at all stages of the innovation process, from design, implementation to application and service development. This brings some of the traditions and experiences of co-creation within software development, e.g. within the open source community, into the wider world of new product and service development and delivery. This is a welcome development as, despite some encouraging trends with public awareness and use of user generated content and social networking, the development of new services and applications remain dominated by the multinational corporate sector leading to a pattern of 'development from above'. If the new infrastructures and applications are to benefit a much wider spectrum of public involvement than is currently the case, there is a need for civic commitment and public support, including financial resources, at all levels to support 'development from below' in applications and services, especially if the full potential of the "Web 2.0" paradigm is to be realised. There is, then, a distinct 'applications gap' at the level of local citizens, too many of whom still sit on the wrong side of the 'digital divide'. The most effective way of bridging this gap is by stimulating greater engagement and experimentation, empowering users to develop digital literacy and competences for themselves and to use these to create their own content and services.

The objective of such initiatives is to provide a wide range of insights which can be usefully drawn upon by others in developing alternative systems, geared to different local needs in different places. Local experimentation therefore becomes part of city-wide and region-wide 'learning networks' whereby the insight gained in one environment can be transferred with suitable adjustments to another. If these 'learning-networks' can then link up - nationally and internationally, then there is the basis for a potentially powerful counter-balance to vested interests, in terms of corporate and state interests, which can be much more proactive in taking an advocacy role in relation to consumer, citizen and wider democratic interests. Developments in advanced communications need to be accompanied by a strategy for development from below which seeks to realise the indigenous potential of cities and regions. Social innovation in the community - involving local government, schools and colleges, public libraries, the voluntary sector, consumer groups and trade unions is a necessary counterpart to organisational innovation led by industry, commerce and government.

Both the idea and the practice of Living Labs, especially in the Manchester context, is then a very significant one, providing a mutually beneficial way of organising key parts of the innovation process and involving people locally, whether residents, students or businesses, in the co-creation and co-production of new applications and services. In Manchester this meant that the MDDA effectively became the co-ordinating Living Lab for the city, both running some user driven open innovation projects itself and also facilitating and supporting similar projects coming from grass roots initiatives, with local research bodies, SMEs, artists and creative networks and other community based organisations.

6.6 TOWARDS 'SMART CITIES': ENGAGING WITH THE FUTURE INTERNET AND THE DIGITAL AGENDA

Putting people at the heart of the digital agenda: 'Smart Citizens in Smart Cities'

The Manchester Digital Strategy provided the framework for the MDDA's work programme over the past three years (2008-11) around the three core themes of digital inclusion, digital industries and digital innovation (as outlined previously). This includes taking forward key ideas outlined in the original "ONE-Manchester" (Open Network E-Manchester) Digital Challenge proposal, such as "turning the digital divide into a digital dividend" – the central theme of the proposal. This looked at the longer term sustainability of digital inclusion policies and practices by developing a new collaborative delivery mechanism for digitally enabled

services and social networking.

The original idea was to provide a sustainable digital development model which could be used to create social capital and community cohesion, also aimed at creating a greater 'sense of place' within socially excluded communities through digital inclusion and capacity building. This, in turn, aims to support the transformational government agenda by providing services which are more accessible and more personalised through innovative uses of digital technologies. As this work develops more attention is also being given to create new and more imaginative business models, especially building upon the experience of social enterprise development, including the idea of 'Digital Cooperatives', new social (economy) enterprises, which would coordinate and support local, regional and national initiatives and realise the benefits of a 'digital dividend'.

This work became central to discussions within the Living Labs network about how to engage with new ideas and approaches, particularly those coming out of the EU's Future Internet Research & Experimentation (FIRE) community. There is a 'third wave' of Internet development underway, where the "Internet of Things", i.e. networked objects, meets "web-centric services", often referred to as the "Internet of Services/Internet of People". The challenge is how these developments can be translated into practical initiatives that meet the wider goals of the Living Labs movement, to co-create and co-produce new 'Future Internet' enabled services that deliver a more inclusive and sustainable knowledge society. At a local level the challenge is to harness these to deliver local benefit, promoting digital inclusion, helping the digital sector to grow and create skills and jobs that are accessible to local people and providing the required digital infrastructure to support innovation and future growth.

This is why the MDDA and its partners have been refining the vision originally outlined in the ONE-Manchester proposals and the Manchester Digital Strategy to focus on the concept of "Smart Citizens in Smart Cities", using digital technologies to promote community engagement, capacity building and social capital. To use the four level social capital model this includes:

- firstly, creating a common vision and a sense of belonging for all communities through imaginative uses of digital technologies to help to transform lives;
- secondly, ensuring that diversity is appreciated and positively rewarded through improved accessibility of digital technologies to support social networking;
- thirdly, engaging people from different backgrounds through the use of digital technologies which enables them to have similar life chances;
- fourthly, encouraging strong and positive relationships to be developed between people from different backgrounds in the workplace, in education and within neighbourhoods by using digital technologies to break down barriers and promote social cohesion.

The MDDA's projects continue to combine innovation through new initiatives, including the Manchester Living Lab, so that it can be the way by which people and businesses can easily connect and collaborate with MDDA projects and other initiatives, together with the further development of well established practice, especially in terms of digital inclusion, such as the "Selling on the Web" courses.

The starting points for this are:

- **Access:** ensuring that all local residents, plus those who come to Manchester to work, study or visit, have the most accessible and affordable ways to use the Internet open to them, including through local access centres, next generation access (NGA) networks and wireless connectivity;

- **Business opportunities:** enabling existing digital businesses to safeguard existing jobs and create new ones, developing pathways into employment through training and skills programmes, including apprenticeships, and generating new business opportunities by supporting new start-ups and social enterprises and promoting new trading opportunities and promotional activities, including through the Manchester Digital trade association and the annual 'Big Chip' awards;
- **Capacity building:** using digital technologies to build social capital and to support community engagement so that there is real local benefit generated by innovation which, in turn, increases digital inclusion, provides access to skills and jobs and improves the quality of life, including through 'green digital' and open data initiatives, working in collaboration with local partners such as the Manchester Digital Lab (MadLab).

Examples of MDDA project development in these areas include:

- **'Fibre to the People'** – the Manchester Living Lab pilot project which is starting in the Corridor area (around Oxford Road, Ardwick and Hulme wards and Knott Mill) to roll out next generation access digital infrastructure using point to point, open access fibre networks and advanced wireless connectivity;
- **Manchester 'Internet Hub'** – ensuring that Manchester can develop its 'Internet Exchange' capacity to be a globally competitive 'Internet Hub' based on enhancing connectivity across the city, especially between Manchester Science Park, Sharp and Media City UK;
- **Low Carbon Open Data Network** – 'Lodanet': extending the wireless connectivity around the Corridor area to collect real-time environmental data using low-cost, low-power sensing equipment and providing open access to the data through a range of online services;
- **Smart Innovation & People** – 'SMARTiP – "Smart Citizens in Smart Cities" – a European project connecting up digitally supported community engagement initiatives in Manchester and four other European cities working in partnership with Peoples Voice Media's 'community reporters' project and the University of Manchester;
- **Green Digital Charter** – a European wide initiative to reduce the environmental impact of digital technologies and to develop innovative 'smart energy' projects, such as Internet based interactive smart meters, that can improve energy efficiency and get people involved in new and imaginative ways of reducing their personal and collective carbon footprints;
- **Digital and Creative Skills** – bringing together businesses in the digital and creative sectors, including through Manchester Digital, education and training providers, community networks and other major employers to develop more innovatory ways for people to gain skills that can help them get access to jobs, set up their own businesses and get access to advanced learning opportunities through non-traditional routes, including apprenticeships.

Creating a more inclusive and sustainable approach to digital development in Manchester

Manchester's current digital projects aim to support the city region continuing to be the engine of regional growth. In order to remain competitive, however, Manchester believes it needs to remain ahead of the curve in terms of digital access, infrastructure and services. This requires a proactive approach at a number of different levels:

a) early, affordable access to 'the next generation' of open access fibre-based digital networks for business, public services and the wider community which are capable of delivering the support required for Future Internet enabled services to generate economic growth. Bandwidth demand is increasing exponentially which means that, given the lead times for infrastructure developments, cities need to be acting now;

b) increasing the capacity for innovation – especially as the digital and creative industries and the knowledge economy are so important to the UK economy. Cities are the places where these sectors cluster and in so doing, create new ideas for products and services and high-value employment opportunities. Easy access to Next Generation Digital Networks is a catalyst for cross-sector collaboration and experimentation. Our ambition is to turn Manchester into a Digital Test-Bed, an open innovation 'Living Lab' for Future Internet next generation services and applications, whether ultrafast broadband, smart energy, e-health or new virtualised capacities through 'cloud computing';

c) creating an enhanced ability to generate and share new ideas - NGA is not just about 'superfast' download speeds. In cities particularly, clusters of high tech digital companies are involved in creating and sharing digital media content and in developing and owning their own infrastructure so symmetric connectivity with fast upload speeds and open access networks are equally as important as faster download speeds;

d) making digital greener and more sustainable: NGA is equally about new green infrastructures, as cities are the primary producers of carbon emissions and, consequently, need to be using NGA to underpin the shift to a low carbon economy by developing new and more sustainable ways in which people can work, study and live. Virtual business networks, for example, using applications such as 'telepresence' can deliver both carbon reductions and access to wider markets. Manchester's work on leading a European wide initiative in partnership with Eurocities to develop this theme around the 'Green Digital Charter' is another example;

e) developing more efficient public services - NGA is key to enabling city service providers to maximise the ability for citizens to self-serve and to provide efficient access to expensive specialist resources, such as expert medical care, using innovative new services such as telemedicine. A further benefit to cities could be the sharing of expertise and collective response to the market in digital networks and specialist services, including shared infrastructure around data hosting, disaster recovery and virtualisation, including cloud based applications and services;

f) exchanging knowledge and expertise - cities are ideally placed to mobilise and aggregate demand for NGA services for the Future Internet 'Smart City' and to provide the strong leadership required to make this happen. The 'Core Cities' network is currently working on an initiative to develop closer engagement between City Leaders, Government, Communications Service Providers and the Internet industry as a whole. In particular, Manchester is keen to continue to working with other cities to influence government policy to recognise the national importance of investment in urban infrastructure to complement the rural 'last third' agenda. Consequently we are establishing a forum within 'Core Cities' where this engagement can regularly take place and the emerging 'Smart Cities' agenda can be shaped through city leadership and regional networking.

A transformational digital infrastructure for the region will require three components:

Access networks: serving businesses and citizens that will take us through the next 20 years and that will offer the maximum opportunity for local businesses to play a role in the supply chain. This effectively means "fibre to the premises" (FTTP) networks supported by the latest wireless technologies. These fibre networks need to be fully open: shared by competing providers and not dominated by any one company or technology;

Digital hubs: where these networks connect with each other and with the rest of the internet, where digital businesses can host the new applications and services on servers connected to these networks, and sometimes where the businesses themselves can locate. These hubs will play a similar role to Internet Exchanges (of which Manchester has the only significant one outside London in the UK), but more of them will be needed, closer to the end users;

Backbone networks: connecting these hubs to each other and with the internet exchange in Manchester. These networks also need to be fully open, available to technology companies and service providers to adapt with different technologies and to compete with each other. This is the primary role of the proposed NGA deployment in the Manchester city region.

By bringing low cost, open access connectivity to several important regional centres, starting with the Manchester city region, such a network can effectively spread the benefit of the South Manchester Internet Exchange (currently clustered around Manchester Science Park) to other parts of the region. This would dramatically improve the business case for the development of hubs and access networks in these areas – initially creating a city-region-wide digital development zone in Manchester and then systematically extending this to other NGA projects across the region.

Truly transformational digital infrastructure requires the widest possible availability and accessibility of fully open access FTTP networks and the digital hubs to support them. Greater acknowledgement needs to be given to the active debate which is going on about the extent of market failure in urban areas as well as rural areas, especially that much more needs to be done beyond simply aggregating/stimulating demand. Active intervention is required on the basis of opening up the building, management and development of fully open access NGA networks using new and innovative business models, including the potential for social enterprises and dynamic forms of public-private-community partnerships. This should include re-use of public assets, as is being developed in Manchester in partnership with Metrolink (the tram network) and Transport for Greater Manchester (TfGM), and innovation through improved collaboration between higher and further education, the private sector and local authorities to develop the transformational digital infrastructure of the future.

The Manchester City Region currently has very little of this kind of capacity in terms of the global scale of development but plenty of potential. It has its small Internet Exchange, is developing the pilot NGA access network in the Corridor 'Living Lab' project (extending links into the Internet Exchange) and it has a new putative hub in The Sharp Project (to the north of the city centre). Competitor cities like Amsterdam are pushing fast to develop this type of infrastructure at a massive scale, through initiatives such as the rapid expansion of the Amsterdam Internet Exchange – "AMSIX", now the largest in the world, and through gigabit trials on its 'City Net' fibre network. Given new opportunities, such as the expansion of the Metrolink tram network, however, Manchester now has a unique opportunity to gain ground and become a global competitor in this field.

Developing NGA infrastructure through the Metrolink-based tramside network by itself does not provide all three components of the infrastructure that are needed but it does bring two key benefits:

- It underpins their development by providing a kick start to one crucial component - the backbone infrastructure to connect hubs and access networks to each other and to the rest of the internet.
- It provides an immediate and affordable infrastructure that can be used by private and public sector to interconnect important centres. Contrary to popular belief, 'dark fibre' connectivity is scarce and hoarded by its owners to provide more lucrative leased active services.

This then would act as the catalyst for further investment and there are a number of ways in which the public sector could see further economic and social benefits from this approach:

- Public sector agencies joining a consortium that invests in and utilises the network could save very substantial costs on connectivity to the Internet and also some point-to-point routes. Improvements in connectivity will enable efficiencies in service delivery.
- This approach would bring high speed, high quality and affordable business connectivity to parts of the city region that would otherwise miss out. This would stimulate investment leading to increased employment with consequent direct and indirect returns for the public sector.
- By enabling the creation of new, affordable access networks in communities that would otherwise miss out, this could lead to creating new pathways to employment and skills supporting, in turn, increased social inclusion, better education and job prospects, reduced crime, and other indirect benefits.

Towards a Manchester Roadmap for creating Future Internet enabled services in Smart Cities

The Manchester City Region NGA initiatives are being developed in partnership by the Manchester Digital Development Agency, MDDA, which is part of Manchester City Council, and the Commission for the New Economy, working on behalf of the Association of Greater Manchester Authorities (AGMA) in the context of the City Region Pilot and the proposed 'Combined Authority'. There are currently three linked initiatives being developed:

a) The Corridor 'Living Lab' NGA pilot project, aiming to connect 500 businesses and 1,000 residential users through a FTTP network, being built by Geo on behalf of the Corridor Partnership, coordinated by Manchester City Council through the MDDA. This will be an access network test-bed enabling new business to business, business to consumer and community based applications and services to be developed as well as innovation in public service delivery in areas such as telecare/e-health, energy efficiency/smart energy, e-learning, smart mobility and flexible working. This is currently being built and the Living Lab test-bed will start trialling applications, including advanced wireless linked to fibre networks, from the end of 2011 for an initial period of 18 months;

b) The Manchester "Virtual Internet Exchange" (M-VIX) proposal, which aims to connect the Corridor fibre network along Metrolink to Manchester two other key economic growth areas: Central Park, which includes the Sharp Project, and then to other key sites, initially in East Manchester;

c) The Manchester City Region NGA Initiative, which is currently undertaking a feasibility study on the scope for market investment in new and innovative models of NGA delivery which would harness the advantages of the core network being developed in Manchester and extend this using all possible routes, e.g. Metrolink and other transport corridors together with Public Service Network development, across the whole of Greater Manchester, including those in the 'final third' rural communities and those in inner urban excluded from access by virtue of financial and other social barriers;

The challenge now is to identify how best to link these proposals in with national policy objectives and to seek support to accelerate their implementation. The Manchester City Region partners believe that this is an innovative approach which, while initially is very much related to the specific opportunities offered because of Manchester's local experience and economic culture, can provide knowledge and experience which would be of benefit to all local areas and regions, urban and rural, in developing NGA across the UK.

This underpins the work that MDDA is doing to develop the scale and scope of the Manchester Living Lab through projects which deliver local benefit around the core themes of its work programme. Drawing upon its experience as a partner in the EU (FP7 funded) FIREBALL (Future Internet Research & Experimentation By Adopting Living Labs – www.fireball4smartcities.eu) project Manchester has developed its new Green Paper (referred to previously, in section 2 above) with a 'Roadmap' for the Local Digital Agenda in Manchester. This aims to translate the overall 'Roadmap' for Smart Cities developed through the FIREBALL project [14] into a specific document focused on the needs and strategic objectives of a specific city, in this case Manchester.

This covers not only existing projects being undertaken by City through the MDDA but also 'bottom up' grass roots initiatives being developed by local partners in collaboration with the MDDA. The 'Roadmap' aims to map existing work going on in the city region, which is relevant to the 'Smart Cities' agenda, and to identify how this fits into the future vision, the challenges and gaps which exist and the future solutions and innovation needs in terms of realising the targets and aspirations of the Manchester city region. The 'Roadmap' is seen as a first stage in the process of developing the Local Digital Agenda for Manchester and the Green Paper is in place to stimulate discussion and consultations so that these responses can be used to validate proposals for future work and that this will be able to inform the production and implementation of the Local Digital Agenda for Manchester.

The Green Paper also sets out what are seen as the real challenges for realising the 'Smart Cities' vision in Manchester, particularly in terms of creating:

"active citizen engagement in the planning, development and delivery of future internet-enabled services in ways which are accessible, empowering and sustainable. There is certainly a much wider appreciation of why this is being suggested or, in some cases, demanded, but this has not yet been matched by action at any widespread or systematic level. This is why Manchester is committed to the three step approach outlined below:

- *Firstly, identifying and analysing good practice, e.g. 'OpenApps' development, 'Apps4' places, (such as* http://www.verkkodemokratia.fi/apps4finland and http://www.gov20.de/apps-4-berlin/*) which are felt to be relevant and (potentially) transferrable to pilot projects being developed at a local level;*
- *Secondly, acting as a catalyst to generate new pilot projects that build on existing good practice at a local level but which also embrace new developments from across Europe and globally which are identified through supporting networks, such as EUROCITIES and the European Network of Living Labs (ENoLL);*
- *Thirdly, drawing out the lessons learned to identify how best to use and re-use the results from pilot projects, both in terms of enhancing the scope and scale at a local level, through extending their reach and developing new business models applicable locally, and in terms of wider replicability across Europe."* [15]

6.7 CONCLUSIONS: MANCHESTER AS A FUTURE INTERNET ENABLED 'SMART CITY'

The experience gained in Manchester through the delivery of local projects over the past five years has enabled a re-evaluation and re-focusing of digital development priorities, around ideas of citizen engagement and 'smart citizens' needing to be at the centre of Manchester's proposed "Local Digital Agenda". The aim is to create a virtuous circle whereby:

a) **digital inclusion** generates skills and aspirations across all sections of society and re-engages people in all aspects of civic life, and;

b) **digital industries** generate new employment opportunities and pathways into these through skill development with local people and the institutions that support this, particularly schools and colleges, and;

c) **digital innovation** is the engine of this growth, with new next generation open access digital infrastructures and services, such as smart energy and smart health/wellbeing, underpinning this and enabling more sustainable growth while supporting greater community engagement which, in turn, supports digital inclusion, especially through Manchester Living Lab initiatives.

The key to realising this, as a 'Smart City' strategy for the city region, is to sustain the momentum of work done to date through:

- **city leadership** (continuing support from the main decision makers at the highest level);
- **investment** in new digital infrastructures and services (even in spite of the economic crisis, where new and more innovative approaches and business models will be needed more than ever);
- **exemplar projects** and activities which really stimulate interest and engagement (two examples in Manchester currently would be the Manchester Digital Lab, MadLab, and the Future Everything Festival).

The Future Internet enabled 'Smart City' is about the transformation of urban living through the imaginative use of digital technologies and ensuring that this can make a significant contribution to sustainable economic growth both immediately and in the longer term. At the same time these technologies also provide opportunities to transform the lives of local residents and the neighbourhoods where they live. This is why the focus on tackling the digital divide and promoting digital inclusion is continuing to be seen as a priority, highlighting the need to ensure that citizens have the capacity, skills and motivation to take advantage of these technologies and that there is a real commitment to focus not only on the transformation of public services in terms of 'business process' but also on co-production, the direct and active engagement of users in the design, delivery and, where needed, the ownership of services.

Some of the policies, as outlined above, are in place to facilitate and support the transformation process of Manchester into a 'Smart City', but there is still much to be done to ensure that the opportunities that the Future Internet can provide to a city region such as Manchester are fully exploited.

There are a number of specific lessons that can learnt from the Manchester's experience which will be used to inform future strategies and the proposed Local Digital Agenda for Manchester in particular:

- the need to develop digitally enabled services that are based on the social, cultural and economic needs of the neighbourhoods, requiring a combination of detailed local research and real efforts to consult with and engage local people as an essential prerequisite for capturing user needs and involving users in the design and delivery of new services, the start of the co-production process;
- that the stakeholders in the project, especially the public sector, need to demonstrate a long term commitment to community engagement and capacity building and invest as much in the development of people's skills, confidence and aspirations as in the technology being deployed;
- the need to have an ongoing evaluation strategy that not only has the ability to identify weaknesses, and even failures, but also has the role of communicating these results directly into the strategic decision making process so that the project can adapt and evolve as quickly and effectively as possible, backed up by effective project management resources;
- the importance of developing real exemplars that push the boundaries of what people know and their expectations, so that people's imaginations are stimulated and horizons widened and that this is communicated with all the power that Future Internet enabled communications can bring, making use of all the capabilities that the most effective social media and social networking can offer;
- the potential for generating added value from innovation and new investment into the area while at the same time focusing existing investment within those locations and sectors which are most capable of delivering growth, in order to respond to the ongoing structural shifts in the economy towards knowledge industries, including Future Internet enabled services, particularly as this is accelerated by economic crisis.

This then is the basis for the next stage of this work in Manchester:

a) Using the Green Paper to focus on the issue of 'Smart Cities - creating an inclusive and sustainable knowledge society' to stimulate further interest and engagement about the concept through consultation and linkages with grass roots initiatives;

b) Developing the new strategy as "A Local Digital Agenda for Manchester" to support future work, coordinated by the MDDA and the Manchester Living Lab initiative with stakeholders and partners from across the city region;

c) Continuing to build the trans-European "Smart Cities Network" to exchange experience and expertise on how to translate the concept of the 'smart city' into reality, working with networks including EUROCITIES and the European Network of Living Labs, and securing resources through EU collaborative projects.

REFERENCES

[1] Marketing Manchester (2009). Original, Modern. Marketing Manchester publications. http://issuu.com/manchestermagazine/docs/original_modern?viewMode=presentation&mode=embed

[2] European Commission (2010). A Digital Agenda for Europe. COM (2010) 245 final/2.

[3] Komninos, N., Schaffers, Hans., Pallot, M., (2011). Developing a Policy Roadmap for Smart Cities and the Future Internet. In: P & M Cunningham (eds.), eChallenges e-2011 Conference Proceedings.

[4] Fensom, S. (2011). Internet Hub. Unpublished paper.

[5] Grant, L. (2010). Reclaiming East Manchester. NEM.

[6] Manchester City Council (2003). Report on establishing the Manchester Digital Development Agency (MDDA). MCC.

[7] HM Government (UK) (2005). Connecting the UK: the Digital Strategy. Prime Minister's Strategy Unit Joint Report with Department of Trade and Industry (DTI).

[8]Manchester City Council (2007). ONE-Manchester Partnership Digital Challenge Proposal. MCC

[9] Tapscott, D., Williams, A., (2006). Wikinomics. Atlantic Books.

[10] Anderson, C., (2006). The Long Tail. RH Business Books.

[11] Manchester City Council (2008). Manchester Digital Strategy. MCC.

[12]Manchester City Council (2003). Manchester: Knowledge Capital. MCC.

[13]Mitchell, W., (1999). e-topia: Urban Life, Jim--But Not As We Know It. MIT Press.

[14] FIREBALL Project (2011). D3.2 Smart City Roadmap (Interim Report). MCC.

[15] Manchester City Council (2011). Green Paper: Smart Cities - creating an inclusive and sustainable knowledge society: A Local Digital Agenda for Manchester (Consultation Draft). MCC.