From *Digital Cities* to *Mobile Regions*: a policy learning process fostering local systems of innovation and competence building

P. Conceição, P. Ferreira, M. Heitor* and J. L. Moutinho

Center for Innovation, Technology and Policy Research
Instituto Superior Tecnico, Technical University of Lisbon, Portugal
http://in3.dem.ist.utl.pt

*corresponding author, mheitor@ist.utl.pt

Paper submitted for publication in the Intl. J. of Technology Management

A preliminary version of this paper was presented at the 13th Annual Conference of the International Association for Management of Technology, IAMOT
Washington, 4-7 April, 2004

April 2004

Abstract

Given the current socio-economic context, in which innovation is a key driver of sustainable development, what are the challenges facing information-based development and cooperation, in a way that contributes to regional policies that stimulate localized learning and indigenous development? This broad question has motivated the work behind the present paper, which considered the development of case studies in selected Portuguese cities and regions and the emerging urbanization trends of increasing urban population, but reduced urban density. It is argued that the progressive integration of mobile ICT´s with sustainable mobility equipments and concepts will facilitate improving well being in urban regions if adequate incentives, infrastructures and institutions are adaptively implemented through a policy learning process. The analysis builds on the concept of local system of innovation and competence building, in a context much influenced by a dynamic of change and a necessary balance between the diffusion of mobile technologies and the social and cultural shaping of information technologies.

From *Digital Cities* to *Mobile Regions*:
a policy learning process fostering local systems of innovation and competence building

P. Conceição, P. Ferreira, M. Heitor and J. L. Moutinho

Center for Innovation, Technology and Policy Research
Instituto Superior Tecnico, Technical University of Lisbon, Portugal
http://in3.dem.ist.utl.pt

1. Introduction: fostering the network society across diversity

Although we are still in a very early and limited stage of the evolution towards what Mitchell [1] called 'cities of bits', it is clear that it has become a "commonplace" to discuss the diffusion of knowledge, and the "knowledge-driven economy" in general, in close association with the introduction and use of information and communication technologies, ICT´s [2,3]. In this context, several national initiatives for the Information Society aim to achieve four broad objectives: to create a more open state, to link and make available to all the available knowledge, to promote Internet usage in education, and to support and develop digital technologies usage by firms [4]. The evidence calls for our attention to the current discussion in Europe aiming to: (a) ensure widespread broadband access and a secure information infrastructure; and (b) develop and ensure access to services, applications and content, covering online public services and e-business [5]. But it also argues for the need to plan systematic actions of competence building with the ultimate goal of attracting new communities of users and to build the necessary capacity for connectivity. Community building and demand creation for digital services became the critical factor for implementing digital communities, requiring proper incentives and institutional settings.

Focusing our attention on ICT´s, Figure 1 presents the intensity of ICT expenditure in various OECD countries by the end of the 20th century against the growth rate of this intensity from 1992 to 1997. Most countries are clustered at the bottom of the figure, with growth rates below 4%. The levels, as indicated by the horizontal distribution of countries, confirm the perception that the US is a leading country. The expenditures on ICT as a percentage of GDP in the US are about 2% above the European average. Individual countries, such as Sweden, outperform the US, but most countries lag behind.

Following recent analysis for knowledge-based industries [6], the results show a diversified array of national situations, with Portugal leading OECD countries in the growth rate of ICT expenditure from 1992 to 1997, with a growth rate of more than 10%, and mainly accounted for by increases in expenditures in telecommunications (about 9%). Expenditures in IT services and software are particularly low, below 1%, and only Turkey, Greece and Poland have shares of expenditure on IT software and services below the Portuguese value. The growth in this category has been equally dismal, below 2% a year. In general, analysis shows large variations associated with countries characterized by small absolute values, exhibiting patterns typical of latecomer industrialization for

Portugal. In addition, the results may represent indications of the process through which latecomer countries become engaged in the new techno economic paradigm [7].

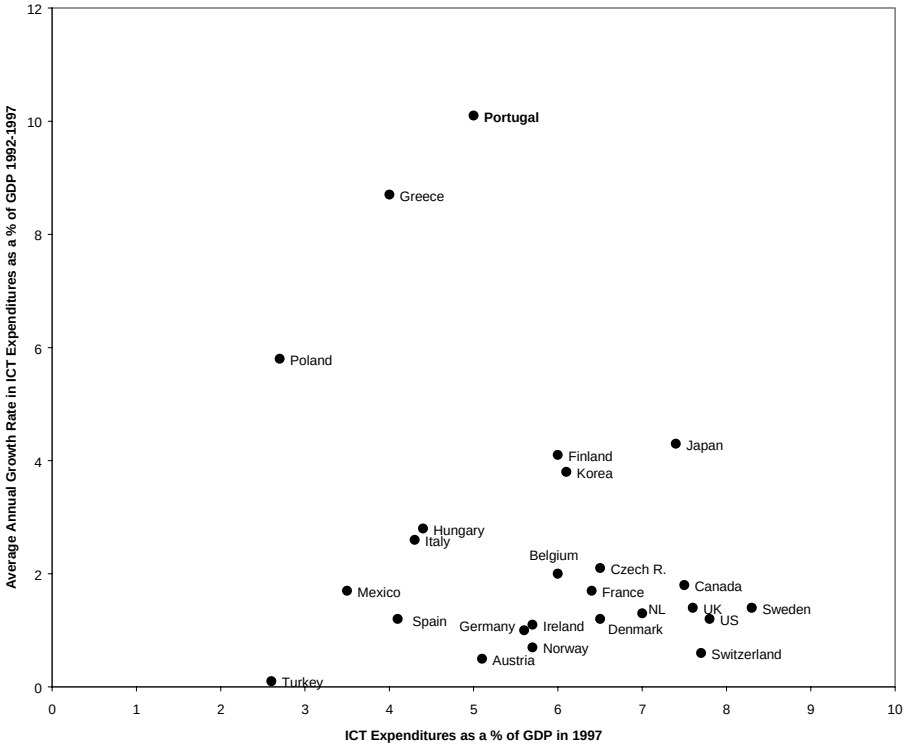

Figure 1. Information and Communication Technology (ICT) Intensity and Growth (1992-97); *Source*. OECD (2000)

The evidence of low absolute investments on ICT in countries such as Portugal is clearly illustrated in Table 1, which shows values per capita for a sample of European regions in the census whose programming documents indicate information society actions and that provide the necessary financial information [4]. The table refers, above all, to regions that have attracted European structural funds and, on this basis, it is important to mention the wide diversity of situations and framework conditions for attracting these funds, which clearly influence any analysis to be considered. But for the purposes of our analysis, it is interesting to attempt to define the extent to which the performance of digital networks and cities would depend exclusively on the limitations of funds, as well as from the capacity to attract them.

Besides large growth rates in ICT investments, the extent to which nations are engaged in the knowledge economy can be analysed making use of the recently established systematic assessment by the World Economic Forum through the "networked readiness", as represented in Figure 2 for 2002 [8]. This indicator offers an aggregated idea of "the degree of preparation of a nation to participate in and benefit from ICT developments" and illustrates the still weak position of southern European countries,

including Portugal and Greece. The main point to note is that the results for most of the OECD countries appears to be dependent from other than the country's overall wealth (as measured in terms of GDP per capita). This includes southern European countries, which are in fact entering the cluster of countries where the effect of increasing GDP on network readiness is less pronounced and other factors, namely at institutional and contextual level, have been shown to particularly influence country's competitiveness.

Border Midland and Western Region	357.8 €
La Rioja	357.8 €
South Aegean	269.4 €
Ionian Islands	241.4 €
Baleares Islands	238.2 €
Western Greece	151.1 €
Açores	117.9 €
Highlands & Islands	98.4 €
Epirus	83.4 €
Alentejo	44.5 €
Peloponese	43.1 €
Continental Greece	42.8 €
Algarve	42.5 €
Centro	29.9 €
Norte	13.3 €
Southern Scotland	9.2 €
Lisboa e Vale do Tejo	6.8 €
Liguria	2.2 €

Table 1. Expected ICT Expenditure per capita for selected European Regions, 2000-06;
Source: Tsipouris, L. [4]

The diversified pattern of the network society, including small absolute values regarding the mobilization of information society, but large variations, can be further analysed making use of a number of typical indicators to characterize the penetration of ICT´s in a country and, for example, recent Eurobarometer data [9] shows values for internet penetration rates, with Portugal getting the highest position in southern Europe for 2002 (Portugal 42%, while Spain 42%, Italy 40%, Greece 18%, with an EU average of 51%), although far away from typical north European penetration rates. A similar picture can be obtained making use of Internet access in the household, with Portuguese rates of 31%, as compared with 29% for Spain and 9% for Greece, while 40% for the EU average and 74% for the USA, although Portugal exhibits growth rates between 2000 and 2002 considerably larger than the European average (namely 72% for Portugal, with 81% for Spain and 89% for France, as compared with 43% for EU average; EOS Gallup Europe, 2002).

Turning to the type of telecom infrastructure, all European countries follows typical average EU trends, with standard telephone lines as the most frequent connection to the Internet access at home (e.g., Portugal 74%, EU average 72%), followed by cable modem (e.g., Portugal 12%, EU average 7%). ISDN, ADSL and Wireless connections are still

relatively low. But these figures are important to set the context of information networks and clearly call our attention for the need to consider contextual levels beyond pure infrastructural issues, when considering measures to foster information networks.

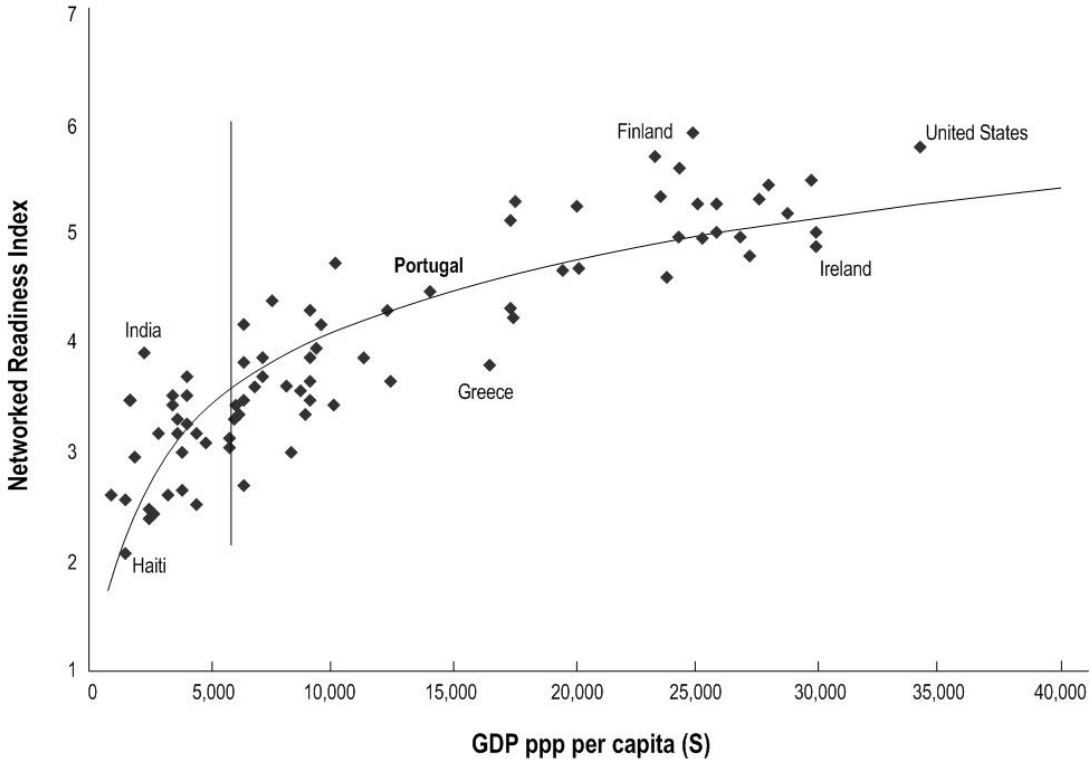

Figure 2. Network Readiness Index versus GDP (PPP) per capita, for 2002, with partial Log regression
Source: The Global information Technology Report 2002-2003: Readiness for the Network Society, World Economic Forum.

In fact, the figures presented above should be further explored in terms of the main point of this paper, in that we are aimed to improve our understating of the conditions necessary for digital networks to succeed, making use of modern technologies in way to foster the inclusive development in a learning society [10]. Learning from the conceptualization of knowledge-based economies [2,3], it can be said that, fundamentally, the performance in knowledge-rich competitive environments in terms of innovative performance depends on the quality of human resources (their skills, competencies, education level, and learning capability) and on the activities and incentives that are oriented towards the generation and diffusion of knowledge.

But beyond human capital, which corresponds to the aggregation of an individual capacity for knowledge accumulation, developing a collective capacity for learning—as suggested by Wright [11] in the context of the US—is as, if not more important, than individual learning. Instead of individual or even aggregated human capital, a further important concept for learning seems to be social capital, as analysed by Conceição et al. [10], among others.

In order to meet these requirements, in previous papers we have considered the development of the information systems oriented towards building networked places and argued that knowledge networks have the potential to attract and mobilize people in the information society and make public administration and markets more effective [12,13]. This helps promote learning trajectories for the inclusive development of society, requiring, nonetheless, effective infrastructures, incentives and adequate institutional frameworks across time and space [14]. In addition, we have also shown the need to look at human-centred systems and that networked places need to be designed holistically, coping with change and continuously assessed in order to accommodate humanity [15].

This paper extends our previous analysis to the need to understand ways to foster the use of new and mobile ICT´s and to plan mobile regions. We refer to the emerging integration of ICT´s and a range of infrastructures and equipments fostering concepts of sustainable mobility, in order to facilitate urban life. The analysis builds on the discussion of McKnight et al. [16], following a comprehensive set of data on digital cities [17], and builds on the need to continuously adapt regional trajectories, both social and technological, and foster the necessary learning capacity of increasingly diversified local communities. In order to address this major research challenge, the paper is organized as follows. Next section builds on empirical evidence, making use of case studies in Portugal of mobilizing the information society. Then we will continue in the third section by discussing the social and cultural shaping of information technologies in order to cope with the accelerated rate of technical change we live on. We discuss our observation in section 4, namely in terms of main issues in managing technical change towards the implementation of mobile regions. Finally, we conclude by briefly presenting a summary of our most important conclusions.

2. Building on the empirical evidence: the continuing effort of mobilizing the information society

The evidence presented in this section is built on the analysis of sample projects attempting to build “digital cities and regions” in Portugal, which have been structured around the electronic provisioning of local government administrative services, complemented by some pilot projects in areas such as e-business and telemedicine [12]. But it should be noted that the Portuguese explosive urbanization rate, as indicated in Figure , was one of our main intellectual motivations to study the co-evolution of urban development and telecommunication services and infrastructures, in terms of the need to foster a knowledge related view of metropolitan areas and surrounding regions. We note that the emerging urbanization trends of increasing urban population are occurring together with the enlargement of urban surroundings in a “donnut-like” shape, giving rise to reduced urban densities. This process has major implications for the understanding of future scenarios for the diffusion of ICT´s at the regional level and may lead to their progressive integration with other technologies that facilitate urban mobility.

The first experiences in Portugal with digital cities started in 1998 through a program jointly funded by the Portuguese Government (who contributed with 25% of the total

investment) and the European Union (75% of the total investments through the European Regional Development Fund). Private investments were insignificant. The program involved 5 small and mid-sized cities (Aveiro, Bragança, Guarda, Marinha Grande, Castelo Branco) and 2 rural regions (Trás-os-montes and Alentejo), aiming to: (a) improve the quality of life in cities; (b) contribute to development of peripheral areas; (c) improve local economy and employment; and (d) fight info-exclusion and help citizens with special needs [18].

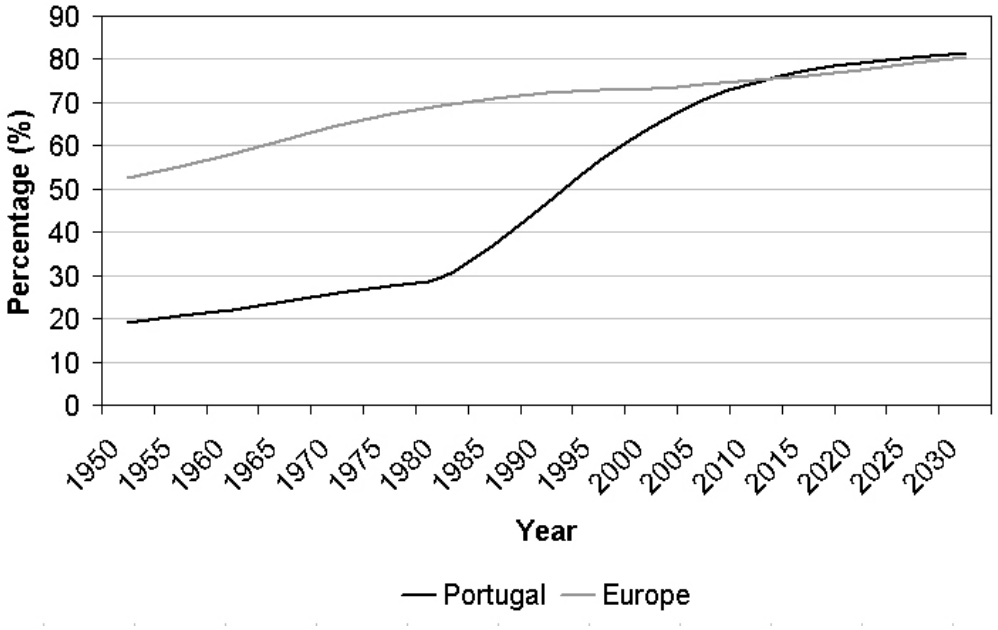

Figure 3 – Percentage of population living in urban areas for Europe and Portugal for the period 1950-2030 (estimates since 1991); Source: [19].

Alentejo and *Trás-os-Montes* are remote agricultural regions, among the least developed in Portugal and Europe, sparsely inhabited by an aging population. Both projects were designed to create new opportunities for the local population, mitigate social and economic disparities, promote regional networking and provide public administration electronic services to peripheral local parishes.

Aveiro is developing a true innovative and entrepreneurial image, in particular connection with the local university and the local branch of Portugal Telecom, which includes important research and development activities. On the other hand, *Marinha Grande* is particularly engaged in traditional, labour-intensive industries and the digital city project has been particularly promoted through the industrial network associated with the local moulds industry. Both these two projects invested mainly on local competitiveness and competence building.

Bragança, *Guarda* and *Castelo Branco* are peripheral cities with relative regional significance. Their approach was to support the adoption of information and communication technologies by individuals, firms, associations and local government and other public organizations.

In terms of regional penetration, the projects listed above covered about 11.30 % of the total Portuguese population (10.44% of the population under 15 years of age) and about 42% of the total surface of Portugal. All projects involved a broad range of relevant actors and change agents within each one of the territories being nonetheless always led by local municipalities. Local higher education institutions were particularly involved only in a limited number of projects (Aveiro, Bragança, Trás-os-Montes).

It should be noted that, at least for the initial projects analysed here, the institutional framework established by the central government was quite flexible and fostering local voluntary initiatives. It was based on the simple provision of guidelines focused on providing content and services related to local public administration and to specific activities with social implications (e.g., healthcare), economic impact (e.g, business-driven corporate networks for regional competitiveness), and aimed to promote cultural contents [20, 21, 22, 23]. Initiatives to mobilize and promote the adoption of the Information Society were part of various applications, although not always considered at the required level, at least beyond that given to the implementation of infrastructures [12].

Bragança Digital focused on creating basic ICT infrastructures and wireless networking environment for local government buildings, health institutions, educational institutions, and local employment agency to provide information and services to local citizens. Other initiatives included the provision of local products (www.rural.net), health, educational and e-business activities [23].

Guarda Digital was promoted by and organization formed by the municipality, local educational institutes, associations" and the incumbent telecommunication operator. It included pilot projects in healthcare e-business, tele-working and educational initiatives [24].

Castelo Branco Digital aimed to connect all public institutions (municipality, social security and health institutions) and local associations (sports, culture and business) to provide an integrated information network to citizens and tourists. For example, it has included the provision in rich media of old Portuguese theatre contents [25].

Marinha Grande Digital, as managed by the local municipality and the Technological Centre associated with the moulds and plastic injection industries, focused on creating an Extranet to provide business-related (mould, plastics and glass) content and services and on facilitating communication among companies and clients. Other initiatives included a centre of advanced telecommunications to promote the use of the Internet [26].

Projects	Physical Infrastructures		Content (non-physical infrastructures)		Context (e)
	Networking and Connectivty (a)	Information Systems (b)	Information Services (c)	Interactive Services (d)	
Aveiro	Local health institutions communication network; Internet access in public schools; People with special needs	Local public administration management information systems; Justice court Intranet; GIS	City guide; Entertainment, Arts & culture initiatives; Local government website	e-business, Agriculture; Job opportunities; Environment; Teleworking	Community building based on city metaphores
Bragança	Municipality communication network; Internet access in public schools	Municipality management information systems; GIS	City guide; Local government website	e-business; Telemedicine; Agriculture	
Guarda	Internet access in public schools		Local government website	e-business; Telemedicine; Teleworking	
Marinha Grande	Advanced telecommunication demonstration centre; Internet access in public schools	Local industries Knowledge network (Glass, moulding and plastics)			Mobilization of firms and public institutions for the use of ICT
Castelo Branco	Municipality communication network; Internet access in public schools		City guide; Local government website; Art & culture		
Trás-os-montes Digital	Internet access in public schools	Content management platform	Regional Portal	Telemedicine; Agricultural Network; Job opportunities	
Alentejo Digital	Intranet for 47 municipalities	Content management platform	Regional Portal	Job opportunities	

Table 2 - Sample "Digital City" projects analysed in Portugal (1998-2000); Source: [13].
(a) Networking and connectivity includes communication networks and Internet access.
(b) Information Systems includes technological components that store and process data like data bases, electronic mail, ERPs, management information systems, content management, application serves and business intelligence software
(c) On-line presence or downloadable forms
(d) Electronic form submission or interaction through the web
(e) Mobilization and context building initiatives

Trás-os-Montes Digital included regionally-based web contents (as described at www.espigueiro.pt), managed by the local Polytechnic, that aggregates content and services of 31 municipalities. The portal is still managed by the local university and includes business and employment opportunities, geo-referenced information, healthcare facilities and technologies to coordinate medical services in rural areas. An important feature of this project is the support network constituted by 84 service centers scattered

throughout the region that provide public Internet access, as well as human support to help citizens' interactions with new technologies [27].

Alentejo Digital brought together 47 municipalities and 3 regional agencies to create a regional information network to provide services and territory-related content to citizens and local firms through regional web-based contents. The main objective was to enable local government teams to learn, use and promote new technologies, namely computer network management and digital content production and publishing. An Intranet was set up linking all municipalities and regional agencies to enable the necessary collaborative work environment. About 50 people were recruited, mostly from local unemployment lists, to work on the project that lasted until July 2001 [28]. Most of those people worked as local agents, based on each one of the town hall facilities of all the 47 municipalities involved, who proactively produced, collected or published relevant local content in the portal. Although they did not work directly with the general public, they were a very important factor of Internet diffusion in the territory covered by the project.

The paragraphs above consider selected Portuguese cities and regions which have been engaged in "digital city" projects in a way to allow us discussing main challenges, and opportunities, for mobilizing the information society in Portugal, Table 2. It is argued that value-based networks have the potential to make both public administration and markets more effective, which helps promoting learning trajectories for the inclusive development of society, but require effective infrastructures, incentives and adequate institutional frameworks. The analysis is based on observations in different Portuguese metropolitan areas and regions with the ultimate goal of increasing regional competitiveness, by promoting public awareness and participation in decision-making processes.

Analysis has also shown that specific communities of practice, CoP´s, have been particularly important drivers of larger network communities [13]. In particular those established with the involvement of higher education institutions and/or technology centers were shown to have an effective mobilizing nature and this let us to discuss in previous papers the diffusion of "knowledge integrated communities", KIC´s.

In general, it is argued that the territory is a basic infrastructure that justifies and invites for the construction of several layers of information, including communication infrastructures and digital contents, but well arranged with local contexts. The discussion frames the issue of the need to promote "inclusive development", that is, of the need for a process of development that includes every citizen in any region, as a problem that goes beyond the creation of conditions to generate knowledge. The most important problem concerns the sharing and diffusion of knowledge, and efforts should be channeled towards the understanding of the conditions for globally integrated learning processes. Learning, in this context, reflects the idea of sustained knowledge creation and diffusion, and we contend that the challenge is to make this a feature of the entire global economy. In this context, we established that national or regional learning depends on the existence of social capital, which is defined by networks and by institutions. Institutions govern the interactions among the nodes of the networks, be the nodes composed of people or of organizations (firms, universities, and local government, for example).

These notes follows current discussion in Europe aiming to (a) ensure widespread broadband access and a secure information infrastructure and (b) services, applications and content, covering online public services and e-business, but argues for the need to plan systematic actions of competence building with the ultimate goal of attracting new communities of users and to build the necessary capacity for connectivity. Community building and demand creation for digital services became the critical factor for implementing digital cities, requiring proper incentives and institutional settings which cope with a broad range of new technologies.

3. Coping with technical change: what can we expect from new developments in ICT´s?

The paragraphs above lead us to a basic question: *how can we cope with the accelerated rate of technical change we live on, so that newer mobile technologies may facilitate mobilizing the information society in urban regions*? Our discussion is framed within three main levels of analysis, namely infrastructures, contents and context, which are comparable with those schemes that consider five mains aspects, namely: infrastructure, access, applications and services, digital content development, and ICT skills development [29]. In fact, we have broadened the scope of the so-called ICT skills development to include other contextual issues and local characteristics of communities of practice.

In the scope of our analysis, the city or region must embed a set of social capabilities that define the context under which digital cities evolve. Consideration of contextual issues in building-up network societies have not always been considered in many different situation throughout the world, as acknowledge by Castells [3], among others, and evidence shows that specific measures to promote adequate contexts and mobilize people in the projects described in the previous section have also been scarce.

But the implementation of complex technology-enabled infrastructures typical of digital cities calls for a broader approach where social and cultural aspects are integrated in early design phases to mitigate “ilities”, such as sustainability, flexibility and scalability [30]. Moreover, we can expect that digital cities to have other unexpected properties, or emergent properties, “developed by users of a system” and “often unknown to the system designer”. Being so, the stakeholders involved in the co-evolution of urban areas and ICTs would be better off if, as proposed by Cooley, “the current mechanistic paradigm of technological and societal development [would be substituted by] human-centered systems [that would] provide a powerful alternative philosophy for system design and a broader educational and societal development”. He adds that “[this philosophy] regards the social and cultural shaping of technology as central to the design and development of future technological systems and society as a whole”, in terms of “knowledge-based adaptive human-centred environments” [31].

Expanding this conceptual framework to the entire city or even whole regions in order to consider the way millions of people interact with information and communication technologies in their daily life, it is clear that the initial approach to design digital cities described in section 2 above need to be reconsidered [15]. Table describes main implications and requirements of emerging trends, so that the vast majority of potential late adopters are inclusively considered in future digital city projects. As Dertouzos [32] argues, we can avoid "drowning in information overload and computer complexity only by throwing out last century's model for computing and adopting – indeed, demanding – a new computing philosophy, a new master plan, that lets people interact naturally, easily, and purposefully with each other and the surrounding physical world". And he adds, "to put it in action requires three big steps: changing the mind-set of users and designers; ensuring that our machines are easier to use and make us more productive; and insisting that new technology reach many more people".

Layer of Analysis	**From**	**To**	**Implications and requirements**
Infrastructure/access	Conspicuous objects	Invisible infrastructure	Embedding ICT infrastructures in urban daily life, fostering **human-centred systems**
	Fixed access	Roaming	Competitive **mobile services** and improved regulatory framework for **increased individual participation**
Content/ services	One-way distribution of information	On-line collaboration and participation	Specific knowledge of institutional and local contexts in order to help developing **interactive contents**
	Web functionalities	Networked Activities	New competences in content and services development, **enhancing user activities and networks**
Human and social Context	Technology supply	Mobilization of users	Mobilizing "**change agents**" to foster communities of practice, CoP´s, and **user involvement**
	Standards	Interoperability	Building **individual and social competences** through knowledge-based adaptive human centred environments

Table 3 - Emerging trends in the mobilization of the information society, towards a new generation of "Digital Cities". Adapted from [15]

Norman [33] noticed that, in fact, technological systems tend to increase internal complexities exponentially to meet the continuous evolution of users needs, but its interfaces are likely to be constantly simplified to perform specific activities to a broader base of users. The opportunities and possibilities of the co-evolution of urban

development and ICTs are so vast that this strategy, “edge to core”, would be more appropriated to implement the next generation of digital cities. It starts by finding out the critical interfaces between city dwellers and its supporting ICT infrastructure and only then developing objective technology-enabled services to meet existing or potential demand.

On the other hand, the number of potentially connected nodes within urban environments has significantly increased in the last couple of years (see Figure), and includes GSM/GPRS wired PDAs, Wi-Fi enabled laptops, 3G mobile phones, ADSL connected game consoles and entertainment PCs, Bluetooth tablet PCs, Videophones, Interactive TVs, real-time environment sensors (e.g. air and water quality), large databases (corporations, libraries, museums, public administration), GPS oriented cars, and GPS traceable trucks and buses. On the other hand, new layers of territory-related data and information are been created in a daily basis, like municipal geographic information, Internet city guides, interactive maps and routes, and 3D worlds. To cope with this increased complexity, a new technology must add another layer of distributed computing and data management to the current Web based information distribution paradigm. In fact, as computers and networks become ubiquitous and interlinked, they will turn out to be another invisible urban infrastructure, like electric grids and sewage systems that will sustain daily life.

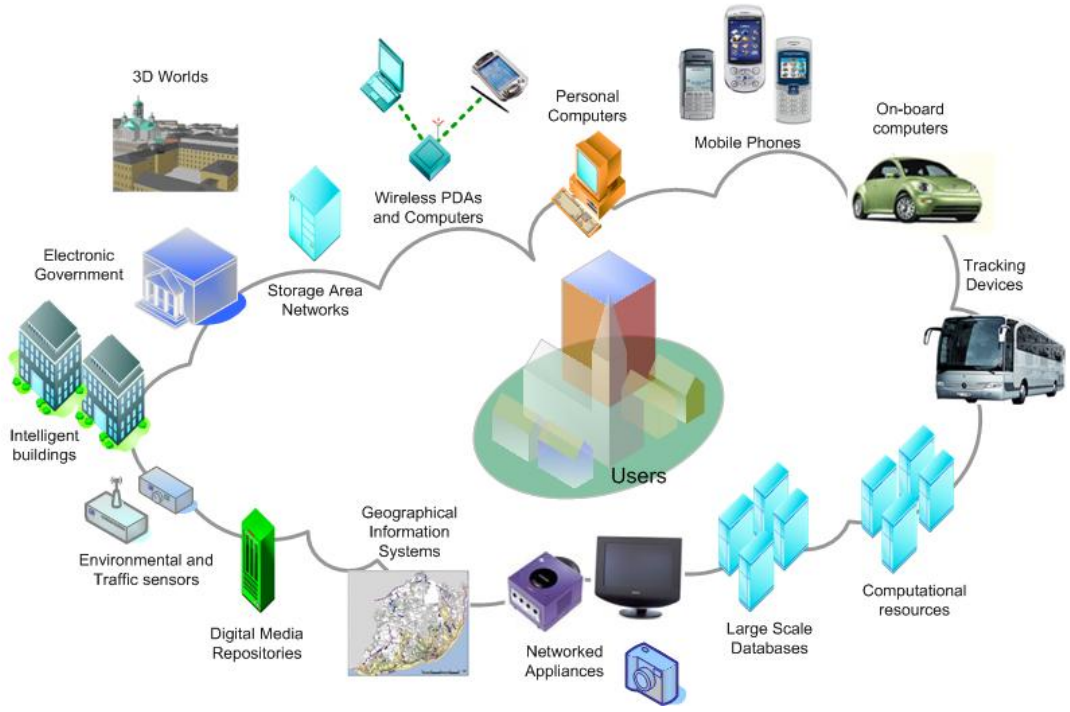

Figure 4 - Grid resources linked together in a “Digital City” infrastructure

Grid computing, as described by Berman et al. [34], can be the "computing and data management and infrastructure that will provide the electronic underpinning for a global society in business, government, research, science and entertainment. Grids, integrate networking, communication, computation and information to provide a virtual platform for computational and data management in the same way the Internet integrates resources to form a virtual platform for information. [They] are intrinsically distributed, heterogeneous and dynamic". Grid computing was shaped by the same early driver that has pushed the scientific communities of practice to build the Internet and the World Wide Web: the construction of a virtual collaborative environment for scientific research. The main objective still is, as it was before, to share networked resources for creation, accumulation and diffusion of knowledge, making use of a 4-layered architecture, including:

1. hardware resources, such as computers, networks, data storage, sensors and other devices that weave the underlying fabric;
2. interoperable protocols, services and applications that virtualize and secure the access to the grid;
3. common grid middleware, tools and services, such as resource allocation and monitoring;
4. Grid applications.

In addition to these layers, one should consider vertical layers representing new devices, and institutional arrangements to create common policies, grid economy and a open global-area networking [35]. In fact, in a previous paper we have argued that on top of the current model, an activity-based, human-centred layer of services should be added to help the mobilization process (as a complementary vertical layer) [15]. This territory-related additional layer could be enabled by specific knowledge-driven ontology [36], natural language [37] and/or the semantic web capabilities for "handling and support for knowledge processing" [38].

The analysis above is broad in scope and considers network societies as wide social and economic processes, which we argue occur across time and space and require the dynamic adaptation of infrastructures, incentives and institutions, in a way that calls our attention for the need to foster learning societies. However, the evidence of the projects discussed in this paper show that we must extend our analysis to other aspects of the learning society. This is because the experience of projects such as those developed in the cities of Marinha Grande and Aveiro clearly shows the important mutual relationships that specific project-based communities have on the facilitation of network societies, but also the fact that the implementation of digital cities may significantly improve the efficiency of those communities.

Within this perspective, our analysis calls for policies that consider long term approaches of dynamic environments, which require to be continuously monitored and evaluated. Specific incentives for infrastructures should continue, but articulated with the need to

foster knowledge-based adaptive human centered environments as drivers of larger communities of users. This requires a continuous pubic effort, but also a better understanding of the effectiveness of the mix of public support mechanisms and private incentives for the development of digital cities.

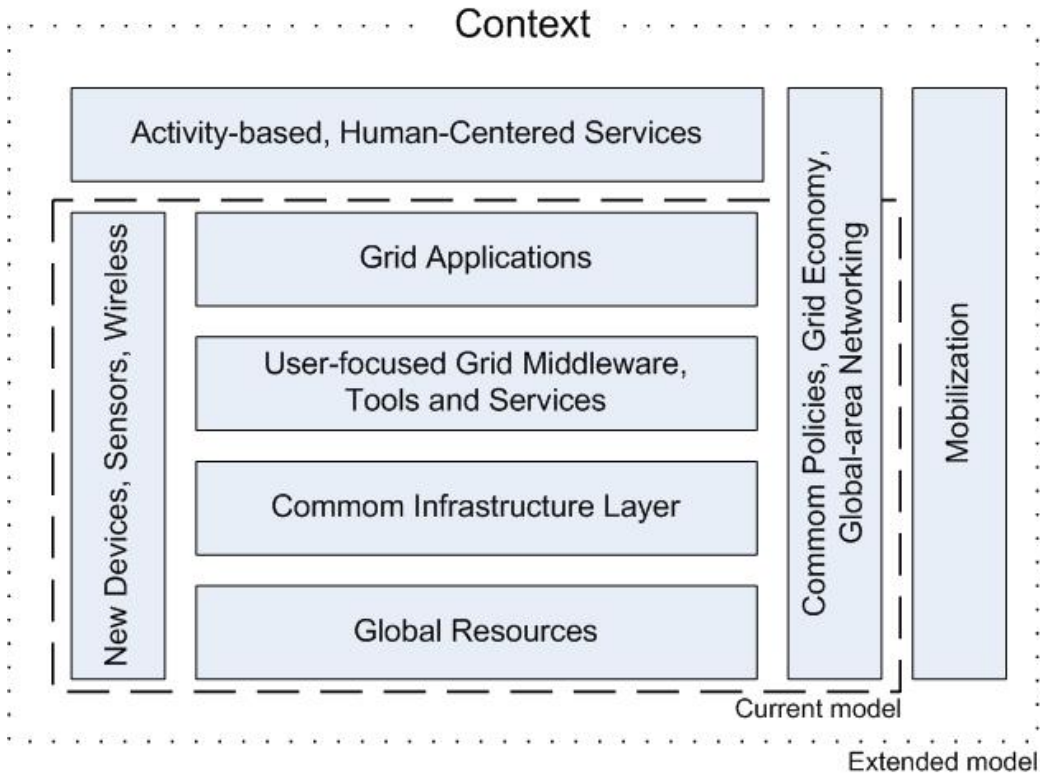

Figure 5 - Layered architecture of a semantic grid enabled *Digital City*; Adapted from [34].

4. Building the spatial dimension of the network society: fostering mobile regions

At this stage, after describing main limitations of current approaches to set "digital cities", but also to briefly describe emerging technologies that will facilitate mobilizing the information society, we can establish our main research question: *what critical factors enable a digital city to become a mobile region*? *What sort of public policies to promote these factors*?

These questions are addressed in the coming paragraphs looking at different dimensions of analysis, as follows:

- *Technological*: understand what types of technologies need to be in place to support a mobile region and which players are willing/should provide it?
- *Organizational*: understand who are/should be the leaders for the transition and under what (business) model should they operate?
- *Behavioral/Geographic*: understand how the resident culture shapes the demand for elements of a mobile region (i.e., contents and services) and thus affects its development
- *Others*: think about other lines of research that need to be addressed in order to understand all the facets of this process

4.1 From digital cities to mobile regions

The growing need to help the physical access of people and goods in urban areas, together with the growing need to have access to information anywhere and anytime [16], generates a set of new technological challenges and business opportunities, as described in Table 4. In order better understanding emerging questions, we should carefully consider both changes in access points and in the fluxes of information.

Considering firstly the density and quality of access points, we are discussing a paradigm shift, as follows:

- *From Fixed Narrowband*: usually obtained only through a fixed line, typically telephone dial-up for narrowband access and DSL/cable for higher bandwidth connections;
- *To Mobile Broadband*: continuum of access points supported by mobile/wireless communication systems, typically GPRS for narrowband access and possibly UMTS for higher bandwidth connections. Fixed access complemented by wireless limited access at hot-spots (GPRS and Wi-Fi).

It should be noted that the continuum of access points for larger band wireless systems is provided by two mechanisms: 1) both GPRS and Wi-Fi allow for roaming across providers. Users can sign-up for a wireless contract with a single provider and use this provider everywhere seamlessly with roaming. However, roaming charges are many times still prohibitive for that matter. In fact, roaming services are not (yet) regulated; 2) GPRS, and UMTS in the near future, allows for seamless hand-over between cells. Therefore, users can move at considerable speeds between cells without losing their data service connections thus seeing a real continuum of access points.

Secondly, if we look at diversity and complexity of the information available, one needs to cope with the following changes:

- *From Descriptive contents*: contents are merely descriptive and services are rarely offered online. Do not engage the citizen to participate/enhance the community;
- *To Advanced data services*: interactive contents that promote public service and the sense of citizenship, online services from companies and local governments as a way to improve quality of life.

In terms of our main research hypothesis, we should note that the reduction of population density in urban areas breaks up the effect of economies of scale in provisioning telecommunication services to the end-user, known to be fundamental for the success of the industry. Broadband solutions based on cable networks or on fiber to the home require considerable capital investments that can only be recovered if enough consumers are served in some sort of multiplexed fashion over the same infrastructure. If this is not the case, it is likely that access to telecommunication services in these areas can only be provided through the use of unbundled network elements of the incumbent carrier(s). However, for this business model to become feasible the access to these elements has to be granted at reasonable prices and with acceptable quality of service, a continuing target for local access regulation in the scope of data communication networks.

In fact, the paradigms associated to urban mobility [39,40], together with the mobilization of the information society regarding new opportunities for value creation, do not fit in the immediate capacity of designing clear business models, but rather (and necessarily) in the capacity to adopt progressive learning logics that make it possible to gradually test and fit business and option models according to basic assumption and trial principles. This conclusion is so much more valid than it is confirmed that there is a vast set of action areas that can only be exploited through the implementation of innovative models of public-private partnerships, thus multiplying the number of intervening agents and, consequently, the number of variables that must be defined to design business models fitting often conflicting needs of wealth creation and maximization of externalities to the community.

Table 4 - Changing architecture towards mobile regions

	From *Digital Cities*	**To *Mobile Regions***
Density/ Quality of Access Points	**Fixed Narrowband** (usually through a fixed line)	**Mobile Broadband** (continuum of access points supported by mobile/wireless communication systems)
Diversity/ Complexity of Information Available	**Descriptive contents**: (services rarely offered online)	**Advanced data services**: (interactive contents, promoting the public space)

Figure 6 summarizes our main argument, in that a variable objects are to be considered in designing mobile regions, together with variable socio-economic and cultural contexts. This leads to the need to carefully develop and continuously access prototypes, making use of proper research design. In particular, if expectable scenarios of progress from "digital cities and regions" to "mobile regions" are mentioned, the various agents involved (i.e., local administration, communications operators, and service companies), are challenged to promote dynamics of access to information and people mobility. For

example, the new communication models that not only allow to decrease the transport dependence but also implement sustainable mobility schemes, as well as, and above all else to settle population out of the big urban centers in social and entrepreneurial competitiveness fairness conditions. These issues embody the need to combine (i) ongoing technological progress and (ii) the adoption of new concepts of sustainable mobility at a metropolitan level, representing a broad range of opportunities to various public and private agents in their different vocations through the value chain that characterizes the "business" of urban mobility today.

Innovation linked to the advent and commercialization of new technologies, at competitive prices, is determined by the capacity to mobilize user communities, joining the possibility offered by:

a) affirmation of bandwidth;
b) democratization of technologies and mobility;
c) ubiquity of equipment with computational and communication power.

Nowadays these technologies are able (in terms of cost, interoperability and reliability) to make some concepts practicable, such as those of triple-play, creation of knowledge sharing communities, creation of backup services for physical mobility of goods and people, development of telematics and ITS systems. Nevertheless, the need to create market(s) for these products / services still persists. In other words, without questioning the proposal of the conceptual value of the services, it is important to agree on the financial value that the potential consumers associate to them, which is an intricate task, especially when bearing in mind that (i) these services tend to be perceived as free of charge (obviously for unrivalled service levels, but this is always understood by the payer) and (ii) it is necessary to migrate consumer profiles (from other needs to these "new needs"), as long as a multiplication of the income is not assumed. In this context, the models currently used to foster the acceptance and recurring consumption of high innovative content products/services, depend on the capacity to adopt flexible dynamics, of constant assessment and refining of cornerstones of the business model.

The paragraphs above show that the implementation of regional mobility infrastructures, jointly with share infrastructure and information access, besides being an instrument of regional management and information availability, also involves a complex system of interactions between infrastructure, content management and the mobilization of user communities, in such a way that it could only be understood in terms of gradual processes of collective learning, particularly determined by complex information fluxes. Specifically, there is the need to understand the territory, besides the availability of a set of resources (namely technology-based ones) in a limited geographical location, but considering a knowledge-based vision, which is necessarily cumulative in nature.

The discussion should be focused on three challenges, which result from previous analysis of "Digital Cities and Regions". Firstly, the use of common networks for accessing and sharing information has been particularly promoted through specific communities of practice, CoP´s, normally integrating forms of knowledge, which play a mobilizing role to ensure a gradual process of collective learning on information access and sharing.

Secondly, the mobilization of the information society is usually based on the cooperation between public, private and social entities, namely through partnerships requiring an administrative framework that promotes its sustainability and dynamics. In this sense, public administrations have been concerned with competitiveness, eliminating entry obstacles and ensuring the access to infrastructures. Nevertheless, new challenges are faced today, namely the articulation between national, regional and community authorities, resulting from the tendency to converge services, network and terminal types.

Thirdly, the innovation dynamics, generating profits to any telecommunications operator should necessarily incorporate the *time* factor, linked to any collective leaning process, either in terms of the establishment of commercial relation, or in the strengthening of social relations, which requires an ongoing investment effort and ongoing follow-up schemes.

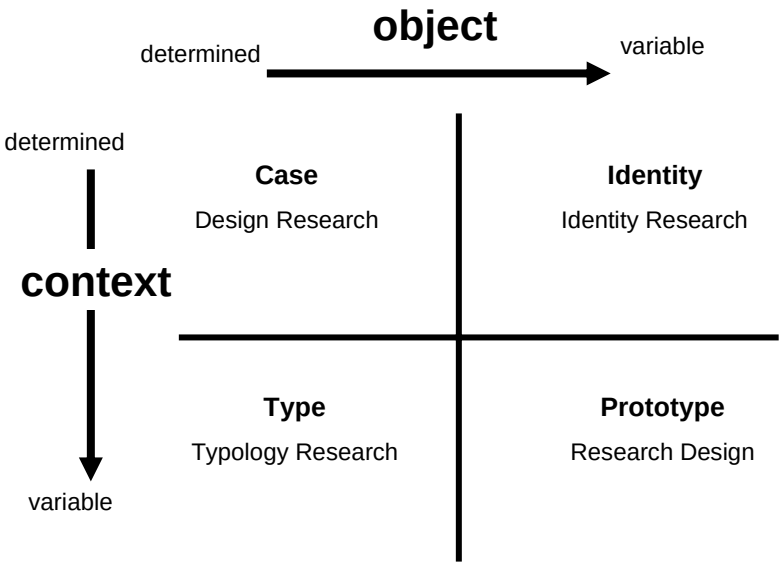

Figure 6. Schematic identification of research patterns towards new challenges, as those emerging for designing mobile regions. Adapted from [41]

4.2 Developing a conceptual framework

In the paragraphs above we clearly show that the territory is a basic infrastructure that justifies and invites for the construction of several layers of information about cities and regions were people live, visit or do business. Mobile regions schemes should also encourage the global legibility of the information architecture of the territory and promote broad and informed participation in the decision-making process of the future of its entire influence area and not only within city limits.

But the question to be addressed is that if "mobile regions", namely in the form of technology-enabled territories, are able to foster institutionally organized *metropolitan systems of innovation* [42] and *competence building* [6,10], with the ultimate goal of increasing regional competitiveness, by promoting public awareness and participation in true public spaces.

In conceptual terms, we may attempt to explore features in the seminal work of Nelson and Winter (1982), for which *organizations know how to do things* through simple rules and procedures (routines) which represent the knowledge memory of the organization. Even firms in the same industry differ in the sense that they accumulate and develop idiosyncratic routines, which form the basis of the firms' distinctive capabilities. Fundamental to the idea of skills and routines is that they are constituted essentially by tacit knowledge and are thus not easily replicated. Replication of routines is thus possible only as a costly, time-consuming process of copying an existing pattern of productive activity. The dynamics in the theory is brought about by the processes of searching for new routines and creating variety and mutations amongst firms, which are then subject to selection processes. The combined interaction of search and selection processes form the basis of the evolutionary approach and relate Nelson and Winter's approach to the theories of organizational learning and population ecology respectively. The routines are thus seen as the knowledge genes of the organization, being transformed by organizational learning and innovation. Although Nelson and Winter's work provided a conceptual foundation for a knowledge-based view of the firm, an essential development was a deeper understanding of what constitutes knowledge, which we attempt to extend for a territory bases.

In this context, a knowledge-based view of the territory assumes that individual, firms and organizations operate in dynamic environments, where markets and technology are changing fast and in unpredictable ways. It also assumes a highly competitive setting, with those agents operating within ecologies of learning, interacting and adapting to the environment. In this framework, organizational capabilities or competencies are understood as clusters of knowledge sets and routines that are translated into distinctive activities. Dynamic capabilities are those that enable individuals and firms to build, integrate and reconfigure internal and external competencies. The knowledge that is embedded in capabilities is a complex and dynamic combination of tacit and explicit knowledge. Individuals operate within organizational contexts in order to be able to share and use their specialized knowledge. As a result, digital cities should consider communities of users and build a context favorable to their increasing participation.

If one considers the broad social and economic context under which mobile regions may be facilitated, we must consider the conditions for integrated learning processes. This has led Conceição, Heitor and Lundvall [10] to build on Lundvall and Johnson's learning economy [43] and to discuss the learning society in terms of innovation and competence building with social cohesion. They view innovation as the key process that characterizes a knowledge economy understood from a dynamic perspective, while competence is the foundation from which innovation emerges, and which allows many innovations to be enjoyed. In other words, it contributes both to the "generation" of innovations (on the

supply side of the knowledge economy) and to the "utilization" of innovations (on the consumptions side of the knowledge economy). Conceptually, the foundations for the relationship between learning and economic growth have been addressed in the recent literature [44], with learning being reflected in improved skills in people and in the generation, diffusion, and usage of new ideas [45].

Learning can occur in many shapes and forms, some of which are informal, some formal. As described before, the institutional framework that comprise the national and regional systems of innovation formalize the technological infrastructure critical to generate the learning processes for individuals, firms, and nations, that ultimately lead to long-term development. Thus, looking at a particular set of organizations, their capabilities and related institutions, provides important lessons for development.

4.3 Policy implications

Under the scope of the ideas proposed above, *new business concepts* may have to be considered as those resulting from the combination of: (i) the need to mobilize a diversified variety of users' communities, by adopting new sustainable development concepts, especially at metropolitan level; (ii) the integration of public and private partnerships and the acceptance of suitable business models; and (iii) ongoing technological advancements. These aspects may represent a business opportunity for the different agents involved in the value chain that characterizes the mobility business and the access to information today.

In particular, reference is to be made to product and business portfolios that help make compatible several price ranges, namely market segments and life-cycle, in order to minimize the risks of launching new products / services. Generally speaking, this pilot-project should: a) maximize the product / service portfolio value; (b) balance the risks of these portfolios.

Due to the range and multiplicity of the business models that can be set out, one of the main concerns is to define a trial and roll-out strategy of new businesses that embodies an adequate strategy that aiming at "creating" market and being familiar with new services / products, thus mitigating over-investment risks in disruptive technological innovations. For instance, basic information should be created in order to anticipate alternative pricing and bundling strategies contributing to maximize the values and size of the markets that are to be stimulated.

In this context, it is also vital to ensure that the structuring decisions in terms of investment in enabling technologies, adoption of middleware solutions and implementation of supporting information systems (e.g. billing), be as transversal as possible, to allow the support of the progressive and ongoing roll-out of new businesses that, in spite of being identified in the mapping phase do not have market conditions to be launched. As a matter of fact, even though it is possible to assume technology as a commodity, one should not neglect the risks it entails, namely sunk-cost creation risks

resulting from wrong decision-making. The purpose is to design models of public-private partnership that support the achievement of some opportunities that cannot be developed autonomously by an incumbent telecommunications operator, but to which its role of making infrastructure available and being "customers' owner" can be decisive.

But beyond discussing the sustainability of mobile regions, namely from a business point of view, one should note that knowledge creation and competence building at the regional level, when seen as a dynamic process of learning, can mitigate the uncertainty about the future of urban areas. Metropolitan areas must be liveable and attractive to all citizens, most of them needing urgent sustainable and innovative solutions to overcrowding, pollution, traffic jams, insecurity, social inequalities, unemployment, and population aging. City authorities will have to invent new models of participative governance and learn to manage change. Information rich networks can provide the main resources to overcome physical barriers to share interests and experiences to prop up creativity and entrepreneurship and to diminish the pressure on urban areas. We conclude by recommending elements and components for policy making and design of mobile regions, arguing for the need to promote regional systems of innovation and competence building.

This is because recent work within the framework of the OECD International Futures Program suggests two broad policy-related conclusions which apply not only to OECD countries in general but to a large extent also to the case of emerging regions. The first is that if one is to build on the opportunities offered by the considerable progress that has been made in key technological sectors, if one is to reap to the full the economic benefits of rapidly integrating markets and the emerging knowledge society; and if solutions are to be found to tackling the challenges that the management of such a rapidly changing world raises, then what is needed are innovative, creative societies. The second is that in achieving that higher degree of innovativeness and creativity, policy will matter. The way ahead does not necessarily mean less government, not less policy but -- certainly in some key areas -- different policy.

Just because we are headed into a rapidly changing world in the coming decades does not mean that we have to throw out all policies and make a completely fresh start. Indeed, some policies that have proved their worth in the past may well continue to do so in the future. However, it is clear that in other policy areas at least incremental adjustments are called for, and in yet others some radical new thinking is required. This provides, in fact, a simple but convenient framework for looking at the role of general policies in the future and their implications for innovation: -- 1) policy continuity 2) policy reform 3) policy breakthroughs.

To conclude, mobile regions generate a set of new technological challenges and business opportunities, but also the need to better consider public and private policies, which should be dealt with in a systematic, iterative and progressive way, in order to foster the quality of live of urban populations and their social well-being.

5. Summary

This paper discusses ways to foster the use of new and mobile ICT´s and to plan mobile regions. It builds on the need to continuously adapt regional trajectories, both social and technological, and foster the necessary learning capacity of increasingly diversified local communities.

Our research hypothesis is based on the fact that in terms of the emerging urbanization trends of increasing urban population, but reduced urban density, the progressive integration of mobile ICT´s with sustainable mobility equipments and concepts will facilitate improving well being in urban regions if adequate incentives, infrastructures and institutions are adaptively implemented through a policy learning process. We build on empirical evidence brought by the analysis of sample case studies in Portugal in terms of emerging challenges in mobilizing the information society, which led us discussing the social and cultural shaping of information technologies in order to cope with the accelerated rate of technical change we live on.

In a previous paper we concluded that networked places need to be designed holistically, coping with change and continuously assessed in order to accommodate humanity. In order to achieve these objectives, semantic grids were discussed in terms of the emerging trends in the design of "digital cities and regions". Here, we extend the analysis to the diffusion of emerging mobile technologies and show that they represent a broad range of opportunities to various public and private agents in their different vocations through the value chain that characterizes the "business" of urban mobility today. In oder to achieve these objectives, specific communities of practice, CoP´s, normally integrating forms of knowledge, may play a mobilizing role to ensure a gradual process of collective learning on information access and sharing. Also, new challenges are faced today, namely the articulation between national, regional and community authorities, resulting from the tendency to converge services, network and terminal types. But, in general, the innovation dynamics should necessarily incorporate the *time* factor, which requires an ongoing investment effort and ongoing follow-up schemes.

Our analysis calls for policies that consider long term approaches of dynamic environments, which require being continuously monitored and evaluated. This led us to argue towards policy portfolios facilitating the learning process associated with building systems of innovation and competence building.

References:

[1] Mitchell, W. (1995), City of Bits, MIT Press

2 Mansell, R. and Steinmueller, W.E. (2000), Mobilizing the Information Society: Strategies fro Growth and Opportunity", Oxford, Oxford University Press

3 Castlells, M. (2001), The Internet Galaxy – reflections on the Internet, Business, and Society, Oxford Univ. Press

4 Tsipouris, L. (2002), Final Report for the Thematic Evaluation of the Information Society, Technopolis

5 EC (2002), e-Europe 2005: An information society for all, COM(2002) 263

6 Conceição, P. and Heitor, M. (2002), "Knowledge Interaction Towards Inclusive Learning - Promoting Systems of Innovation and Competence Building", Technological Forecasting and Social Change, 69(7), pp. 641-651

7 Freeman, C. and Louçã, F. (2002), As time goes by, Oxford Univ. Press Mansell, R. and Steinmueller, W.E. (2000), Mobilizing the Information Society. Oxford Univ. Press

8 Dutta, S. and Jain,A. (2003), The Networked Readiness of Nations, The Global Information Technology Report 2002-2003, World Bank's infoDev Programme.

9 Eurobarometer 2003, http://europa.eu.int/comm/research/press/2003/pdf/cc-report_en.pdf.

10 Conceição, P., Heitor, M., and Lundvall, B. (eds., 2003), "Innovation, Competence Building, and Social Cohesion in Europe: Towards a Learning Society", London, Edward Elgar.

11 Wright, G. (1999). Can a Nation Learn? American Technology as a Network Phenomenon, in: Learning by Doing in Markets, Firms, and Countries, eds. N. Lamoreaux, D.M.G. Raff, and P. Temin, The University of Chicago Press, Chicago and London

12 Heitor, M. and Moutinho, J. (2004), "Digital Cities and the network society: Towards a Knowledge-Based View of the Territory?", in Gibson, D., Heitor, M. and Ibarra, A., (eds.), "Knowledge and learning in the Network Society", New York, Purdue University Press.

13 Heitor, M. and Moutinho, J. (2004), "Digital Cities and the opportunities for mobilizing the information society: case studies from Portugal", in Tanabe, M., van den Besselaar, P. and Ishida, T., (eds.), "Digital Cities III – Computational and sociological approaches", Berlin, Springer Verlag.

[14] Conceição, P., Heitor, M., and Veloso, F. (2003), "Infrastructures, Incentives and Institutions: fostering distributed knowledge bases for the Learning Society", Technological Forecasting and Social Change, 70(2), pp. 583-617.

[15] Heitor, M. and Moutinho, J. (2004), “Building Human Centered Systems Based on Communication Infrastructures: Evidence from Portugal”, Engineering Systems Symposium, Massachusetts Institute of Technology, USA, March 31, 2004

16 McKnight, L., Selian, A. & Vongpivat, P. (2002), "Mobile Regions: Entrepreneurship, Information and Communication Technologies, and Innovation System Models", Journal Trends in Communication.

17 Tanabe, M., van den Besselaar and Ishida, T. (2002). Digital Cities II – Computational and sociological approaches. Springer Verlag.

18 MCT, (1997), “Iniciativa Internet”, Portuguese Ministry of Science and Technology (in Portuguese).

[19] United Nations (2002), “World Urbanization Prospects: The 2001 Revision (Data Tables and Highlights)”, Population Division, Department of Economic and Social Affairs, United Nations Secretariat.

20 Aveiro Digital City Coordination Team (2001) “Relatório de Avaliação do PACD_1998-2000”. Available from http://www.aveiro-digital.pt/.

[21] Municipality of Aveiro, University of Aveiro and Portugal Telecom, S.A. (1998) “Programa Aveiro Cidade Digital”, Available from http://www.aveiro-digital.pt/.

[22] Aveiro Digital City Coordination Team (2001)” Relatório Global da 1ª Fase do Programa Aveiro Cidade Digital 1998 – 2000”. Available from http://www.aveiro-digital.pt/.

[23] Associação para o Desenvolvimento de Bragança Cidade Digital (2001), “Relatório Final Bragança - Cidade Digital”. Available from http://www.braganca-digital.pt/.

[24] http://www.ipg.pt/adsi/; Guarda Digital.

[25] http://www.cm-castelobranco.pt/cb_digital/; Castelo Branco Digital.

[26] http://www.marinhagrandedigital.com/; Marinha Grande Digital.

[27] http://www.espigueiro.pt/; Trás-os-Montes Digital.

[28] http://www.alentejodigital.pt/; Alentejo Digital.

[29] Tsipouris, L., (2002), “Final Report for the Thematic Evaluation of the Information Society”, Technopolis.

[30] Moses, J. (2004), "ESD Monograph Framing Paper: Foundational Issues in Engineering Systems", MIT, Working Paper.

[31] Cooley, M. (2000), "Human-centered Design", in Jacobson, R., (ed.), "Information Design", Cambridge, MIT Press, pp. 59-81.

[32] Dertouzos, M. (2001), "The Unfinished Revolution: Human-Centered Computers and What They Can Do for Us", Nova York, Harper Collins Publishers.

[33] Norman, D. (1998), "The Invisible Computer: Why Good Products Can Fail, the Personal Computer Is So Complex, and Information Appliances Are the Solution", Cambridge, MIT Press.

[34] Berman, F., Fox, G. and Hey, T. (2003), "The Grid: Past, Present and Future", in Berman, F., Fox, G., and Hey, T., "Grid Computing: Making the Global Infrastructure a Reality", Chichester, Wiley.

[35] Foster, I. (2003), "The Grid: A new Infrastructure for the 21st Century", in Berman, F., Fox, G., and Hey, T., "Grid Computing: Making the Global Infrastructure a Reality", Chichester, Wiley.

[36] Fensel, D., van Harmelen, F. and Horrocks, I. (2003), "OIL and DAM +OIL: Ontoloy Languages for the Semantic Web", in "Davies, J., Fensel, D., and van Harmelen, F. (eds.), "Towards the Semantic Web: Ontology-Driven Knowledge Management", Chichester, Wyley.

[37] Lenci A., Calzolari N. and Zampolli A. (2002), "From Text to Corpora: Computational Lexicons and the Semantic Web", Proceedings of the AAAI Workshop, Eighteenth National Conference on Artificial Intelligence, AAAI 2002, Edmonton.

[38] De Roure, D., Jennings, N. and Shadbolt, N. (2003), "The Semantic Grid: A Future E-Science Infrastructure", in Berman, F., Fox, G., and Hey, T., "Grid Computing: Making the Global Infrastructure a Reality", Chichester, Wiley.

[39] J.-G. Dufour, J.F. Fritsche, C.Ripert 81996), "Le programme «Transports de marchandises en ville»: quelques repères pour une approche globale"; Transport Urbains, n.91.

[40] Lester B. Lave, and Heather L. MacLeanb (2002). An environmental-economic evaluation of hybrid electric vehicles: Toyota's Prius vs. its conventional internal combustion engine Corolla. Transportation Research Part D: Transport and Environment, 7(2) , March, pp. 155-162

[41] Frieling, D. (2001), "Deltametropolis: an exercise in strategic planning", in M. Echenique and A. Saint (eds.), "Cities for the new millennium", London, Spon Press, pp. 95-103.

42 Fischer, M., Diez, J., and Snickars, F., (2001), Metropolitan Innovation Systems: Theory and Evidence from Three Metropolitan Regions in Europe, Springer-Verlag, Berlin

43 Lundvall, B.-A. and Johnson, B. (1994), "The Learning Economy", Journal of Industry Studies, 1 /2, pp. 23-42.

44 Bruton, H. (1998), "A Reconsideration of Import Substitution", The Journal of Economic Literature, 27 (June), pp. 903-936.

45 Conceição, P. and Heitor, M. (2002), "Knowledge Interaction Towards Inclusive Learning - Promoting Systems of Innovation and Competence Building", Technological Forecasting and Social Change, 69(7), pp. 641-651