Wireless City Berlin – Solutions for a Smarter City

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Abstract

Cities in Europe face the challenge of combining competitiveness and sustainable urban development. Technology such as wireless communication and ubiquitous computing is playing an increasingly important role in this context, helping to co-create solutions which can make the urban space 'smarter'. The city of Berlin is launching the project 'Wireless City Berlin' (WCB) to demonstrate the potential of such technologies in multiple application scenarios. This paper analyses the terms 'smart' and 'wireless' with respect to urban development and introduces a typology of wireless city initiatives. Further, it presents the main work areas of the WCB project and relates it to other wireless city initiatives in Europe.

1 Introduction

Cities face the challenge of combining competitiveness and sustainability in their urban strategies. Particularly in the European Union where differences in economic, social and environmental standards are harmonized "one of the common trends has been [...] the increase in competition between cities to attract inward investment. A dominant theme is what is termed 'public-private partnership'." [Thor96]. Cities partner with industrial organizations, with academic institutions and – sometimes – directly with their citizens, aiming to sharpen their city profile and co-create solutions which improve the urban infrastructure and the quality of public service provision.

Information and communication technology (ICT) is one of the key enablers in this context [Mino00]. Increasing network bandwidths, evolving wireless transmission standards, miniaturization of hardware and mobile access at decreasing costs allows to create solutions,

which enhance current services or disruptively create new innovations. Such services can target at individuals (e.g. citizens or tourists), businesses (such as local commerce) or public institutions (also referred to as e-government and mobile government). While state-of-the-art solutions have been built as web-based solutions, the upcoming paradigm of ubiquitousness will lead to services which are embedded in the user's environment [Gall03]. This vision implies that the urban environment autonomously adapts to their actors making the use of ICT 'smart'. The limits of public ICT investment are less of a technical, but rather of an economic kind. A careful analysis is needed when evaluating the benefits and costs of evolving technology investments as well as the expectations and acceptance of the prospected users. New services will only succeed, if the technology brings a substantial benefit and integrates seamlessly into people's everyday life.

The city of Berlin is launching the project 'Wireless City Berlin' (WCB) involving multiple industrial and research partners to demonstrate the potential of wireless technologies in the urban environment. This paper presents the WCB project in detail illustrating and discussing the value of wireless city solutions in selected application scenarios. We conclude by comparing the WCB project to other European initiatives and qualify the overall approach in Berlin in the light of the experiences made by other European metropolises.

2 Related Work

2.1 The Notion of Smart Cities

In many western countries, the discussion about the future of urban development has been influenced by the concept of so called 'smart cities'. Yet, it is surprising that the term has not been widely used in spatial planning literature nor in urban research [Giff07]. Rather we notice that the concept derives from a self-labeling process adopted by some designated cities and regions which use the term to market certain aspects of their urban development [Holl08]. This marketing can refer to new urban districts (e.g. the 'Malta Smart City' [Knig08] or the 'Almere Smart Work Center' [Boor08]), to an improvement of governmental services (e.g. in the EU 'Smartcities project' in the North Sea region [Fane08]), to measures for energetic efficiency (e.g. in the 'Malaga Smart City' project [Mete09]) or to the application of ubiquitous technologies (e.g. in cities in the state of North Rhine-Westphalia [MNRW09]). So there is a

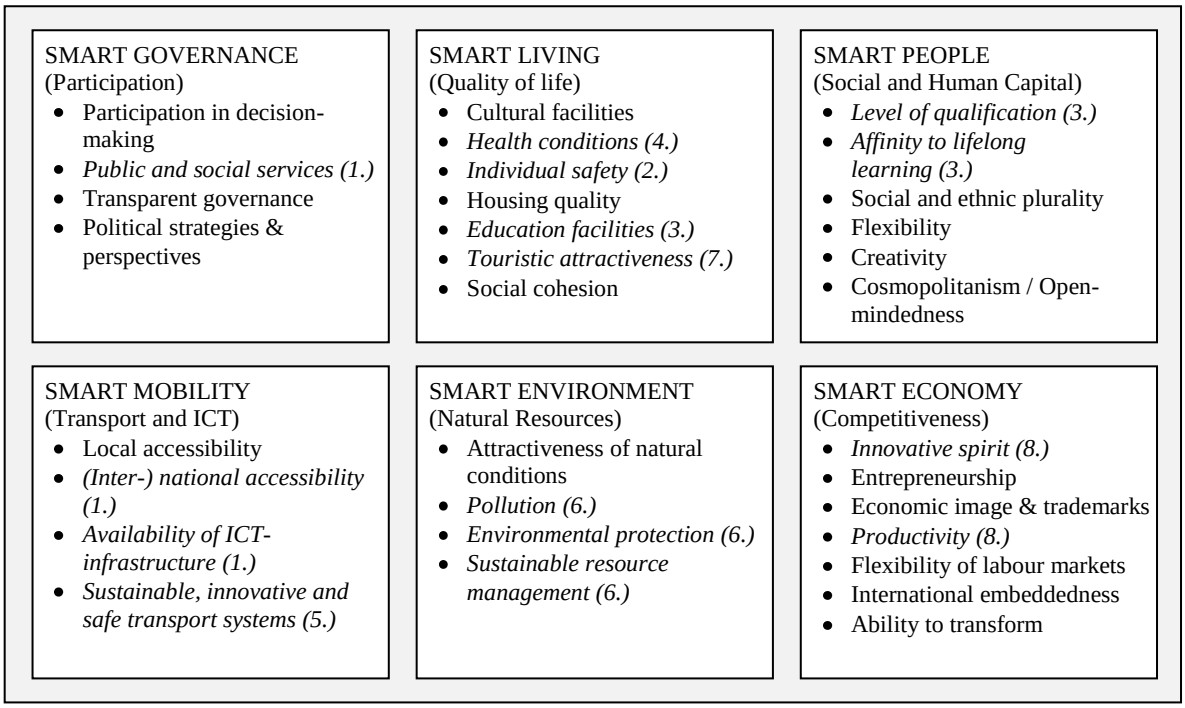

Figure 1 – Characteristics and factors of a smart city [Giff07]
(characteristics most relevant for wireless technology in italic)

whole range of elements that supposedly characterize this new urban form and in most examples of such ‘smart cities’ we find a mixture of these elements.

Taking into account the lack of definitional precision, we conclude that the notion ‘smart’ can be understood rather as a general ability of a city. The Centre of Regional Science, Vienna, proposes an operationalization of the ‘smart city’ concept into six categories referring to governance, living, people, mobility, environment and economy [Giff07], see Figure 2. The framework forms the basis of a comprehensive city ranking which can help municipal decision makers to advance in certain categories and thereby improve city competitiveness as a whole.

2.2 Wireless City Initiatives and Technology

A wireless city initiative can be defined as a (temporary or long-lasting) coalition of public and private partners with the goal of driving the development, deployment, and operation of wireless services and corresponding infrastructure in an urban area to fulfill the overall strategic goals of the municipality [Wink09]. A wireless service is any service-functionality which can be accessed by consumers to request actions to be performed by a service provider via wireless communication means.

Wireless communication in the first hand refers to next generation mobile networks such as UMTS, HSPA, Wi-Fi and WiMAX. For a comprehensive overview of these technologies it is

referred to [Park07] and [Lind06]. However, the paradigm of ubiquitousness combines the mobility aspect with pervasiveness [Lyyt02]. Therefore also short-range communication standards such as RFID, NFC and Bluetooth ought to be subsumed under the notion of 'wireless', since they enable an interaction with the direct environment.

In [Wink09] eight main application clusters have been identified for urban wireless services: 1. public service access, 2. public safety, 3. education, 4. health, 5. transportation and traffic, 6. infrastructure and utilities, 7. tourism and entertainment, 8. Mobile commerce and other business. This finding is consistent with other classifications, e.g. in [Kwon07]. Given the characteristics presented in [Giff07] we find that wireless technology can play a vital role in many, but not necessarily all characteristics of a 'smart city'. Figure 1 highlights in italic those factors which are relevant for wireless technology. A wireless city initiative thus can be seen as a vehicle to fulfill the technology-related objectives on the way towards becoming a smart city.

2.3 Typology of Wireless City Initiatives

Cities worldwide have taken different approaches and gone through different stages in exploiting the potential of wireless technology. Based on an exploratory analysis presented in [Wink09], we find that early initiatives have focused more on the infrastructure aspect while latter initiatives find focus more on the service application side of wireless technology. Three types of initiatives can be differentiated:

(1) Most cities have started with small pilot initiatives which basically focus on the provision of internet access in selected areas of the city (commonly as public Wi-Fi spots), such as parks or commercial zones. Those initiatives can be denominated as 'pilot initiatives and late movers'. For example, the 'Wi-Fi project' in Berlin can be attributed to this cluster, having announced to mount free municipal wireless in the city center starting with a few pilot areas which are already operating. Like in numerous other initiatives of this kind the goal is "to make [the city] a more attractive as a place to live and work" [SPIE09].

(2) Secondly, in recent years a couple of cities have taken the lead and made significant investments to equip the urban space with vast wireless infrastructures (Wi-Fi spots, zones and clouds) and to build required backbone infrastructures. These 'infrastructure-focused early mover' initiatives are commonly embedded in larger programs and connected to higher-level goals which contribute to urban strategies [Aude07]. The Paris project which covers currently over 400 Wi-Fi spots and is embedded into the larger program 'Paris Ville Numérique' can be quoted as an example here. The project not only aims at supporting the city's attractiveness in

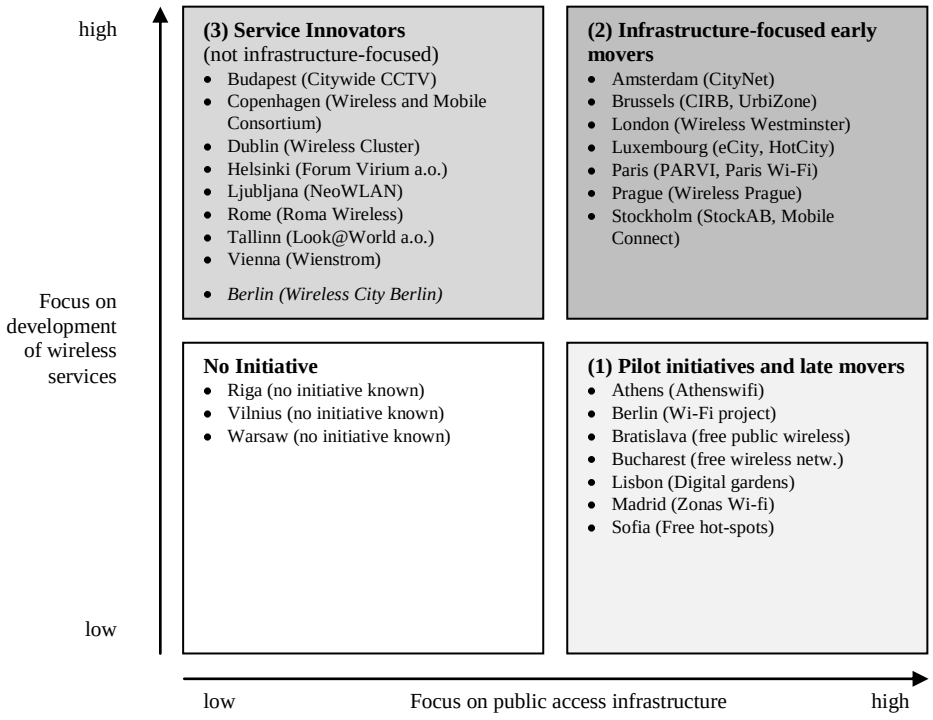

Figure 2 – Typology of wireless city initiatives in European metropolitan areas, based on [Wink09]

various fields, but also at stimulating the economic development, and modernizing the government service delivery through a number of application projects [Pari06].

(3) And thirdly, a more recent approach can be identified among such municipalities which refrain from large infrastructure investments (and their possible adverse effects on private competition). These initiatives are characterized by acting more as innovation clusters bringing together different stakeholders and building on private competition to provide wireless solutions. Given the footrace of substitutable standards for wireless networks (e.g. 3G vs. WiMAX), these 'service innovator' initiatives take into account that the services to be created are not necessarily bound to a particular infrastructure, but may be delivered later on through several networks and competing operators. For example in the Helsinki 'Forum Virium', which includes various industrial partners as well as prospective end-users, the acceptance of novel mobile media services has been explored in a living lab [Viri08]. Such initiatives follow the goal to promote the development of new digital services by exploring novel solution from the demand side rather than from an infrastructure point of view.

Altogether, these three types of initiatives can be differentiated by the two characteristics *focus on public access infrastructure* and *focus on development of wireless services*. Figure 2

depicts the results of [Wink09] in a matrix view, arranging wireless initiatives of 24 European metropolitan cities according to this typology.

3 Wireless City Berlin

3.1 Project Goals and Setup

Against the background of the emergence of smarter cities, the city of Berlin is launching the project 'Wireless City Berlin' (WCB) which is supported by the European Regional Development Fund (ERDF). The Project targets at fostering innovation and positioning the Berlin area as a leading region for smart city solutions. A 'Wireless Transfer Center' will be established as a common platform for all wireless activities in this region. The project setup involves multiple regional and supra-regional industry partners (supplier as well application partners) and different research groups at the universities of Berlin (i.e. Humboldt-Universität zu Berlin, Beuth Hochschule für Technik Berlin, Universität der Künste Berlin).
The expected outcomes of the project can be summarized as follows [WCB09]:

- Overarching Wireless Transfer Center Berlin as an independently operating and coordinating entity
- An action and communication program as a basis for engaging all parties in industry and research and allowing for know-how transfer between them
- User acceptance studies, key success factors and innovation diffusion models for wireless services in defined solution scenarios
- Working prototypes for these application scenarios which demonstrate the feasibility of these wireless services
- A model approach for the development of innovative solutions in the urban area suitable the transfer to other future fields of technology

The project timeline is three years starting in 2009, and is divided into two phases with project evaluations at regular intervals. After that, a transition phase follows where pilot solutions and demonstrators shall be gradually carried over to their deployment in the urban area. The

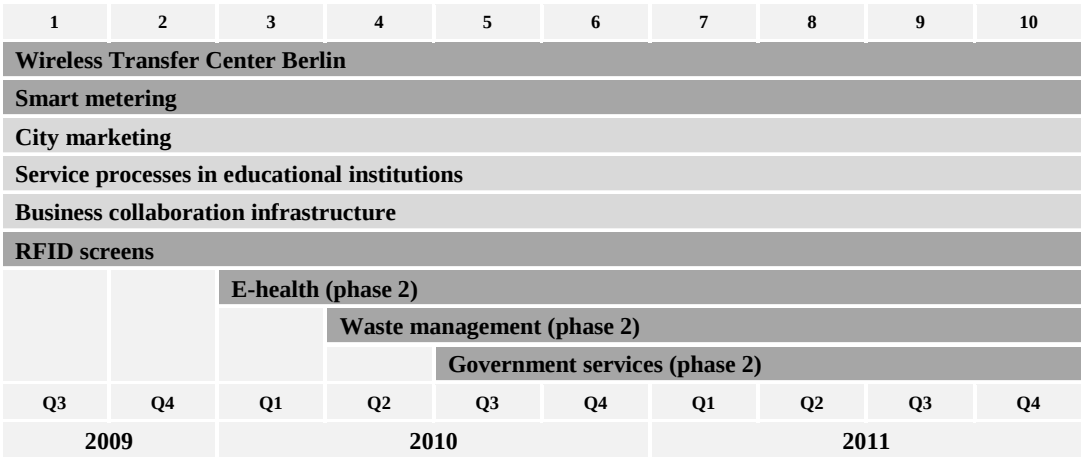

Figure 3 – Wireless City Berlin: Project timeline and work streams [WCB09]

initiative is expected to have a long-term effect on penetration levels of wireless technology in the urban space as well as the effectiveness and efficiency in each of the solution scenarios.

The solution scenarios comprise the topics ‘smart metering’, ‘city marketing’, ‘service processes in educational institutions’ as well as ‘e-health’, ‘waste management’ and ‘government services’ (only the first three are in scope of the first phase). Project streams are designed according to these topics plus an overarching work stream for the setup of the Wireless Transfer Center as well as the two cross-functional work streams ‘business collaboration infrastructure’ and ‘RFID screens’. The overall project timeline and work streams are depicted in Figure 3. Those streams which will be further detailed in 3.2 are highlighted.

3.2 Selected Work Streams

For the sake of brevity, this paper focuses on the detailed description of three work streams which are predominant in the first phase and suitable to explain the contribution of the whole project to deliver ‘smart’ solutions. These scenarios are ‘city marketing’, ‘service processes in educational institutions’ and the cross-functional work stream ‘business collaboration infrastructure’.

3.2.1 City Marketing

The city marketing work stream investigates the potential of wireless technologies in Berlin’s strategic growth areas: creative industries, tourism as well as in retail and trade. Goal in retail and trade is to design an architecture for a city-wide advertising space that senses nearby activities and interacts with pedestrians using Wi-Fi, RFID or mobile phones. Based on

prototypes, both end-user acceptance and effectiveness of such innovative communication channels are quantified. The results may form the basis for the development and implementation of a city-wide interactive advertising infrastructure.

The fashion industry forms a vital part of Berlin's creative industry and predestines to make innovative use of wireless technologies. In this context, novel concepts of marketing and distribution in the fashion industry will be derived. The ideas ought to reshape the role clothing can play in daily life. All scenarios are evaluated with respect to end-user acceptance, economic viability, and practical feasibility. The most promising scenarios are realized as prototypes and re-evaluated under real conditions. The findings are provided to small and medium-sized enterprises which can use them to develop innovative services and products.

In the field of tourism, so-called interaction points and mobile applications are deployed to make the city's infrastructure more user-friendly. Tourists as well as locals may interact with these interaction points by using various technologies such as RFID, NFC, and Wi-Fi. For example, interaction points may provide recommendations and coupons for nearby shops, restaurants, bars, museums, and sights. An empirical study analyzes which services are particularly demanded and which access technologies are mostly accepted. This analysis forms the basis for the planning and design of a number of LBSs to make living and travelling in Berlin more convenient and enjoyable.

Possible synergies and integration-potential across initiatives is examined. For example, the interactive advertising infrastructure may respond to intelligent clothing or some LBS may determine the appearance of an interactive billboard. By and large, an infrastructure is built that lets room for the integration of a variety of services developed either by outside partners or that are developed within the project.

3.2.2 Service Processes in Educational Institutions

Private universities SRH Hochschule Berlin and Berlin UMC Hochschule Campus Berlin are included in the project. The project aims at the use of wireless solutions to support the universities' internal processes, for example through the introduction a digital student-card, and, ultimately, to automate management processes.

Building on experiences in public schools, innovative solutions for private universities are developed and implemented. The implementation is evaluated according to user acceptance. Processes in private universities, which can be uniformly displayed and automated with use of wireless technologies, relate primarily to the following areas:

- Access control systems (entrance area, rooms such as library, laboratories, etc.)
- Lending, inventory management, theft prevention and tracking of technical equipment (e.g. projectors, overhead projectors, etc.)
- Lending, inventory management, theft prevention and tracking of media in libraries and interaction with web-based services (e.g. Wiki systems, Amazon, etc.)
- Authentication for electronic study management systems (personal data for the study office, staff management, etc.)
- Billing systems (e.g. for multifunction printers)

In a first step, the basic architecture of a comprehensive RFID-based solution for universities is derived from a requirements analysis. In a second step, the solutions are implemented as prototypes and tested. In a third step, the respective solutions are evaluated on the basis of tests, experiments as well as surveys.

The system and its components (Access control system, inventory management, tracking, theft protection, etc.) are implemented in a test environment and evaluated in terms of user-acceptance, usability and cost efficiency. SRH Hochschule Berlin and the UMC Hochschule Campus Berlin apply both quantitative and qualitative methods to identify criteria for the acceptance of the smart solutions. Finally, a holistic concept for smart solutions in private universities is developed and tested along with an acceptance model

3.2.3 Business Collaboration Infrastructure

Goal of this cross-functional work stream is the development of a demonstrator for a service-oriented collaboration infrastructure for the Wireless Transfer Center Berlin. Through applying a service-oriented architecture it is intended to enable a flexible integration of new WTCB-own services and the reuse of existing services (i.e. software functionality which is available over the internet). The logic which defines the control flow between these services can be modeled within a middleware which forms an essential part of the business collaboration infrastructure.

The resulting prototype is intended to be operated among various parties, such as service providers, information providers, infrastructure providers and municipal departments (e.g. for monitoring and controlling the service usage). Therefore, the setup approach also needs to cover the business and collaboration perspective:

In a first step, the role- and application-specific benefits will be evaluated for each solution scenario. Collaborative solutions are frequently characterized by cost- benefit-asymmetries between the different parties. A cost-benefit analysis and the development of a participation model considering respective incentives stand at the beginning of this work stream.

In a next step, the relevant high-level services are identified for each scenario and described in an IT product portfolio. This description includes the requirements on the aggregate end-user services as well as required groups of medium- and low-level services and the according requirements on service quality.

In a subsequent step, for each of the WCB scenarios (i.e. 'city marketing', 'educational institutions', etc.) the solution prototype will be complemented with the required service architecture demonstrating the feasibility of the SOA-based approach. At the same time, an appropriate evaluation method is applied to identify those services, which can be utilized in across multiple scenarios. For example, the resulting SOA may particularly provide location-based services, billing and payment, user identification and RFID object identification, ERP functionality and other services on different devices.

Finally, a feasibility study is to be carried out on the utilization of the SOA among all WCB partners. It is also the aim of this stream, to gather the existing dynamics of interaction between these partners and to determine the optimum degree of information transparency between them. Based on this knowledge and the results of the cost-benefit analysis, the future model for the ongoing operations of the WTCB collaboration infrastructure can be determined and uphold between the parties to assure long-term sustainability.

3.3 Qualification of the WCB project

Given the typology presented in 2.3, the 'Berlin Wireless City' project can be qualified as a 'service innovator' initiative (type 3). Especially the setup of a Wireless Transfer Center, which is one of the main goals of the project, is a core characteristic of such an innovation cluster which focuses on the knowledge transfer for wireless technologies (here with a particular focus on RFID). Given the number application scenarios within the project, it focuses mostly on the solution perspective (*focus on development of wireless services = high*) and only very limitedly on the infrastructure view (*focus on public access infrastructure = low*). The argued classification is displayed in Figure 2 by an additional bullet point for the WCB in italic.

The effect of such initiatives in the first instance lies in a stimulation of the economic fabric regarding the application of wireless technologies. This may take place through an integration

of research and development activities, utilization of synergies between application partners, and support for the development of business models – all of which are goals anchored in the mission of the overarching Wireless City Transfer Center [WCB09]. In a second step this stimulation may then cause more indirectly an improvement of municipal services and ultimately affect city attractiveness.

4 Summary and Conclusion

The emerging trend towards ‘smarter’ cities strengthens the importance of information and communication technology in urban development. Wireless city initiatives can be seen as a vehicle to fulfill technology-related objectives which refer to wireless technology. Based on a typology of related wireless city initiatives in Europe, three main strategies for wireless initiatives have been differentiated: infrastructure-focused, service-focused and both.

We presented how the WCB projects aims to provide services to citizens and businesses in diverse solution scenarios, such as ‘city marketing’, ‘educational institutions’ and a cross-functional scenario for a ‘business collaboration infrastructure’. The WCB project can therefore be attributed to a cluster of ‘service innovator’ initiatives. The comparisson with other initiatives of this type suggests that the WCB project may contribute to increased city attractiveness mainly through stimulating the economy fabric and acting as a driver of innovation. This way, the WCB project is able to complement other more infrastructure-focused initiatives in Berlin (e.g. ‘Berlin Wi-Fi’). Yet, due to a lack of a common framework we can hardly measure or compare the success of the Berlin initiative with other initiatives. The development of such a framework remains one of the major tasks for future work.

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