# The Turku Approach to Create a Wireless Infrastructure

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**Abstract:** *One major goal of eGovernment is the provision of an efficient and cost-effective infrastructure enabling access to online resources for all citizens. While at the beginning this goal was basically related to Internet, today there is growing demand for providing access anywhere and anytime also where wired networks are not available. Major drivers of this development are emerging technologies as WLAN and the growing mobility of inhabitants as well as increasing usage and penetration of mobile phones. Another driver are emerging opportunities for new services for citizens based on mobile technology summarized under the term mGovernment. In order to enable mobile applications on a larger scale an efficient infrastructure is necessary. In this paper the approach of Turku, Southwest Finland, in creating a wireless infrastructure will be described based on a case study.*
**Keywords:** Mobile infrastructure, Private-Public-Citizen Partnership.

## 1. Introduction

One major goal of eGovernment is the provision of an efficient and cost-effective infrastructure enabling access to online resources for all citizens. While at the beginning this goal was basically related to Internet, today there is growing demand for providing access anywhere and anytime also where wired networks are not available. Major drivers of this development are the growing mobility of inhabitants the increasing usage and penetration of mobile phones (in some developed countries even over 100%) as well as maturing technologies as WLAN and emerging technologies as WiMax, which enable an efficient wireless access. Another important driver are emerging opportunities for new services for citizens based on mobile technology called under the name mGovernment (for an overview see Roggenkampp 2004, Kishchu and Kuscu 2004, Reinermann und Franz 2005, and Deutsche Städte und Gemeindebund 2005). In order to enable access anywhere and anytime as well as mobile applications on a larger scale an efficient wireless infrastructure is necessary.

Currently there are two approaches for building a wireless infrastructure: by way of 3G wide area wireless networks as for example UMTS and by way of alternative technologies as WLAN and WiMax. The first approach is based on networks that are working in regulated spectrum and require high investments. They are provided by mobile operators in a commercial manner. Even though there have been delays of several years, at present most European countries have a good coverage of UMTS networks. However there are still problems with the acceptance of the new technology and the availability of end devices und appropriate services. Even though the introduction of 3G has provided the possibility to switch to volume based pricing, services based on them are still expensive and based on metered payment models. As a result the introduction of 3G did not boost mobile data services yet. The stage of development of mobile data services and communication is comparable to the early days of Internet, when high prices hindered the usage of online applications.

The delay of UMTS has given the chance for alternative technologies to arise. Such technology in the area of wireless communication are WLAN and the emerging technology WiMax. WLAN enables bandwidth of up to 11MB and can be used at a distance of up to 100 m. WLAN has been established as a complementary technology for wireless access by way of hotspots at public places as airports, railway stations, and similar (Schmidt and Townsend 2003). It has spread also in private homes and industry. In industry it is used in order to allow overall access to employees and support their mobility within the company premises. In private housing WLAN is also used in order to provide convenient access to Internet from all over the home.

One hotspot can cover the last mile of online access as one hotspot can theoretically be effective up to 100 meters. The interconnection of several WLAN hotspots enables a broader network and coverage of a whole region or building. The possibility to share resources by connecting WLANs has resulted in many so called WLAN or WiFi communities (Schmidt and Townsend 2003, Fuentes-Bautista and Inagaki 2005).

There are two approaches to build a wireless network based on WLAN: top-down or bottom-up (Fuentes-Bautista and Inagaki 2005). The top-down approach is pursued by commercial players as mobile operators or Internet Service Provides (ISP), which provide hotspots on frequent public spaces as for example airports, railway stations and similar. This type of hotspots are up till now still quite expensive and are basically used by mobile employees for business purposes. The bottom-up approach is mainly based on private initiative and results in so called WLAN communities. A WLAN community is based on the principle of free economy or open source- members connect their hot spots to a WLAN network that can be used by all members for free. The more members the broader the coverage of the WLAN community.

In order to be successful, communities need to provide solutions for the following problems related to organizing and running WLAN communities:

- The community needs network management and authentication software in order to recognize members and to allow at least minimum of registration support.
- The community needs strict rules who is allowed to use it and how it can be used.
- The community is based on the principle that everybody participating will share his/her Internet connection and WLAN bandwidth with the other participants. In particular the sharing of Internet access has provoked legal considerations and also resistance from ISPs who do not want their customers to share their Internet access with others, in particular non customers.

Given the above characteristics WLAN communities in many countries remained a private endeavor that is somewhere in a grey zone of legality (Cappanovo et al. 2003). Recently WLAN communities have been discovered by public authority, in particular town and municipality governments, as one cost-effective, alternative approach to building wireless access infrastructure (see for example Fuentes-Bautista 2005; Powell and Shade 2005; Shamps 2005, Tapia et al. 2005). In this paper a successful approach for building and running a free WLAN community based on a public-private-citizen partnership in Turku, Southwest Finland will be described and discussed.

The content of the paper is structured as follows: In section 2 the research approach is described. Section 3 provides a detailed description of the Turku SparkNet-OpenSpark WLAN community and a short overview of its development history. The value chain, i.e. business web of SparkNet-OpenSpark is discussed in section 4. In section 5 the development towards a Living Lab is described and section 6 closes the paper with a conclusion and outlook in further research.

## 2. Research Approach

In this case study we will present a successful approach for building a free city wireless infrastructure with a private-public-citizen partnership. The case-study methodology generates insights into social processes in real-life context through in-depth investigation. As the phenomenon under investigation is new, the case

study will be explorative and descriptive (Yin, 1994) explaining and describing the approach in Turku and the resulting SparkNet-OpenSpark infrastructure. The focus of the case study lies on the involved players, the process of building the WLAN community and the resulting infrastructure. The aim of the case study is to provide answers to the following questions:

- Who are the players involved in the creation of the infrastructure and what are their relationships?
- What are the key success factors?
- What are the implication of public WLAN communities for larger issues of access, mGovernment and involved players?
- How transferable is the approach to other cities and regions?

The case study is based on background material about the resulting infrastructure and semi-structured interviews with key persons representing the involved institutions. In addition one of the authors is user herself, and brings in the view of the private users. The persons interviewed were:

- Thorbjörn Andersson, representative of City of Turku, IT Services Department, Director of IT Services.
- Christer Carlsson, representative of Åbo Akademi University, Professor, Director of the Institute for Advanced Management Systems Research
- Matti Kiviö, CEO of MP-MasterPlanet Ltd.
- Esa Aarnio, University of Turku, Computing Centre, Data Network Unit, Chief Planner.

## 3. SparkNet and OpenSpark: The TURKU WLAN Infrastructure

### *3.1. Description of the Current Status of the Infrastructure - What is SparkNet and OpenSpark?*

SparkNet, one of the world's largest public WLAN networks, is an example of combining existing hot spots into a free WLAN network by way of a public-private-citizen-partnership in a very affordable way. SparkNet has been growing very fast and covers today almost 70% of the city of Turku (c.f. 1). Turku is the oldest city and former capital of Finland, located in the south-west corner of the country. At present it is the fifth largest city in Finland. In the greater city area there are approximately 250'000 inhabitants, but including neighboring municipalities in the coastal area and in the archipelago the population amount to 350'000. The archipelago with its 20'000 scarcely populated islands provides a challenge for broadband connectivity.

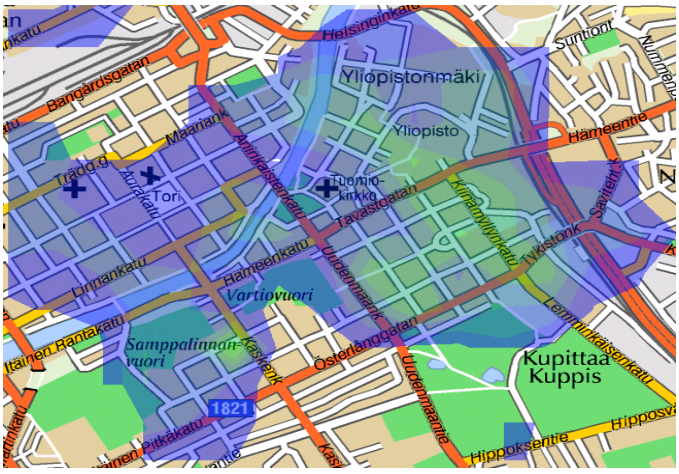



*Figure 1: SparkNet-OpenSparc coverage of the university area in August 2005 (Kusmanen 2005)*

In short SparkNet constitutes of:

- Over 1'200 access points (as of March 2006) and more than 20'000 logins per month and increasing time of usage by users (over 50'000 hours in March 2006) (c.f. 2).
- Secure and free access to one's own intranet through SparkNet (email, calendar, data access own servers).
- Over 100'000 user accounts (Note! The area comprises a population of 250'000-350'000).
- Roaming agreements with a number of Finnish universities.
- SparkNet users have access through own existing user account.
- Flexible infrastructure and user account management (visitors can join the network with an access code).
- Easy usage, no dedicated hardware or software required.

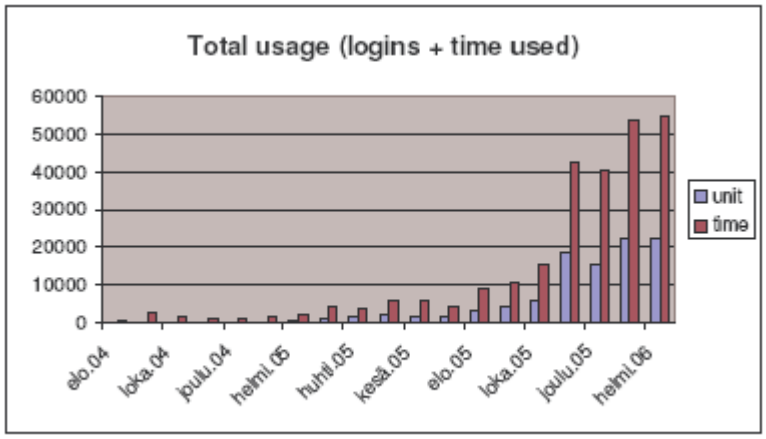



*Figure 2: Number of login and total hours use of the SparkNet-OpenSpark network in the period from October 2004 to February 2006*[1]

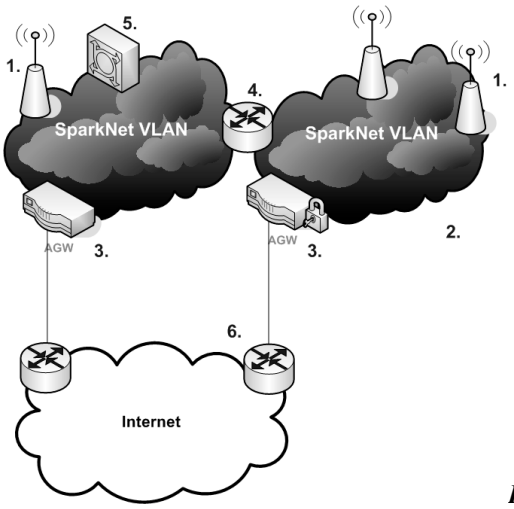
The users of SparkNet-OpenSpark are employees of the participating private companies and public authorities, private companies acting as SparkNet service providers (restaurants, cafés, yachting clubs, hotels), employees and students of universities (3 universities in Turku, 1 polytechnic) and Turku citizens:

In a nutshell, the technology used in SparkNet comprises (c.f. 3):

1. Access points:
   - 802.11b and 802.11g compliant access points + OpenWRT
2. SparkNet WLANs:
   - SparkNet uses either a physically or logically separated LAN as its backbone
3. Authentication gateways:
   - AGW authenticate users either locally or using RADIUS service (roaming). RADIUS service is centralized using SparkNet proxy service.
   - An Authentication Gateway (AGW) Provides local DHCP services + performs NAT for internal IP-addresses
   - HTTP server: Authentication is done using users' browsers
4. Dedicated routers:
   - Separated layer - 2 segments are joined using dedicated routers
   - Multi operator environment in Turku uses Linux boxes as routers
   - Requirements for routers: Policy routing and DHCP relay service
5. Operation selection services:

[1] Source: Masterplanet, March 2006. Data provided during the interview.

- Network card MAC addresses are bound to operator to relay DHCP request to users operator [1]
- Selection is done using users' web browsers




SparkNet components

1. Access points
2. Spark WLANs
3. Authentication gateways AGW
4. Dedicated routers connecting Spark WLANs
5. Operator selection service server

***Figure 3: SparkNet Components***

### *3.2 The Development History of SparkNet-OpenSpark?*

How was SparkNet-OpenSpark created? The study of background material and the interviews with responsible persons of involved institutions revealed the following development path:

The beginning of SparkNet dates back to Spring 2003 when the first draft agreement and pilot testing area were designed between a privately owned SME[2] - MP-(MasterPlanet Oy)[3], the University of Turku and ICT Turku Ltd., a subsidiary of Turku Science Park Ltd., whose mission is to speed up growth of the ICT cluster in Southwest Finland[4]. The three institutions agreed to join their WLAN networks into one common WLAN network available for free usage for their employees and students. SparkNet went live on 15.04.2003.

The idea to join investments and to share existing WLANs available in Turku and at other Universities of Turku has been launched before. However, in order to join networks authentication software is required as well as a qualified company to provide and maintain both the authentication software and the network. Several commercial providers of WLAN hotspots in the Turku area have been approached. Non of them was willing to provide the authentication and network management software for free. Finally the company MP agreed to take over the task and provide the service for free. The relationship between the public organizations and MP-Masterplanet started when Turku University's IT department decided to outsource part of the IT-infrastructure of the university to Masterplanet. MP-Masterplanet and the CEO himself were thus known to the university. Initially the cooperation with the university to create SparkNet was not of commercial nature. However, MP-Masterplanet felt that such cooperation would be the best way to market its own services and to create a positive image for the company. In addition, they were offering WLAN access points on the market and also provided access to SparkNet as a commercial service for visitors, tourists and other citizens not participating in the network. Thus, they were motivated to cooperate with the universities and the common project was regarded as an investment. However, later on though the

[2] Small and Medium Size Enterprise
[3] http://www.masterplanet.fi/.
[4] http://www.turkusciencepark.com/TSP/www_fi.nsf/(MainMenu)/$first?OpenDocument.

agreement was non-commercial it turned out that through SparkNet business opportunities for MP-Masterplanet emerged in particular when other private companies joined the network.

During the succeeding half a year, after hard negotiations other local universities (Abo Akademi University, Turku School of Business and Administrations) and the Polytechnic of Turku joined the network with their WLAN networks followed by the cities of Turku and Naantali.

Presently, new roaming agreements are being made on a weekly basis with companies, private people and different types of organizations. The concept based on co-operation between different organizations creates common benefit: the idea is to share a piece of one's own and thus have access to a large community. The how and why one of the world's largest wireless networks (WLAN) has emerged is simply by encouraging the use of existing network components in order to facilitate collaboration of network partners.

In March 2005, an open WLAN community called OpenSpark was founded and enabled by Masterplanet in parallel to SparkNet. OpenSpark is a wireless community of private persons who act collaboratively like the organizations enabling SparkNet. By connecting private OpenSpark base stations to an existing broadband internet connection each private user is sharing the broadband connection and can take advantage of the whole network. OpenSpark has expanded thanks to the initiative of the city to donate 500 base stations to citizen that would request it by an application. Each joining municipality follows this approach. For example at the beginning of 2006 the city of Raision joined by investing in 100 hot spots, which were placed at public spaces and also donated access points to citizens (SparkNet 2006).

At the beginning of 2006 the two networks SparkNet created by city authorities, universities and industry and OpenSpark created by private citizens where joined. The smooth integration was enabled by the same management software provided by Masterplanet. Another factor that is constantly increasing the popularity of Open Spark is the fact that private users can easily connect at home with the same authentication as in their work environment. The idea of the joined SparkNet and Open Spark community is to connect available wireless networks into a larger entity where all the agreed parties can access the network through the SparkNet partner network. At present SparkNet-OpenSpark is spreading to other cities and countries. Some university staff who visit regularly other institutions either in Finland or abroad have installed OpenSpark for convenient use during their stay abroad. This has extended SparkNet coverage to places like Firenze, Manhattan (USA) and other countries. Besides regional spread further development is planned in the direction of a Living Lab test bed, as well as provision of additional services as VoIP.

In summary SparkNet started as a private-public partnership among Masterplanet, the University of Turku. Later on the city authorities joined as well as private citizens with their private access points. The partnership transformed into a public-private-citizen-partnership and based on a bottom-up approach resulted in a open wireless network covering almost the whole city. The public-private-citizen partnership formed a special value web, in which all participants provide a contribution and get an added value from the network. In the next chapter the value web, its participants, their motivation and gains will be described in detail.

## 4. SparkNet-OpenSpark Business Web (B-Web)

At present Spark-Net-OpenSpark is a growing WLAN community based on a public-private-citizen partnership (c.f. 5):

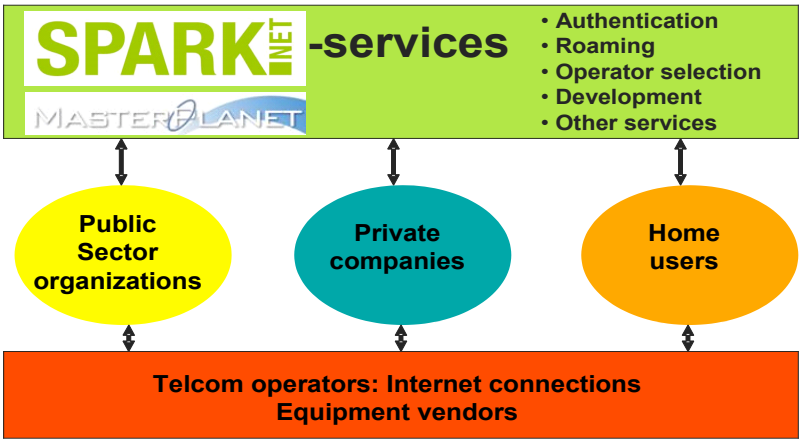



*Figure 5: Spread of SparkNet-OpenSpark in Finland in August 2005 (Kuosmanen 2005)*

The partnership resulted in a striving value web in which each player contributes and is able to get value for himself. According to Tapscott (Tapscott et al. 2003) a B-Web is a *"distinct system of suppliers, distributors, commerce service providers, infrastructure providers, and customers that use the Internet for their primary business communication and transactions. Sets of different contributors come together to create value for customers and wealth for their shareholders. Each participant focuses on a limited set of core competencies."* In the case of SparkNet-OpenSpark the value creators are at the same time the customers and consumers.

In accordance with (Tabscott at al. 2003) the B-web of OpenSpark-SparkNet can be visualized as follows:

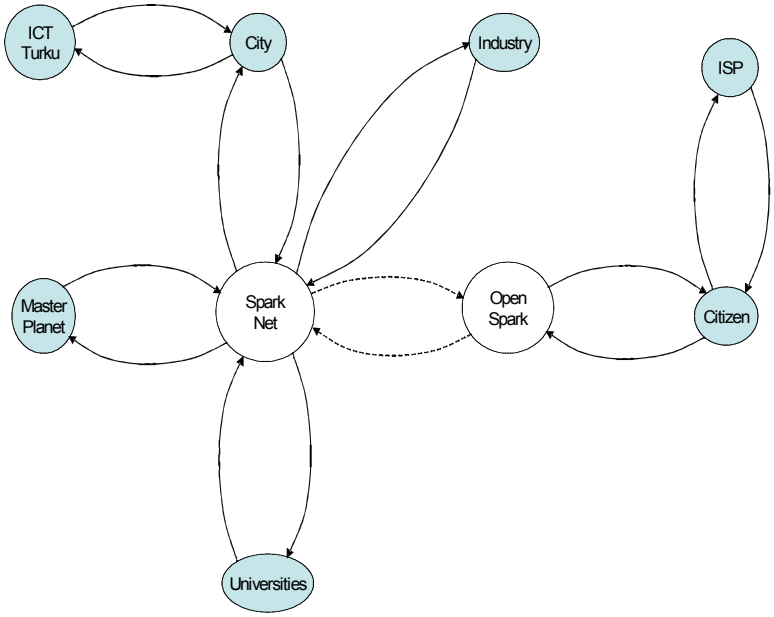



*Figure 3: The OpenSpark-SparkNet B-Web*

In the following subsections each participant category will be described in more detail with respect to their role, motivation, investment and their specific gains of the network. In addition the relationship among participants will be analyzed

***4.1 Involvement of Masterplanet Ltd***

**ROLE:** MP-Masterplanet[5] is the commercial link in the SparkNet co-operation. Masterplanet provides the software and tools enabling the roaming among the different networks, the authentication gateways, the management of OpenSpark users and the necessary know-how to maintain the network. Masterplante also offers access points for sale and consulting support for installation of WLAN networks at companies and universities.

The involvement of MP-Masterplanet was crucial to build up a functioning co-operation and leverage on the idea that had emerged considering the possibility to share networks. MP-Masterplanet was the link needed to create the tools that allow combining the shared use of the different networks by separate organizations through roaming services. Through SparkNet technology created and sold by MP-Masterplanet sharing of the networks is possible and access to broadband becomes portable and scalable. The idea in itself, however innovative, could not have been put into practice by the universities alone as governmental institutions. The task of the universities' IT departments is to provide a network for staff and students and sharing the independent networks of different universities would not have been possible without the roaming tools and services provided by MP-Masterplanet.

**INVESTMENT:** Masterplanet invested in development of the managing and authentication software for the WLAN community. In addition Masterplanet secures the further development of the community software and provides a permanent support for OpenSpark users as well for installation of access points.

**GAINS:** In the value chain MP-Masterplanet is not an ISP, its business does not consist in providing DSL connections. The business model for MP-Masterplanet is to provide management, authentication and roaming possibilities. MP-Masterplanet sells SparkNet technology and services which combine functioning DSL connections and WLAN networks to a larger infrastructure. In addition Masterplanet sells access and online WLAN time for visitors of Turku (tourists, business travelers and similar). Commercial users can access SparkNet for a reasonable price by making a subscription via SMS. They are then given a login name and I.D via return SMS, making access to the network, easy, and user friendly. A SparkNet I.D. gives them uninterrupted access at any location, allowing then to be mobile and work efficiently during their stay in the region even if they are active at several locations in different municipalities. By having access to the shared resources, Masterplanet can provide a broader coverage for commercial users of the network. In addition it can leverage the multiplication role of involved universities and state authorities. For example students get in touch with SparkNet as soon as they enroll. As more and more private companies are joining SparkNet various business models are implemented depending on the type of agreements and type of uses.

### *4.2 Involvement of local Universities*

**ROLE:** The Universities have initiated the network and participate in the network through their own access points and wireless network. In addition they manage and support their own student users. By providing access to each student as soon as they enroll, they are also a very important promoter and multiplicator for the network.

**INVESTMENT:** Investment for the University of Turku has been so far 250 base stations. A base station equipped with SparkNet technology is made available by MP-Masterplanet for approximately 100€. The expense for the university amounts to 25.000€. This means that coverage is available according to need in the most used locations and the student dormitories. The computing centre has financed around 50 stations in larger communal areas or meeting rooms, the other 200 have been bought by the university departments. The departments increase the number of base stations according to their need.

[5] www.masterplanet.fi

The university's computing centre employs furthermore a couple of people who do the installations according to the requests of the departments and are responsible for maintenance. The computing centre also keep statistics of the use so they can track down peer to peer traffic to make sure it is not abused. The computing centre also monitors the radio connectivity which may some time cause disturbances and they have developed automatic recovery.

**GAIN:** The goal of the university was to provide wireless access to staff and students thus to create easy accessibility while enhancing mobility. The fact was that several universities, the Turku Polytechnic and the Turku Science Park are located in proximity to each other and their activities are closely linked and depend on cooperation. This requires mobility between the institutions and departments, staff and students. All three universities had a functioning network and were starting to build up an own WLAN. The idea to join the networks by sharing bandwidth not only created an easy way to cooperate but opened up a wide infrastructure with no additional cost.

The result is that now staff and students, in addition to their email account, automatically receive an active directory password. SparkNet also allows university staff to provide their visitors with access to all the base stations through SparkNet identification. Every institution provides support services for their own users, but each user is able to access wirelessly their own network from whatever location at any of the participating institutions just using the password they are given by their own institutions. For the users the whole area appears like one large network, they don't know that they are actually using several organizations' networks linked to each other. SparkNet technology allows roaming and user management. Every access point is equipped with an authentication gateway (AGW). User management is possible at a single access point globally through rerouting and a centralized database, it is enough that a connection can be established. This makes building separate WiFi services for each institutions irrelevant. Parallel wireless networks are not needed because SparkNet provides the connection to a functioning authentication service.

Every registered student receives an account and a password for the active network which enables usage of all SparkNet stations installed at any location in the region. The student village has fixed connections and it has official SparkNet hotspots. Thus the student village does not provide wireless base stations in addition to the fixed connections, but it does allow students to install OpenSpark if they wish. This was made possible since the beginning of 2006. In general students are encouraged to privately join OpenSpark accounts if this fits their mobile use better. Intrusion and misuse is very uncommon and has created only isolated problems. Heavy users of bandwidth can be identified through their user ID and if necessary the connection can be stopped. The connection can be reopened under certain terms. This applies for both fixed and wireless connections.

### *4.3 Involvement of local government*

**ROLE:** As all other participants, local government provides access points for sharing. In addition it has been since the beginning an important facilitator and promoter of the network.

ICT Turku's managing director was the person that ignited the extended use of SparNet by enabling an agreement between the universities, the city and MP-Masterplanet. Creating a mobile infrastructure for all the working population of the city, be it employed in research, university or public administration, or any professional activity benefiting from mobility, was the highest priority of the activities of ICT Turku Ltd as a city owned company. Thus ICT Turku was instrumental for the materializing of the initial SparkNet agreement. The City of Turku and the City of Naantali were among the first municipalities to be convinced of the benefits. From the city's point of view SparkNet enables in an easy and affordable way to build up coverage throughout the city area while decreasing fiber lines and keeping investment costs at a minimum. Consequently the city decided to equip its offices and employees with base stations to render city

employees whose work depends on mobility most efficient. In order to make sure that city employees using SparkNet would benefit, the city organized training sessions provided by MP-Masterplanet.

Another city led initiative was to make available 400 base stations for free to citizen and entrepreneurs who wish to join OpenSpark and apply for it. It is regarded to be beneficial for entrepreneurs to make full use of mobility within the region. Entrepreneurs can work in the SparkNet area without depending on a physical working space of their own, they can operate in a way that enables them to be truly mobile and constantly connected.

**INVESTMENT:** The city has invested in 250 access points, which are shared within the network and has adjusted the basic infrastructure by investing about 100'000 Euro. In addition additional 500 access points have been purchased and donated to interested citizens.

**GAINS:** There have been no concrete Return on Investment calculations, but the city has gained positive value out of the network with respect to three aspects: coverage of the whole city with low investment, increase in the image, boost of regional development and transformation processes and provision of comfortable, almost free, always on support for employees and student as well as visitors to the city. It reached some of the milestones of the information society strategy by providing infrastructure by combining and leveraging existing infrastructure and investments by industry and citizens.

The involvement of the local municipal government enabled the acceleration to the cooperation between the universities, the administrative unites of the city and local companies. The city of Turku was very determined to implement its information society strategy and its regional development strategy.

### *4.4 Involvement of Citizens*

**ROLE:** Citizens are participating by sharing their Internet access and are at the same time major consumers of the network.

**INVESTMENT:** Each interested citizen needs an Internet access and in addition to that an WLAN access point, which are sold by Masterplanet for about Euro 100.

**GAINS:** As SparkNet connects organizations as owners of a functioning WLAN OpenSpark makes possible a wireless connection to citizen having a functioning ADSL connection independently of the ISP. Each family member receives their own password and OpenSpark allows everyone in the family access to the whole SparkNet community. It is a user friendly solution to be able to move around in a big network, without noticing the technology allowing the connection to the different available networks as one moves from one location to another. This is something that commercial ISPs cannot provide. Even if certain ISPs may cover large areas in certain countries especially providing access for users regularly traveling and using public spaces like hotels, cafés, airports this type of service leaves out other professional, personal, or family needs of being connected.

If a private person wishes to install a wireless network for home use the choice to use OpenSpark is a very affordable one and it has the added value of allowing access not only at home, but also to any other OpenSpark access point as well as to SparkNet access points.

### *5.2. Involvement of ISPs*

**ROLE:** The ISPs have a very important role, as they provide the background wide area Internet broadband connection for users. Without background Internet connection the whole network is not possible.

**INVESTMENT:** For the ISPs there is no additional investment required. However ISPs usually consider initiatives as SparkNet and in particular OpenSpark as threats to their markets and business models. In the Turku case it has been possible to act in agreement with three of the four operators providing internet access to the organizations and to the homes.

**GAINS:** The OpenSpark-SparkNet network has reached a critical mass of users and coverage and provides considerable network effects for users. As such it can be considered a value added by the ISPs as the interest in SparkNet creates additional business opportunities for them. A user can participate in SparkNet-OpenSpark only if he provides and shares his Internet access. Thus ISPs cooperating with SparkNet can gain competitive advantage compared to the operator that resists the idea of sharing the bandwidth they provide with other potential users. This negative reaction was the initial response of the operators, which even tried to take legal measures against SparkNet. The situation has now improved with three of the four operators giving their consent and supporting the SparkNet and OpenSpark concepts.

# 5 Development towards a Living Lab

The concept of Living Labs originated from MIT (see for example Intille et. al. 2005). The concept is constantly being developed at MIT as well as in European institutions and through European projects of the 7th framework programme (some examples of IST projects are BrainBridges, CoreLabs, C@R) (see for example Oliveira et. al. 2006).

Living Labs include a holistic research methodology for sensing, prototyping, validating and refining complex solutions in real-life social contexts. Partners shall include as soon as possible all stakeholders: users and their organizations, developers, service providers, equipment manufactures, cities and their relations are governed by some form of partnership model (*Public-Private-Partnership*). A Living Lab can be summarized as follows:

- Used to explore technical development in a *social context*; moving out of laboratories into *real-life* contexts involving new technologies & end users.
- Major paradigm shift from quality factors towards emotional factors, and lately to customer experience, i.e. a *user-centric* focus.
- A natural move for ICT, life sciences, Earth science and any innovation domain that deals with *human and social problem* solving and *people's everyday lives*.
- Situated research methodologies for sensing, prototyping, validating and refining complex solutions in *multiple and evolving real life contexts*.
- They can cover research involving whole *cities and regions* as well as *communities of practice* and *small groups* being monitored in buildings.

Real-life Living Labs as opposed to “closed Labs” are better able to capture innovative, creative ideas; they stimulate new ideas, provide richer contexts of concrete R&D challenges and allow performing early and continuous validation (not just prototype-testing at the end). Concepts are developed in full-day (user) contexts (users are not viewed as “workers”, “patients”, “travelers” or “citizens” separately).

Furthermore, Living Labs can be used in experimenting the integration of innovative technologies in dynamic and real-life scenarios, thus constantly trying to understand and improve how the concept of Living Labs can develop and help the incubation of new ideas in the normal industrial development cycle. In systematically creating conditions for learning through *innovation* and involving the users at an early stage, the concept seems particularly suited as an instrument for exploring complex “systemic innovations” including high forms of inclusiveness and user-centricity.
SparkNet and OpenSpark provide now a basic infrastructure, which offers opportunities for early adaptors’ experimentation both for public sector service development as well as for commercial validation.

Companies like Nokia may find it of advantage to test mobile internet devices, or e.g. the Health Department of the City of Turku may have the opportunity to include running part of a project that hat received attention at the Stockholm Challenge Award 2006 as a mobile internet service. The ideas concern re-engineering of the health-check up process in public students' health care hoping to generate innovative solutions for using many technologies in one process to arrive at the best possible results. The number of potential clients for applying the new primary health care system of Turku according to the eHealth strategy is about 200'000. With its 1200 base stations and 100.000 user accounts SparkNet and OpenSpark could provide an environment for testing eHealth services on mobile internet. In a Living Lab setting looking at the user in its multiple roles as worker, patient, traveler, citizen, family member, eHealth services may in the end develop in a more user-centric way, creating value for the user at different levels of the usage of ICT and also value for the service providers by being able to identify possible relevant aspects present in connection to other usage.

Further testing and extensions of SparkNet-OpenSpark are planned in two directions: On the one hand development of value added services as for example VoIP. On the other hand extension of SparkNet to the archipelago. In the Turku Region the archipelago area presents a challenge. Connectivity is needed even in the archipelago remote areas on the islands and at sea. SparkNet and the open community of OpenSpark aim at using collaboration in wireless infrastructure to support smooth incorporation of ICT tools into everyday business practices in the archipelago area. In the Turku Archipelago the business development agency has founded a development company owed by the archipelago municipalities with the task to set the infrastructure for applications supporting mobile life and leisure. In May 2005 Skärgårdsnät, the Archipelago net development company, set up WiMax masts to create the infrastructure.

## 5. Results/Findings

### *5.1 Summary of Achievements, Challenges and Critical Success Factors of Collaborative Wireless Infrastructure*

**Achievements:** With the joint efforts of the private-public-citizen partnership the following was achieved:
- Coverage of the city with wireless access enabling an "always on" connection for all involved parties
- Possibility for citizens and employees for comfortable access to services
- Creation of added-value for all involved parties by joining investments and existing infrastructures.

With a minimum of investment a high coverage of access was achieved.

**Challenges:** The organization of this kind of co-operation is challenging. Members want to be very independent in their decision making at all stages. Considering what has been achieved in Turku one can conclude that despite of the potential difficulties of operating a wireless network by sharing capacity SparkNet's excellence lies precisely in this aspect: it is a successful co-operation between independent parties. All member organizations share part of their resources and work input in order for the whole community to gain benefits. The participating organization base their work for the community on the conviction that the best way for one's own organization to benefit is to create value for the whole community. According to the open source principle every organization constantly works on improving the solutions sharing its own resources and benefiting from the parts that are shared.

Some imbalances may at times arise. For example since the computing centers of the different participating institutions have developed different management practices if a user has problems while using temporarily a base station belonging to another network managed by another organization service may vary from what he/she is used to, either because the same type of solutions are not guaranteed by each organization or because the user has no knowledge who the accessed base station belongs to.

The major challenge arises in the attempt to leverage the interests of all players providing access. The developed infrastructure provides clear competition to mobile operators and to some extent to ISPs. In particular the plans to continue development in the direction of value adding services as for example VoIP could enforce the conflict of the competing companies.

**Critical Success Factors:** The main success factors for the WLAN community based on a private-public-citizen partnership can be summarized as follows:

- High dedication, involvement and support by the local government. This was only possible because the government is not involved in ownership with one of the involved telecommunication companies and because there has been no auctioning of spectrum for 3G communication. Given this the government could freely chose the best and most cost-effective solution to provide broad coverage for citizens.
- Sustainable business models of all involved players, that provide continuous added value. With this respect also the readiness of involved players (for example ISPs and Masterplanet) to cannibalize their business in order to achieve added value in a new form.
- Fast reach of a critical mass in particular by joining SparkNet and OpenSpark.

## 6. Conclusions and Further Research

The different models of SparkNet infrastructure may interest other location and be transferable under certain conditions. However, more research into the actual usage of the different models may help to distinguish the features that need to be developed to guarantee that SparkNet keeps momentum. The vision is that SparkNet offers fast and affordable Wi-Fi connection thus enabling mobile Internet. Connections have been slow and expensive but SparkNet changes this thus enabling mobile Internet for heavy use. This leads to new services to be developed especially through the collaboration of local players, this includes several collaborative layers, technological, organisational, societal and human, which can be bundled into a Living Lab community and methodology. Thus research into the role of SparkNet may need to be approached through the kind of setting geared not only for improved local collaboration, but the role of an OpenSpark community and a SparkNet type of collaboration at global level for new innovations. The challenge lies in defining and taking into use new service models using SparkNet and OpenSpark as well as issues of security and privacy.

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