From Macedonia to Mauritius: New Trajectories in Wireless Broadband Development

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Abstract

In the developed world, broad technological dominance and advances in infrastructure deployment have led to commoditized Internet access. In parallel to these trends, two developing countries from different parts of the world are making history by deploying ‘state of the art’ nationwide wireless broadband networks. These two nations, Macedonia and Mauritius, had nothing in common, but since early 2006, both of them will provide their citizens ubiquitous wireless Internet access. Since they will be the first countries in the world to deploy wireless networks at this scale, we seek to analyze the commonalities and differences between technology strategy, government policy choices, public and private institutions, informal citizen networks, and the broader socio-economic impacts of such deployments. In this paper, we describe how these two trajectories are novel, yet significantly different, with a potential for effecting unique types of change.

1. Introduction

Since ‘broadband economy’ is becoming ever more prevalent in the developed world, investing in nationwide broadband Internet access network would seem to be a logical step for developed countries in sustaining their global competitiveness. Nevertheless, two developing countries, Macedonia and Mauritius, with 8 and 15 percent Internet penetration respectively (less then 1% of all Internet access was broadband), became the first in the world to deploy nationwide wireless broadband infrastructure, thus interconnecting businesses, local governments, schools, and citizens [1,4]. Nationwide wireless broadband access within the developed countries is not an immediate necessity primarily due to the sophisticated telecommunications infrastructure and effective business models. Still, many projects aimed at facilitating large-scale wireless broadband access are starting to emerge (including municipal efforts in several US cities), typically followed by a set of reactions (not all passive) from the industry incumbents and regulatory bodies [9,10,13,14].

In this paper, we seek to investigate the suitability of Macedonia and Mauritius for nationwide wireless broadband deployment, the key drivers and initiatives for such activities, and the specific deployment models and actors involved in each case. While acknowledging many similarities, we also believe in the unique characteristics of each country relevant for the success of the particular venture, and more importantly, vital to the potential socioeconomic impact. We further examine the appropriateness of the ‘intelligent community indicators’, as described by the Intelligent Community Forum [5], in building an assessment framework for the impact of these deployments. In addition, we try to compare and contrast the experience from Macedonia and Mauritius to the municipal wireless efforts in the US.

2. Global Internet Trends

Worldwide Internet penetration in 2005 was at 15.7 percent of the world population. However, Internet penetration in developed and developing countries differed significantly, thus extending the ‘digital divide’. Table 1 shows the 2005 world Internet penetration (Internet users per 100 inhabitants) by region and country. North America was the leader with 68.1 percent penetration, while Africa, at the other extreme, only had 2.5 percent Internet penetration.
Asia, with more than one third of the total world Internet usage, had 9.9 percent of its population using the Internet. In Europe, the total penetration was at 35.9 percent but countries from the EU accounted for 49.8 percent, whereas the rest of Europe had 17.5 percent penetration.

Table 1. Worldwide Internet Penetration

<table>
<thead>
<tr>
<th>World Regions</th>
<th>Internet penetration in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>2.5</td>
</tr>
<tr>
<td>Asia</td>
<td>9.9</td>
</tr>
<tr>
<td>Europe</td>
<td>35.9</td>
</tr>
<tr>
<td>EU</td>
<td>49.8</td>
</tr>
<tr>
<td>Rest of Europe</td>
<td>17.5</td>
</tr>
<tr>
<td>North America</td>
<td>68.1</td>
</tr>
<tr>
<td>USA</td>
<td>68.1</td>
</tr>
<tr>
<td>Latin America/Caribbean</td>
<td>14.3</td>
</tr>
<tr>
<td>Oceania/Australia</td>
<td>52.9</td>
</tr>
<tr>
<td>WORLD TOTAL</td>
<td>15.7</td>
</tr>
<tr>
<td>Macedonia(^1)</td>
<td>8</td>
</tr>
<tr>
<td>Mauritius</td>
<td>15</td>
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</tbody>
</table>

As far as Macedonia and Mauritius are considered, they were below the world average for Internet penetration (especially Macedonia), and recent wireless broadband deployments could be seen as a dramatic effort in narrowing the gap between them and the developed world. While US was the world leader in terms of total number of broadband Internet subscribers, China and Japan followed closely in second and third place. However, in terms of household broadband penetration (connections per 100 households), even though the US experienced 12 percent growth in 2005, it was still ranked only nineteenth in the world with 33 percent penetration, while Hong Kong, the leader in this category, had over 73 percent of its households accessing the Internet via broadband connections [8]. In view of workplace connectivity, as of December 2005, more that 85 percent of the US workers actively using the Internet had broadband access.

3. Technology Alternatives for Broadband Wireless Deployment in Macedonia and Mauritius

The Intelligent Community Forum has identified broadband infrastructure as one of the basic indicators of an ‘intelligent community’ [5]. An ‘intelligent community’ represents a town, city, country or a region where Internet bandwidth is considered to be an essential utility, vital in creating economic growth and public welfare. The underlying mechanism of the ‘intelligent community’ is the culture of use, expressed in a skilled and highly mobile knowledge workforce. Increasing technological sophistication, growing user awareness and interest, and the availability of custom content are accelerating the trend towards ‘wirelessly enabled’ broadband communities in multiple global locations. There is an ongoing debate about the most suitable technology for delivering wireless broadband access. To date, wireless deployment has been prominent in university campuses, private and public enterprises, and public spaces in cities from the developed world. In this paper we consider WiFi and WiMAX since they were the choices of Macedonia and Mauritius. The significantly lower cost of deployment (as compared to DSL or cable), the time-efficiency, ease of use and virtual omnipresence, make wireless broadband access the most logical choice for developing countries lacking sophisticated telecommunications infrastructure. In addition, benefits such as increased productivity, opportunities for new business models, greater citizen satisfaction, lower costs, and more effective local governance make wireless broadband access extremely appealing to developed countries as well.

Introduced in 1997 (when IEEE formally developed the 802.11 standard), WiFi (Wireless Fidelity) enabled wireless broadband Internet access via unlicensed spectrum in the 2.4 GHz and 5 GHz bands. In addition, the technology could also be used to wirelessly connect Internet Protocol based devices to each other or to a wire line network [25]. WiFi provided data rates up to 54 Mbps within a range of 20-100 meters, which resulted in various applications including enterprise and campus networking, ad hoc networking, public access in “hot spots”, home networking, and others. There were a number of different 802.11 standards (also known as the “alphabet soup”), which hindered WiFi’s commercial acceptance. The major challenges of WiFi diffusion included the security of wireless networks, the quality of service, total cost of ownership, the compatibility of standards, and the underlying network architecture.

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\(^2\) The percentage was estimated with the help of several NGOs operating in Macedonia, including USAID.
WiMAX (Worldwide Interoperability for Microwave Access) has been referred to as an extension of WiFi. WiMAX provides an increase in range and bandwidth and is being promoted by the WiMAX Forum [23], a wireless industry consortium with over 100 members (including AT&T, British Telecommunications, France Telecom, Fujitsu, Intel, Siemens Mobile). WiMAX was the common name associated with the IEEE 802.16 suite of standards. The first standard was officially published in late 2001 by the IEEE and was followed up by the 802.16a standard in early 2003. Both standards supported peak data rates up to 75 Mbps and had a maximum range of 50 km. The frequency range was 10-66 GHz for line of sight and 2-11 GHz for non-line of sight standards. In the beginning of 2005 the WiMAX Forum started certifying equipment for conformance and interoperability.

4. Deployment Models

The reason behind our interest in Macedonia and Mauritius is simple. They were the first countries to deploy nationwide wireless broadband networks (as opposed to the US, Japan, the EU countries, and South Korea). Considering the size and scope of the wireless broadband networks, these two examples may prove to be the perfect testing ground in analyzing societal and business level research issues [16,21], proper public and private resource management [14,22], as well as the municipal wireless broadband challenges affecting several US cities [9,10,12]. In the sections below, we explore the cases of Macedonia and Mauritius in greater detail.

4.1. Wireless Deployment in Macedonia

4.1.1. Macedonia and its Internet usage profile. Macedonia is a mountainous country located in the Southeast of Europe with a surface area of 25,710 km² and population of 2.1 million people [7]. The 2004 GDP of the country was US$ 5.2 billion, with annual GDP growth of 2.5 percent. Internet penetration in Macedonia was at 8 percent, well bellow the European average of 35.9 percent and the world average of 15.7 percent. However, the telecommunications infrastructure is well developed in terms of fixed and mobile telephony, with more mobile subscribers than those using fixed lines. More specifically, the following briefly describes the circumstances relevant to the Internet usage in Macedonia [6,7,19,20]:

- Only 30 percent of the population used computers with majority of users being students. There were significantly more male than female users.
- The level of computer and Internet usage varied significantly throughout the country.
- Only 8 percent of the population was subscribed to an ISP (with insignificant broadband penetration). 20 percent of the households had computers.
- More than 97 percent of the private and public companies had computers and 80 percent of them had Internet access (primarily dial-up modem connections). The financial industry was the most developed in terms of Internet usage and services.
- E-commerce was not developed and there was a lack of local content providers.

4.1.2. Macedonia Connects: The path to nationwide wireless broadband access. In times when broadband Internet access was considered a luxury, and computer equipment costs were extremely high, a project titled ‘Macedonia Connects’ sought to bring broadband Internet connectivity to all 460 elementary and secondary schools throughout Macedonia [2,20]. The project was officially introduced on December 24th, 2004, by releasing the request for proposals for the expansion of broadband networking and Internet connectivity in Macedonia [28]. The ‘Macedonia Connects’ project was funded by the United States Agency for International development (USAID) and implemented by the Academy for Educational Development (AED). In spite of the primary goal, ‘Macedonia Connects’ had a secondary and tertiary aspiration as well [20]. The secondary goal was to allow low-cost, high-quality broadband connectivity to local governments, educational institutions, SMEs, and various NGOs. The final goal of the project was to provide complete broadband coverage for all businesses and citizens of the country.

The complexity of the project, and its potentially high socioeconomic impact, led to the formation of a public-private consortium which included the Government of Macedonia, its Ministry of Education and Science, USAID, AED, Peoples Republic of China, Microsoft, Motorola, On.Net (the local ISP implementing the wireless network), the Education Development Center (EDC), and iNET [27]. Given the scale of the project, it was decided that the deployment model would be top-down, selecting AED in charge of the management and implementation of the wireless network. Later on, the independent management of the project proved to be crucial to its success. The government was included in the project from its beginning, and it provided the necessary logistics and
The wireless deployment started in May, 2005, by signing an agreement with the local Internet provider On.Net, and by September, 2005 all primary and secondary schools in Macedonia had broadband Internet access and appropriate computer labs. The technology selected by On.Net was a wireless mesh infrastructure using Motorola Canopy System (MOTOwi4 Canopy) and Strix Systems 3630 mesh nodes [3]. The main reason behind the decision to choose wireless broadband solution for Internet access was the low cost of implementation, the ease of use, the current infrastructure and topography of the country, and telecommunication regulations. In addition to primary and secondary schools, On.Net provided connectivity to 24 secondary school dormitories, 15 university faculties, 15 Educational Development Board offices, more than 1000 businesses and 50 municipalities [20]. As of 2006, 95 percent of the country’s population had access to wireless, broadband Internet service [1].

The key drivers of the ‘Macedonia Connects’ project included the liberalization of the telecommunications market, the strategic partnership with Microsoft in implementing the e-government initiatives, computer donations from the Peoples Republic of China, and the IT training of school teachers and government officials, funded by USAID. The lack of low-cost telecommunication services, including broadband Internet access, was usually attributed to the monopoly of the national incumbent, Macedonian Telecommunications (MT). Therefore, the privatization of MT was the first step towards market liberalization. However, many ISPs and telephony operators tried to compete on the new market, but the monopoly of MT continued [27]. On December 31st, 2004, legislation came into effect which ended MT’s monopoly, and ‘Macedonia Connects’ proved to be the real test of market and government maturity in Macedonia. As of 2006, all goals of the project had been met, all primary and secondary schools had free broadband access, and 95 percent of the population was covered with wireless broadband Internet network.

Now, the challenge for Macedonia was to create a ‘culture of use’ and a highly skilled knowledge workforce, capable to innovate and generate content for the ‘broadband economy’.

In summary, the following factors led to successful implementation of the ‘Macedonia Connects’ project: public-private partnerships, liberalization of the telecommunications market, focused involvement of the government, appropriate regulatory environment, donations, independent management, and proper timing.

4.2. Wireless Deployment in Mauritius

4.2.1. Facts about Mauritius and its Internet usage.

Mauritius is a tropical island off the East Cost of Africa, located in the Southwest Indian Ocean. The Republic of Mauritius consists of four islands: Mauritius (with surface area of 1,865 km²), Rodrigues (104 km²), the Agalega Islands (104 km²), and the Cargados Carajos Shoals (1.3 km²). The population of Mauritius is 1,216 million (December 2002) with the highest population density in Africa of 596 persons per km². The country is organized in municipalities and villages; 97 percent of the population resides on the island of Mauritius [26]. The 2004 GDP of Mauritius was US$ 6.1 billion with an annual growth rate of 4.2 percent [24]. Mauritius had 15 percent Internet penetration, well above the African average of 2.5 percent, and close to the world average of 15.7 percent [26]. However, the broadband penetration was insignificant, at least until the country got its first nationwide WiMAX network [4].

4.2.2. Mauritius as a ‘Cyberisland’: From sugarcane to wireless broadband.

Unlike Macedonia’s top-down deployment model, Mauritius used more of a bottom-up approach in developing its wireless broadband network. The liberalization of the telecommunications market and the National Telecommunications Policy adopted in 2004 allowed Networkplus (subsidiary of ADB Networks), in partnership with the WiMAX vendor Navini Networks, to deploy a nationwide broadband wireless network [4]. The deployment efforts started at the beginning of 2005, and as of June 2005 Mauritius was enjoying the portability of its first wireless broadband network, ‘Nomad’. Networkplus was a major independent service and support provider, owned by a private investor from Dubai and a local entrepreneur. A second WiMAX network was already on the horizon. Data Communications Limited (DCL) had applied for a WiMAX license and planed to build a nationwide network. As far as mobile operators were concerned, the market had two major players, Emtel, with its MTMS network deployed in 2004, and Cellplus, the mobile subsidiary of the national incumbent, Mauritius Telecommunications (MT). Emtel was the first mobile operator south of the equator with its TACS network deployed in 1989 and it was a joint venture of Millicom (50 percent), and the local group Currimjee-Jeewanjee Co Ltd. As with wireless broadband, the mobile market was also expecting another entrant, MTNL (Mahanagar Telephone Nigam Limited - India’s state run telecom giant), deploying CDMA
network to provide wireless and fixed wireless services in 2006 [4]. These market conditions indicated strong local entrepreneurship, bottom-up preference in developing the technology, and a healthy investment environment.

The reason behind the choice of WiMAX as a technology for providing broadband Internet access (by Networkplus) can be found in the rugged terrain of Mauritius, the cost-effective implementation solution, ease of use, and plug-and-play connectivity. In addition, the equipment provided by Navini Networks is supposed to take advantage of the next generation mobile broadband wireless access, the 802.16e WiMAX standard [4]. This could imply direct competition with the mobile operators, and its regulation is being considered by the ICT (Information and Communication Technologies) Authority of Mauritius [4,18].

As in the case of Macedonia, the liberalization of the telecommunications market (a process triggered with the privatization of MT), proved central for successful wireless broadband deployment. However, the government still held a substantial share in MT (in control of the submarine fiber-optic cable providing all phone and Internet bandwidth). Therefore, local entrepreneurs and investors in the telecommunication industry identified this issue, and other potential regulatory setbacks, as major bottlenecks in the country’s development efforts for competitive telecommunications market [17]. The exorbitant import duties on technical equipment that reach up to 80 percent were one example of this.

It is important to emphasize the ambitious vision of the Government to transform Mauritius into a ‘Cyberisland’. From sugar production and textile manufacturing, Mauritius had ambitious goals of becoming a high-tech center for computer and telecommunications industries [17]. The government wanted to put Mauritius in a position to go after the lucrative business process outsourcing (BPO) market. The ICT growth policies and guidelines reflected this initiative [17,26]. Mauritius created an incubator to help ICT entrepreneurs over start-up hurdles, and planned to build three high-tech parks, one of which, in Ebene, was already completed [4,17]. In addition, the government had an ongoing initiative, along with the private National Productivity and Competitiveness Council, to educate and train its citizens to be computer-literate and thus globally competitive [17,26]. An advantage of Mauritius was the multilingual society, speaking English, French, Hindi and Creole. This fact allowed for globally competitive content innovation.

5. Discussion and Lessons for Future Wireless Communities

It is important to analyze the recent developments in Macedonia and Mauritius from several different perspectives including: (1) The most relevant dimensions upon which the wireless deployment models are built, (2) Using the Intelligent Community indicators in building an assessment framework for the potential socioeconomic impact as applied to Macedonia and Mauritius, and (3) Comparison to the municipal broadband efforts in other developed countries.

5.1. Dimensions important to selecting the proper deployment model

There are several important dimensions that help define the deployment models of the wireless broadband networks in Macedonia and Mauritius: market conditions, regulative environment, government involvement, user involvement and sophistication, content availability and the current level of the deployed technology.

More specifically, in terms of market conditions, regulative environment, and user involvement, it seems that Macedonia and Mauritius share similar challenges. However, the government involvement and the role of various NGO-initiated programs varies between these two countries, with Macedonia showing higher government participation in projects related to improving the broadband access for educational and government institutions, municipalities, businesses, and individuals. While Macedonia and Mauritius are on the same level in terms of deployed technology, content creation and availability is much smaller in Macedonia, thus requiring proper government intervention to bridge that gap with the rest of the developed world. In addition, both countries opted for nationwide wireless broadband access as a solution to the perceived market
failure, which is characterized as inadequate investment/competition in broadband last mile initiatives [9]. Macedonia had a top-down approach with the management of the project delegated to an NGO, AED, and the funding primarily provided by another NGO, USAID. In addition, there was a host of private/public actors involved in providing basic support related to computer and software supplies, computer and Internet training, and regulatory assistance. In contrast, the Government of Mauritius also sought to provide a competitive regulative environment for the telecommunications industry, but other dynamics were primarily left to the market itself. Accordingly, Network Plus became the first wireless broadband provider in Mauritius, with a second company, DCL, announcing its entrance in the market as well. However, since government involvement was minimal, Network Plus did not provide coverage to the island of Rodrigues due to unfavorable profitability projections [4]. In Macedonia, the project ‘Macedonia Connects’ requested from On.Net to provide wireless broadband access nationwide, especially in areas where other broadband alternatives are not present or where the ISPs are not financially motivated to do so.

5.2. Intelligent Community Indicators

The deployment of nationwide wireless broadband infrastructure in Macedonia and Mauritius can be used as a case in point when considering the ubiquitous nature and the swiftness of emerging technological change. Moreover, the scale of these developments requires an appropriate framework in order to analyze the broad socioeconomic impact both on local and national level. The Intelligent Community Forum (ICF) has placed the ‘Intelligent Communities’ in the core of the emerging ‘broadband economy’ and has identified five key indicators as a conceptual framework for understanding the level of competitiveness of a community in the Digital Age [5]. The five indicators are as follows: broadband infrastructure; knowledge workforce; innovation; digital democracy; and marketing. We believe these indicators can be integrated as part of a promising framework for assessing the potential impact coming from nationwide wireless broadband networks. Both countries satisfy the minimum requirements set by the first indicator, broadband infrastructure. In addition, the government efforts aimed at providing e-government and e-learning services are a substantial part of the fourth indicator, the presence of digital democracy. Having an affordable broadband access to information is only as good as the knowledge workforce responsible for the country’s innovative prowess. The availability of a knowledge workforce is one of the indicators essential to the process of building an ‘intelligent community’. ‘Macedonia Connects’ had a primary goal to provide broadband Internet access to all primary and secondary schools, thus acknowledging the country’s determination in building globally competitive knowledge workforce. In addition, innovation is a process involving various public and private actors, and as such it is an indicator where progress is still to be seen both for Macedonia and Mauritius. These recent deployments, supported with continuous marketing activity, should be a good introduction into an increased effort of promoting the determination for global innovation and competitiveness.

5.3. The US municipal broadband initiative

It is perhaps difficult to make a direct comparison between the experience from Macedonia and Mauritius and the emergence of public and private ‘hotspots’ in developed countries, e.g. the municipal wireless efforts in the US. Effective infrastructure, competitive and established telecommunication operators, favorable regulatory environment, mature markets and diverse funding channels make the developed countries a significantly different setting in terms of deploying wireless broadband networks and utilizing their benefits. Nevertheless, the size of the deployments in Macedonia and Mauritius, along with their potential impact on national level, represents an intriguing reason to assess their commonalities to the US wireless broadband models. At the end of 2005 there were more than 300 municipal initiatives of this kind [11,13], with ‘Wireless Philadelphia’ (Philadelphia, Pennsylvania) considered one of the most relevant representatives.

The primary reason for such municipal involvement is the perceived market failure of the incumbents in providing affordable broadband Internet access [9]. Municipalities have the incentive to pursue broadband deployment either as a wireless broadband provider or as a broadband consumer, or both. The business models being considered in deploying wireless broadband networks vary from community network models (free or low cost access offered by the cities or non-for-profit community groups), public utility models (the city manages the wireless network as a public utility), private consortiums, and cooperative wholesale models [14]. In this context the deployment in Mauritius resembles the private consortium business model (private ISPs are responsible for the wireless broadband deployment), while for Macedonia, the corporate wholesale model fits most appropriately.
As previously discussed, the regulatory environment, state and federal legislations, and reactions from incumbents seem to be a serious challenge for municipalities in their efforts to build wireless broadband networks. The opponents claim there is a failure of the municipal broadband initiatives in creating public value in terms of social prosperity and economic progress [10]. However, the majority of actors involved in the debate agree that municipal broadband plays a critical role in providing ubiquitous Internet access to everyone in the community, thus increasing its competitiveness and socioeconomic value [11,12].

Parallel to the municipal efforts focused on the underserved areas, there is an increasing interest in providing wireless broadband access in areas usually considered to be America’s most wired cities. In this case, private consortiums (Google’s initiative in San Francisco being the most famous example) are interested in providing free Internet access in order to support their business operations, offer their services to a larger market and thus attract more local customers.

6. Conclusions

In conclusion, based on our previous discussion, we would like to put forward several observations regarding the developments in Macedonia and Mauritius. Given the unstable political surrounding of Macedonia, along with the internal issues regarding liberalizing and effectively regulating the telecommunications market, it was impossible for the country to successfully use the bottom-up approach of Mauritius in deploying its nationwide wireless broadband network. Therefore, the choice of public-private partnership with independent management (provided by AED) can be seen as the key factor in the recent success of the ‘Macedonia Connects’ project. It remains to be seen if the societal and economic impact of these deployments would result in new business models and applications. Using ICF’s indicators may be a promising method of assessing the broader socioeconomic effects.

We believe that providing nationwide wireless broadband access is becoming a widespread global trend, and could soon become an important indicator of global competitiveness and socioeconomic prosperity, as well as a powerful tool in bridging the ‘digital divide’ on all levels.

References