Experiences from the Promonte Wireless Broadband Project

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The Promonte Wireless Broadband (PWB) project has been a collaboration project between Telenor Research & Innovation[1)] (R&I) and the Telenor-owned operator Promonte in Montenegro. The PWB project's main goals were to roll out an all-IP network including Fixed WiMAX, Wi-Fi and HSPA using a common core network and to investigate the business potential related to different combinations of these wireless technologies. The project mandate was approved in April 2008 and the project ended October 2009, and currently the PWB network is fully managed and operated by Promonte. This paper summarizes the key experiences from the PWB project and shows up-to-date traffic statistics for the network.

1 Introduction

Accessing and using Internet services is a major trend in people's life all over the world. Using wireless broadband for Internet access is expected to be the main growth area within telecom in the next years, following the saturation of mobile telephony in most markets. As an experienced mobile telephony operator, Telenor should be well positioned to take a leading role in utilizing this opportunity.

In early 2007 the top management in Telenor decided to set up a project to gain operational and commercial experience with different wireless broadband network technologies in an emerging market. Promonte, the Telenor-owned mobile operator in Montenegro, volunteered to take the role as a pioneer Telenor business unit (BU) working together with Telenor R&I to investigate this opportunity. The key goals of the project were set out as follows:

1 Study and understand the characteristics of the Montenegrin broadband market;

2 Design, test and deploy an all-IP network integrating Fixed WiMAX, HSPA and Wi-Fi technologies;

3 Investigate the business potential of these different wireless broadband network technologies;

4 Provide valuable knowledge for other Telenor BUs planning the introduction of wireless broadband.

A key challenge for the Telenor Group is to develop a broadband strategy to meet the market demand in emerging markets. In emerging markets the fixed lines are often in a poor condition or non-existent, and wireless access may be the only sustainable solution in offering broadband services.

By the end of 2007 Promonte had acquired the needed licenses to offer broadband services. As early as 2006, HSPA-spectrum was secured in the 2.1 GHz band, and late 2007 Promonte acquired Fixed WiMAX spectrum (3.6 – 3.8 GHz band) with the purpose of testing the benefit of using Fixed WiMAX to add wireless broadband capacity and expand the broadband offering. With this capability Promonte was in the position to offer broadband Internet services by combining three different wireless technologies – HSPA, Fixed WiMAX and Wi-Fi. Currently, Promonte is offering wireless broadband services from over 70 HSPA base stations and 12 Fixed WiMAX base stations. Both Fixed WiMAX and HSPA are used to feed more than 100 Wi-Fi hotspots at hotels, restaurants, marinas and public sites. In addition, Fixed WiMAX is used to provide fixed Internet access and leased line capabilities to large businesses and governmental agencies.

The PWB network architecture integrates equipment from different vendors, based on different technologies into an all-IP network with a common core network. A third party OSS/BSS solution has been used to integrate this equipment into an all-IP network. This integration was very successful and resulted in a stable, high-capacity network with few resources needed for operations and maintenance.

2 Characterization of the Montenegrin Market

Montenegro is one of the smallest European countries. The area of 13,812 km^2, placed in south western part of the Balkan Peninsula, is populated by 672,000 inhabitants (195,000 households). The diversified geography is characterized by a highly indented Adriatic coastline with narrow coastal plains, backed

1) *Currently Telenor Corporate Development.*

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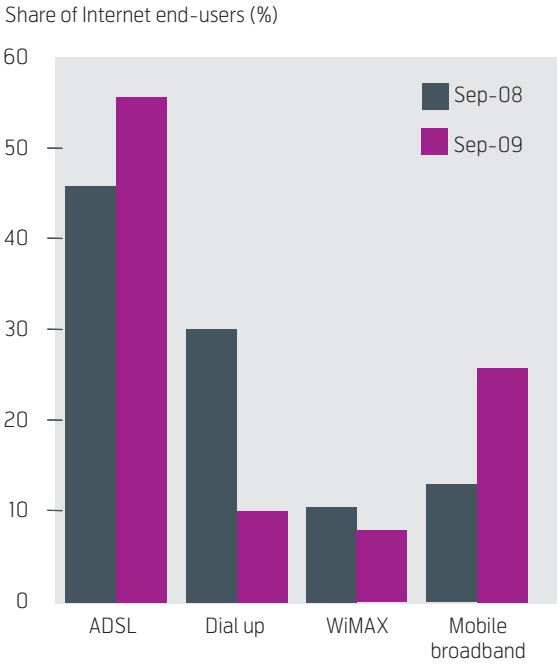

Figure 1 Technologies that end-customers are using for accessing the Internet in Montenegro

by rugged high limestone mountains and plateaus. The administrative and economic centre of Montenegro is its capital Podgorica with around 200,000 inhabitants.

After obtaining its independency in 2006, Montenegro has quite a stable political situation. Governmental activities are guided by a clear ambition to join EU as soon as this will be possible. Strong GDP growth in 2008 (6.9%[2)]) has been slowed down in 2009 by the global financial turmoil and recession. Purchasing power is still low; average gross income is around €650 per month. Tourism is the industry in focus. Each year more than one million tourists visit Montenegro. Usually, around 65% of the tourists visit during the three summer months, which means that the country's population is doubled at that time of year.

The Montenegrin telecommunications market is characterized by declining penetration in fixed telephony, saturation in mobile telephony and strong growth of Internet and broadband services.

There are three major market players:

- T-Com (subsidiary of Magyar Telecom), owner of the landline copper infrastructure, offering fixed and mobile telephony, Internet and IPTV services;
- m:tel (owned by Telecom Serbia), offering fixed telephony and Internet access through a Fixed WiMAX network, as well as mobile services;
- Promonte (owned by Telenor), offering mobile services and Internet access through Fixed WiMAX.

The price sensitive mobile market is mainly driven by promotions and discounts, with multi-SIM customers as a consequence. On top of that, the acquisition peak during the summer tourist season influences the exaggerated mobile SIM penetration.[3)]

The Internet and broadband market is showing strong growth. Still, there is no official Internet penetration figure, but surveys conducted during 2009 by the Regulator Agency estimate that 42% of the households have Internet. An internal Promonte analysis shows an Internet penetration of 45% in September 2009, which is an increase of 11% in 12 months. Figure 1 depicts what technologies that the end-customers are using for accessing the Internet in Montenegro. From this figure it can be concluded that the rapid growth in the Internet penetration is mainly caused by an increasing number of ADSL and mobile broadband subscriptions.

The estimated Internet market share in September 2009 was:

- T-Com (ADSL, dial-up and mobile broadband): 72%
- Promonte (mobile broadband): 14%
- m:tel (Fixed WiMAX and mobile broadband): 14%

Wi-Fi usage in Montenegro is low; only 1% of the users are using Wi-Fi for Internet access.

In spite of a high price perception, popularity of mobile broadband is growing among Internet users. It is mainly due to the simplicity of installation and usage, and service availability almost anywhere.

3 Technical Aspects Related to the PWB Network

3.1 Overview of the PWB Network Architecture

The PWB network is depicted in Figure 2. The network consists of Fixed WiMAX equipment from two vendors, Wi-Fi equipment from three vendors and HSPA equipment from one vendor. A common, third party OSS/BSS solution has been used to integrate

2) *Source: Statistical Office of Montenegro.*

3) *Official SIM penetration in December 2009 was 208%.*

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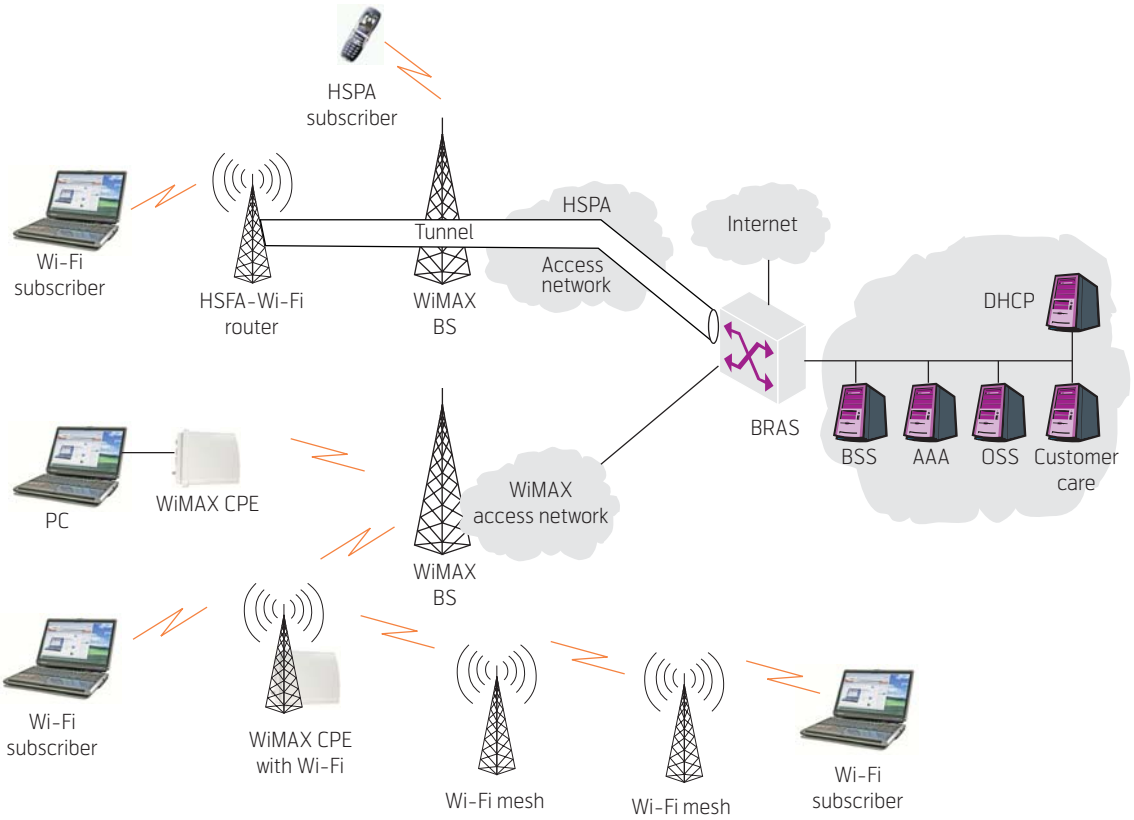

Figure 2 The PWB network architecture

this equipment into an all-IP network. The users of this network are either end-customers connecting wirelessly to Wi-Fi access points backhauled by Fixed WiMAX, end-customers connecting to Fixed WiMAX Consumer Premises Equipment (CPE) or end-customers connecting wirelessly to Wi-Fi access points backhauled by HSPA, so-called HSPA-Wi-Fi routers. The traffic from the HSPA-Wi-Fi routers is tunnelled through the HSPA network to the Broadband Remote Access Server (BRAS), which is the main aggregation point in the PWB network.

The PWB project developed a new solution that made it possible to identify and bill each individual public customer accessing a HSPA-Wi-Fi router. Consequently, all end-customers using Wi-Fi connect via the same core network and can connect to the Internet in the same way independent of the backhaul technology.

The main advantages of the PWB architecture are the following:

- Fixed WiMAX can be used to offer fixed broadband Internet access cost-efficiently in markets with poor copper, cable and fibre infrastructure.
- Wi-Fi access points deployed in hotels, cafés, restaurants, marinas and public places can be used to reach customers who have laptops without an HSPA interface or to reach areas with no HSPA coverage.
- One common core network that can be used to serve all end-customers connecting via Wi-Fi or Fixed WiMAX.
- The modular all-IP architecture makes it possible to select network equipment from different vendors more freely.
- The HSPA-Wi-Fi routers can be used to offer Internet in areas with spare HSPA capacity.

3.2 Fixed WiMAX, HSPA and Wi-Fi

Fixed WiMAX is a technology based on the IEEE 802.16d standard and is tailor-made for providing fixed wireless access. The customers connect to the Fixed WiMAX network via fixed, outdoor CPEs, preferably with line-of-sight between the CPEs and the Fixed WiMAX base stations. Throughputs of up to 5 Mbit/s for a 3.5 MHz channel have been experienced in the PWB network for distances up to 5 km. In lab measurements performed in Norway 10 Mbit/s has been achieved for Fixed WiMAX with a bandwidth of 3.5 MHz. High-Speed Packet Access (HSPA) is standardized by the 3rd Generation Partnership Project (3GPP) and is an enhanced version of UMTS. The real-life throughput of HSPA can be up to 3 Mbit/s for a 5 MHz channel when using the ele-

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mentary version of the standard and only 5 of 15 codes per carrier. It should be noted that for advanced versions of HSPA, the throughput can exceed 40 Mbit/s. In the PWB network, the Fixed WiMAX equipment used the 3.6 – 3.8 GHz band while the HSPA equipment used the 2.1 GHz band.

Wi-Fi is a technology based on the IEEE 802.11 standard that operates in the 2.4 GHz and 5 GHz unlicensed bands. In the PWB network, IEEE 802.11g equipment was used in the 2.4 GHz band while IEEE 802.11a equipment was used in the 5 GHz band, and the real-life throughput of this equipment can reach 20 Mbit/s in environments with little interference. Since the Wi-Fi throughput normally exceeds the throughput provided by the Fixed WiMAX and HSPA backhaul, Wi-Fi is in most cases not the capacity bottleneck in the PWB network. The network architecture consists of Wi-Fi access points both with mesh functionality and without mesh functionality. In a Wi-Fi mesh network, the access points communicate wirelessly with each other and only a few of the access points are connected to backhaul. This makes the network easy and rapid to install and deploy, and it can represent an inexpensive way to increase network coverage and avoid expensive cabling.

3.3 The PWB Core Network Elements

The BRAS is at the heart of the PWB network since all the traffic that is exchanged between the PWB customers and the Internet goes through this network element. In addition to being the main aggregation point of traffic from the PWB access network, the BRAS is responsible for routing traffic in the PWB access network. Furthermore, the BRAS provides the logical termination point for Point-to-Point Protocol (PPP) sessions and is also responsible for enforcing QoS policies corresponding to the different groups of users. Moreover, the BRAS is the interface to the Authentication, Authorization and Accounting (AAA) RADIUS server which is responsible for rejecting or allowing access to the Internet.

The AAA server is one of several servers constituting the PWB core network. In addition, the core networks consist of a Business Support System (BSS), an Operations Support System (OSS), a customer care system and a Dynamic Host Configuration Protocol (DHCP) server which assigns end-customer IP addresses. The BSS controls the customer database and enables the customers to pay for Internet access through a captive portal web page. The customer care system is often seen as a part of the BSS. The customer care web portal can be used by call centre agents and other operator representatives. This web portal allows operators to manage users, manage series of vouchers, generate and manage invoices, define services and set prices for different services. The OSS manages all the network elements and gives alarms related to the status of the network equipment. In addition, the OSS can be used to configure the network elements.

3.4 Key Results from Technical Tests

During the lifespan of the PWB project, several technical tests were performed. The main findings from these tests were:

- The distance between the Fixed WiMAX BS and the CPEs in a sector varies from 1 to 5 km, but most links have line-of-sight or near line-of-sight conditions since the CPE is normally mounted on the roof of the customer site. The large majority of the CPEs reported to have 64 QAM modulation, providing maximum throughput in each Fixed WiMAX sector.

- Outdoor Wi-Fi access points pointing towards the building façade can in some cases be more cost-effective than using only indoor access points for providing good indoor coverage. They are often also faster and easier to deploy than indoor access points. However, deploying outdoor Wi-Fi access points for indoor coverage should only be done when the building façade has a certain transparency for radio signals.

- In a Wi-Fi mesh network, the access points communicate wirelessly with each other and only a few of the access points need to be connected to backhaul. Mesh should be chosen on sites where cabling is difficult and/or expensive. Since the throughput of Wi-Fi is significantly higher than the throughput of Fixed WiMAX and HSPA that were used for backhaul, Wi-Fi mesh was never experienced to be the limiting capacity factor in the PWB network.

- The HSPA-Wi-Fi router was tested with two different HSPA antennas and one directional HSPA antenna, both mounted indoors and outdoors. For an interference-limited HSPA network, using an external, omni-directional HSPA antenna positioned in eg. the window, will in most cases not improve the throughput compared to the standard omni-directional antenna mounted directly on the router. However, using an external, directional antenna pointing in the direction of a base station will improve the throughput significantly due to improved gain and interference suppression.

- Two different outdoor Wi-Fi access points with adaptive beamforming were tested in a city area

Techno-economic analysis	Business case modelling
• Based mainly on equipment prices and network performance data	• Predicts profitability
• Does not include revenue and thus not profitability	• Includes forecasts of revenue
• Is often used for benchmarking and comparison of different technologies	• Includes forecasts of costs, CAPEX and OPEX, from the techno-economic analyses
• Typical output: Capital expenditures (CAPEX) per site, CAPEX per subscriber, CAPEX per Mbit/s, Operational expenditures (OPEX) per subscriber	• Typical output: Internal Rate of Return (IRR) and Net Present Value (NPV)

Table 1 Main characteristics of business case modelling and techno-economic analyses

with 4-storey buildings. A basic cost/benefit analysis shows that it was not cost effective to select outdoor Wi-Fi access points with adaptive beamforming arrays for the PWB project.

4 Business Cases and Techno-Economic Analyses for the PWB Network

In this chapter both business cases and techno-economic analyses will be presented. The main differences between these two types of analyses are summarized in Table 1.

4.1 Techno-Economic Analyses

The following two techno-economic analyses for Promonte's network will be presented here:

- CAPEX for different HSPA deployment options
- CAPEX of HSPA vs Fixed WiMAX for backhaul
- Cost analysis: Fixed WiMAX vs DSL

CAPEX for Different HSPA Deployment Options

In this section the CAPEX of different HSPA deployment options will be investigated. These numbers are based on the assumption that the HSPA base stations are located in existing sites and include upgrade costs for backhaul, transport network (SDH) and core network for different HSPA deployment options[4]. Figure 3 shows the cost elements as a percentage-distribution for each network configuration. Base stations and backhaul are identified as the most significant cost drivers, while core network elements, transport network upgrades and radio network controllers have little impact on the total cost. Note that the share of radio network controllers and core elements increases with higher capacity HSPA deployment options.

Figure 4 shows the total CAPEX per Mbit/s for a 3-sector 3G/HSPA base station. From this figure it is clear that the CAPEX per Mbit/s decreases with higher capacity HSPA deployment options. In theory, the number of Mbit/s offered by the network is proportional to the number of customers that can be supported. This may indicate that an operator deploying HSPA has less CAPEX per customer the more customers it has. However, for flat rate subscriptions this may be a dangerous conclusion to draw since often only a few of the customers will consume the main part of the capacity. Moreover, it seems likely that such high-consuming customers will select the operators offering the highest throughput.

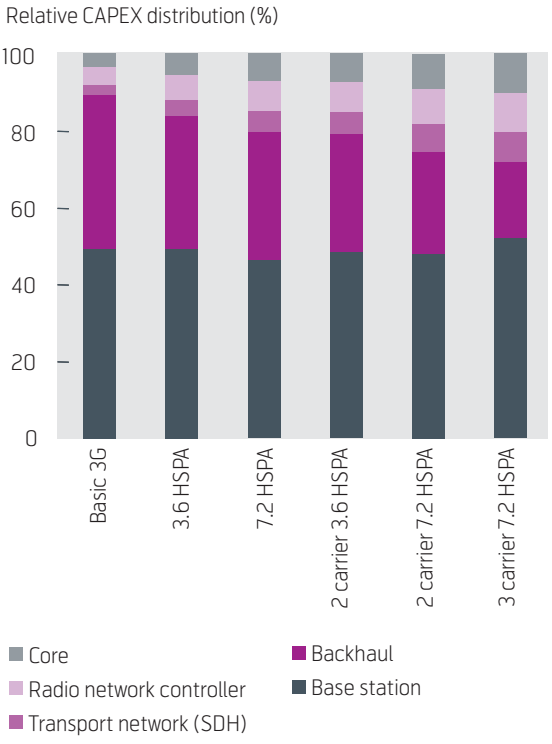

Figure 3 CAPEX distribution for the different HSPA deployment options

[4] *Basic 3G refers to UMTS as specified by 3GPP's Release 99.*

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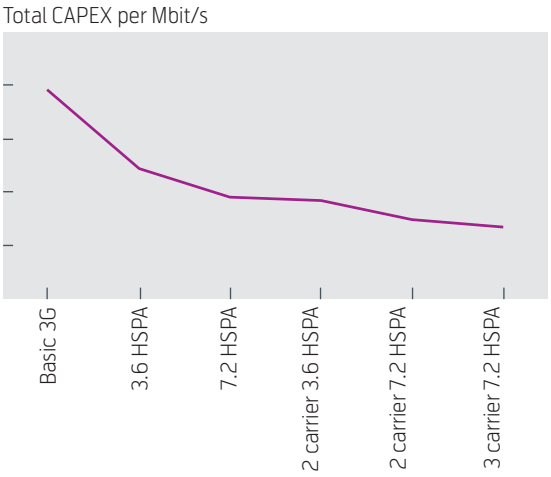

Figure 4 CAPEX per Mbit/s for different HSPA deployment options

Note that in the PWB project Wi-Fi is only used as a 'nomadic' complement to the country-wide mobile broadband offering, which is based on HSPA. Therefore it does not make sense to compare directly the capacity cost of HSPA mobile broadband versus the capacity cost of Wi-Fi or Fixed WiMAX. The services (mobile vs nomadic) are simply too different. However, the PWB network also uses HSPA as a backhaul solution for Wi-Fi hotspots. In this situation the capacity cost of HSPA as backhaul solution can be compared to the capacity cost of Fixed WiMAX as backhaul solution. Such a comparison will be performed in the next section.

CAPEX of HSPA vs Fixed WiMAX for Backhaul

Since the Wi-Fi equipment is low-cost, the backhaul cost of Wi-Fi hotspots is the main cost factor for the Wi-Fi business. Hence, a cost analysis of using HSPA versus Fixed WiMAX as backhaul solution for Wi-Fi hotspots in the PWB network has been performed.

The CAPEX of the following two Wi-Fi backhaul options were compared:

- Deployment of a new Fixed WiMAX/Wi-Fi network, based on co-location with existing GSM/3G sites;
- Upgrading of the existing basic 3G (UMTS Release 99) network, where all added capacity is allocated to broadband (no circuit-switched voice).

The results show that the Wi-Fi backhaul based on Fixed WiMAX can have lower cost per Mbit/s than the corresponding cost for the Wi-Fi backhaul based on the HSPA network.

It is important to realize that the HSPA network supports full mobility, while the Fixed WiMAX/Wi-Fi network can only support fixed and nomadic usage. Hence, Fixed WiMAX/Wi-Fi is only to be preferred in situations where

- Broadband capacity shall be provided to fixed or nomadic customers within a smaller geographical area; and
- There is no spare capacity in the existing 3G/HSPA network.

In the PWB project the main use of the Fixed WiMAX network has so far been as a backhaul solution for public Wi-Fi hotspots. A broadband network with Wi-Fi as last mile access enables the operator to reach all Wi-Fi-enabled laptops and smartphones. By complementing the HSPA network with Wi-Fi in highly populated areas, the traffic from Wi-Fi-enabled, nomadic and capacity intensive laptops can be off-loaded onto the WiMAX/Wi-Fi network. This will increase the throughput that can be offered to each customer and decrease the cost per Mbit/s compared to a pure HSPA network.

Cost Analysis: Fixed WiMAX vs DSL

Since Fixed WiMAX can be used to offer fixed broadband services to businesses and households, Fixed WiMAX can be a direct competitor to DSL in many markets. A techno-economic comparison between Fixed WiMAX and DSL for the Montenegrin market has therefore been performed. The main conclusions from this analysis are:

- DSL has a lower cost base than Fixed WiMAX, except for extremely low subscriber numbers. This is because the cost driver is the subscriber equipment and the associated installation cost, which is much higher for Fixed WiMAX than for DSL.
- Fixed WiMAX has a larger coverage area than a DSLAM, and this will result in a better business case for Fixed WiMAX compared to DSL in sparsely populated areas.
- In general, it was found that Fixed WiMAX is more profitable for a population density less than x inhabitants per km^2 and that DSL is more profitable for a population density of more than y inhabitants per km^2, where $x < y$. For population densities between x and y, a case-by-case analysis must be made in order to conclude. For the Montenegrin market[5)] x equals 10 inhabitants per km^2 and y equals 50 inhabitants per km^2.

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In most countries with good quality fixed telecommunication infrastructure, it can therefore be concluded that Fixed WiMAX will only play a marginal role as an additional technology to cover some rural areas. However, in many emerging markets, Fixed WiMAX and HSPA/LTE seem to be the only technologies that can be used to offer fixed broadband in the near future.

4.2 Business Cases Including HSPA, Fixed WiMAX and Wi-Fi

For all telecom operators it is essential to evaluate profitability of its offerings, taking into account market trends, competition, internal strengths and weaknesses. Both external industry analyses and company-internal analyses are important to achieve sustainability of good results and satisfying margins. In the PWB project, a profitability analysis was performed for the study period 2008-2015 for the following four cases:

The business case analysis described below shows that Case 4 is the most profitable. However, achieving this profitability will require strong focus on the marketing and sales process and some organizational changes, and thus this case is also seen to be the case with the highest risk. With a modest broadband demand, deploying only HSPA (Case 1) can serve the customers' needs more profitably.

- Case 1: HSPA to consumer and businesses (no Fixed WiMAX or Wi-Fi)
- Case 2: Case 1 + Wi-Fi in hotels, restaurants, cafés, marinas and public places
- Case 3: Case 2 + Fixed WiMAX to businesses
- Case 4: Optimistic Case 3 + Fixed WiMAX to consumers

Key Facts and Assumptions for the Business Cases

Several scenarios and cases were found relevant. In order to efficiently analyze these, a profitability analysis model was built. The model includes the complete broadband business in Promonte, covering HSPA, Fixed WiMAX and Wi-Fi. On the revenue side, forecasts of the market potential, market share and the possibility to manage a holistic product portfolio are considered. The cost side includes technical and market-related OPEX, and CAPEX regarding deployment of HSPA, Fixed WiMAX, Wi-Fi networks. The key modelling assumptions are:

- Fixed WiMAX is considered as Promonte's answer to T-Com's DSL products.
- HSPA and Fixed WiMAX are offered both to business customers and consumers, Wi-Fi is offered mainly to tourists and travelling business people.
- Fixed WiMAX is seen as an interesting value proposition for business customers in the growing tourism industry in Montenegro.
- The products and pricing in the model are based on the existing product portfolio on HSPA and Wi-Fi, while assumptions for the Fixed WiMAX offering is based on competitors' prices and discussions with Promonte.
- The speed of customer adoption for the various products is based on Internet and PC penetration, purchasing power, availability of the devices, and forecasts on the market share potential.
- HSPA, Fixed WiMAX and Wi-Fi network deployment is based on different population densities in three topographical areas (rural, urban and dense-urban), and the traffic demand from the segments for each product. The network coverage is based on the roll-out plans Promonte has committed to through their Fixed WiMAX license, see Figure 5,

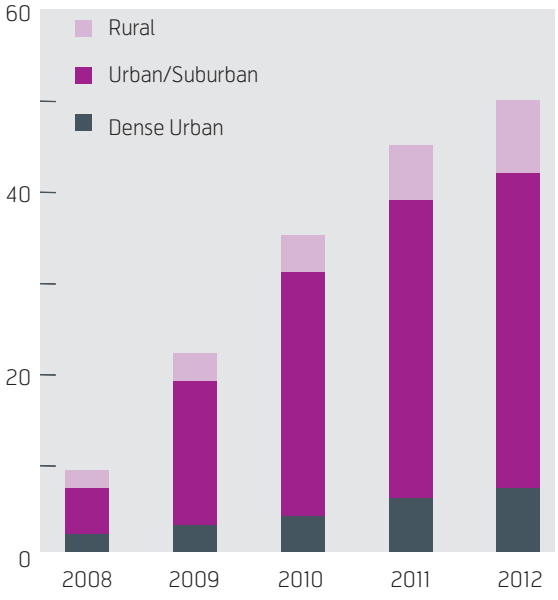

Figure 5 Number of base stations based on Promonte's commitments stated in the Fixed WiMAX license. The actual number of base stations deployed is 12 at the end of 2009

5) *One uncertainty with the underlying calculations is that detailed information about the status of the fixed telecommunication network in Montenegro has not been used. Hence, it is possible that there will be more costs (eg. installation work) related to deploying DSL than what has been included.*

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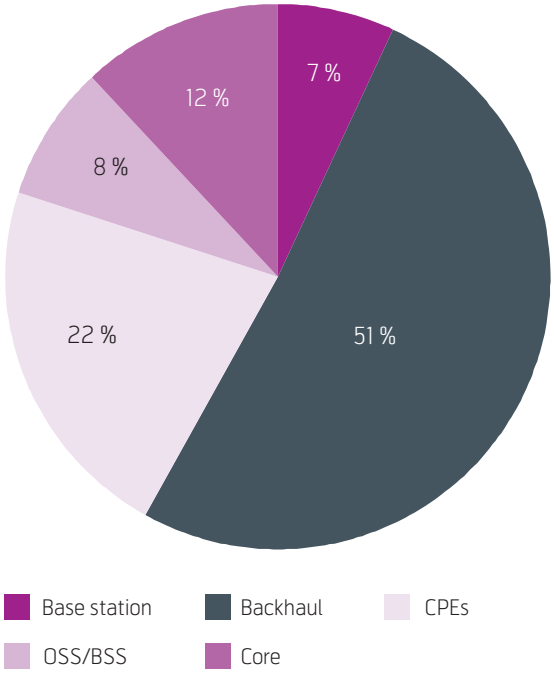

Figure 6 CAPEX breakdown for Fixed WiMAX in Case 4, 2008-2012

while capacity is calculated based on traffic assumptions on down-links. The network modelling has been further developed and used in several other Telenor broadband projects [Elnegaard].

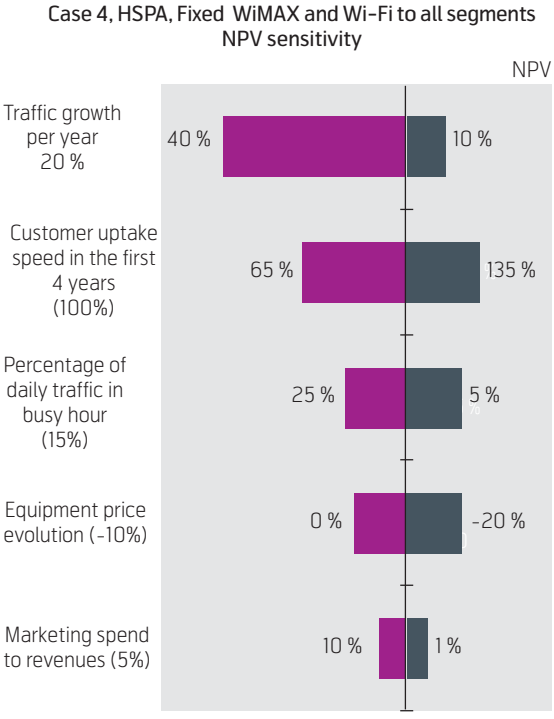

Figure 7 Results of the sensitivity analysis for Case 4 where HSPA and Fixed WiMAX offerings are available to all customer segments

CAPEX and OPEX Analysis

The results of the CAPEX and OPEX breakdown structure analysis for all wireless broadband technologies in the PWB network show that HSPA CAPEX and OPEX are the most dominant due to the wide-area deployment of this technology and more customers using mobile broadband. In addition, most of the backhaul costs are sorted under HSPA costs. Wi-Fi has the lowest CAPEX and OPEX covering only the costs related to Wi-Fi access points and minor additional headcounts. Costs related to core and transmission are included either through HSPA or Fixed WiMAX. Figure 6 shows the CAPEX breakdown for Fixed WiMAX in Case 4. This shows that the main CAPEX driver is backhaul, when backhaul upgrade is needed. The key OPEX drivers are staff costs (56%) and sales and marketing (20%).

Sensitivity Analysis

In order to create a sustainable business, it is important to know which parameters affect the profitability and to what degree. The impact of parameters, such as traffic growth, customer growth and equipment price on NPV was studied through sensitivity analyses. The main results of the sensitivity analysis of Case 4 are shown in the Tornado chart[6)] in Figure 7. This chart depicts how the NPV is influenced by a variation of five main parameters. The base case parameters in Case 4 can be read in the parenthesis after the parameter name. The vertical line in the figure illustrates the NPV with these base case parameters, and the bars on each side of this base case line illustrates how NPV varies when the selected parameter varies to the values shown in the bar edges. This is a helpful tool when analyzing what effect the most sensitive parameters have on NPV.

The sensitivity analysis for Case 4 indicates that the most sensitive parameters are:

Annual traffic growth above 20% without any changes in price levels has the highest potential for negative impact on the financial results. Several drivers can explain high traffic growth:

- The introduction of flat pricing or price reduction per volume;
- Service portfolio management. Since different applications generate different load, it is also important to look at an impact of introducing new services on the capacity load.

Speed of customer uptake where the results show that slower time to market would affect the profitability

6) *Tornado chart shows the influence of varying one parameter at the time in a multi-parameter 'what-if' analysis.*

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severely. Note, however, that the changes of market shares in these two extreme values are not considered. Successful uptake can be achieved through affordable and transparent pricing, increased broadband access and terminal penetration, attractive services and effective marketing.

Traffic concentration in busy hour affects the costs of network deployment. Therefore, mechanisms to reduce busy hour traffic while trying to increase usage and revenues should be considered and analyzed. Offerings such as different prices for different times of the day, with higher rates for busy hour could increase the profitability through less need for capacity upgrades and a higher customer uptake.

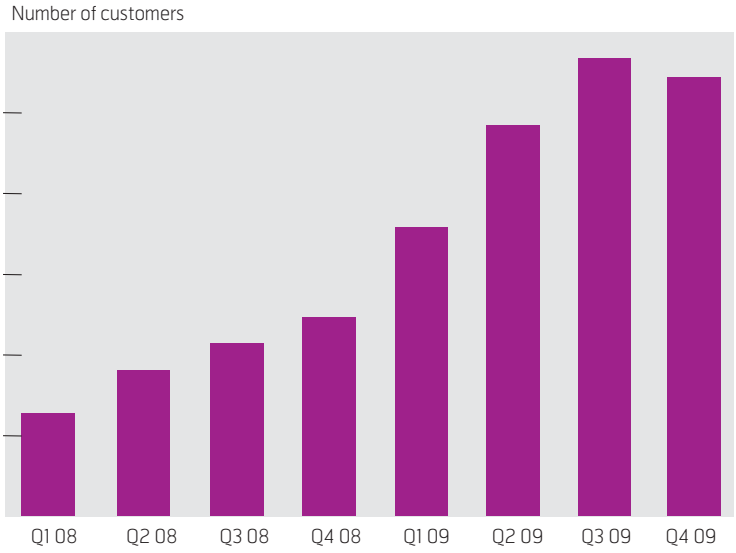

Figure 8 Promonte's mobile broadband customers

5 Traffic Statistics

5.1 Mobile Broadband

In January 2008 Promonte launched the Internet Anywhere products as its mobile broadband offer. The four postpaid and one prepaid packages are intended for large-screen Internet access through HSPA/UMTS/EDGE/GPRS modems. These products are based on charging per volume of traffic. At the end of 2009 mobile broadband customers constituted almost 3% of the total customer base.

Figure 8 shows the development in Promonte's mobile broadband customers. The small dip in the number of customers from Q3 to Q4 in 2009 comes as a consequence of mobile broadband subscriptions used by tourists during the summer months.

Since the mobile broadband launch, the total data traffic growth has been very fast: during the last two years the total data traffic has increased 14 times. The aggregated data traffic in Promonte's network increases almost linearly with the number of mobile broadband customers since the increase in data traffic is mainly caused by the large-screen customers. These large-screen customers now generate about 80% of the total data traffic in Promonte's mobile network. On average, the 2G (EDGE and GPRS) data traffic amounts to approximately 17% of the total data traffic while the 3G (UMTS and HSPA) data traffic amounts to approximately 83% of the total data traffic in Promonte's mobile network.

The average traffic generated per mobile broadband customer is increasing very slowly which indicates that mobile broadband subscriptions are used for basic Internet services, eg. email, browsing, news and community services. The daily traffic profile shows that mobile broadband subscriptions are mostly used for private purposes. During the day traffic is growing and has a peak between 9 pm and 11 pm, see Figure 9. Each of these two busy hours is contributing to 13% of the total daily traffic.

The latest official market share figures show that Promonte's mobile broadband market share is 59%[7]. During this period the main customer uptake driver was availability of low-priced modems for large-screen Internet access.

5.2 Wi-Fi Hotspots

The Wi-Fi access points in Promonte's network are both backhauled by WiMAX and HSPA. Figure 10 shows the development in the total number of Wi-Fi customers per quarter in Promonte's network. The peak in Q4 2008 comes as a consequence of a campaign with free of charge access. In opposition to HSPA, the number of Wi-Fi customers is low. This

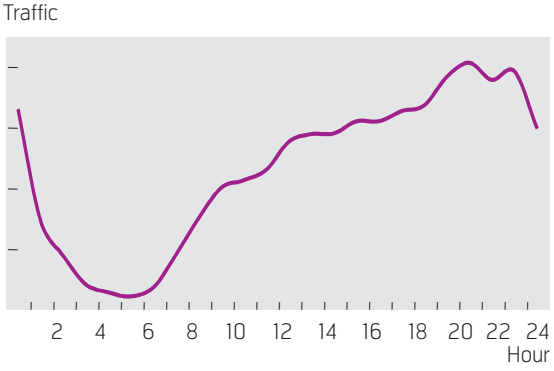

Figure 9 The average daily traffic profile for Promonte's mobile broadband customers

7) *Regulator Agency annual report for 2008, published in June 2009.*

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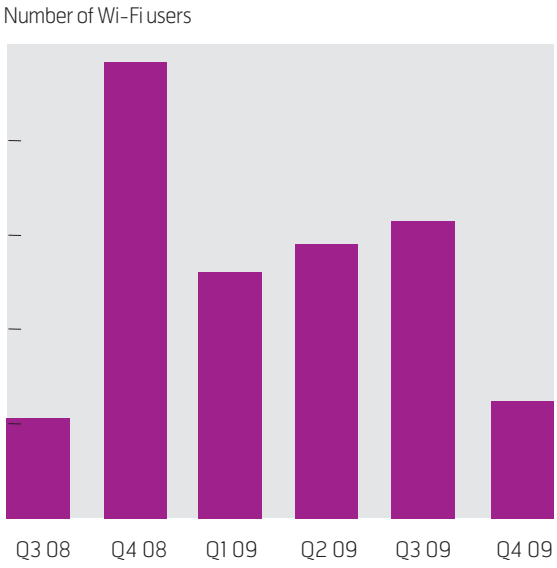

Figure 10 Number of Wi-Fi users per quarter in Promonte's network

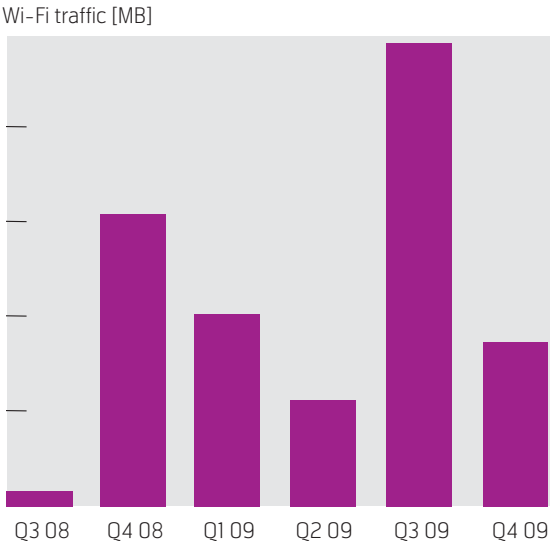

Figure 11 Total traffic generated by the Wi-Fi customers per quarter

seems to be caused by low interest among local population and tourists, high price perception, as well as low awareness about the offer. However, for Telenor's Norwegian Wi-Fi network 'Trådløs sone', the traffic development was also very slow in the first three years of operation, which indicates that the customers need time to become aware of the Wi-Fi offering from Promonte.

Figure 11 shows the development in the total aggregated Wi-Fi traffic per quarter in Promonte's network. The average consumption per user per month is around 500 MB, which is similar to the mobile broadband consumption. The Wi-Fi traffic peaks during the summer tourist season, which indicates that Wi-Fi users are mainly tourists.

The daily traffic profile for Wi-Fi is similar to HSPA with continuous growth during the day and busy hour between 10 pm and 11 pm.

Fixed WiMAX subscriptions for consumer and business market were launched in Q4 2009, and no traffic statistics are yet available for this customer segment.

6 Concluding Remarks

The PWB project has designed, tested and deployed an all-IP network integrating Fixed WiMAX, HSPA and Wi-Fi with a common OSS/BSS. This network also includes a unique solution that makes it possible to identify and bill each individual public customer accessing a Wi-Fi router with HSPA backhauling. This enabled Promonte to deploy low-cost public Wi-Fi hotspots. It took two months from signing the contract with the integrator until the network was commercially launched.

Through different business case and techno-economic analyses, HSPA was found to be the most profitable technology for the next few years, with good upgrade potential to cover a large number of customers with high capacity needs. However, Fixed WiMAX together with Wi-Fi can be a cost-efficient complement to HSPA, especially in areas without a fixed infrastructure like copper, cable and fibre. Achieving profitability for Fixed WiMAX/Wi-Fi will require a strong focus on the marketing and sales process.

Reference

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