Determining the Viability of a Mobile TV Ecosystem with the Monte Carlo Method

Kris Van Bruwaene¹, Pieter Veevaete (formerly with²), Olivier Braet³, Etienne Deventer¹, Wout Joseph¹, Lieven De Marez², Luc Martens³ and Pieter Ballon⁴

¹Vlaamse Radio- en Televisieomroep (VRT), 1043 Brussels, Belgium, {Kris.VanBruwaene|Etienne.Deventer}@VRT.be
²Research Group for Media & ICT (MICT), Ghent University/IBBT, B-9000 Gent, Belgium, Lieven.DeMarez@UGENT.BE, Pieter.Veevaete@gmail.com
³Dept. of Information Technology, Ghent University/IBBT, B-9050 Ghent, Belgium, {Wout.Joseph|Luc.Martens}@INTEC.UGENT.BE
⁴Studies on Media, Information and Telecommunication (SMIT), Vrije Universiteit Brussel/IBBT, B-1050 Brussel, Belgium, {Olivier.Braet|Pieter.Ballon}@VUB.AC.BE

Abstract

Mobile TV has been trialed in several countries, and some have started commercial operations, but the recent failure of two high profile ventures points to an uncertain future. In this paper we describe a model to investigate the viability of a mobile TV ecosystem, with particular emphasis on Flanders (Belgium). We cope with the uncertainties in market penetration and take-up rate by combining a survey with a Monte-Carlo simulation.

Keywords

Mobile Television, Business Modeling.

1 Introduction

In recent years mobile TV has received considerable interest in Europe and several other countries. At the time of writing (April 2008) ten countries have started commercial operations with the DVB-H standard and more are to follow in 2008. Other standards (DMB, Media-FLO, OneSeg) are being used commercially in different parts of the world. It is as yet unclear how succesful these ventures will turn out to be in the long term, as two have already ceased operations after only a short lifetime.

In this paper we investigate the viability of a mobile TV ecosystem, with particular emphasis on Flanders (Belgium). We avoid the problems of risk and revenue sharing between partners by concentrating on a single entity, called the ecosystem.

2 The Ecosystem

The ecosystem under consideration consists of most elements of the mobile television value network, with the exception of the content providers and the handset supply chain. It comprises the broadcast network operator, carrying most of the investment risk, content aggregators
and service providers. The latter are typically mobile telephone operators, taking care of customer relations like billing and help desk.

We consider this as a single entity, although in reality competing operators may be part of the ecosystem. Therefore, the ecosystem should not be considered as a vertically integrated monopolist. The objective is merely to investigate the viability of mobile television as a whole in a particular market, irrespective of the number of operators offering the service, but preferably (although not necessarily) sharing the risk by using a common broadcast infrastructure. This approach also avoids the problems of risk and revenue sharing between partners in the value chain, which have been covered elsewhere [Ballon e.a. 2008].

We consider two revenue sources for the ecosystem: direct user payments and a share of the revenue earned by commercial content providers by broadcasting to mobile devices, such as advertising or tele-shopping. The latter source can also be interpreted as a carriage fee for broadcasting the content, or could be implemented as a rebate on the content fee the ecosystem pays to the content providers.

Revenue or costs associated with consumer equipment (i.e. handsets) is left out. This is typical for the Flemish market, where combined sales of handsets and subscriptions are forbidden by Belgian law. Yet handset penetration and its growth are vital parameters in the model, but without any monetary consequences to the ecosystem other than market size.

3 Growth Modeling

Although the eventual market penetration of the service determines the long term viability of mobile TV operations, the rate of growth towards this final penetration has an impact on the viability as well. In the starting phase, the ecosystem accumulates considerable debts for the network build-out and initial operations. If growth occurs too slowly, the ecosystem may succumb to its debts or interest payments. Shareholders may come to the rescue, but will only do so if there is a prospect of sufficient profit in a not too distant future.

Growth modeling is often over-simplified in commercial business models, usually only by a linear ramp-up. We have chosen the more elaborate Bass model [Bass 1969]. The Bass model can be seen as a linear combination of two simpler models, as shown by the differential equation for penetration growth $F(t)$:

$$F'(t) = p(1 - F(t)) + qF(t)(1 - F(t))$$

The solution to the first term is the exponential distribution, starting as a linear ramp-up, backing off as the market saturates. The parameter $p$ is called the coefficient of innovation, and depends on the marketing effort. The second term is the logistic curve. It describes “contagious” growth, proportional to the market share already obtained $F(t)$ and the share remaining to be “infected” $1 - F(t)$. Parameter $q$ is the coefficient of imitation.

The parameters $p$ and $q$ can be derived from the penetration of identical products or services in related markets. This posed a problem: when we started the project in early 2006, only the Korean market had mobile TV in commercial operation; other markets (Japan, Finland, Germany, UK, Italy) would only begin shortly afterwards, and take-up figures were very scarce. Moreover it was unlikely that Flanders would exhibit the same take-up as the Korean market.
We chose to enlarge the scope by not just considering identical, but related products and services. To be related, a product or service must have one or more of the following characteristics in common with mobile television: mobile or portable use, rich content (payed or free), interactivity, recent growth and the Flemish or Belgian market. This gave us a very broad range of services, which was narrowed down by requiring the public availability of market figures (usually taken from quarterly reports). We ended up with a list of 32 platforms.

First we gathered market figures for each of these platforms during their growth period (up to the second or third quarter of 2007), and fitted these with the Bass model. The fit was performed with the Levenberg-Marquardt algorithm implemented in the Gnuplot program [Gnuplot]. To facilitate convergence, we first fit with the logistic curve and used the resulting saturation value and time constant ($T$) as seeds for the Bass fit (with $q = 2/T$).

It appears that in the majority of cases, the coefficient of innovation $p$ is about an order of magnitude smaller than the coefficient of imitation $q$. We therefore ran the Monte Carlo simulations with a fixed $p = 0.0574$, the average value over the 32 platforms.

To obtain a distribution for $q$ in the simulation, we constructed a cumulative distribution, which was then curve-fitted with a Weibull distribution (Fig. 1). We found no particular reason why this should be a Weibull distribution, it just happens to offer the best fit (Kolmogorov-Smirnov $p = 0.96$) compared to other candidate distributions such as log-normal ($p = 0.75$), Rayleigh ($p = 0.74$) and exponential ($p = 0.46$).

![Cumulative frequency vs. Bass $q$ (year)](image)

**Figure 1: Weibull fit to the $q$ values.**

The resulting cumulative distribution:  \[ P(q) = 1 - e^{(-q/\lambda)^k} \] has shape parameter $k = 1.509$ and scale parameter $\lambda = 0.982$.

One important parameter remains to be determined: the eventual market penetration of mobile television, as a function of its price. This is the demand curve, covered in the next section.
4 Market Modeling

In order to be successful we assume the ecosystem will have to offer a substantial range of channels, in the order of ten or more. If that is the case, the shape of the demand curve will be near Gaussian, according to the central limit theorem: the value of the offer to any individual is the sum of the (for that individual) random value of every available channel.

To determine the position of the demand curve we conducted an internet survey in parallel with the start of the user trial (September 2007). Over 4000 correspondents were invited, 727 completed a questionnaire, 575 remained after thorough data cleaning.

The Product Specific Adoption Potential (PSAP) method [De Marez 2006], [Verleye e.a. 2005] was applied to obtain a reliable segmentation forecast for the adoption of mobile TV. PSAP validates the adoption intentions with overlapping questions and respondent-specific targeted questions based on their previous answers regarding willingness-to-pay and interest in mobile television applications and content. The users were allocated to one of three adopter segments, based on their adoption potential for mobile television as a whole: earlier adopters (6.1 percent of the respondents), early majority (10.6 percent) and later adopters (83.3 percent).

![Model (Gaussian):](image)

Figure 2: Upper and lower Gaussian demand curves

A question on the willingness-to-pay for a mobile TV handset indicated that 53.4 percent of the respondents had no intention to buy a handset at all. This figure was used to scale down the results of the following questions on willingness-to-pay for services. 24.2 Percent of the respondents were only interested in free to air mobile TV, 24.5 percent opted for pay-per-view (PPV) and the remaining 51.3 percent preferred a monthly subscription fee.

We joined the PPV and subscription classes, which allowed us to draw two curves: one “lower bound” demand curve with the earlier adopters and early majority added together, and an “upper bound” with the full sample, both scaled for handset adoption. The free-to-air viewers were added to the upper curve at price zero. Figure 2 shows the resulting penetrations and the best fitting Gaussian demand curves.
Both curves intersect at around 50 euros per month, which allows us to construct random curves between the two limiting ones, by just forcing them through the intersection point. A curve is then determined by only a single random parameter, either its slope (the standard deviation of the normal distribution) or its mid-point (average) where penetration reaches 50 percent. Note that for both limiting curves the mid-point is located at a negative price, -28.5 and -3.0 euros/month respectively.

5 Model Specifics

We confine ourselves to some important or salient features.

5.1 Network Costs

One important feature is the cost of the broadcast network. As Flanders and Brussels are densely populated in a relatively small area and mostly flat (i.e. easy to cover with terrestrial transmitters), we aimed at full indoor coverage with portable reception. A question about willingness to pay for outdoor-only reception resulted in a value less than half the value for indoor reception.

Five possible network configurations to achieve full indoor coverage with 16QAM modulation have been reported elsewhere [Joseph e.a. 2007]. The capital expenditure (capex) corresponding to the various options ranged from about 20 million to 100 million euros. The lowest cost option, using high masts exclusively, many of which would have to be built, is considered unachievable. Joseph e.a. (2007) also includes a way to recalculate the number of stations required with other modulation parameters. We applied this for QPSK modulation, thereby halving the bit rate and the number of programs on offer.

![Graph showing distribution for network CAPEX with coverage scenarios and modulation schemes](image)

**Figure 3: Distribution for network CAPEX with the coverage scenarios and modulation schemes**

To model the capex we used a similar technique as we did for the Bass $q$, but with a normal distribution: many scenario options (mast height, transmitter power, site location, antenna type) contribute additively to the cost. The result (Fig. 3) shows a mean of 74.5 million euros.
with a standard deviation of 10 million euros for a 16QAM-network, and 27.8 million euros mean and 5.6 million standard deviation with QPSK. Network operational expenses and deprecations are modeled as linear functions of the capex.

5.2 End User Price

As the ecosystem typically comprises several competing service operators, it can be expected that each of them will develop its own pricing scheme and bundles with other services. In the long run this will turn most of the consumer surplus into revenue. At this stage however it is impossible to incorporate these pricing schemes in the model. If the model selected only random prices, it would perform suboptimally businesswise, compared to the real pricing schemes. We therefore chose to always select the optimum price, yielding maximum income from the demand curve. This has the additional benefit of removing a random variable (price) from the model, thus reducing uncertainty.

5.3 Viewing Time

Viewing time has a direct impact on advertising revenue, and is therefore also part of the model. It was not yet (at the time of writing) measured in the Flemish trial, so we based our figures on the results of other trials, which showed rather consistently viewing times in the order of 30 minutes per day. We allowed a standard deviation of 10 minutes on this value. The monetary value of viewing time was derived from the total television viewing time in the Flemish market, and its commercial value. It appears that viewing time and its value have only an insignificant impact on the final value of the ecosystem.

5.4 Other Parameters

The model contains a number of fixed parameters, mainly covering costs (e.g. for conditional access, customer relations, spectrum license, wages, marketing) and accountancy data (taxation rates). Most of these were retrieved from public sources. Where this was not possible, we consulted an expert panel of industry representatives within the trial project. Inflation is left out of the model, but is implicitly catered for by a lower capital cost (see below).

The results presented below have a network deployment time of one year before the start of commercial operations, and an entirely equity financed network, i.e. no initial debt. Applying debt financing appeared to be very detrimental.

The content cost varies uniformly between 30 and 60 percent of the average revenue per user (ARPU). We consider it equitable to use the same percentage for the return of advertising revenue to the ecosystem.

5.5 Capital Cost

The weighted average cost of capital is also used as the discount rate for the net present value calculation, and as the interest rate for debt and for financial assets. We chose a random variable with a normal distribution centered around the inflation-corrected estimate of 10 percent, with a standard deviation of 2 percent.
6 Results

6.1 Net Present Value

The main result is the net present value (NPV) histogram of the ecosystem. Fig. 4 shows two typical examples. To enable comparisons between countries the NPV is normalised per capita, based on a fixed head count of 6.15 million. NPV is calculated over a term of 22 years, to cover at least one full equipment replacement cycle.

The peaks on the left represent scenarios that end in bankruptcy, most of them within six years.

![Histogram of NPV per capita for a 16QAM network (left) and a QPSK network](image)

**Figure 4:** Histogram of NPV per capita for a 16QAM network (left) and a QPSK network

6.2 Sensitivity

Equally revealing is the correlation of the resulting NPV with the random input variables to the Monte Carlo method. This can be considered the sensitivity analysis of the model. Table 2 lists – for the 16QAM network only – the varying parameters with their distribution and its characteristics, and in the final column the correlation with the NPV, in descending order of their absolute value. The model appears to depend mostly on four parameters: demand, take-up speed, content costs and network capex. Not surprisingly, the determining factor for survival is rapid growth (high Bass $q$) coupled with high demand. Scatter plots between pairs of values reveal further interesting relations.

**Table 2:** Random input variables to the model and their impact on NPV

<table>
<thead>
<tr>
<th>Variable</th>
<th>Distribution and parameters</th>
<th>cor. w. NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid-point demand price (€/month)</td>
<td>Uniform, low = -28.55, high = -2.97</td>
<td>+0.45</td>
</tr>
<tr>
<td>Bass $q$ (year$^{-1}$)</td>
<td>Weibull, $k = 1.509$, $\lambda = 0.982$</td>
<td>+0.44</td>
</tr>
<tr>
<td>Content cost (% of arpu)</td>
<td>Uniform, low = 30, high = 60</td>
<td>-0.33</td>
</tr>
<tr>
<td>Network capex (M€)</td>
<td>Normal, $\mu = 74.54$, $\sigma = 10.23$</td>
<td>-0.30</td>
</tr>
<tr>
<td>Capital cost (%/year)</td>
<td>Normal, $\mu = 10.0$, $\sigma = 2.0$</td>
<td>-0.15</td>
</tr>
<tr>
<td>Viewing time (min/day)</td>
<td>Normal, $\mu = 30$, $\sigma = 10$</td>
<td>+0.01</td>
</tr>
</tbody>
</table>
8 Conclusion

Combining a web survey with a Monte-Carlo business model shows that the success of mobile television in Flanders is highly dependent on demand and content cost, more than on network capital expenditure. It suggests that further market research is essential before rolling out mobile television, and that new attractive applications may be required to enhance the success rate. Although care has been taken in selecting the model parameters, caution is due in interpreting the result. The authors are aware of assumptions that could influence the result in a positive or negative way, but space constraints prohibit us from entering into details. It would be unwise to base investment decisions exclusively on our results.

9 Acknowledgments

This article is based on results from the MADUF project, funded by the Interdisciplinary Institute for Broadband Technology (IBBT), a research institute founded by the Flemish Government in 2004, as well as by partner companies Belgacom/Proximus, Cisco/Scientific Atlantic, Nokia Siemens Networks, Option International, Telenet and VRT.

References


Gnuplot: http://www.gnuplot.info/


Program

Wednesday 16th July 2008 (More..)

Thursday 17th July 2008 (More..)

Friday 18th July 2008 (More..)

09:00 - 11:00

Workshop: Adaptive Multimedia and IPTV Streaming over P2P Networks

- Network efficiency in P2P Streaming
  - M. Alhamdi, A. Lotte
- Peer-to peer Service Level Negotiation: towards QoS and security guarantee
  - M.A. Chafou, N. Yacoubi, Y. Belaid, F. Krif
- Determining the Viability of a Mobile TV Ecosystem with the Monte Carlo Method
- End-to-End Admission Control Mechanism for Multimedia Streaming over SP-driven P2P Networks
  - M. Moustak, T. Ahmed
- System Architecture for advanced TV Services in an IPTV Environment
  - P. Seeger, C. Roshan, S. Lubicz, M. Becker, F. Balon