Preface

This research is conducted for the Technical University of Delft, faculty Technology, Policy and Management at T-Mobile. The objective of this research is to find out whether the knowledge that is gained in the past 4.5 years has been sufficient to finish my masters.

In this research I focus on the impact of mobile VoIP on the financial position of the mobile operators. The Porter model is used to analyze which forces either create a sustainable environment for mobile VoIP or become a hinder. The forces are internal rivalry, new entrants, supplier power, buyer power and substitution. Based on the competitive analysis, an empirical model is designed with which the financial impact of the scenarios will be calculated. This will clarify how mobile VoIP can have an impact on the mobile operator and what the mobile operator could do.

I would like to express my gratitude to my mentors from TU Delft; they are Ir. Rudi Westerveld and Ir. Hendrik Rood. They have been a great support and guide, and I appreciate their efforts for my research. I also want thank Fred Herrebout of T-Mobile for his support, guidance and proper directives in the course of this research. Finally, I want to thank Prof. Rene Wagenaar for his input regarding this research.

I also want to thank my parents, my little brothers Zeeshan and Shayan Khan for their support. Next to my family I want to express my gratitude for the friends who helped me with my thesis. Those are A. Yavuz, C. C. Schouten, K.Putter, N. Bharosa, R. Bueno de Mesquita, and S. Tariq. Thank you very much for your support.

Delft,

Kanwal Khan
Executive summary

In this research the main scope is the Dutch mobile voice market. It is defined as the market where customers are able to call from any place in the Netherlands. The competition is high between the four mobile operators and also mobile virtual network operators have accessed the market. They have done that by enclosing a wholesale deal with a mobile operator. This way they can deliver the similar mobile services. The MVNO’s have lowered the entry barriers by enclosing a deal. These were high because the mobile operators have obtained all the licenses for the GSM and UMTS network and each provider has almost 100% coverage in the Netherlands. The consumers and suppliers of handsets and dealers have very small effect. In the case of the consumer it has mainly to do with the fact that the switching cost of post-paid user is high. Besides that, the customer isn’t only price sensitive but wants a combination of price, quality, services and brand.

Handset suppliers have the disadvantage that the switching cost of the mobile operators is low and they are their largest customers. Next to that the dealers are dependant of the commission they receive from the mobile operators to sell their subscriptions or service.

Voice over Internet Protocol (VoIP) will lower the entry barriers as a technology. Customer needs a mobile broadband connection and a device. This way the mobile operator can be bypassed by the VoIP provider. VoIP will be defined at three ways. These manners are selected because two of them have entered the fixed telephony market, which are peer-to-peer (Skype) and indirect access (Vonage). Peer-to-peer means that the customer who has VoIP software can only communicate with the person, who also has the VoIP software on his smart device. In the case of indirect access the customer can call anybody and be called by anybody. This is possible by means of a gateway, which allows off-net calls.

The last way is the convergence of fixed to mobile. This is possible at two ways, which are by means of UMA. That way a WLAN becomes a part of the GSM network. Next to that the customer could also use his WLAN by means of VoIP to call and the GSM network to call when he is not within reach of his WLAN or when he is called. BT is going to deliver a similar service named Blue phone in UK.

Skype and Vonage have a certain success on the global fixed telephony market. Customer has called for nearly 30 minutes per month peer-to-peer and 100 minutes with Vonage. An average customer calls almost 200 minutes. So the impact could become high. The converged model could also have large effect. This has to do with the fact that a fixed network operator or ISP or cable provider could stimulate this model strongly. That way it would be able to compete with mobile operators which have resulted until now from fixed to mobile substitution.

When VoIP providers will enter the market they will have to bridge the entry barriers. Those are the smart devices, coverage of the mobile broadband networks, and quality of those networks for VoIP in specific and the mobile numbers to be able to deliver comparable services as the mobile operator. Besides the entry barriers the customer has to become accustomed to usage of mobile internet, mobile VoIP and using soft phones on their smart device. A soft phone is software that you can download on your device and then you see a phone in your screen. At the moment customers barely use mobile internet according to researches of Telecom paper. Neither do customers use their devices for such technical issues, because they are very reluctant in using new applications. This is also based on prior research of the usage of customers.
The handset suppliers create for the VoIP provides a sustainable environment, because they develop devices which have as feature IP telephony and access to WLAN. Next to that even the mobile operators could create a business environment that is attractive for the VoIP providers when they will focus more on UMTS and the devices which support new applications. At the moment VoIP provider have very high entry barriers therefore they could only have effect when the above mentioned developments take place. Therefore scenarios are designed in which the impact is calculated for the mobile operator. The calculation is done by means of an empirical model which is also based on the competitive analysis.

The scenarios that are designed represent the year 2008. The reason that this time horizon is chosen has to do with the fact that then the UMTS network will be rolled out fully, WLAN will become more available, the penetration of smart devices will increase and the bugs in UMA and the devices will be solved.

There are designed four scenarios which are labeled as following:

- Aggressive VoIP providers
- Mobile network operators rule
- Fixed network operator in the driving seat
- Mobile broadband services becomes successful

These are the scenarios that are analyzed. The conclusion that can be derived based on the analysis is that there can’t be said in general what the financial impact will be for T-Mobile. This has to do with the fact that the behaviour of a customer is very unknown. The choices a customer would made based on price quality ratio could be very different than the scenarios has assumed. There could be given an indication that when these scenarios will occur as defined than the following conclusions can be derived for one customer in specific who calls 200 minutes.

The first and the last have the most financial impact for that particular customer. The first one creates a financial benefit for the mobile operator because the prices won’t be reduced much and the interconnection cost will reduce when customer use VoIP. Also the SAC will reduce, because VoIP providers deliver devices to the customer. This way the mobile operator will mainly earn by means of mobile VoIP.

In the last scenario the financial impact will be negative because the customer won’t have to pay very low price for access to mobile internet. This way the mobile operators will have to receive their earnings from the services they will deliver for mobile internet. That would also mean that the mobile operators will have invested a lot in the new services to make them viable and attractive for the customer.

In the second scenario the mobile operator loose the earnings from the calls to foreign destinations. This scenario does have financial impact for that particular customer. Only it depends how the mobile operator positions itself towards UMA and whether the fixed network operator will deploy wireless LAN’s by himself to make his service more attractive and promote heavily the devices which are necessary for either UMA or VoWLAN. A WLAN will always be constrained by area where the access point is positioned. The loss for the mobile operator will be the minutes that he will loose when customers will use their WLAN to call from home cheaper. In the case of UMA the mobile operator could earn by means of the whole sale deal that the FNO has to enclose to use the GSM network of the mobile operator and integrate UMA.
T-mobile is recommended to act at the moment defensive because VoIP isn’t a threat today. Yet, it has to take into consideration that by acting defensive it could loose revenue. Customer could choose to use mobile internet for more application and services then only for VoIP. Therefore an offensive behavior could be considered in the future when more researches have taken place and it would seem that the defined scenarios could occur.

In that case T-Mobile has to focus in specific on the first and last scenario, because it could have the largest impact per customer. Also the other two has to be taken into account. T-mobile should apply the followed strategies that could have the most effect, which are:

- Pricing
- Introduce new (mobile broadband) services
- Become a service provider of wireless LAN’s or other applications
- Deliver VoIP by itself.

T-mobile will be advised to research few aspects in further detail which aren’t done in this research because of the scope of the research and the time limit. First of all it would be important to analyze what the price elasticity is of a customer and how the customer base of T-mobile will react on VoIP. This way the whole financial impact for T-Mobile can be analyzed. That means that each price plan would have to be taken into consideration by T-mobile.

Next to that it is also important to know to which extent the quality price ratio is important for the customer. Then it would become clear how the customer will react on changes in the price quality ratio.
## Abbreviations

<table>
<thead>
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<th>Description</th>
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<tr>
<td>ADSL</td>
<td>Assymetric Digital Subscriber Line</td>
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<tr>
<td>AUC</td>
<td>Authentication Centre</td>
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<tr>
<td>BSC</td>
<td>Base Station Controller</td>
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<tr>
<td>BSS</td>
<td>Basic Service Set</td>
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<td>BT</td>
<td>British Telecom</td>
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<tr>
<td>BTS</td>
<td>Base Transceiver Station</td>
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<td>COIN</td>
<td>COMmunication Infrastructure</td>
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<td>EIR</td>
<td>Equipment Identity Register</td>
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<tr>
<td>GSM</td>
<td>Global System of Mobile Communication</td>
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<td>GSN</td>
<td>GPRS Support Node</td>
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<td>GPRS</td>
<td>General Packet Radio Service</td>
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<tr>
<td>H.323</td>
<td>Defined according to ITU as packet based multimedia communication systems. H.323 can also be used for session control.</td>
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<td>HLR</td>
<td>Home Location Register</td>
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<td>IETF</td>
<td>Internet Engineering Task Force</td>
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<td>IP</td>
<td>Internet Protocol</td>
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<td>ISP</td>
<td>Internet Service Provider</td>
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<td>MDA</td>
<td>Mobile digital assistant</td>
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<td>MMS</td>
<td>Multi Media Services</td>
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<td>MOS</td>
<td>Mean Opinion Score</td>
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<td>MSC</td>
<td>Mobile Switching Centre</td>
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<td>MVNO</td>
<td>Mobile Virtual Network Operator</td>
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<td>Nma</td>
<td>National competition authority (Nederlandse mededingings autoriteit)</td>
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<td>NRA</td>
<td>National Regulation Authority</td>
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<td>OPTA</td>
<td>Onafhankelijke Post en Telecommunicatie Authoriteit</td>
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<td>PATS</td>
<td>Public Available Telephony Service</td>
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<tr>
<td>PC</td>
<td>Personal Computer</td>
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<tr>
<td>PSTN</td>
<td>Public Switched Telephone Network</td>
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<td>QoS</td>
<td>Quality of Service</td>
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<td>ROC weight</td>
<td>Rank Order Centroid weight</td>
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<td>SAC</td>
<td>Subscriber acquisition cost</td>
</tr>
<tr>
<td>SGSN</td>
<td>Serving GPRS support node</td>
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<tr>
<td>SIM</td>
<td>Subscriber Identity Module</td>
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<tr>
<td>SIP</td>
<td>Session Initiation Protocol</td>
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<tr>
<td>SMARTER</td>
<td>Simple Multi-attribute Rating Technique Exploiting Ranks</td>
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<tr>
<td>SMS</td>
<td>Short Message Service</td>
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<tr>
<td>TCP</td>
<td>Transmission Control Protocol</td>
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<tr>
<td>UMA</td>
<td>Unlicensed Mobile Access</td>
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<td>UMTS</td>
<td>Universal Mobile Telecommunication System</td>
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<tr>
<td>UNC</td>
<td>UMA Network Controller</td>
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<tr>
<td>USIM</td>
<td>UMTS subscriber identity module</td>
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<tr>
<td>VLR</td>
<td>Visitor Location Register</td>
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<tr>
<td>VNO</td>
<td>Virtual Network Operator</td>
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<tr>
<td>VoDSL</td>
<td>Voice over Digital Subscriber Line</td>
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<tr>
<td>VoIP</td>
<td>Voice over Internet Protocol</td>
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<tr>
<td>VoWLAN</td>
<td>Voice over WLAN</td>
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<tr>
<td>W-CDMA</td>
<td>Wide band Code Division Multiple Access</td>
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<tr>
<td>Wi-Fi</td>
<td>WLAN</td>
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<td>WLAN</td>
<td>Wireless Local Area Network</td>
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1. Introduction

1.1 Situation of the telecommunication market
The current state of the Dutch market consists of high competition. This has to do with the entrance of new competitors who deliver similar services as either the network operators or ISP’s. For example triple players have bundled the fixed, broadband services and cable for television. Sometimes the customer can also get mobile telephony in the same package. That way they deliver the customer a complete package. The customer won’t require any other network operator or ISP for the similar services1.

The Dutch telecommunications market exists of fixed operators, mobile operators, cable providers, ISP’s, (A)DSL providers, equipment and handset suppliers, MVNO’s, and IP telephony providers. Each of these actors are positioned in a certain market segment and a certain part of the value chain. Their positions within the market will be elaborated in the following section. This will illustrate how each actor is positioned and how they want to protect their market share. In figure 2 (in appendix introduction) is shown the interdependency of these actors. Each of these actors’ perspectives is mentioned in table 1 of appendix introduction.

Mobile network operators
Up to the 28 June 20052 the mobile market in the Netherlands had five mobile operators that each had their own mobile network3. After the merge of KPN and Telfort there are four mobile operators. Telfort will remain as brand in the market. By doing so KPN has gain a market share of 53% and has now nearly all the MVNO’s that are active in the mobile telephony market4. There are two MVNO in the market that aren’t owned by KPN and that is Scarlet and UPC which utilizes the network of Orange to deliver their services. The position of each mobile operator in the mobile telephony market is based on his market and revenue share. KPN has the largest market and revenue share, which makes it the biggest player within the mobile market. After KPN Vodafone is the biggest followed by T-mobile and finally Orange (see figure 1). By looking at the market shares it becomes clear to what extent they are capable to gain a larger share, change from position and how much impact their strategies could have on the other mobile operators. The strategies of KPN and Vodafone have a big impact on the positions of the other two mobile operators, because they have obtained a larger market and revenue share than the other two. Therefore T-mobile and Orange will have to put in a lot of effort to be able to compete with Vodafone and KPN and eventually gain market shares.

The strategies of KPN and Vodafone are somewhat based on their history. They were the first who entered the market5. That way they could orient themselves mainly on the business segment and the consumer market. T-Mobile and Orange are mainly focused on the consumers and small/medium business markets6.

1 http://www.scarlet.nl/scarlet-one.php 18/08/2005
2 Global Antitrust weekly, 25 June -1 July, Issue 342, page 6
3 The Dutch telecommunications market 2000, P.J.P. Ballon, PRO Verhoest, TNO rapport, 2000, page 85
4 Citigroup smith Barney, Telfort acquisition, 28-06-2005, page 2
5 The Dutch telecommunications market 2000, P.J.P. Ballon, PRO Verhoest, TNO rapport, 2000, page 85
6 Dutch mobile operators, Telecom paper research, Dirk Bout, September 2004
The handset suppliers are very important for the mobile market because a consumer cannot use the service of the mobile operators without a handset. The mobile operators take into consideration the preferences of the consumer and then choose a certain supplier for their devices. At the moment there are a number of handset suppliers from which the most visible suppliers in Europe are Nokia, Motorola, Sony Ericsson, Siemens and Samsung. Based on the market share the position of each handset supplier can be decided. Nokia is the one who has the largest market and revenue share. The other suppliers are mentioned in a rank order namely Motorola, Samsung, Siemens and lastly Sony Ericsson with the smallest market and revenue share. The market share as mentioned in Table 1. The number of these handset suppliers is small and act reciprocal towards the mobile operators because they are their buyers. Only they also take into account the preferences of the customer because they also sell directly to the customer, not only by means of the mobile operator.

On the other hand it is also important for the handset supplier to follow the market and be able to differentiate by means of new features or shapes of handsets. Inclusion of IP telephony, WLAN and other types of features could add value to their product. That way they could increase their market share.

<table>
<thead>
<tr>
<th>Market share</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
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<tbody>
<tr>
<td>Nokia</td>
<td>35.1%</td>
<td>34.8%</td>
<td>30.5%</td>
</tr>
<tr>
<td>Motorola</td>
<td>16.3%</td>
<td>14.5%</td>
<td>15.4%</td>
</tr>
<tr>
<td>Samsung</td>
<td>9.8%</td>
<td>10.8%</td>
<td>12.7%</td>
</tr>
<tr>
<td>Siemens</td>
<td>8.2%</td>
<td>8.4%</td>
<td>7.3%</td>
</tr>
<tr>
<td>Sony Ericsson</td>
<td>5.3%</td>
<td>5.2%</td>
<td>6.2%</td>
</tr>
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Table 1: Market share of the largest handset suppliers in Europe

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7 Morgan Stanley, Telfort merger, 28/06/2005
8 Strategic Analytics
Fixed telephony
The fixed telephony market exists from mainly carrier select operators, virtual network operators, ISP’s, ADSL providers, cable providers and the network operator. The several operators active in the fixed telephony market have resulted into high competition. For example, one prominent VNO is Tele2 who is active in as well the fixed as the mobile network and has gained a certain market share of approximately 3.2%. Besides this, several ISP’s has started to bundle fixed, mobile and internet services. That way they have started to act as a triple player. An example of such a triple player is Scarlet, who delivers fixed telephony, mobile telephony, and digital TV and internet services as one package to consumers.

Next to this fixed telephony also has to compete with the mobile operators. A lot of customers are switching from fixed to mobile telephony\textsuperscript{10}. Therefore the fixed network operators and ISP’s must also compete with the mobile operators and MVNO’s.

The position of the ADSL providers is rather different from the other actors within the market. They only lease ADSL lines to ISP’s. Any other actors who want to deliver ADSL services can hire some capacity from those lines. Some ADSL providers are also ISP’s, such as KPN, Tiscali, and Wanadoo. Because of that, they can act strategic in more segments and gain market shares.

IP telephony providers
IP telephony providers have IP PBX with which they deliver voice services through the IP network. Mostly the business segment is the target group of the IP telephony providers. Enterprises have their own IP network, which has to do with the excessive usage of electronic communication and data transfer. By means of the IP telephony providers, these enterprises can also have voice services through their IP network.

The emerging technologies allow these players to orientate themselves on several market segments and increase competition. The main emerging technologies have been voice over DSL. The current new technology which has started to enter the market is voice over internet protocol (VoIP). Voice over DSL has allowed several ISP’s to deliver voice services over the fixed network. VoIP is different from VoDSL, because VoDSL has to be connected to a certain ADSL line\textsuperscript{11}. VoIP can be placed on the top of any network which is connected to the IP network\textsuperscript{12}. As result VoIP, as a technology, has a nomadic character. The description of VoIP will take place in detail in the second chapter.

Ministry of economical affaire
The ministry has as goal to increase the welfare of Netherlands. This is possible by creating such an economical environment that the buyer power of the consumer will increase. Therefore sees the ministry VoIP as a way to enhance competition. The ministry is the one who can change the number plan whenever required; only it takes time before the changes take place. In the number plan each number has a certain location in which it can be used. So numbers can’t be used for nomadic use. With nomadic use is meant that a number isn’t related with a certain location. In the further research there will be analyzed whether a change will be required for VoIP and whether a change will take place.

\textsuperscript{9} Telecom paper research, Dirk Bout, 20/09/2004, page 20
\textsuperscript{10} De digitale economie 2004, CBS, page 43-44
\textsuperscript{11} Voice over packet technology, Stratix, December 2003, VoIP options for OPTA, page 13
\textsuperscript{12} Voice over packet technology, Stratix, December 2003, VoIP options for OPTA, page 2
National regulation authority, OPTA
The last and very important actor is OPTA, who regulates the telecom market. “OPTA is a governmental institution and operates as an independent organization. It has to comply with law and regulations for post and electronic communications services. The main objectives of these regulations and laws are to enhance competition. This will increase the buying power of the consumer”\textsuperscript{13}. The laws and regulations are based on the telecommunication law and the directives, which are set by the European Union. Each country can take adequate measures for the particular markets with the regulations as directives. In this way the governments of each country can respond adequately to changes in the telecom market.

National competition authority (Nma)
Nma is an institution which follows the activity of the market and steers when possible oligopolies or (private) monopolies are developing. Until now Nma isn’t much involved with VoIP yet, because it has just started with entering the fixed telephony market. When monopolies or alliances or any kind of barriers are created against a new entrant, then the Nma reacts on those activities.

These were the three main regulatory bodies in the Netherlands, which have impact on the several actors, who operate in the telecommunications market.

1.2 T-Mobile as problem owner
T-Mobile is the mobile operator for whom this research will be conducted. T-Mobile is a mobile operator that delivers voice services by means of its GSM and GPRS network. T-Mobile will also deploy the UMTS network according to the license that they obtained in 2000\textsuperscript{14}.

The main goal of T-Mobile is to make profit and gain a rate of return. This has to do with the obligation they have towards their shareholders. To be able to make profit they have to deal with their competitors. These consist of approximately 30 parties. Three of these are mobile operators and the other competitors are MVNO’s which have focused on certain niches\textsuperscript{15}. Therefore it is important that they analyse the strategies of the competitors and plan their own strategies to cope with the competitors. The department strategy marketing is responsible for the analysis of the market regarding possible changes that could have negative impacts on the revenue of T-Mobile.

The main objective of the strategy department of T-Mobile is to develop a path to deploy long term strategies. T-Mobile will be able to act in time when changes in the market occur. To them Voice over Internet Protocol (VoIP) was a new technology which could become a possible threat or benefit for T-Mobile. That is why they want to conduct research to analyze what the impact of mobile VoIP will be in the future. T-Mobile will be able to act in time and have a clear view of the possibilities that are available for T-Mobile and what the threats would be for them.

\textsuperscript{13} http://www.opta.nl/ 06/08/2005
\textsuperscript{15} Dutch mobile virtual operators, D.Bout and E. Achterberg, research report, telecom paper, page 38 25/05/2005
1.3 Problem definition

The main focus within this research will be on the mobile telephony market. At the moment VoIP has only entered the fixed telephony sector, but mobile broadband networks create the opportunity for VoIP providers to access the mobile telephony market. First of all it is important to know what the state of the mobile market is and how mobile VoIP could become a threat for the mobile telephony market.

Mobile market

The current mobile market is very competitive. As mentioned earlier there are a lot of MVNO’s active in several niches. Besides that, there are three other mobile operators with whom they have to compete. The fixed network operator also creates a threat for the mobile operators. This has to do with the fact that customer have switched from fixed to mobile telephony. Therefore the fixed network operators want their customers back. This will be done for example by means of the services of triple players or by delivering digital telephony.

Next to the competition, the penetration of SIM cards is 94%\(^{16}\). This means that the market isn’t completely saturated. It is possible that customers take two or more subscriptions. Before saturation of the mobile market occurs the mobile operators have to attract the customers. That way it is possible that they can increase their market share. Only the customer won’t be able to call more minutes then earlier. This has to do with the time a person has to call. Therefore the revenue market is saturated.

Mobile VoIP could increase the competition. For a mobile operator, such as T-Mobile, it is important to be aware of the changes that possibly could occur by means of the VoIP providers and which could have impact an impact on their market share or revenue. Therefore it is necessary to look at the possible business models of VoIP providers and the enablers of mobile VoIP.

VoIP as a possible threat

VoIP as a technology increases competition. This is possible because VoIP as a technology lowers the entry barriers for the VoIP providers. Customers need a mobile broadband connection and a smart device. Next to that the quality of the mobile broadband networks is very important for the VoIP providers. Based on the quality the VoIP providers could deliver voice services which could be similar to the voice quality of GSM. But the latter has to be researched. The three main elements that are required before VoIP providers could enter the market are as followed. Besides the three elements other aspects could also be an enabler for mobile VoIP. Therefore those aspects will also be mentioned in the following section.

At the moment mobile broadband networks, such as WLAN and UMTS are available. Full coverage of WLAN is highly questionable, especially because it only covers a certain area where the access point is\(^{17}\). To be able to have full coverage that would mean that almost 1 million access points has to be deployed\(^{18}\). On the other hand UMTS is being rolled out by the mobile operators according to the license. That would mean that the full coverage will be somewhere in 2008\(^{19}\). Smart devices have also become available for customers. This increases the possibility increases that mobile VoIP could become a threat.

\(^{16}\) Dicht op de huid van marktleiders, IT Commercie, mei 2005
\(^{17}\) http://www.pulsewan.com/data101/802_11_b_basics.htm 21/05/2005
\(^{18}\) Experts of T-Mobile
\(^{19}\) GSM and UMTS, the creation of Global Mobile Communication, Friedhelm Hillebrand, 2002, page 139
The NRA, the ministry of economical affairs and Nma see VoIP as a way to enhance competition. Therefore they will attempt to promote VoIP at several manners. In what degree depends on the circumstance in the future. The competition could be increased by allowing the VoIP providers to use mobile or geographic numbers for nomadic use. With nomadic is meant that the numbers aren’t assigned to certain locations as the number plan is designed currently by the ministry of economical affairs. Besides that when the mobile terminating access tariffs will reduce the VoIP providers could lower the prices for their services. Mobile terminating access tariffs are the prices an operator has to pay to a mobile network operator when its subscriber calls to the subscriber of the mobile network operator. This way they could differentiate by means of prices and compete with the mobile operators.

Another issue that is related to VoIP is that besides voice services it also delivers value added features such as click to call, e-mail notifications of voicemail and even multimedia services such as video conferencing, etc. This gives the VoIP providers the possibility to differentiate themselves from the other mobile operators on the mobile telephony market and eventually gain a large market share eventually.

1.4 Research
This research is done because there are a lot of uncertainties regarding VoIP and the effect that it may have on T-Mobile. Several factors will be analyzed and worked out to deliver a proper advice regarding the development of mobile VoIP for T-Mobile. The main question of this research will be as followed:

What implication may VoIP have on the financial position of T-Mobile?

The sub research questions are as followed:
- What is VoIP?
- How will the VoIP enablers, such as technology, regulation, quality, and tariff structure and customer attractiveness, influence the development of VoIP?
- How fast could VoIP become a threat?
- How will this affect market position and competitiveness?
- What are the possible strategies or recommendations in the case of mobile VoIP?

1.5 Research methodology and delineation
In this paragraph the goal, methodology and delineation of the research will be mentioned. This will be done to imply how this research has been set up and what the research field is. After that the rapport structure will be made clear.

1.5.1 Purpose of the research
The goal of this research is to explore how mobile VoIP could become a threat for the mobile operators. Therefore it is necessary to design scenarios in which mobile VoIP could become a threat. To be able to design scenarios it is important to know what the current state of the mobile market is. How competitive the market is, what the opportunities and barriers are for the VoIP providers to enter the mobile market and how the enablers of mobile VoIP will develop. That way a design of scenarios becomes feasible.

20 VoIP marketing strategies in Australia, Daniel Swift, OVUM, February 2005
1.5.2 Methodology

The competitiveness and the state of the mobile market would be assessed by means of the five forces model of Porter. The reason that Porter is selected has to do with the fact that the mobile operators perceive VoIP as a threat, who will enter the mobile voice market as new entrant. Porter is the methodology which has the possibility to examine how new entrants could enter a market and have impact on it. The Porter model shows also how the several forces could develop and create either a barriers or a sustainable business environment for the VoIP provider.

Porter as methodology has as purpose to analyze the competitiveness of a market. Therefore the following five forces are used to analyze the impact. The five forces of the Porter model are new entrants, buyers, suppliers, substitutes and the internal rivalry. New entrants are the VoIP providers who will enter the mobile voice market. Porter looks at the entry barriers with which the new entrant has to deal before they can enter the market.

Buyer power has to do with the bargaining power and the price sensitivity of the consumer. Based on these two aspects could be defined to what extent the customer can have impact on the mobile operator and VoIP provider.

Supplier power is determined by means of the bargaining power of the buyer and the number of suppliers of homogeneous products. The supplier power takes also into account whether the supplier has a bargaining power. Thereby is looked into what extent they are dependant from their customer and how they can gain a market share.

In the case of VoIP the suppliers are handset suppliers and dealers.

Porter defines a substitute as a product which has the same function but is a different product. For example a car is a substitute of a train. In the case of mobile VoIP there will be looked whether VoIP is a replacement of mobile voice or just another way to deliver mobile voice. The last power is internal rivalry. The internal rivalry is determined by means of the amount of players in a market, the size and the competitiveness in price or products. By examining the internal rivalry it becomes clear to what extent competition is available and how new entrants could have impact on the existing market.

By means of the Porter model it becomes clear where the threats and opportunities lay for as well the mobile operators as the VoIP providers. Besides that also the development of possible enablers for mobile VoIP becomes clear. The analysis will be done by means of available literature and forecasts are based on historic data.

Before the scenarios are designed it is important to be able to calculate the impact of the scenarios. This model will be based on the current state of the mobile market, development of the five forces and the uncertainties will be taken into account. Three perspectives will be used, namely that of the customer, the mobile operator, and the VoIP provider. Then it becomes clear what the customer wants in a certain scenario and what kind of affect the choice of the customer has on the position of the mobile operator and of the VoIP provider. The methodology that will be applied to design the empirical model is a system model of which the Simple Multi-attribute Rating Technique Exploiting Ranks (SMARTER) model and the Pareto model are part of the subsystems.

The system model is based on an input, output and a system in which the calculations are made. In this model the margin of either the mobile operator or a VoIP provider, which is the revenues minus the cost is calculated. Besides that there is also looked at the cost price of the customer per month per business model and the quality will also be considered. The quality scores are based on the SMARTER model. A SMARTER model is

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21 Strategy Safari, the compete guide through the wilds of strategic management, Mintzberg et al, 1998, page 101
22 Competitive strategy, Techniques for analyzing industries and competitors, Michael E. Porter, 1980, page 23
based on the fact that alternatives are rated on several attributes\textsuperscript{23}. The values that are
given to the several attributes will be based on the workshops with people from the
marketing department and on the literature that is available on this subject.
The Pareto diagram will be based on the trade off between the cost price of the
customer per month and the values that each of the business model has obtained from
the SMARTER model. That way the customer could select the most appropriate business
model. The selected price quality ratio will result in the impact for the mobile operator
and the VoIP providers.

When the empirical model is designed with which the impact of the scenarios can be
calculated, the scenarios will be designed. They will be designed based on the driving
force method of Goodwin and Wright\textsuperscript{24}. The reason for the selection of this method has
to do with the fact that this method takes all types of scenarios into account. Not only extremes scenarios are designed by means of this method. Also there is a certain degree
of predictability and uncertainty allowed. Therefore this method will be the most useful in
the case of designing scenarios for mobile VoIP. The strategies can be developed on the
basis of the scenarios and the impact can be calculated. The scenarios are designed on
the basis of the competitive assessment and the empirical model.

1.5.3 Delineation of the research field
The first boundary is that potential VoIP providers outside the Netherlands will not be
considered in this research. The main focus will be the Dutch telecom sector and the
foreign countries will mainly be used as examples or as benchmarks. Countries such as
The United States and The United Kingdom will be analyzed for benchmarking, because
VoIP providers have already entered their fixed telephony market.

In this research only the consumer market will be considered. The consumer market is the
market consisting only of consumers. The choice is made based on the customer base of
T-mobile, which mainly consists of residential customers.

The several actors which operate in the fixed network will be clustered as following. The incumbent KPN won’t be taken in consideration as potential entrant, because the
organizational structure of KPN is very complex. KPN is active in several segments of the
fixed market and of the mobile voice market. It would become very difficult to analyze its
behavior and develop strategies. From now the fixed network operators will be
categorized as the ISP, ADLS providers, cable providers, so all the broadband providers.

The main issues, which are technology, regulation, financial aspects, mobile devices and
mobile internet usage and customer attractiveness, will be taken into account, because
they are tightly interrelated with each other. Some factors won’t be taken into account.
One of these factors is the availability of the protocols. These protocols are open
standards developed by IETF and are available for any company to apply them for their
usage.

The fixed telephony market will also be taken into account because VoIP providers have
already entered the fixed market in several forms. Therefore it is important to follow the

\textsuperscript{23} Decision analysis for management judgement, second edition, Paul Goodwin and George
Wright, 1999, page 37-43
\textsuperscript{24} Decision analysis for management judgement, second edition, Paul Goodwin and George
Wright, 1999, page 357-375
development of VoIP in the fixed telephony market. Another reason why fixed telephony market will be taken into account has to do with the competition between the fixed and mobile market.
Next to that the other actors who are closely related with the mobile market will also be taken into account. For example, the handset suppliers and dealers will be taken into account. The handset suppliers are very much dependant on the mobile operators and vice versa. The dealers are the ones who sell to the customer the subscriptions of the mobile operators.

1.5.4 Report structure
This report is divided into three main parts. Each part has a certain functionality. The first part explains what the current state of the mobile voice market is by means of the porter model. All the five forces are applied. Then there is explained what VoIP is and how it will be utilized in this research, who could deliver the VoIP services and how these services could be delivered. From chapter 4 to 7 there will be analyzed how VoIP will have effect on the forces when they will try to enter the mobile voice market and what the possible development of the enablers will be.

The second part is based on the design of the model with which the scenarios will be calculated. The several phases, which are conceptualization, specification and verification and validation, are mentioned in this part.

The last part is meant to design the scenarios and calculate the impact of those scenarios. This will illustrate the impact those scenarios have on the financial position of the mobile operator, after which the strategies will be worked out and mentioned.
Part I: VoIP and competitive threat assessment

In this part three main things will occur. In the second chapter the mobile voice market will be analyzed by means of the Porter model. Each force will be taken into account. That way the current state of the mobile voice market will become clear and its competitiveness. Mobile VoIP will be introduced and the VoIP providers which could deliver at a certain way their services.

Then there will be explained what mobile VoIP is, which mobile broadband networks could be used for mobile VoIP and which new technologies sustain VoIP. Also will be explained who the VoIP providers could and what their proposition is. Besides that there will also looked how they could deliver their services to become a viable alternative of mobile voice. It illustrates then how VoIP could enter the mobile telephony market and which new mobile broadband networks are available and could be used for mobile VoIP.

In the chapter 4-7 there will be analyzed what will happen when the VoIP providers will enter the mobile voice market. The forces of Porter will be applied in the case of VoIP. First of all the entry barriers that the VoIP providers have to bridge will be mentioned. This way it would become clear when and how they can or should enter the mobile voice market. Then there will be looked at the supplier and buyer power which could create sustainable environment for the VoIP providers. The other forces will be analyzed. Besides that the possible development of each force will be taken into consideration. That way the trends will be become clear. There will also be looked at the impact the VoIP providers could have on the mobile market currently and how each of the forces will develop in the future. These way scenarios could be developed by means of the trends and the uncertainties which are derived from the Porter analysis.
2. Mobile voice market
In this chapter the mobile voice market will be analysed by means of the Porter model. That way it would become clear how the market is construed and how difficult it is for a new entrant to access the market. The forces that will be elaborated are the internal rivalry, supplier power, buyer power, substitution and the entry barriers that new entrants have when they want to enter the mobile voice market.

2.1 Internal rivalry
Currently the rivalry between the players of the Dutch mobile voice market is high. There are nearly 27 mobile virtual network operators (MVNO’s)\(^25\). MVNO’s are operators who do not have their own network. They have enclosed a wholesale deal with a mobile network operator. Mostly the MVNO’s have focused on niches. This way they don’t have large impact on the position of the mobile operators. One of the most prominent MVNO’s is Tele2 who is active in as well the fixed telephony market as mobile telephony market. Next to the MVNO’s five mobile network operators were active in the mobile market. Recent activities have resulted in the fact that Telfort has merged with KPN. The merge has to be approved by the Nma. Therefore in this research five mobile network operators will be taken into account as active operators in the mobile telephony market. They are KPN, Vodafone, T-Mobile, Telfort and Orange. These compete with each other heavily by means of pricing and new products and services. For example T-mobile has focused on mobile broadband by launching hotspots everywhere in the Netherlands. Vodafone has launched a new bundle with which the customer would call cheaper to foreign countries. The roll out of the UMTS network could also create a way for the mobile operators to differentiate by means of new services. KPN and Vodafone have already starting with launching UMTS devices, services, etc to differentiate themselves from the other operators.

The internal rivalry is very high especially between the five mobile network operators. They are competing very heavily to obtain a larger market and revenue share. The latter is the most important for the most MNO’s because that way they make their shareholder content.

Business model of mobile network operator (MNO)
The mobile network operator has as business model the following proposition. Customer receives mostly a device when they buy a subscription or a prepaid of the mobile network operator. The selection of the devices is done according to the preferences of the consumer. A large assortment is available to give the customer a choice between a variety of devices. The costs for the devices are named subscriber acquisition cost (SAC). Besides that, the mobile operators also deliver devices to customers who are at the end of their contract. This way customer doesn’t switch very fast to another mobile operator and mostly those costs are lower than the SAC. Next to that the mobile operator has bundles of voice or money as subscription and the customer could choose to use additional services such as short message (SMS), multi media services (MMS), etc\(^26\). The customers of the mobile operators can call to anybody and be called by anyone. OPTA allocates mobile numbers to these operators and the ministry of economical affaire manages the number plan. That way the customer can be called and identified

\(^{25}\) Telecom paper, 2005
\(^{26}\) Dutch mobile operators, 2004 H1, half year update June 2004, Telecom paper
when he calls to somebody\textsuperscript{27}. Customers are accustomed with this way of working. Also the services that they can use and the customer service they can call for information has become a requirement for the customer. Any other approach which doesn’t resemble in a certain way the business model of the MNO could create for the customer misunderstandings or negative perception regarding that particular business model. Besides that, the customer has in the whole country coverage. This way the customer can be mobile and within reach all the time.

The mobile operator also gives to the dealers a commission for the sold subscriptions per customer and for additional services such as data usage bundles. Mostly the dealers use this commission to purchase the handsets directly from the handset suppliers and sell them with the subscription of the MNO. The dealer is that way dependant from the commission of the mobile operator.

**Business model of a MVNO**

MVNO’s has as business model that they enclose with a MNO a wholesale deal and then use their network to deliver mobile voice services. MVNO’s mostly do not deliver handsets and if they do as Tele2 does then they have a very small assortment. Those devices are mostly old devices. The advantage of the MVNO’s is that they can focus on marketing activities instead of maintaining and investing in a GSM network.

**2.2 Substitution**

Porter defines a substitute as a complete substitution. A substitute is a product that is different for the consumer but can be used for the similar purpose. In the case of mobile voice there aren’t any substitutes. This has to do with the definition of the mobile voice market. With mobile voice is meant that the customer can call anywhere with his mobile. He is not restricted to a certain area.

Therefore MVNO’s do not deliver services which are substitutes. They deliver the same product at the same way to the customer. The difference is mainly at the structural side of the business model, where they have enclosed a wholesale deal with the MNO.

**2.3 Supplier power**

Porter defines the supplier power as the power the suppliers have to bargain with the mobile operators. The mobile operators have to suppliers which are the handset suppliers and the dealers which deliver their subscriptions.

**Handset suppliers**

As mentioned in paragraph 1.1. there are few large handset suppliers in Europe. They deliver the devices to the mobile operator, and dealers\textsuperscript{28}. The handset suppliers do not operate in a market where the switching cost from one supplier to another is very high. The mobile operators and dealers can easily purchase from the different suppliers according to the wish of the customer. Therefore the handset suppliers are dependant from the mobile operators specific because they are actually their large customers. Therefore they will act reciprocal towards them. This way they won’t have a great bargaining power.

**Dealers**

The dealers are dependant from the commission they receive from the mobile network operators. As long as the mobile network operators keep the commission high or higher

\textsuperscript{27} Beleidsregels nummers voor VoIP diensten, OPTA, 11 april 2005

\textsuperscript{28} http://www.nokia.nl/nl/support/serviceP.html?cn=nl&re=Zuid%20Holland 26/08/2005
then their competitors. The dealer will mainly promote the subscriptions of the particular MNO which gives the highest commission. Therefore the dealers do have a bargaining power as long there are more than one MNO. When all of them decide to reduce the commission or only one remains then the dealers will be highly dependant. Their bargaining power will reduce strongly. Currently the dealer does not have a large bargaining power because it is also dependant from the MNO’s and the commission they give. The MNO’s do not differ a lot in those costs.

Conclusion that can be derived is that the supplier power is low as can be seen in figure 2. The handset suppliers are largely dependant from the mobile network operators, because they are their largest customers and switching cost between suppliers are low. The dealers are dependant from the commissions they receive from the MNO’s. The commissions are the largest part of their earnings.

### 2.4 Buyer power

In the first instance the consumer doesn’t have a bargaining power. A new customer can purchase a subscription or prepaid and the devices that are sold along with it. When consumers already have a subscription the mobile operator could take the request of the consumer into consideration. This way the customer has a bargaining power only not in a large extent. The latter has also to do with the fact that the customer can’t switch very easy from one provider to another. This has to do with the duration of the contracts that the customer signs when he chooses to call as a post-paid user. In the case of prepaid the customer has very low switching cost. Only for a customer who calls very often prepaid becomes very expensive.

Besides that the customer is price sensitive. Yet the price is not the only criteria of the customer to choose for a certain operator. Otherwise MVNO’s would have larger impact then they have now. Tele 2, who is the largest MVNO, has only 3.8% of the market. The combination of pricing, service and brand determines the choice of the customer to either choose for an operator or switch. These aspects are very important for the research to take into account, because the customer determines mainly the revenue of the mobile operator.

It results into the fact that the bargaining power of the customer is low and he is price sensitive in combination with other factors such as the services the customer can use, and brand perception and awareness. This way the customer can’t have great effect on the mobile operator because it doesn’t select an operator on the basis of one criterion and he can’t switch easily from one provider to another because of the contracts. The bargaining power does increase when the customer uses prepaid.

### 2.5 Entry barriers of the mobile voice market

New entrants have the difficulty that all the frequencies for as well GSM network as for UMTS network are already obtained by the mobile network operators. Therefore any new entrant can’t obtain the license for either one of the networks. This way a new entrant will have to invent a way to enter the mobile voice market. MVNO’s have done that by means of the wholesale deal with the mobile operator. The VoIP provider could also become a new entrant who could have large impact on the position of the MNO. This is possible because VoIP as a technology enables new entrant to bypass the mobile operator. Therefore in chapter 3 is explained what mobile VoIP is, which configurations

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29 Based on the analysis of T-Mobile
30 Based on customer satisfaction reports and mobile monitor of 2004
are possible, who can deliver those services and how they can deliver their services. The entry barriers are high of the mobile voice market. Yet they have been lowered by means of the MVNO’s and now it is possible that VoIP could even lower the entry barriers. Into what extent the VoIP provider are capable to lower the entry barriers and become a threat for a mobile network operator will be elaborated in the following chapters.

Figure 2: Porter model of the mobile voice market
3. Mobile Voice over Internet Protocol (VoIP) overview

In this chapter Mobile VoIP will be explained, which configurations are available, who can deliver those configurations and in which manner. First VoIP as a technology will be elaborated. By defining VoIP on mobile and its way of working the concept of mobile VoIP will become clear. After that few VoIP configurations will be selected that are prominent concerning mobile VoIP. This way the research field will be defined more accurately.

For the usage of mobile VoIP mobile broadband networks are required, because a customer needs a mobile broadband connection to be able to use mobile VoIP. Therefore it is important to know how the mobile broadband networks are constructed and in what degree they are similar to the GSM network that is used currently for mobile voice services. Besides that, there will also be looked at the technology which sustain VoIP and could be applied by VoIP providers or other actors of the telecommunication market to deliver VoIP services.

In paragraph 3.5 there will be looked at the VoIP providers which could deliver those configurations and how strong their impact could be. In the last paragraph there will be looked how they could deliver their services and in what degree they could become a complete alternative of mobile voice for the customer.

3.1 Voice over Internet Protocol (VoIP)

Voice over IP is a technology which is based on the IP protocol of internet. Voice is delivered by means of an IP network. This technology converts voice into digitized packets by an encoder. The encoding of the voice packets happens by means of voice codec’s such as G.729, etc.31 “A voice codec is an algorithm with which segments of analog voice signal will be encoded into digital data streams” (W.C. Hardy, 2003). These voice codec’s are mostly standardized and are already available in the network and in the handset. For VoIP on the mobile network the handsets have to be either handsets based on IP telephony or smart phones on which the software of VoIP can be placed or Unlicensed Mobile Access (UMA) devices which allow switching between a IP network and GSM network. The packets are then transmitted via the internet by means of the VoIP protocols, for example H323 and SIP.32 The function of these protocols is to control the session of the call set up. The signaling part happens in combination with a soft switch and one of the protocols. The soft switch is placed within a server.33

In the case of mobile VoIP this depends on what the destination of the call is. If a VoIP user wants to call to another VoIP client, who has VoIP software then the call will be directly diverted to the destination by means of the protocols and if necessary also via the server.34 In the case of off-net calls a gateway will be required to be able to set up a call between a VoIP subscriber and a PSTN phone or GSM35 (see figure 3). Then numbers become a requirement because a VoIP subscriber should be able to (call anybody and) be called by anyone. Therefore a database of an institution such as COIN is required. COIN is an institution which posses a database in which the numbers of the several

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32 “H323 is an ITU standard protocol suite for real-time communications over a packet network” (Goode, 2002, IEEE) and “SIP is an Internet Engineering Task Force standard for the set-up of multimedia sessions between internet end-points (Voice over packet technology, Stratix, December 2003, VoIP options for OPTA, page 16)”. 
33 IP Voice and associated convergent services, Analysus, 28/01/2004, page 35
34 IP Voice and associated convergent services, Analysus, 28/01/2004, page 35
35 Voice over packet technology, Stratix, December 2003, VoIP options for OPTA, page 19
mobile subscribers are registered. If a subscriber wants to take his number to another provider then COIN as institution makes that possible.37

Figure 3: VoIP architecture included with a gateway

3.2 Possible configurations of providing VoIP services

VoIP as a technology can be applied in several ways. Therefore it is narrowed down to three possible configurations, which are the peer-to-peer configuration (Skype), indirect access (Vonage), and fixed mobile convergence (BT) at two manners. These configurations are based on business models which already exist or are announced to be launched in the telecommunications market. The reason to select these configurations is because they are already available on the fixed network. Besides that, the first two configurations are also selected because the VoIP provider can bypass T-Mobile and deliver VoIP services by means of the mobile broadband network of T-Mobile.

In the case of fixed mobile convergence other aspects play a role for the selection. UMA is for example a technology that could be used for fixed-mobile convergence. UMA is a technological solution which could be deployed within a short period. That way minutes from T-Mobile could be snatched by the VoIP provider which will use UMA for switching between WLAN and GSM network. Besides that WLAN could also be used in combination with the GSM network. Only the handover won’t happen and the customer can’t be called when he is using his WLAN to call to somebody. This could have large impact on the minutes that are normally called at home. Therefore it is important to analyze how fast and how much UMA and the other configurations could impact the position of the mobile operators, and in specific the position of T-Mobile.

3.2.1 Peer-to-peer

Usage of VoIP services between only VoIP users is called peer-to-peer. They don’t have to go off-net to be able to communicate with each other (see figure 4). An example of this type VoIP use is Skype. The customer has to download VoIP software on his MDA or smart phone. A smart phone is equal to a GSM handset but can access internet and has several features similar to those of a MDA but it is smaller in size. Features as IP telephony integrated in the handset could also occur in the nearby future. Then downloading

37 http://www.portingxs.nl/Actueel/pxs_nbr3.pdf 15/07/2005
software won’t be required. The user should only be able to know which IP address or user ID he has to dial to be able to call somebody else who has also IP telephony integrated in his device.

The VoIP provider doesn’t need to settle any kind of commercial agreement with a mobile operator who has an access network as an MVNO has to have. The end-user, who wants to use VoIP, has to get a broadband wireless connection by him self. This connection should be always online if he wants to call and be called at anytime38.

Figure 4: Model of peer-to-peer configuration

### 3.2.2. Indirect access

In this model VoIP providers can also avoid the mobile operator who owns the access mobile broadband network. This is possible because the user only needs a broadband connection and the settings on his mobile to access the SIP server of the VoIP provider or download software on his device. The user can then utilize the service of the VoIP provider (see figure 5).

Because of this a VoIP provider won’t need to settle a commercial agreement with a mobile operator. The end-user will need access to the wireless broadband network and the handset which could be used for VoIP. This way of delivering the VoIP services is comparable to what a VoIP provider does in the UK at the moment named Vonage39.

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38 IP Voice and associated convergent services, Analysus, 28/01/2004, page 20
39 IP Voice and associated convergent services, Analysus, 28/01/2004, page 20
3.2.3 Fixed mobile convergence

In this model any fixed or new VoIP provider can choose to use UMA for delivering voice services to a customer. The fixed part will be supported by VoIP and UMA will enable the handover between the IP wireless LAN and the mobile access network. In this case a fixed operator or a VoIP provider will have to settle a commercial agreement with a mobile operator to place the UMA network controller within the GSM network. This will be necessary because billing will happen by means of the MSC of the GSM network (see figure 6). The disadvantage of UMA is that the technological complexity is high. This has to do with the fact that UMA has to be integrated in a mobile network. That way WLAN becomes a part of the GSM network. An example is BT who is going to deliver a similar converged service by means of Bluetooth, named blue phone.\(^{40}\)

It is also possible that UMA won’t be used for convergence. Customer could also use the WLAN by means of VoIP to call anybody and the GSM network to be called or any other combination between WLAN and GSM network. The fixed operator will have to stimulate the development of the devices which have WLAN integrated. It is only not certain how the business model will be developed, because there aren’t examples available in the market at the moment. Yet, it could become a large threat for the mobile operators because they will loose the minutes that were normally called by means of the GSM network.

In this model the end-user won’t have any kind of requirement. It would be efficient if the user does have access to WLAN at home and in his office area. That way the usage of this model will become more apparent and cost effective for the customer. The main disadvantage in this model is the development of the technology and of the handsets which support UMA and of devices which support WLAN.

3.3 Mobile broadband wireless networks

The mobile broadband networks that could be used for VoIP are GPRS, UMTS and WLAN (802.11b). Therefore it is important to know the distinction between those networks and their similarities. By comparing those networks with the GSM network it will become clear whether these networks can become a substitute of the GSM network in the future.

The technical architecture of each mobile network and of WLAN is mentioned in the appendix Part 1. The conclusion that can be drawn from the architecture is that the mobile networks are based on a cellular interface which has a certain frequency for which the mobile operators had to acquire a license as well for GSM network as for UMTS network. GPRS is an extension of the GSM network. The main functionality of GPRS is to allow data services which aren’t real time, such as mms.

For the UMTS network the mobile operators have to place new base stations. This has to do with the fact that the UMTS standard is based on a new technology called Wide band code division multiple access (W-CDMA)\textsuperscript{41}. The reason for choosing this technology instead of the one that the GSM network utilizes is its efficiency. This technology distributes the spectrum according to the demand and the position where the subscriber is standing. So it doesn’t appoint a pre determined time slot to each subscriber like the GSM network does\textsuperscript{42}. In figure 6 all the mobile networks are mentioned which are the follow up of each other.

The standard 802.11b of WLAN can be applied on an available spectrum that can be used for free. There is no license required and the user can set up a WLAN hotspot very easy. Only a broadband connection is required to set up a hotspot. The access point is connected with broadband connection. The disadvantage of the WLAN is that it covers only a small area where the access point is positioned. Therefore a WLAN can’t have full coverage like the mobile networks.

\textsuperscript{41} Advanced wireless communications infrastructure, J.M. Bauer, R.Westerveld. C.F. Maitland, 12th ITS- Europe Regional Conference, page 3, 2001

\textsuperscript{42} Based on the interview with an expert in T-Mobile of UMTS
3.4 Universal access architecture (UMA)

UMA is a technology which allows switching between the GSM network and WLAN (see figure 8). This is made possible by an element of this technology which allow the flow of data and information between the GSM network and WLAN. That element is the UNC (UMA Network Controller), which functions as the BSC of the GSM standard. In doing so UNC can establish the connection between the BSS’s of the WLAN and the GSM core network. This means that billing could be done by means of the MSC of the GSM network. UMA provides the conversion from IP address to mobile numbers. End-users can be called even when they are using the WLAN as communication network\(^{43}\). So WLAN becomes a part of the GSM network.

\(^{43}\) FMC: Explaining CTP and UMA, OVUM, Cerri Pawsey and Jeremy Green, December 2004, page 6
Conclusion

VoIP as a technology lowers the entry barriers of the mobile voice market. This is possible by means of the three configurations which are defined as peer-to-peer, indirect access and fixed to mobile convergence. The UMA technology allows fixed to mobile convergence. It is also possible that WLAN will be combined with the GSM network, only without the usage of UMA. That would mean there won’t take a handover place. The customer would have to switch by himself. The selection of these configurations is made because VoIP providers have started with delivering their services on the fixed telephony network. Besides that, the first two configurations can bypass a mobile operator and the latter could have rapidly impact on the revenue of the mobile operators.

The mobile broadband networks that are available for the usage of mobile VoIP are GPRS, UMTS and WLAN. The difference between these networks is that GPRS and UMTS can have full coverage. This allows a customer to be fully mobile when he uses mobile VoIP on these networks. In the case of WLAN the customer is restricted to a certain area. This lowers the utility of WLAN for the customer. An alternative such as UMA increases the utility because a consumer can switch from WLAN to the GSM network when the coverage area of WLAN is ended. This results in the fact that the customer will be in reach everywhere.

Based on the analysis and available information it becomes clear that the configurations can be applied on the several mobile (broadband) networks. In table 2 is the combination of the configurations and the mobile (broadband) networks shown.

<table>
<thead>
<tr>
<th>Mobile VoIP configurations</th>
<th>GPRS</th>
<th>UMTS</th>
<th>WLAN 802.11b</th>
<th>UMA(GSM/WLAN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peer-to-peer</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Indirect access</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Convergence of mobile and fixed</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Table 2: application of the mobile VoIP configurations on the mobile (broadband) networks

44 FMC: Explaining CTP and UMA, OVUM, Cerri Pawsey and Jeremy Green, December 2004, page 6
This delineates the research to the above mentioned mobile VoIP configurations and the mobile (broadband) networks, which are either available or will become available in the future.

3.5. VoIP business models

According to the porter model new entrants could create a threat. In the case of VoIP new entrants could become an issue for the mobile operators. As defined in paragraph 2.2. three VoIP configurations are selected. In this paragraph the propositions of the VoIP providers related with those configurations will be mentioned. The business models of the VoIP provider will be mentioned to make clear how they want to enter the mobile voice market and whether they have the means to change their position within the market. The assets and resources for the VoIP providers will mainly be provided by investors, venture capitalists and stakeholders. The investments of Skype and Vonage will only be worked out. This has to do with the fact that they are new entrants. BT isn’t a new entrant for the telecom market, but has changed from strategy to be able to compete with the mobile telephony market.

3.5.1 Skype

The reason that Skype is taken as example has to do with the following. Skype is one of the VoIP providers from which the software is downloaded within a very short time and usage has increased within the years. Since 2003 has Skype started with delivering his services. Now nearly 0.1 million\(^45\) users have downloaded Skype on their PC’s or PDA’s from which nearly 2.2 million users are online\(^46\). Almost 10 milliard minutes have been called from Skype to Skype users\(^47\) since January 2003 till June 2005. This means that the customers call 33 minutes per month peer-to-peer\(^48\).

The software of Skype is proprietary and based on the ad hoc network concept. So it searches for the PC/ PDA with the most capacity and selects that as the super node which provides the routing of the VoIP calls between the VoIP users and external users. Every PC or PDA knows also where the other pc’s or PDA’s are within the ad hoc network. That way the calls can be routed at an efficient manner\(^49\).

Strategy

The strategy of Skype according to Zennström is that Skype can be used as a promotion tool for broadband networks. That way the network provider can deliver his broadband services and voice services by means of Skype\(^50\). Next to that Skype has introduced Skype in and out to attract customers and obtain profit. Eventually when the penetration will be high and Skype can gain scale advantages it could become a monopoly with its proprietary software.


\(^{46}\) This measurement is done around 3 PM on 2/3/2005 because then everybody on the whole world is awake and can come online.

\(^{47}\) http://share.skype.com/blog/facts_and_figures_news/minutes_served:_ten_billion/ 20/07/2005

\(^{48}\) By analyzing the number of customers using Skype since January 2003 and summing them up, you can calculate the number of minutes that are called per month.

\(^{49}\) Skype: putting the hype in VoIP, the register,

http://www.theregister.co.uk/2003/09/24/skype_putting_the_hype/ 12/05/2005

Investments
Investments are important for a company. That way they can add value in their business and develop. In the case of Skype, it doesn’t have to invest a lot in its network, because it is a self-sustaining ad hoc network. Yet, to gain scale advantages investments are required. Skype has the advantage that the peer-to-peer solution is an innovative technical solution. Besides that, the strategy of Europe is that development in IT leads to economical affaires. Therefore investments in Skype have been high, as well by several technical institutions as by venture capitalist. Skype can invest in new services such as Skype OUT and Skype IN and align with several parties to be able to deliver their services to the customer.

Choice for only Skype
The latter has to do with new features of Skype which are Skype Out and Skype In. Skype out is the service that the subscriber can call to anybody. Only he/she will have to pay for the call. Skype In means that the Skype subscriber can be called by anyone. The reason that these features aren’t taken into account has to do with the following. Skype Out and Skype In don’t differ a lot from the services that Vonage delivers already in US, Canada and UK. Next to that Vonage has developed him self more and already acts as fixed operator. Therefore Vonage will be taken into account to analyze his development and possible impact and not the versions of Skype.

3.5.2 Vonage
Vonage is one of the VoIP providers who deliver its services according to the indirect access model. The reason that Vonage is chosen has mainly to do with his matureness within the telecom sector. Vonage acts as full grown fixed network operator without his own network. Vonage started in 2002 and had acquired 7500 customers that year. Since then Vonage has acquired approximately 500000 customers, who do not use only peer-to-peer VoIP but also pay for the service of Vonage. The total numbers of minutes that have been called are 1.5 milliard minutes in January 2005. If 1.5 milliard is divided by 400.000 customers in monthly usage then the customers have called 104 minutes per month.

The proposition of Vonage is to differentiate from the fixed network operators by means of VoIP. VoIP allows nomadic use. That way a customer can access Vonage services at any place, only a broadband connection is the requirement for utilization of the Vonage services. The customer has to either download SIP software on his computer/ laptop or receive an adapter that can be plugged into his fixed phone. That way the customer can call and be called. The customer has to buy credit to be able to call. Credit can be bought by means of the website of Vonage, which is set up at a very user friendly way.

The strategy
Vonage has as strategy that it acts as a provider who delivers nomadic services and advanced features which can’t be delivered by fixed network operators. Those features

51 http://international.abi.co.uk/index.php?option=com_content&task=view&id=265&Itemi... 21/04/2005
52 http://www.techweb.com/wire/26804234#_ 16/06/2005
53 www.vonage.com 22/07/2005
54 www.theregister.co.uk/2004/11/02/vonage_voip/print.html 18/04/2005
55 www.vonage.com
56 http://www.techweb.com/wire/networking/56900754 25/02/2005
57 A VoIP market introduction, FirstPartner Strategic Marketing & Research, 2004, page 17
58 A VoIP market introduction, FirstPartner Strategic Marketing & Research, 2004, page 16
59 A VoIP market introduction, FirstPartner Strategic Marketing & Research, 2004, page 16-18
are for example voicemail, call back, online account information, etc. Next to that Vonage focuses on countries which have appropriate niches. With appropriate is meant those markets, which have kept high margins. For example in UK the tariffs are very high and Vonage can deliver his services at very low price.

Vonage is also focusing on WLAN that is an extension of the fixed network. Eventually their focus is on WIMAX, from which a network has to be deployed and licenses obtained. WIMAX is a wireless broadband network which has a large range and uses spectrum that is licensed. To be able to deliver mobile services handsets are required. Therefore Vonage is going to launch in the summer of this year “a portable WiFi handset, the F-1000, configured with Vonage’s Voice over IP (VoIP) phone service”\(^{60}\). They are already busy since last year with testing of several handsets that can be used for WLAN\(^{61}\).

**Investments**

For Vonage investments are required to be able to deliver their services to customers, and expand. The investments in Vonage by investors and institutions have reached approximately 208 million dollars in September 2004. This gives them the opportunity to expand globally and increase marketing\(^{62}\).

**3.5.3 British Telecom (BT)**

BT is a fixed operator in UK who wants to introduce VoIP. By means of VoIP he wants to deliver services which allow mobile and fixed convergence. BT intends to do that by using a new technology called UMA. Yet, to be able to deliver VoIP services via UMA BT needs a partnership with a mobile operator, because UMA allows handover between a WLAN and GSM network. Next to that the base station of UMA has to be placed in the core of the GSM network. BT has arranged an alliance with Vodafone in UK to deliver fixed and mobile convergence service\(^{63}\). The customer will only need a handset in which UMA is integrated. BT and Vodafone will supply these devices. That way the customer can switch from his home WLAN to the GSM network and vice versa. That way the customer would have coverage all the time and could lower his GSM cost by using his WLAN extensively\(^{64}\).

**Strategy**

By delivering mobile fixed convergence BT has taken an offensive strategy against new VoIP providers and MVNO’s which are pushing the prices downwards. BT can lower his network cost because of VoIP. That way it can lower his tariffs and change the pricing structure\(^{65}\). On the long run BT is focusing on the development of WiFi and WIMAX\(^{66}\).

**Conclusion**

Vonage could have larger impact then Skype because they have sold more minutes than Skype has done. Only if the downloads are compared then it seems that Skype has more success. So it depends how these VoIP providers could settle within the mobile voice market. Vonage has the advantage that it wants to act as a network operator and delivers a combination of services with which it could become more attractive for the consumer.


\(^{61}\) www.theregister.co.uk/2004/11/02/vonage_voip/print.html 18/04/2005

\(^{62}\) VoIP newsletter. Mercator capital, September 2004

\(^{63}\) http://news.independent.co.uk/business/news/story.jsp?story=522693 16/06/2005

\(^{64}\) http://wireless.engadget.com/entry/12340000020039335/ 17/06/2005

\(^{65}\) http://news.zdnet.co.uk/communications/0,39020336,39202749,00.htm 17/06/2005

\(^{66}\) http://www.1threadwatch.org/node/1245 17/06/2005
Next to Skype and Vonage BT could also gain a large market share. It depends mainly on the availability of the devices with UMA or WLAN integrated, and the usage of WLAN. The fixed network operator or even cable providers or ISP’s could enter the mobile voice market with this model. This way they could have large impact on the revenue of the mobile operators. The revenues at home would go then to the FNO’s instead of mobile operators.

3.6. Mobile VoIP as alternative

Mobile VoIP can be delivered at two manners, but there are conditions related to each of those possibilities. Mobile VoIP could be either an alternative or a partial alternative of mobile voice. The focus of this paragraph will be mainly on the new VoIP providers, such as Vonage and Skype. In this chapter these possibilities will be worked out.

3.6.1 Alternative of mobile telephony

Mobile VoIP could become a viable alternative for mobile telephony. Therefore are few very important requirements necessary before mobile VoIP can become a substitute of the existing services of the mobile operators. The two VoIP configurations, peer-to-peer and indirect access could only become a viable alternative in the case of the following requirements:

- The devices are available which support VoIP or have open operating systems where VoIP software is downloadable.
- The user interface of these devices should be user friendly and comparable with the interface of GSM handsets.
- User experience should be similar as that of the GSM network. The customer should be able to call and be called by anyone and anywhere. Next to that the customer should be able to use the similar services as the mobile operators deliver to their customer.
- The coverage of the mobile broadband networks should be sufficient. Otherwise the customer won’t be within reach all the time.
- Number should be available for VoIP providers and those numbers should be mobile numbers in the case of mobile VoIP. Otherwise customers won’t perceive mobile VoIP as mobile telephony.
- The pricing and the cost of handset should be set at a way that the customer gains cost advantage. It should be cheaper for the customer to use VoIP.
- Brand awareness and perception are also important. Customers won’t choose very fast for a provider when they are not familiar with the brand. Also the perception plays a large role in the choice of the customer.

These are the main factors that should be available before mobile VoIP can be seen as a viable alternative of mobile telephony. At the moment all these aspects aren’t really available. For example the devices are in the market but the penetration is very low and the user interface isn’t equal to that of the GSM handset. Customer has to download a soft phone to be able to use mobile VoIP. Next to it the full coverage of the mobile broadband network will take time. This is a costly occurrence and the mobile operator will deploy the networks completely when their strategic position allows that based on the obligations they have regarding the license they obtained to deploy UMTS network.

The user experience is also very important for the customer to switch from one provider to another. With user experience is meant the service that is delivered to the customer. The VoIP providers should be able to deliver the similar services as the mobile operators. For example SMS services, billing, customer services, etc. Besides that the customer should
also have the possibility to call to anyone and everywhere. When the VoIP providers are able to deliver the same services as the mobile operators, then they can compete with the mobile operators.

VoIP providers can obtain mobile numbers only if they use the number for mobile purposes. For nomadic use the personal assistance numbers, are available for the VoIP providers. The geographic number can only be used within the area to which it is assigned\(^\text{67}\). Nomadic use isn’t allowed with a geographic or mobile number currently.

The pricing of the VoIP providers isn’t yet the cheapest solution for the consumer. The customer needs a broadband wireless connection to be able to use mobile VoIP. The prices of the fixed fee data bundles are very expensive (see appendix part 2, table 3). Next to it the customer needs a device and the customer won’t receive for free those devices with a fixed fee data bundle. So the cumulated costs are very high for the customer per month.

There hasn’t been any research to the brand awareness and perception of the VoIP providers. Based on the experience of the marketing department it is clear that a new VoIP provider will have higher entry barrier to deliver a brand which is recognized by the customer as a loyal and reliable brand. Existing operators are more familiar to the customers. Besides that the perception about a certain company can depend on their prior activities.

### 3.6.2 Partial alternative of mobile telephony

In the case of partial substitution the VoIP provider could have a higher chance of success. They could focus on certain niches. For example calling to foreign countries could become a niche for the VoIP providers. The mobile operators have very high tariffs to call to foreign countries. The new VoIP provider, such as Vonage is very cheap in that case. The customer can buy data bundles for a particular amount of minutes. He/she can call for those minutes to foreign countries at a very cheap rate. In appendix part 2 table 3 and figure 4, these cost figures are compared with each other and the difference becomes clear.

The VoIP providers can focus on the niches where the mobile operators have kept high margins and numbers aren’t required then. Only three factors are necessary in that case and that is a device which sustains VoIP, coverage to use a wireless broadband connection and the price of the data usage.

**Conclusion**

To become a viable alternative VoIP providers have to be able to deliver services that are similar to that of the mobile operators. Therefore they need to have devices which enable VoIP, mobile broadband coverage, handsets which have a similar user interface and services that are comparable with those of the mobile operator. Besides that pricing of services, brand awareness, and perception play also a large role when the customer has to choose between operators. At the moment the mobile VoIP providers can’t become a full substitution. It is possible that in the future several driving forces create opportunities for the VoIP providers to access the mobile market and have large impact.

As partial alternative mobile VoIP could have a higher chance to succeed. The tariffs to call to international destinations are very expensive. The VoIP providers can select this

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\(^{67}\) Consultatie nummerbeleid voor VoIP diensten, OPTA, 30 november 2004
niche to deliver their services at a low rate. This gives them the possibility to have an impact on the revenues of the mobile operators. This impact will be minimal because customers don’t use their mobile phones very often to call to international destinations. Based on the percentage minutes that is called to foreign countries
4 Entry barriers for mobile VoIP

In this chapter the entry barriers of the VoIP providers as new entrants will be elaborated. In chapter three the configurations, possible VoIP providers and several ways to deliver VoIP services are already mentioned. By looking at the entry barriers it becomes clear when they could enter the mobile voice market and how high the entry barriers are at the moment and in the possible future.

The entry barriers for mobile VoIP are based on technological and regulatory aspects. Mobile VoIP could become a viable alternative of mobile telephony when it bridges certain entry barriers that are required to deliver mobile voice services. These entry barriers will be worked out and their possible development in the future.

The entry barrier is first of all the voice quality of mobile VoIP. To be able to deliver similar voice quality as the mobile operators delivers the VoIP providers have to cope with certain requirements. These requirements are mainly based on the characteristics of the mobile (broadband) networks and the selection of the voice codec’s. Besides that the mobile devices to use mobile VoIP are necessary. Otherwise the customer can’t be mobile and VoIP couldn’t be an alternative of mobile telephony. Therefore the development of these devices and their availability will be worked out in paragraph 4.2. In paragraph 4.3 will be looked at the regulatory part, which could create entry barriers for the VoIP providers.

4.1 Voice quality in the case of mobile VoIP

Mobile VoIP has the disadvantage that it has to comply with several requirements before the voice quality becomes similar as that of the GSM network. Therefore the several requirements will be mentioned in this paragraph and worked out. That way it is also possible to identify which mobile (broadband) networks won’t be able to deliver sufficient quality for mobile VoIP.

Requirements to mobile (broadband) networks for VoIP

The quality requirements for mobile VoIP are based on latency, QoS protocols, user rate down- and uplink, the coverage of the networks and the voice codec’s. Each of these aspects will be worked out in this paragraph and the value of each parameter for each network will be given summarized in table 1 in appendix part 1.

4.1.1 Latency

Latency is the time that a packet takes to go from the source to the destination, in other words the delay. In the case of VoIP latency is the travel time of a packet from one end-user to another. This time consist of more than one component. First component is the network delay, which occurs when the voice is transmitted over IP between two points. Between these points a path is created which traverse different bandwidths. Another delay has to do with the compression / decompression (codec’s) of voice in IP packets. Codec’s are standardized and are elaborated in paragraph 4.1.5. The reason that the codec’s are worked out separately has to do with the fact that each codec delivers a certain quality. Therefore it is important to show the effect that each codec has on the quality. The last aspect is jitter. “Jitter is the variation in time it takes different packets to traverse a network before they can be re-sembled at the destination and converted back into a voice signal”.

Only it won’t be taken into account further because it is very

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69 VoIP A market introduction , First partner strategic and marketing research, 2004, page 6
70 VoIP A market introduction , First partner strategic and marketing research, 2004, page 6
difficult to analyze jitter per network. It goes beyond the scope of the research. For voice, real-time delivery of voice is required. Therefore the latency can’t be higher than 150ms\(^1\). That way the customer will perceive the voice quality as the quality of the GSM network.

GPRS has a high latency; it has a range of 300 – 650 milliseconds. This way a VoIP calls can’t have a sufficient quality and disruption will take place while a conversation.

WLAN is based on IP, and the maximum latency of TCP/IP in the worst case is 120 second. This means that WLAN has a delay that would be very large in the worst case. It depends merely also on the broadband connection to which the WLAN access point is connected. When the broadband connection is engineered at such a way that it reduces the latency to the required level then VoIP calls can take place. This is possible, because VoIP is already used in the fixed telephony market. One main disadvantage of WLAN is that it has a fading effect. “Fading is the rapid variation in signal envelope due to the transmitted signal undergoing reflection(s) and scattering leading to multiples copies with different amplitudes, phases and delays summing up at the receiver”(Awoniye, IEEE, 2004, page 3712). This way latency could become higher.

UMTS has a latency of 200 ms. Latency is high, but by adding QoS protocols the voice quality can be achieved which is required to be able to deliver the proper voice quality.

4.1.2 QoS protocols
QoS protocols create the possibility that prioritizing of the data is possible. This possibility is important for VoIP because voice has to be real time. GSM doesn’t require any kind of QoS protocol, because it is circuit based. This means that any call that is set up is done according to a circuit which has to be terminated before another call set up occurs. GPRS on the other hand doesn’t have any possibility to have QoS protocols. This has to do with the goal for which it is used by the mobile operators. The main purpose of GPRS has been to deliver data services, such as mms, SMS and other services which aren’t based on real time delivery. Therefore real time delivery isn’t required and QoS protocols can’t be added.

In the case of WLAN there are two places where QoS protocols could be added. The first part is fixed network to which the WLAN is connected. The fixed network does have added QoS protocols to deliver sufficient quality on demand of the customer. The second part is from the access point and the wireless interface. The standard that is taken into account in this research is 802.11b. It can be used by anyone and doesn’t have any possibility of adding QoS protocols. This has to do with the fact that it is developed for a bandwidth that can accessed by anyone\(^2\). Newer versions of WLAN do have a possibility to add a QoS protocol but they go beyond this research\(^3\).

UMTS has the possibility to add QoS protocols\(^4\), such as Differentiated services (DiffServ) or Integrated services internet (IntServ)\(^5\) (Goode, page 1495, 2002). That way the

\(^1\) Voice over WLAN, Extricom, white paper, 2003-2004, page 3
\(^2\) http://www.pulsewan.com/data101/802_11_b_basics.htm 21/05/2005 and Technical white paper, Quality of service in WLAN networks, Radionet Finland, 2003, page 3
\(^3\) http://www.s3group.com/wireless_systems/wlan_qos/ 14/06/2005
\(^4\) Toward an all -IP-based UMTS system architecture, Lieve Bos and Suresh Leroy Alcatel, IEEE 2001
customer can receive the quality that he demands. When this possibility will be utilized depends on the strategy of each mobile operator (Goode, 2002).

4.1.3 User rate down- and uplink

The user rate down – and uplink is parameter which implies that what the data rate is when somebody or something upstream and downstream of data. In the case of VoIP a customer downstream data when somebody is talking to him by means of VoIP. When he is talking to somebody then he is uploading data. By knowing the speed of the user down – and uplink, it becomes clear whether there is enough capacity to deliver voice packets fast enough to have a sufficient voice quality. In the case of WLAN the values of the user down – and uplink are not different. WLAN is synchronous and the up- and downlink are equal. The values for GPRS, UMTS and WLAN are mentioned in the table 3.

For VoIP with minimum kilobytes per second that is required according to Skype. There should be taken into consideration that Skype uses proprietary software which is engineered at such a way that it selects a voice codec that utilizes the smallest amount kilobits. According to Skype A VoIP calls needs minimal 24 kilobits per second and maximum 128 kbps. By looking at this range it would become clear which of the three networks is the most appropriate for mobile VoIP.

<table>
<thead>
<tr>
<th>Network</th>
<th>GPRS</th>
<th>UMTS</th>
<th>WLAN 802.11b</th>
</tr>
</thead>
<tbody>
<tr>
<td>User peak rate downlink</td>
<td>24-40 Kbps</td>
<td>220-330 Kbps</td>
<td>4-6 Mbps</td>
</tr>
<tr>
<td>User peak rate uplink</td>
<td>20 Kbps$^{76}$</td>
<td>64 Kbps</td>
<td>4-6 Mbps</td>
</tr>
</tbody>
</table>

Table 3: Values of the up- and downlink

In this case WLAN and UMTS are the best alternatives for mobile VoIP compared with GPRS. WLAN has the largest bit pipe as well in the up- and downlink. This means for the user that he can call and be called by anyone without any disruption while he is calling. In the case of UMTS the customer can perform also a clear conversation. GPRS won’t deliver in that case a sufficient voice quality, because its user peak rate up- and downlink is the minimal value of bit rate that is required for mobile VoIP.

4.1.4 Coverage of the mobile (broadband) networks

The coverage of the mobile broadband networks is very important for the VoIP provider. The customer has to be mobile and should be able to use the mobile VoIP services everywhere and anytime. This is only possible when the mobile broadband networks have sufficient coverage.

The coverage of GPRS is already 100%, but the coverage of UMTS isn’t there yet. At the moment most mobile operators are rolling out their UMTS network according to conditions of the license they obtained. According to the license the mobile operators should have 20% coverage in 2005, approximately 70% in 2006 and expected 80% coverage in 2007$^{77}$. In the case of UMTS and GPRS the term coverage is defined as how many people of the total population have coverage. The reason that UMTS won’t be rolled out immediately has to do with the fact that the GSM network has 100% coverage

$^{76}$ WiMax- “last Mile”, WiFi Backhaul, Fixed Broadband Wireless Standard or 3G killer?, Strategy Analytics, march 2005, page 32

$^{77}$ GSM and UMTS: The creation of Global mobile communication, Friedhelm Hillebrand, page 139
and most customers use their mobile phones to call to somebody. The use of mobile internet is very low. After analyzing historic data about the usage of mobile internet it become clear that customers aren’t found of it. The penetration of mobile internet has a linear trend line.78

In the case of WLAN the issue is that WLAN is constrained to the area in which the access points are placed. That way, WLAN couldn’t have full coverage. Whether WLAN could have coverage over a large area it depends on several factors. Those have to do with the strategic choices that network operators make, the choices customers and companies make. For example a lot of mobile operators have become active in the WLAN market. They have started with deploying hotspots at places where customers come a lot, such as restaurants, trains, etc. Besides that a lot of people have started with setting up their own WLAN at home. Also companies have their private WLAN, but they aren’t accessible by anybody else then their employee. Therefore these private wireless LAN’s won’t be taken into account in this research.

The value of coverage will mainly be derived from the possible number of wireless LAN’s at home. This has to do with the fact that customers can use only their own wireless LAN without any incremental cost. The wireless LAN’s of the mobile operators are charged for a certain fee. Therefore the WLAN at home is a preferred alternative for the customer. In the coming years the coverage will increase. This has to do with the laptops, which have as additional feature now that the access to a WLAN is already integrated. Besides that, the number of hotspots that the mobile operators deploy will also increase the coverage only the usage of these WLAN will be charged. It does depend on the strategy and the cost whether the mobile operator will place hotspots. When the cost will increase the network operators will stop with placing hot spots at new public places.

4.1. 5 Voice codec’s

“A voice codec is an algorithm with which segments of the analog voice signal will be encoded into digital data streams” (W.C. Hardy, 2003). These voice codec’s are mostly standardized and are already available in the network and in the handset. The selection of a voice codec’s happens automatically in a handset. Each network supports few codec’s. The GSM network supports only four types of codec’s, which are GSM full rate, GSM enhanced full rate, GSM half rate and GSM alternative multi rate codec (AMR). The handsets support these voice codec’s only. Therefore the VoIP providers should be able to use those codec’s otherwise they can’t deliver there services. Besides that, for each codec is a Mean Opinion Score (MOS) value measured. This MOS value is based on researches with a test population in which people tell what how they experience the voice quality. A MOS value has a value between 0 to 5, which means that 0 is worst quality and 5 a very good quality.

Every codec results into a voice packet that has to be delivered from one end to another. Converters are required when voice has to be transported from one type of communication network to a different type. Each codec has a particular bit rate which is shown in table 2 in appendix part 1. The codec’s with the highest bit rates are the ones

78 The trend line is designed by means of historic data about the usage of mobile internet by customers. There is looked at the R square value which determines in what degree the trend line resembles a certain growth. In the case of mobile internet usage it was 0.9488. Therefore the growth of mobile internet will occur at a linear way. Ofcourse other forces could have impact that could result into a change of the trend line.
80 Quality VoIP- an engineering challenge, R J B Reynolds and A W Rix, BT technology, 2001, page 23
which are less compressed. The disadvantage of compression is that the voice quality for VoIP deteriorates. This way the user won’t be satisfied with the result. The advantage of compression is that more network resources become available. For a mobile operator the codec’s which use less overhead is more preferable than the ones which have a large overhead. For a VoIP provider codec’s such as G711 are the most preferred. That way they can deliver a high quality call. The MOS value of 4.1 for G711 confirms the statement that less compression results in a higher voice quality.

<table>
<thead>
<tr>
<th>Codec’s</th>
<th>kilobits/s</th>
<th>kilobit/minute</th>
<th>MOS value</th>
</tr>
</thead>
<tbody>
<tr>
<td>G711</td>
<td>64</td>
<td>3840</td>
<td>4.1</td>
</tr>
<tr>
<td>G726</td>
<td>40</td>
<td>16</td>
<td>2400</td>
</tr>
<tr>
<td>G728</td>
<td>16</td>
<td>960</td>
<td>3.6</td>
</tr>
<tr>
<td>G729</td>
<td>8</td>
<td>480</td>
<td>3.9</td>
</tr>
<tr>
<td>GSM Full rate</td>
<td>13</td>
<td>780</td>
<td>3.5</td>
</tr>
<tr>
<td>GSM enhanced full rate</td>
<td>12.2</td>
<td>732</td>
<td>4.0</td>
</tr>
<tr>
<td>GSM half rate</td>
<td>5.6</td>
<td>336</td>
<td>3.85</td>
</tr>
<tr>
<td>GSM AMR</td>
<td>4.75-12.2</td>
<td>285-732</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Table 4: The standard voice codecs with their MOS value’s

The selection of the codec in the case of mobile VoIP determines the quality of the voice. The VoIP providers are dependant from the mobile operator, because in the handsets are only the codec’s available which are also a part of the standard of GSM or UMTS. This means for the VoIP providers that they have to develop such software that the quality remains the same as the GSM network but the codec that is used is for example GSM full rate. Otherwise the VoIP providers have to deliver handsets by themselves which support the codec they require to deliver their services.

Conclusion

From the mobile (broadband) wireless networks is GPRS the only network that isn’t capable to deliver proper quality for VoIP. This has to do with latency, user up- and downlink, selection of the proper voice codec’s for mobile VoIP and whether QoS is possible. In that case GPRS doesn’t qualify to the several criteria that are required for mobile VoIP. So GPRS won’t be analyzed further in the research. The main mobile broadband networks for the use of mobile VoIP are UMTS and WLAN. The coverage of UMTS is shown in the table 5. WLAN has only the difficulty that it is connected to a broadband connection. That way it is constraint to a certain area. Therefore it won’t be able to cover a full area as UMTS network. Therefore the possible values for WLAN coverage won’t be mentioned because they can’t be derived with any kind of certainty.

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverage</td>
<td>0</td>
<td>20%</td>
<td>70%</td>
<td>80%</td>
<td>90%</td>
</tr>
</tbody>
</table>

Table 5: Coverage of WLAN (802.11b) and UMTS

81 Quality VoIP- an engineering challenge, R J B Reynolds and A W Rix, BT technology, 2001, page 24
82 A technical white paper on Sage’s PSQM test, Renshou Dai, August 7 2000
84 Quality VoIP – an engineering challenge, R J B Reynolds and A W Rix, BT Technology, 2001 and Voice over Internet Protocol (VoIP), Bur Goode, Proceedings of the IEEE, volume 90, no. 9 September 2001/page 1498
The conclusion that can be derived from the fact that the mobile broadband networks do not have full coverage and the quality for mobile VoIP is still questionable creates high entry barriers for the VoIP providers. This way it would become difficult for the VoIP provider to enter now the mobile market, but in the future there is a possibility that the VoIP providers could have impact on the position of the mobile operators. In the year 2008 the people coverage could be approximately 100% of the mobile broadband networks. Whether that is possible depends on the situation and the other forces which play a role in the mobile telephony market.
4.2 Mobile devices for VoIP

For VoIP providers another enabler is very crucial. Those are the mobile devices with which VoIP providers can deliver mobile VoIP. The devices which can support the three VoIP configurations that are chosen as the most threatening competitors are the smart phones, PDA or MDA and UMA integrated handsets. The smart phones and the PDA or MDA can be utilized in the case of peer-to-peer configuration or indirect access. This has to do with the fact that these devices have the possibility that VoIP software can be downloaded if they have an open operating system. The UMA devices are in particular meant for the fixed to mobile converged configuration. These devices enable to switch from a WLAN to a GSM network. In this paragraph the penetration of the smart devices will be elaborated and development of as well the features as the characteristics of these devices.

4.2.1 Mobile digital assistant (MDA)

A MDA is a device which has several features such as digital agenda, Microsoft office, E-mail and any other kind of feature that could be used for business purposes. Nowadays more and more consumers are using these devices for their personal use. This latter is also possible because the MDA’s have an additional feature. The consumers can also call with these devices and they are becoming smaller in size. That way the MDA can be used as a GSM handset, only with extra features.

For VoIP these devices are ideal. This has to do with the fact that the consumer has to download VoIP software. Then the consumer can use the soft phone to set up a call. A soft phone is a phone that a customer can see in the display of his handset. These devices are user friendly in case of VoIP, because the display of a MDA is larger than those of a GSM handset. Besides that, the display has mostly a touch screen. That way the consumers do not have to struggle with the cursors of their handset. Another advantage for VoIP providers is that consumers, who use MDA, are accustomed with using their display as a dial.

The disadvantage of these devices is that the operating systems could be disabled by the mobile operators. This means that the customers can’t download all the software he wants. The mobile operators could choose for this option because they subsidize the devices and the manufacturers of the handsets are dependant of them. They are their buyers and as mentioned earlier there aren’t a lot of handset suppliers in the market. That way the handset suppliers will probably act reciprocal.

The development of these devices could result in a more user friendly interface for consumers. For example, integration of WLAN access, additional features such as IP telephony and pre-set settings for use of VoIP. These developments could lead to penetration of these devices for mobile VoIP.

Growth

The growth of the MDA is defined by extrapolating historic data of sales of the MDA in West- Europe. By adding a trend line a formula can be set. The trend line resembles an exponential growth. This can be said based on the R square value of 0.9577. The growth of the PDA/MDA will be exponential.

The formula will be as following:

\[ Y = 0.0707 \times e^{0.5713x} \times \text{scale factor for the Dutch market} \times \text{share of T-mobile} \]
The Y is the sales of the MDA’s in millions and the X is the year in which the MDA’s are sold. The reference point for the value X is the year 2001. The data for the West-European market is obtained from the consultancy agencies Strategy Analytics. By means of the GFK figures for the year 2004, the scale factor for the Dutch mobile telephony market could be set. The scale factor is the total number of sold PDA/MDA in the Dutch market divided by the total number of sold MDA in West Europe. After that the amount is calculated with the market share of T-Mobile. That way the approximate value of sold MDA’s will become available.

The values of the number of sold MDA’s based on the trend line are mentioned in table 6.

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of sold MDA’s</td>
<td>11465</td>
<td>20299</td>
<td>35940</td>
<td>63634</td>
<td>112669</td>
</tr>
<tr>
<td>Penetration of MDA’s</td>
<td>11465</td>
<td>31764</td>
<td>67704</td>
<td>131338</td>
<td>244007</td>
</tr>
</tbody>
</table>

Table 6: Sales figures of MDA’s for T-Mobile

4.2.2 Smart phones

Smart phones have similar features as MDA’s but they look like GSM handsets. That is the main difference between smart phones and MDA’s. For customers is such a smart phone an attractive device which they can use easily. Only difficulty in the case VoIP is that a customer has to download software before a VoIP call can be set up. Next to that the customer can’t dial directly by pushing the buttons of the handset. The customer has to dial with a soft phone. A VoIP call has to be set up by means of a cursor of the device.

A lot of handset suppliers are developing the devices. The probability that IP telephony and access to WLAN will be integrated in these devices is very high because the handset suppliers assume that eventually all the networks will become IP based. Also that WLAN will become available everywhere. For example Motorola has already developed a device which supports VoIP on WLAN and has even launched that. The Motorola CN620 is now for business purposes.

Another disadvantage for consumers at the moment is that the displays are very small of smart phones. If they would use a soft phone then it will require extra effort to set up a call. For some types of customers this won’t be an appropriate alternative for mobile telephony.

Growth

The growth of the smart phones is defined by extrapolating historic data of sales of the smart phones in West-Europe. By adding a trend line a formula can be set. According to the R square value of 0.9654 and the trend line, which sustains the R square value, the growth of the smart phones will be linear.

The formula will be as following:

85 These figures are indicative. They do not resemble the sales figures of T-mobile.
86 http://www.mitsuivp.com/cgi-bin/WebObjects/f1f2557f0f.woa/wa/read/104667449a9/02/08/2005
87 http://www.windowsfordevices.com/articles/AT7118576212.html 22/07/2005
Y = 3.8701 * X – 5.7881 * scale factor for the Dutch market * share of T-mobile

The Y is the sales of the smart phones in millions and the X is the year in which the smart phones are sold. The reference point for the value X is the year 2001. The data for the West-European market is obtained from the consultancy agency Strategy Analytics. By means of the GFK figures for the year 2004, the scale factor for the Dutch mobile telephony market could be set. The scale factor is the total number of sold smart phones in the Dutch market divided by the total number of sold smart phones in West Europe. After that the amount is calculated with the market share of T-Mobile. That way the approximate value of sold smart phones will become available.

The values of the number of sold smart devices based on the trend line are mentioned in table 7.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of sold smart phones</th>
<th>Penetration of smart devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>5670</td>
<td>5670</td>
</tr>
<tr>
<td>2005</td>
<td>7934</td>
<td>13604</td>
</tr>
<tr>
<td>2006</td>
<td>10198</td>
<td>23802</td>
</tr>
<tr>
<td>2007</td>
<td>12462</td>
<td>36264</td>
</tr>
<tr>
<td>2008</td>
<td>14726</td>
<td>50990</td>
</tr>
</tbody>
</table>

Table 7: The forecasted sales figures of smart phones for T-Mobile

4.2.3 UMA integrated devices

The standardization of UMA will be completed this year. The prospect is that the UMA device will come in 2006. At the moment these devices have a lot of disadvantages which seem to be an unattractive alternative for consumers. The main disadvantages are as following:

- UMA devices aren’t compatible with the third generation networks of the mobile operators⁸⁸. That means that the customer can’t use all the services of mobile operator when he uses the GSM network. In specific when the third generation networks are rolled out and also used for voice.
- At the moment UMA can’t support multiple access points and multiple wireless technologies. This creates difficulties in the sense that most wireless hotspots exist of multiple access points. That way UMA can’t be used when wireless LAN’s with more than one access point exists.
- Also the handover between wireless points and wireless technologies isn’t possible with the UMA technology yet⁹⁹.

This means that UMA isn’t yet developed enough to be able to use on a large scale. The standardization and development of UMA will take time. But when this technology is matured and his malfunctions are repaired. Then this technology can become a real threat for the mobile operators.

Other requirement for this device is also they should have a similar user interface as the GSM handsets. That way, consumers will intend faster to utilize these devices. The target group is in specific the people who have their own private wireless LAN’s and also at work.

⁸⁸ www.arcchart.com/blueprint/print.asp?id=368 13/06/2005
⁹⁹ www.arcchart.com/blueprint/print.asp?id=368 13/06/2005
Growth
The penetration of UMA devices can’t be analyzed by means of historic data or extrapolation. Therefore there should be analyzed the factors which enable the penetration of these devices. UMA devices could only be developed and sustained when network operators support UMA and WLAN will become more available and more customers will have private wireless LAN’s at home. This way the UMA devices could become very rapidly available in the mobile voice market.

Conclusion
The mobile devices are another requirement for mobile VoIP. Customers need these devices before they can use mobile VoIP. The penetration of these devices based on a forecast which is shown in the table 8. Based on the values the conclusion can be derived that the there isn’t a high penetration of the smart devices. For example at the moment T-mobile has 2.24 million customers and if the amount of the sold devices will be divided by the number of customer than the percentage will be very low. Even if the value of the sold devices in the forthcoming years will be divided by the same amount of customers then the percentage is also very low, approximately 5% of the whole customer base will have then a smart device in 2007. Therefore entry barriers for the VoIP providers are very high if they want to enter the mobile market.

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration MDA</td>
<td>11465</td>
<td>31764</td>
<td>67704</td>
<td>131338</td>
<td>244007</td>
</tr>
<tr>
<td>Penetration smart phones</td>
<td>5670</td>
<td>13604</td>
<td>23802</td>
<td>36264</td>
<td>50990</td>
</tr>
<tr>
<td>Penetration of UMA devices</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 8: Penetration of the smart devices

The possibility exists that the other forces that are also playing a role in the mobile market create opportunity windows for the VoIP providers. In the case of the devices it really depends on the choice of the mobile operators, handset suppliers and on the business model of the VoIP providers whether the penetration of the devices increases faster than the trend line, which is set up.

4.3 Regulation of VoIP
The most regulators within Europe approve VoIP and see it as a possibility to increase competition between and within the fixed and mobile markets. Therefore they won’t become a hurdle in the path of VoIP. Certain aspects do play a role that has to be taken into account. Those aspects are the numbers, and emergency services. Each of these aspects creates an entry barrier on a certain way for the VoIP providers.

4.3.1 Numbers
The VoIP providers need numbers, otherwise their customers can’t be called by anyone and they couldn’t call to anyone. In the case of the peer-to-peer configuration this isn’t an issue but for the indirect access (Vonage) and the converged model numbers are important. The allocation of numbers will be elaborated. OPTA is the institution who distributes the numbers to operators and providers and the ministry of economical affairs

90 http://www.t-mobile.nl/corporate/htdocs/page/wie_is_t_mobile/ps3.0.1.1.asp 20/07/2005
develops the policy regarding the number allocation. In the case of VoIP a short term solution was required before the number plan would be changed. Therefore OPTA has made a decision as long the number plan isn’t changed by the ministry. That means for the VoIP providers that there are three possible locations considered for them. Those are the geographic numbers, mobile numbers and number for personal assistance services (for the internal network of a company). The requirements for the usage of either the geographic numbers or the mobile number are that the VoIP providers have to act according to the number plan and the criteria’s that are set for the usage of those numbers\textsuperscript{91}. For Vonage this would mean that they could use mobile numbers only for mobile purposes and geographic numbers for fixed usage. This creates for the VoIP provider a difficulty, because for the usage of indirect access only a broadband connection is required. That could be a fixed broadband connection or a mobile broadband connection. That way it would create a barrier for the VoIP provider of indirect access. Using personal assistance numbers for nomadic use is possible. Only the customers aren’t accustomed to use personal assistance numbers and the customer perceives those numbers as a costly event. The same difficulty will occur in the case of the converged model\textsuperscript{92}, where the consumer uses as well the fixed as the mobile network for UMA services.

<table>
<thead>
<tr>
<th>Business model</th>
<th>Geographic number</th>
<th>Mobile numbers</th>
<th>Personal assistance numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peer-to-peer</td>
<td>Location</td>
<td>Only mobile usage</td>
<td>Nomadic</td>
</tr>
<tr>
<td>Indirect access</td>
<td>Location</td>
<td>Only mobile usage</td>
<td>Nomadic</td>
</tr>
<tr>
<td>Integrated model</td>
<td>Not</td>
<td>Only mobile usage</td>
<td>Nomadic</td>
</tr>
</tbody>
</table>

Table 9: The numbers and their locations per business model

### 4.3.2. Interconnection

Definition of interconnection according to telecommunication law: “The physical and logical connection of telecommunication networks, which are utilized by the same or another organisation to enable the end-users from a organisation to communicate with the same or another organisation or have access to the services, which are provided by another organisation.\textsuperscript{93}” This means end-users should be able to communicate with each other and it shouldn’t matter who delivers the service. Interconnection cost is also related with interconnection. Those costs are called the terminating or originating cost. Each mobile and fixed network operator has to pay interconnection cost when their subscribers or users call to another network and they receive money when the subscribers or users from other networks terminate calls on their network\textsuperscript{94}. These interconnection cost are regulated and calls to fixed network have as terminating cost 0.01 euro and to mobile it is 0.12 euro\textsuperscript{95}. When these costs will reduce the VoIP providers could lower their tariffs and become more competitive. As long as these costs remain at the same level the VoIP providers can’t have lower tariffs for off-net calls to mobile subscribers. This way their competitive level will remain low when they will enter the mobile voice market.

\textsuperscript{91} Beleidsregels nummer voor VoIP diensten, OPTA, 4 april 2005
\textsuperscript{92} The treatment of Voice over Internet Protocol (VoIP) under the EU regulatory framework, European commission, 2004
\textsuperscript{93} E.J. Dommering (1999), handboek telecommunicatier recht, pp. 3-52.
\textsuperscript{94} Rapportage over de marktdenitie van het afwikkelen van gesprekken op mobiele netten, Nma, 1/8/2002, page 3-5
\textsuperscript{95} BRON: www.opta.nl 02/09/2005
Conclusion

Numbers are also important for the VoIP providers. That way there customer can call and be called by anyone. At the moment VoIP providers can’t use mobile or geographic numbers for hybrid purposes. Personal assistance numbers are made available for nomadic use. Only the perception regarding these numbers is negative. The customer assumes it as a costly event. It depends when the ministry of economical affaire will change the number plan and allow the VoIP providers to use mobile and geographic numbers for hybrid usage. As long as the interconnection cost for especially the mobile numbers remain high then they can’t set low tariffs to mobile numbers.

5. Substitution

When VoIP will enter the Dutch mobile voice market it will be mainly an alternative. Only when WLAN is used then it is a substitute of mobile voice. This has to do with the fact that mobile voice is defined as a voice service that is everywhere available. WLAN is connected to an access point and can only give coverage to a certain area. Therefore it is a substitute of mobile voice. WLAN could become a full substitute and a partial substitute. These two alternatives are mentioned below.

5.1 Full substitute

In the case of the fixed to mobile convergence configuration by means of UMA the provider is a substitute. WLAN will become a part of the GSM network. The main difference is that the business model will become viable when the UMA devices are developed and used and customers have a WLAN at home or can access at other places easily a WLAN. Besides that, the prices should be low when the customer uses a WLAN to call with his UMA device and the UMA provider should be able to differentiate himself by means of new services which aren’t available on the mobile market.

5.2 Partial substitute

Besides that the customers could also choose to use their private WLAN to call by means of VoIP and use their GSM network to call when they aren’t within the reach of their WLAN. It would become a viable alternative when VoIP is used as a partial alternative at home. This would be mainly possible when WLAN becomes more available at home and customers have devices which have access to WLAN integrated. This way the VoIP providers or fixed network operators could have large impact on the revenues of the mobile operators. Normally the minutes that the customer calls at home by means of his GSM will be called by means of WLAN.

Conclusion

The converged model is already an alternative, because it uses a GSM network when there isn’t a WLAN available and vice versa. Yet, the model will be successful when the UMA devices are developed and brought to the market. Besides that the wireless LAN’s have to become available at public places and at home. Also an alliance with mobile operator is required for this model, otherwise UMA won’t work. Because of the alliance the mobile operator could earn back a certain rate, by means of the wholesale offer the mobile operator will offer to the FNO/cable provider/ ISP. When the convergence model is used for partial usage it could have impact on revenue of the mobile operator. This has to do with the fact that the mobile operator will loose the minutes that the customer normally calls at home. He will mainly use his private WLAN therefore.
6. Buyer power
The buyer power is another force of the Porter analysis. For a country as the Netherlands that are a lot of competitors for a mobile market. Therefore the competition is high and it depends on the customer for whom he chooses and how a competitor creates an incentive for a customer to switch from provider. Only the bargaining power until now has been low. This can be changed only it depends on how the customer perceives mobile VoIP.

6.1 Fixed and mobile market for VoIP
The customer will choose earlier for VoIP on the fixed network than on the mobile network. This has to do with the fact that customers do not have the urge nowadays to use mobile internet for regular use. The fixed market on the other hand has grown and developed in delivering internet to the customer by means of several types of subscriptions. The customers are now accustomed to internet usage by means of the fixed network. Besides that, customers find it difficult to use their mobile devices for rather technical issues. The most customers only want to call and send SMS with their mobile phones. Using internet and downloading software is assumed as discomforting, especially when they have to call with a soft phone instead pushing the buttons on their mobile phone.

6.2 Mobile VoIP for the customer
The customer would only use mobile VoIP if the VoIP providers are able to deliver similar services as the mobile operators, and the customer has the similar perception about the VoIP provider as about the mobile operator. Also the pricing is a crucial aspect for the customer. As long as the voice prices are lower than the data prices and the customer has to buy a phone to be able to use mobile VoIP then it wouldn’t be attractive for the customer to select mobile VoIP. Therefore the combination of pricing, service and brand determines the choice of the customer to either choose for an operator or switch. These aspects are very important for the research to take into account, because the customer determines mainly the revenue of the mobile operator. Besides that, VoIP providers can deliver additional features which aren’t delivered by means of the mobile operators. That way the VoIP providers can differentiate themselves. For example a customer could receive an e-mail that announces audible the heading of the mail on the mobile phone.

Conclusion
For customers the usage of VoIP on their mobile phones isn’t a very attractive solution. This has to do with two things. First of all customers aren’t accustomed with using mobile internet. Their reluctance can be seen in the penetration figures of the percentage of customers that uses mobile internet. On the fixed network the customers are already accustomed with internet and are prepared to take additional services, such as digital television in combination with their internet subscription. Secondly, customers only want to use their mobile phones for calling and sending SMS. This has become clear in customer satisfaction researches. Besides that, customers want to use mobile VoIP as they use now the mobile services of the mobile operator. The perception regarding the brand and the awareness of it is essential for the customer. That way the customer assumes that the operator delivers a good quality of service.

96 This is based on customer satisfaction reports, and results of the mobile monitor.
The last aspect that is very crucial for a customer is the price. The data prices have to be lower than the voice prices. Besides that, the customer shouldn’t have to pay for the device. Otherwise he/she won’t have an incentive to choose for a VoIP provider. It is possible that new advanced features delivered by the VoIP provider could have an affect on the consumer, who would choose the VoIP provider. The forces which can enable mobile VoIP are mainly the entry barriers, the strategic moves of the mobile operators and how the VoIP providers themselves set up their business model.

7. Supplier power
The last force of Porter is the supplier power. It is possible that the suppliers could create a force that could become an opportunity window for VoIP providers. Therefore it is important to take in consideration the supplier power. The suppliers for mobile telephony are the handset suppliers and the dealers, who sell the subscriptions of the mobile operators. These two actors will be worked out, because possible alliances could have impact on the position of T-Mobile. In the case of the fixed to mobile convergence, the fixed network operator or ISP won’t need these alliances because they would be aligned with a mobile operator. The mobile operator already has business relationships with as well the handset suppliers as dealers. Only the development of UMA and the development of the integrated devices is an obstacle for the operators which want to offer fixed to mobile convergence.

7.1 Handset suppliers
The prospect is that eventually the telecom sector will change from circuit switched networks to IP based network. That is the reason why the most handset suppliers are already anticipating on it. Handsets are being developed which include IP telephony as an option. In Europe there are approximately 5 large scale suppliers, which are Nokia, Motorola, Sony Ericsson, Siemens, and Samsung. Handsets are a must for the VoIP providers to deliver their voice services at the mobile market. Therefore an alliance with the large scale handset suppliers would have large impact. That way the devices could be pre-configured with VoIP settings. The disadvantage for the VoIP providers is that the mobile operators already have a supplier – buyer relationship. The large scale suppliers don’t want to jeopardize this relationship. New handset suppliers could take into consideration an alignment with the VoIP providers. Only the impact will be low because it depends on the business models of the VoIP providers whether they also want to invest in that alignment.

7.2 Dealers
Dealers are the most prominent channel for the mobile operator that is utilized by the customers. Therefore mostly the mobile operators give subsidies on the handsets and commissions for selling their subscription. A lot of dealers buy handsets themselves from the handset suppliers by means of the commission and sell only the SIM cards of the mobile operators. Only the commission for the data bundles isn’t very high. This has to do with the fact that mobile internet isn’t attractive for the consumer. That means the dealers have to subsidize the handsets for VoIP on their own cost, which they won’t earn back.
It is possible that the dealers sell the data bundles as voice bundles with pre-configured devices for VoIP. Only those devices have to be subsidized by somebody and it depends on the business model of the VoIP provider whether he wants to subsidize the devices.
Conclusion
The handset suppliers are already anticipating on the changes of the market. They have started with developing and launching devices which sustain IP telephony. Alliances of VoIP providers with the large handset suppliers could have large impact on the position of the mobile operators. On the other hand the handset suppliers have already business relationships with the mobile operators and they won’t want to jeopardize that relationship. New handset supplier could consider an alliance with the VoIP providers, but their brand won’t be that much recognized. Therefore it would have a small impact on the mobile operators.

For the dealer there should be an incentive to sell devices with the data bundles of the mobile operators as one package. This incentive has to be created by the VoIP providers. Therefore the business models of the VoIP providers should change that way that they either subsidize the devices or give commissions when data bundles are sold in combination with their VoIP software on it. Only in that case the dealers could consider an alignment or cooperation with the VoIP providers.
Conclusion of the competitive threat assessment

The competitive threat assessment is shown in figure 9. The diagram is elaborated as following. In this research there is looked at the mobile voice market. The product with which the new VoIP providers want to compete is mobile voice. The VoIP providers have the advantage that they can enter the mobile market because they do not have to deploy a network or acquire a wholesale deal with a mobile operator as MVNO’s have to do. On the other hand they do have to bridge the entry barriers such as the availability of the devices, the coverage of mobile broadband networks and regulation. In the case of the latter the NRA doesn’t want to create large barriers for the VoIP provider. Based on the analysis even these entry barriers are high. Almost 5% of the customer base will be enabled to use mobile VoIP on their devices in 2008.

Next to the entry barriers other forces also have effect on the entry of mobile VoIP. The business models of the VoIP providers define which way they will enter the market and whether their business model will be attractive for the customer to use mobile VoIP. They also have effect on the other forces, such as the supplier power. In figure 9 the means are mentioned with which the VoIP provider could create incentive for the customer to choose for the VoIP provider. The VoIP providers could enter as new entrants who have never accessed the Dutch telecom market, such as Skype and Vonage. On the other hand a fixed network operator or ISP could access the mobile market by means of UMA, which enables convergence between fixed to mobile. Or customers could choose to combine WLAN and the GSM network according to their preferences and make a viable converged alternative possible.

The suppliers of handsets create also a sustainable environment for the VoIP providers in the mobile market. By developing devices which have as additional features IP telephony and access to WLAN mobile VoIP could become attractive for the customer. Next to that it is also possible that the handset suppliers could align with the VoIP providers. That way the VoIP providers could deliver devices which have pre-configured settings for the usage of mobile VoIP.

The intern rivalry in the mobile telephony market is high; this has to do with the fact that there are nearly 27 MVNO’s and 5 mobile operators who have to compete with each other. The MVNO’s have orientated themselves on the several niches. That way they have less impact on the market and their shares are low. Yet, the mobile operators are competing actively by means of pricing. For example Vodafone has launched a new price plan with which the customers could call very cheaply to international destinations. Besides that several mobile operators are trying to orient on several segments of the mobile market. For example T-mobile has deployed in the Netherlands hotspots. The high competition creates for the new VoIP provider a barrier to enter the mobile voice market easily.

The buying power of the consumer is low because the customer doesn’t have a large bargaining power, only when he wants to renew its contract. But that depends on the initiative of the customer. Besides that, the customer has high switching cost as a post-paid customer. Next to the bargaining power the consumer selects a provider not only on price but also on brand, quality, services and user interface.

Mobile VoIP is a viable substitute in the case of the converged model, because the customer will use anyhow the GSM network. When a WLAN is accessible then the
customer could call cheaper on the fixed part. Next to that advanced services could be
delivered by means of integration of voice and data.
Based on these analysis the empirical model will be designed and the scenarios for
mobile VoIP.

Figure 9: Porter model for mobile VoIP
Part II: Modelling of the empirical model

In this part the model is designed with which the scenarios will be calculated. The design of the model is based on the analysis of the competitive assessment and delineation of the research field that has taken place in the first and second chapter. The design will be done in few phases, which are conceptualization, specification, verification and validation of the model. Before the phases are worked there will be explained why a certain methodology is selected to design this empirical model.

In the model three perspectives are taken into account. That way it becomes clear what the impact of mobile VoIP will be on the position of the mobile operator. There will be looked which business model is the most appealing for the customer to select based on certain criteria’s. Those criteria’s are based on the fact that mobile VoIP has to be a substitute of mobile telephony. After the selection of the adequate business model the cost (dis)advantage for the mobile operators and VoIP provider will be looked. Only in the case of fixed to mobile convergence the cost (dis)advantage won’t be taken into account. This has to do with the fact that the converged version has similar cost structure as the mobile operators have. This way the impact of the scenarios would become clear after the scenarios are designed in chapter 9.
8. Design of the impact model for VoIP

The design of the model is done in few phases. First is decided which methodology will be applied in the case of the forecast model. After that the design phases are worked out, which are conceptualization, specification, verification and validation phase. In the conceptualization phase is the image-forming of the problem elaborated. In the specification phase the model is filled in with facts and figures. By means of those facts and figures the several scenarios can be calculated. The verification and validation phase are meant to analyze whether the model resembles the reality.

8.1 Selection of the methodology

To select for mobile VoIP a methodology there has to be looked at several factors. First of all the VoIP providers have to be able to deliver certain features to become a viable alternative of mobile telephony. Those features are the user interface, user experience, brand recognition and perception, and mobile numbers. Besides that the entry barriers to enter the mobile voice market are very high. Customers need smart devices and a mobile broadband coverage before they can use mobile VoIP. Then the VoIP providers could become a substitute of mobile telephony regarding the service they will deliver.

Besides that, prices of handsets and subscriptions play also a large role for the customer before he prefers mobile VoIP instead of mobile telephony. Therefore there has to be examined what each business model will cost the customer per month and in what degree the VoIP business models resemble the service of the mobile operators. After the selection is done by the customer the impact on the mobile operators and VoIP providers can be calculated. By examining the possible earnings of the VoIP providers it becomes clear how they can position them in the future and how much impact their business model could have on the mobile voice market.

The requirements for the model are that it should have the possibility to resemble the point of view of each actor. It should be possible to combine other methodologies to resemble the choice of the customer. The last requirement is that it should be possible to take uncertainty into account.

A system model is the best alternative to select for conceptualization of the model and it is also simple to convert the model into an excel file. Excel of Microsoft enables a user to make calculations and change parameters whenever required without changing other data in the sheet. Therefore excel will be selected for the calculations of the scenario’s and the results.

The reason why a system model is selected has to do with the fact that the system can be divided into sub systems and each subsystem could have a methodology or a combination of it. Besides that, a system model provides the advantage that it is simple and defines clearly the system and the factors that have affect on it. For mobile VoIP this is ideal because the inputs are the parameters which will change in the future and the output has to be calculated by means of the values within the system. The system model provides also the possibility to add other methodologies in a sub system. In the case of the customer, the customer has to make a choice between the different business models. This choice is based on the quality price ratio. With quality is meant the score that is given to the business models based on the fact in what extent they can become a
partial or a complete alternative of mobile telephony. To be able to assess the quality of the attributes per business model a SMARTER model is an adequate method. A SMARTER model shows the preferences for the customer for each attribute as a rank order centroid (ROC) weight. The way the ROC weights are assigned to a certain attribute depends on the choice of the customer. In this case the marketing department will give values based on their experience. Next to that each attribute has a value. Some values are a fact but the others are assumed on the basis of researches or prior experience. This way there will be given for each business model a score that could change according to the scenario.

The selection of the business model is based on the price quality ratio, which can be shown by means of a Pareto diagram. The advantage of this way showing the price quality ratio it becomes directly clear for the viewer.

8.2 Conceptualization of the model

The model is based on the Porter model in which mobile VoIP is a new entrant. The forces in the case of mobile VoIP are the supplier power, buyer power, entry barriers, substitution and internal rivalry. The development of these forces could create a sustainable environment or barriers for the VoIP providers.

The main focus of the model is the customer. It depends on the choice of the customer, which operator he will select and what impact that will have on the earnings of the mobile operator and of the VoIP provider. The system model is shown below in figure 10. The system model contains three elements and those are the input, output and the system itself.

In the case of mobile VoIP the input parameters are the values that can change in the future. That way the values can be changed according to the scenarios. As shown in the diagram the input parameters are as following:

- Attributes by means of which mobile VoIP could be either a full alternative or partial alternative of mobile telephony
- Percentage of change for voice tariffs
- Percentage of change of the prices for data usage
- Percentage of change of the convergence prices for as voice as for data usage
- Penetration percentage of smart devices
- Probability that the customer of a mobile operator will use mobile VoIP instead of mobile telephony
- Selected business model by means of the price quality ratio.

The output is the value that is achieved by means of calculation. Those values are price quality ratios per business model for a customer and the margin for as well the mobile operators as the VoIP providers. Margin is the difference between the revenue per customer and the interconnection cost and for the mobile operators the subscriber acquisition cost (SAC). These costs are taken into account because these costs are variable costs. These are dependant from the number of customer.

Another reason why SAC and interconnection cost are analyzed has to do with the following. The mobile operators subsidize handsets. That way the customers can receive a handset with their subscription for almost for free. For the VoIP providers SAC isn’t financial beneficial. They can’t earn the cost back from the customer according to their current business models. This is a main difference between the mobile operators and the VoIP providers. Interconnection costs are a way for the VoIP providers to earn money. This is possible when the VoIP customer will be called. Then the VoIP provider will earn from the interconnection cost. Of course the VoIP provider also has to pay interconnection cost when his customer calls off-net. The same counts for the mobile
operators. Only in the case of the VoIP providers this seems the most prominent way to earn money from his customers. The network and departmental costs aren’t taken into account of this research. This has to do with the complexity of these costs which go beyond the scope of the research.

The calculation takes place within the system. The system is divided into three sub-systems. The first sub-system concerns the choice of the customer and the other two are meant to determine the financial impact for T-Mobile and the possible margin for the VoIP providers after the choice of the customer.

In this model it is assumed that the customer is rational. It means that the customer has all the information that he requires to make a thorough and right decision in his advantage (S. Alter, 1999). The criteria for the customer to choose for a provider are obtained by means of customer satisfaction researches. Two main factors are determined for the choice of the customer. That is the price of the monthly cost of the subscription and the prices of the handsets and the quality. Quality is defined very broadly. With quality is meant the score that is given to the business models based on the fact in what extent they can become a partly or a full substitute of mobile telephony.

Figure 10: System model for the forecast of the impact of VoIP
8.3 Specification of the model
The model exists of four parts, input, output, facts and assumptions and the calculations. These four parts will be worked out. That way it will become clear what the content of the model is and how the impact could be calculated.

8.3.1 Input
The input variables are the factors that would change in the future. The degree in which the input variables could change will be elaborated in chapter 9. The input parameters are the reduction percentages of the voice and data prices, international called minutes, penetration of smart devices, probability of usage of devices for mobile VoIP and the values of the quality attributes.

Voice and data prices for (inter)national destinations
As competition enhances within the mobile telephony market there is a high probability that as well the voice prices as the data prices will reduce. Therefore the input parameters will mainly be reduction percentage, only if the competition will reduce. That seems rather difficult.

International called minutes
The possibility could occur that the customers will call more to international destinations by means of VoIP. This has to do with the high prices that the mobile operators ask for calls to international destinations, while the VoIP have cheap prices for international destinations. Therefore the international minutes are also include as input parameters.

Penetration percentage of smart devices
The penetration of smart devices plays a large role in the case of mobile VoIP. Customers need a device to be within reach everywhere, otherwise they couldn’t be mobile. The penetration of smart devices determines how many customers are enabled to use VoIP. The term smart devices is used in this research as a group name for all the type of devices which seem to be similar to GSM handsets and can be used for VoIP. For example MDA, smart phones and UMA devices.

Probability of using the smart device for mobile VoIP
There is a chance that a lot of customers who use smart device for regular issues eventually will use it also for VoIP. It is possible that this probability will increase and more customers will think about using their smart devices for mobile VoIP. Therefore it is important to have this parameter as an input variable.

Quality attributes
The quality attributes are the factors that could change in the future and could make VoIP a viable alternative for customers. To analyze the quality attributes per business model the SMART model is used. The reason to select the SMART model for this subsystem is elaborated in paragraph 8.1. The choice to select the SMARTER version of the SMART model has to do with the uncertainty that is involved in the case of VoIP and the choice of the customer. The choice of the customer can’t be fully determined. Based on earlier research and experience of the marketing department some assumptions can be made about the preference of consumers for each attribute. The ROC weight is predetermined. The values of the ROC weight are based on the number of attributes. In the case of five attributes the values according to Goodwin and Wright are as following:
46, 26, 16, 9 and 3.

**Ranking of quality attributes**
The ranking and the values for the ROC weight are mentioned in table 10. Based on researches of “mobile monitor” it has become clear that customers want full coverage. They want to be within reach all the time. The other attributes are based on assumptions. This has to do with the fact that at the moment there aren’t any actors such as VoIP providers in the mobile telephony market. It can’t be defined with a certainty.

The assumption is that the customer wants a similar service as the service of the mobile operator. Therefore the user experience and user interface should be similar as mobile telephony. The user experience has to do with the services of the operator and user interface with the handsets. User experience is assumed as a more preferred attribute than the user interface. For customers the service of an operator is more important in the sense that they are enabled to use the service for which they are paying. The handset and his interface are more an incentive for a customer to choose for a certain operator.

Next to that the brand is also an important attribute, but less than user experience and interface. Customers have mostly certain perception of a brand and awareness of a brand. That will have affect on the choice of the customer.

To become a viable alternative of mobile telephony the VoIP providers should also have mobile numbers. That way the customer will perceive mobile VoIP as mobile telephony and the customer could call and be called by anyone. The reason that this attribute has the lowest value is because average customers are more oriented on the earlier mentioned attributes. The number creates the incentive for a customer to choose for the VoIP providers.

<table>
<thead>
<tr>
<th>Quality attributes</th>
<th>ROC weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverage</td>
<td>46</td>
</tr>
<tr>
<td>User experience</td>
<td>26</td>
</tr>
<tr>
<td>User interface</td>
<td>16</td>
</tr>
<tr>
<td>Brand</td>
<td>9</td>
</tr>
<tr>
<td>Numbers</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 10: the preference of the attributes

**Scale of the SMARTER model**
The scale that is used in this SMARTER model is the interval scale. Interval scale means that the values are ranked according to preference and the interval between the values shows in what degree that proposition is preferred more or less than the reference point. The reference point in this research is T-Mobile.

The value of the quality attributes is based on the current state. These values can be changed according to the scenarios. Therefore there won’t be given for every attribute a value. The business models are the peer-to-peer WLAN, peer-to-peer UMTS, indirect access WLAN, indirect access UMTS and integration of mobile and fixed. For each of these business models the quality attributes have a certain score. As mentioned the values of those scores won’t be given because it depends of the scenarios which will be designed in chapter 9.
Table 11: SMARTER model

<table>
<thead>
<tr>
<th>Quality attributes</th>
<th>ROC weight</th>
<th>Mobile operator</th>
<th>Peer2peer WLAN</th>
<th>Peer2peer UMTS</th>
<th>Indirect bypass WLAN</th>
<th>Indirect bypass UMTS</th>
<th>Integrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverage</td>
<td>45</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>User experience</td>
<td>25</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>User interface</td>
<td>16</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Brand</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Numbers</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Quality scores</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Coverage
The coverage of WLAN will have a development as the utility graph shows. The reason that this diagram is mentioned is to show how low the utility is of WLAN for a customer. This has to do with the fact that WLAN has only coverage where the access point is positioned. So the customer can’t have full coverage and won’t be able to use WLAN all the time. That way his utility will be low. That is also the reason why the utility curve grows so slowly.

The UMTS coverage is based on the conditions of the license. As mentioned in paragraph 4.1.4., the score for the coverage of the UMTS network in 2005 is 20% and will increase. Only how fast that depends on the conditions of the license and the strategic choices of the mobile operator.

For the converged business model the score will be equal to the score of the mobile operator because they also use GSM. The GSM network has full coverage in the Netherlands.

![Utility graph for coverage of WLAN](image)

User experience
In the case of peer-to-peer the customer can only call to people who have also VoIP software, such as Skype. Therefore the value for user experience will be very low. In the case of indirect access the value should be higher because the customer can call and be called by anybody. Besides that the VoIP providers also delivers several services, such as voicemail, call diverting, etc. The customer only needs a mobile broadband connection and a device which sustains VoIP.

In the case of the integrated business model the customer should have similar user experience as the mobile operator. This has to do with the fact the customer will use the GSM network and billing issues, customer service will be handled by means of the mobile operator with which the fixed network operator or ISP has aligned.
User interface
The user interface is important for the customer, because customer shouldn’t experience any kind of discomfort while using their mobile phones. In the case of peer-to-peer the customer has to download VoIP software and use the soft phone to be able to make calls. That way the user interface score will be low for peer-to-peer.

In the case of indirect access the customer has to do the same thing as in the case of peer-to-peer or can choose to pre-configure the devices as Vonage has done on the fixed line. If the latter happens then the user interface score for indirect access will be much higher, because the customer won’t experience any particular discomfort.

Fixed to mobile convergence has a high score because the device would have the similar interface only the handover between the GSM and WLAN could be noticeable. That way the score will be lower than that of the mobile operator.

Brand
In the case of peer-to-peer business model, Skype, customers are rather familiar with it. This has to do with their earlier product, Kazaa. Kazaa is software that can be downloaded on a PC. The person can use this software to download at an illegal way audio music. A lot of law suits have taken place against the builders of Kazaa. Therefore customers could be reluctant in using their services. Besides that the brand Skype isn’t used for mobile usage and they haven’t put any effort in marketing. Therefore the customer will prefer a mobile operator instead of peer-to-peer usage.

The VoIP provider who delivers indirect access, such as Vonage, is even less popular. The customers aren’t aware of these providers. This has to do with the fact that they have oriented themselves to certain countries and markets.

The provider of the integrated business model in UK, named BT, is already a recognized brand within the telecom sector. There only disadvantage is that customers aren’t familiar with an integrated solution. Therefore the value will be lower than that of the mobile operator.

Numbers
For peer-to-peer there aren’t numbers necessary and available, this has to do with the fact that the customer is restricted and can’t call to everybody. So it isn’t a public available telephony service (PATS)\(^{97}\). The indirect access business model will get a mobile number when they orientate themselves on the mobile market. Therefore as well peer-to-peer as indirect access will get the score of 0. In the case of the converged model they have mobile number as long as they use it for mobile purposes. The score will be then 100 as the score of T-Mobile.

8.3.2 Assumptions and facts
A lot of assumptions are made to be able to calculate the revenues and costs for the mobile operator and VoIP providers. There are four situations assumed that could be convenient for the customer. These four situations are a complete alternative or a partial alternative of either the bypass model or the converged model.

The figures that are mentioned in the table are the assumed values based on sales figures and experience of the marketing department.

Complete alternative
In the case of full substitution the average users will be taken into account. For the average users it is assumed that the customer takes a subscription for 2 years and for 200

\(^{97}\) IP Voice and associated convergent services, Analysus, 28/01/2004
At T-Mobile, the price of the bundle for 200 minutes is 26.50 euro per month. So when these customers want to use VoIP, they will need a data bundle that is unlimited. Otherwise, the customer won’t be able to be called any time. There are data bundles at the moment which are especially for WLAN and UMTS. T-Mobile has launched recently a bundle for WLAN. The price of the bundle is 19.95 euro per month and the customer can use it unlimitedly. Only the customer won’t receive a handset. KPN has launched an UMTS bundle which has a limit of 440 minutes. The cost price of this bundle is 45 euro. Next to these specific bundles, T-Mobile has also an unlimited bundle for mobile broadband. The cost price of that bundle is 59.50 euro. Also in this case, the customer won’t receive a device.

Another very important assumption is that the customer will always choose for the lowest price. The quality is important but according to “mobile monitor,” customers are very cost conscious and want to be sure what they have to pay monthly. That is also the reason that the customers prefer bundles for a certain amount per month instead of paying per minute.

The integrated business model is another issue. There are made few important assumptions. The price the customer has to pay for the convergence model should be cheaper than the voice prices of the mobile operators. Besides that, it should be cheaper for the customer to call by means of WLAN then with the GSM network. Customer perceives a monthly fee for a certain bundle as the most convenient alternative for payment of phone bills. Therefore, a money bundle would be the best solution for the customer to be able to use in which calling by means of his WLAN would be cheaper. That way, the fixed network operator will make the converged model more successful.

Partial alternative

The third situation has to do with partly substitution. In this case, the customer wants to use VoIP to call to international destinations. The customer needs a subscription to call on his mobile within the Netherlands. Thereby it is assumed that the customer will use the average bundle of 200 minutes per month. Besides that, the customer will also need a data bundle to have a mobile broadband connection. The smallest bundle is of 100 minutes for the price of 17.85 euro per month. The customer could also choose to use his WLAN for a mobile broadband connection. That way, the customer would only need to pay for the router of 40 euro that would be 1.60 euro per month. The price that is assumed for the international call per minute is 0.75 euro. This price is based on the average cost of a customer when he calls to international destinations. The customer will call the same amount of minutes 2 years long.

The last situation is that the fixed network operator doesn’t use UMA but deliver devices which support WLAN access. That way, the customer can use his WLAN by means of VoIP and his GSM subscription when he is not within the reach of his WLAN. That way, the customer could use VoIP as a partial alternative at home. It depends how a fixed network operator will set this business model. Almost 20% of the time, customers call at home. The customer calls averagely 200 minutes per month. It will mean in the partial

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98 The assumption is based on how customers use their minutes in reality. In that case, the customer uses approximately 200 minutes at average.
99 The limit is based on the following calculation. Skype uses averagely 465 kilobits per minute and 1Mb is 1024 kilobits. This means that 1024/465 * the amount of Mb results into the amount of minutes.
100 Based on the customer satisfaction research
converged case that he will call now 150 minutes by means of his GSM network and the remaining minutes by means of his WLAN at home.

**Cost**
To be able to calculate the margin the subscriber acquisition cost (SAC) has to be assumed per price plan and the interconnection cost. The SAC can be filled in by any mobile operator. Also, because there is confidentiality issue related with SAC. Therefore an amount won’t be mentioned only the manner how SAC is calculated. The mobile operators do not have to pay for every customer every year SAC. Some customers remain for a longer time than two years. Therefore a correction has to take place which examines the percentage of gross adds in the period of two years for which SAC will be paid. This will be calculated by taking an average of the gross adds per month and dividing by the average customer base. Then the amount has to be multiplied with 24 because there is assumed that a customer has a contract of 2 years. The interconnection cost of traffic from mobile to mobile is 0.124 euro and of mobile to fixed 0.01 euro. For international traffic the interconnection cost are assumed 10 eurocent for as well to fixed destinations as mobile.

The outgoing traffic within the Netherlands is assumed. There is assumed that 47% of the calls are from a mobile to a mobile of another MNO, 27% from a mobile to a fixed line and 26% calls take place on-net. This means the customers of the same mobile operator call with each other. The mobile operators seem to have more outgoing traffic off-net than incoming traffic. Therefore the operators will have to pay for the interconnection cost anyhow.

**Revenue**
The number of customer depends on the base of a mobile operator. Therefore any value can be added by a mobile operator to calculate the scenario. The number of VoIP customers is based on the penetration percentage of the smart devices. This way the revenue can be calculated.

**8.3.3 Calculations**
In this paragraph the formulas of the calculations will be elaborated. This way it will become clear how the output is calculated. The calculation can be seen in appendix part 3, table 4 and 5.

**8.3.4 Output**
The outputs are the values that are obtained by means of the calculations and the choice of the customer based on the several business models. The outputs are the margins for each business model in the case the customer has all the information that is required. The customer will select for the price quality ratio that seems to be the most convenient. This way the margin will be calculated for the most preferred business model.

**8.4 Verification and validation**
In this paragraph verification and validation of the model will take place. With verification is meant that the dimensions of the units that are chosen are correct. Validation is meant to analyze whether the model resembles the reality. The model that is used is a combination of two models, SMARTER model and the system model. Therefore the verification and validation will take place of both of the models. First verification will take place then validation.

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101 [www.opta.nl](http://www.opta.nl)
8.4.1 Verification
Verification is a manner to analyze whether the structure of the model is correct. Therefore several tests are available. The tests that will be done are the dimension analysis, extremes and sensitivity analysis.

Dimension analysis
The purpose of the dimension analysis is to look whether the values of the four parts have the right dimension. That way the output can be calculated properly. Eventually, the scenarios will be calculated accurately.

The unit of each formula is given. This way it becomes clear whether the dimensions are correct or not. According to the tables in appendix part 3 each formula has the correct unit. That results in an output in euros as it should.

Extremes
The input should determine the output. Therefore there has to be looked whether the input has impact on the output and in which degree. This can be done by filling in one by one in each input two values. Those are 0 and 100 in the case of percentages and in the case of numbers 0 and a very high value, such as 1000.

<table>
<thead>
<tr>
<th>Input variable</th>
<th>Input value</th>
<th>Expected output value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage penetration of devices</td>
<td>0%</td>
<td>Margins stay the same because customer can’t use mobile VoIP</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>Margins become very high because there are no interconnection cost</td>
</tr>
<tr>
<td>% of price in the integrated business model</td>
<td>0%</td>
<td>The customer has to pay only for mobile cost per month and that remains the same</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>The customer has to pay for mobile cost + cost for calling at home. That is the output</td>
</tr>
<tr>
<td>% of data prices</td>
<td>0%</td>
<td>There are no earnings based on data bundles, because the data bundles are for free</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>The current state remains. The mobile operators remain the cheapest</td>
</tr>
<tr>
<td>% for international voice tariffs</td>
<td>0%</td>
<td>The operator remains the cheapest with 0 euro on international call per minute</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>The current state remains. The customer has to pay for his mobile subscription and international calls</td>
</tr>
<tr>
<td>% for voice tariffs</td>
<td>0%</td>
<td>Margins for the mobile operator become negative because the cost price of the voice bundles is reduced to 0</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>The mobile operators have still the same price</td>
</tr>
<tr>
<td>International minutes</td>
<td>0</td>
<td>Then the cost are based on the price of the bundles, because</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>The mobile operator is in this case more expensive than the</td>
</tr>
</tbody>
</table>
Kanwal Khan  Mobile VoIP a threat or a treat  TU delft

| Value coverage in case of the operator | 0 | 100 | 54 | 100 |
| Value user experience in case of the operator | 0 | 100 | 74 | 100 |
| Value user interface in case of the operator | 0 | 100 | 84 | 100 |
| Value brand in case of the operator | 0 | 100 | 91 | 100 |
| Value numbers in case of the operator | 0 | 100 | 96 | 100 |

Table 12: Extreme values assessment

From the results it has become clear that the input has the adequate impact on the output. It depends on the price how attractive an alternative becomes for the customer and what impact it has on the margins of the operator and the VoIP provider.

In the case of the quality attributes the business model of the mobile operator is used as reference point. This is done to analyze purely what the impact is if one of the input values of the quality attributes is changed. The result is that the impact is in correspondence with the ROC weight that is assigned to the certain quality attribute.

**Sensitivity analysis**

In this paragraph the model and the SMARTER model will be analyzed by means of the sensitivity analysis. The purpose of the sensitivity analysis is mainly to look how sensitive the output is when the input is changed with a minimum. If the model is more sensitive than expected, that would mean that there are made some faults in setting up the model and it doesn’t resemble the reality which is modeled.

**SMARTER model**

To analyze whether the attributes are ranked according to the purpose the values of the scores will changed and the impact looked. The values will be changed with small margins that way it would become clear how much impact the change has.

<table>
<thead>
<tr>
<th>Business model</th>
<th>Coverage</th>
<th>User experience</th>
<th>User interface</th>
<th>Brand</th>
<th>Numbers</th>
<th>Total score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>80</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>80</td>
<td>0</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>80</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>95</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>100</td>
<td>80</td>
<td>100</td>
<td>100</td>
<td>97</td>
</tr>
</tbody>
</table>

Table 13: Sensitivity results of the SMARTER model

As can be seen from the results the output is dependant from the ROC weight. The attributes which has the highest weight has the most impact and the one who has the lowest weight almost no impact. So the model has reacted as assumed.

**The model**

For the model the input values will be changed with 1%, 5% and 10%. That way it would become clear how much impact these small changes have on the output of the model.
The output that is used is based on two perspectives. The first one is that of the mobile operator whereby the margin per customer is calculated and looked how sensitive the margins are in the case of the above mentioned changes in the input. The second perspective is that of the customer. There is looked at the cost per month of the customer and what impact the changes have on the cost per month. This way it will become clear which aspects are very sensitive and should be taken into consideration while designing the scenarios.

The outputs that are used for the sensitivity analysis are as following:

- Margins per customer per business model. Each data bundle and the two voice bundles are taken into account. The data bundles are the WLAN bundle of 19.95 euro without a device, a UMTS bundle of 45 euro with a device, and a data bundle with an unlimited usage for 59.50 euro. Also the SAC and interconnection cost per customer are taken into account. That way the margin is calculated per customer per business model.
- The margin per customer for international usage. Thereby there is looked at the minute price and the minutes.
- Cost per month for a customer in the case of the integrated business model. Thereby the voice price at home can be reduced by means of the input parameter.
- Cost per month for the customer in the case of all the business models and calls to international destinations.

Those are the output variables and there changes regarding the current state are called variation. Variation is calculated at the following way:

\[
\text{Variation: } \frac{(\text{The changed output} - \text{the output when everything was 100\%})}{\text{the output when everything was 100\%}}
\]

That way it becomes clear how much impact the changes in the input have on the output.

The reason why the VoIP providers aren’t worked out in this analysis has to do with their business model. Their main earnings are based on interconnection cost. Therefore analyzing the impact based on these changes won’t increase the insight of the model and make it more reliable.
Table 14: Results of the sensitivity analysis of the model

The results of the sensitivity analysis show clearly that the mobile operator is the most sensitive for the reduction of their voice prices and in the case of data bundles, such as the UMTS bundles whereby it subsidizes handsets. The customer isn’t sensitive for small changes in the prices. It is even less sensitive for the changes in the data prices and in the case of the converged business model. Both aren’t sensitive for the change in prices for international calls or when a small percentage is changed in the minutes that are called to international destinations. Small variations do not have any impact on the cost per customer or margin of the customer.

8.4.2. Validation

Validation is applied to know whether the model represents the reality. There are two manners to analyze it. First of all you can analyze it by looking at analogies. This is called benchmarking. Another way to check the model is by letting experts give their advice regarding the model and the content of it.

Benchmark

A benchmark will be done to see in what degree the model resembles the reality. MVNO’s seem to resemble a lot of features of the VoIP providers and their business models. The main difference between MVNO’s and VoIP providers is that MVNO’s ask the operator to get permission to use their network. Therefore they pay a certain amount to the mobile operator. The VoIP providers on the other hand can bypass the mobile operator. But the customer has to pay for the mobile broadband connection. That way the mobile operator earns his access fee. In the case of mobile VoIP the customer pays the access instead of the service provider.

Tele2 is a company who has almost a similar background as the VoIP providers, such as Skype and Vonage. The similarity has to do with the fact that as well these VoIP providers as Tele 2 have focused first on the fixed telephony market and then started to focus on the mobile market to increase their market share.
Tele2 can be used in the case of the customer. Thereby the output quality price ratio will be calculated. That way it would become clear whether a business model such as Tele2 resembles the same effect as in reality in the mobile telecommunication market. Tele2, as MVNO, delivers limited set of handsets and doesn’t have a customer service as all the mobile operators. Therefore the score for the user experience will be 70, because customers find a customer service and a large assortment of handsets an important part of the service of a mobile operator. The brand recognition of this MVNO is 80 based on the researches of the Telecom paper. All the other values of the quality attributes are similar as those of the mobile operator. Therefore the value for those attributes will be 100. This results in a quality score of 92.

The pricing of Tele2 is very low but expensive for the people who want to call a lot any time. Tele2 has peak and off-peak tariffs with subscription of 5 and 10 euro. These subscriptions do not have a contract limit. But when the minutes will be calculated based on their tariffs and thereby will be assumed that the customer will choose for the cheapest solution. That means the customer will call when the off-peak tariff is charged, which is 10 euro cent per minute with a start tariff of 6 eurocent. This means that the customer can only call less than 100 minutes if he chooses for the 10 euro per month subscription102.

![Pareto](image)

Figure 12: Pareto of Tele2 and mobile operator

Based on the Pareto it becomes clear that if the customer would be rational it would choose for Tele2 instead of mobile operator. Only that isn’t happening in the practice. Customers do not only look at the price but it is the combination of the several features and the price. As result it becomes clear why Tele2 has such a small market share.

102 Dutch mobile virtual operators, D.Bout and E. Achterberg, research report, telecom paper, page 38 25/05/2005
Therefore it is important for the VoIP providers to be able to deliver similar features as the mobile operators to be able to compete with them and a reasonable price.

**Expert validation**
This test is based on the experience of the experts of the marketing department. According to the marketing department the values of the output resemble the reality. Therefore this model can be assumed as a valid model.
Part III: Strategies and recommendations
In this part the scenarios are worked out according to the driving force method of Goodwin and Wright. This means that there are looked at the most plausible scenarios in which mobile VoIP could have impact on the situation of T-Mobile. The scenarios are developed by means of the competitive assessment and the empirical model that is designed. Based on the prior analysis the uncertainties and trends will be mentioned. After that these trends and uncertainties will be clustered and axes will be designed which will result in to scenarios. After the design of the scenarios a value will be given to the several input variables of the empirical model. That way the impact will become clear. When the impact has become clear strategies will be developed for the mobile operator to be able to react on the development of mobile VoIP.
9. Scenario's
The design of the scenarios is done by clustering trends and uncertainties. This method is named the driving force method according to Goodwin and Wright. The uncertainties and trends are derived from the competitive assessment and are mentioned in paragraph 9.1. Each trend and uncertainty is related to the forces and actors which play a large role in the case of that particular force. Therefore the clustering of the trends and uncertainties is done per actor who could have the most potential to drive a scenario with certain conditions. These scenarios will take as well the worst cases into consideration as the cases which less impact. This way landscape will become clear of the paths that the VoIP providers could follow.

The main research question:

What implication may VoIP have on the financial position of a mobile operator?

The timeline in which these scenarios will be worked out will be of 3 years. That means that there will be looked till 2008. The reason that this period is chosen has to do with roll out of the mobile broadband networks and penetration of smart devices. Until then UMA already will be standardized and the devices could be promoted if required. Besides these factual factors it would be rather difficult to design scenarios for a longer period. This has to do with the fact that otherwise the uncertainties will increase too much and the mobile voice market can’t be determined at all by means of the driving force method.

9.1 Trends and uncertainties
The trends are based on the prior analysis of the mobile market and the development of it. The uncertainties are also trends from which the development is uncertain. Therefore they are uncertainties. In this paragraph the trends and uncertainties regarding mobile VoIP will be worked out.

9.1.1 Trends for mobile VoIP
The trends are based on the competitive assessment by means of the Porter model. Trends are mostly a movement that happens in general and has certain consequences. Therefore the trends will be mentioned along with their consequences. Besides that there will be looked at which forces do the trends have affect. That way it would become clear which actors in the mobile voice market are affected by the trends. The trends, their consequences and the impact of these trends on the forces of Porter are mentioned in table 15.

<table>
<thead>
<tr>
<th>Trend</th>
<th>Consequences</th>
<th>Porter forces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction of mobile internet</td>
<td>Penetration of smart devices and MDA will increase</td>
<td>- internal rivalry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- new entrants</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- supplier power</td>
</tr>
<tr>
<td></td>
<td>Mobile broadband networks, such as UMTS in combination with HSDPA, will be rolled out.</td>
<td>- internal rivalry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- new entrants</td>
</tr>
<tr>
<td>Competition will remain in the mobile telephony market</td>
<td>For the mobile operators the SAC remains a manner to differentiate themselves from each other and retain customers</td>
<td>- internal rivalry</td>
</tr>
</tbody>
</table>
WLAN ubiquitous     WLAN becomes more available at home  
  Access to WLAN will be integrated in devices  
  All electronic communication networks become IP based  
  UMA becomes a standard which is compatible with the mobile broadband networks of the mobile operators and the handover between WLAN and GSM network isn’t noticeable for the customer.  
  Handset suppliers will develop more devices which sustain IP telephony  

Table 15: Trends, consequences and the impact on the forces

9.1.2 Uncertainties
The uncertainties are based on the actions that the several actors within the mobile voice market could take. These actors are aligned with one or more forces of the Porter model. Therefore the actors could become the driving force of the scenarios with certain conditions. These conditions are based on the environmental changes which are highly expected to occur in 2008. The uncertainties are elaborated as following:

- The mobile operators determine whether the prices for data usage will become cheaper than the voice prices. It depends how the mobile operator positioned itself in the future regarding mobile internet and VoIP provider.
- The uncertainty exists whether mobile will become more attractive than fixed telephony. A trend which is occurring now could also change. Therefore it is uncertain whether fixed to mobile convergence will certainly take place. That is way it is placed as an uncertainty. In the case of fixed to mobile convergence the FNO will try to gain his market share back by means of the convergence model. BT is an example of such an action to protect their market shares.
- In the future the mobile operators could choose to focus more on the mobile broadband services. That way they could differentiate themselves from the other competitors in the mobile market. Besides the mobile operators there are also the VoIP providers which could deliver new services by means of VoIP. This way they can differentiate themselves from the mobile operators and deliver voice and data integrated services.
- If isn’t sure in what extent the regulator will try to promote VoIP. It is clear that VoIP is seen as a way to enhance competition. Whether the competition will increase by means of the VoIP providers or the internal rivalry will increase isn’t clear.
- The VoIP providers do not have at the moment the same business model as the mobile operators. Only the customers are accustomed with this way of using mobile telephony. Therefore the VoIP providers would have to imitate in a degree the model of the mobile operators. Only in what extent that will be required depends on the conditions and the actions of the VoIP providers.
- It isn’t sure whether the customer will use mobile internet, especially because the customer is now very reluctant in using mobile internet.
- WLAN could be deployed at several public places. This could be done by means of a mobile or a fixed network operator. Only it is a costly event therefore a network operator has to take into consideration whether it is strategically beneficial and whether the customer is prepared to use it for a certain fee.

These are the uncertainties that have to be taken into account while designing the scenarios. Each of these uncertainties have affect on the forces of Porter which are
aligned with the actors that play a role in the mobile voice market. The uncertainties and impact on the forces are mentioned in table 16.

<table>
<thead>
<tr>
<th>Uncertainties</th>
<th>Way of development</th>
<th>Impact on the forces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference between price level of voice and data usage</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Voice cheaper than data</td>
<td>- internal rivalry</td>
</tr>
<tr>
<td></td>
<td>Data cheaper than voice</td>
<td>- new entrants</td>
</tr>
<tr>
<td>Probability that fixed to mobile convergence will take place</td>
<td>High</td>
<td>- new entrants</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>New services and applications for new mobile broadband networks become attractive (voice and data integration)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>More</td>
<td>- internal rivalry</td>
</tr>
<tr>
<td></td>
<td>Less</td>
<td>- new entrants</td>
</tr>
<tr>
<td></td>
<td>Not</td>
<td></td>
</tr>
<tr>
<td>To which extent will the regulator promote mobile VoIP and convergence</td>
<td>Passive</td>
<td>- internal rivalry</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>- new entrants</td>
</tr>
<tr>
<td></td>
<td>Active</td>
<td></td>
</tr>
<tr>
<td>To which extent will mobile VoIP be an alternative of mobile telephony with similar quality attributes (see paragraph 5.1 and 5.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Full</td>
<td>- internal rivalry</td>
</tr>
<tr>
<td></td>
<td>Partial</td>
<td>- new entrants</td>
</tr>
<tr>
<td></td>
<td>Not</td>
<td></td>
</tr>
<tr>
<td>To which extent will the customer use mobile internet</td>
<td>High</td>
<td>- new entrants</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>- internal rivalry</td>
</tr>
<tr>
<td>If WLAN will become more available at public places will the customer then be prepared to pay for it</td>
<td>True</td>
<td>- internal rivalry</td>
</tr>
<tr>
<td></td>
<td>False</td>
<td>- new entrants</td>
</tr>
</tbody>
</table>

Table 16: Uncertainties and the degree

9.1.3 Clustering of the uncertainties and trends

The clustering will be done by combining the uncertainties with the trends. The basis on which the clustering will take place is an actor which has the largest potential to have impact on the uncertainties. Besides that, there will also be certain conditions which could play a large role in the future.

The actors within the mobile market are the mobile operators, MVNO’s, and the regulator. The other actors which have affect on the market share of the mobile operators and MVNO’s are the customers, VoIP providers, fixed network operators, ISP’s and cable providers. From these actors there are four actors which could become drivers with certain condition in the mobile voice market. This has to do with fact that these actors want to increase their market share by either entering the mobile voice market or by differentiating. Those actors are the mobile network operators, fixed network operators or ISP or cable providers and VoIP providers. Besides them, the consumer could have also large impact if he follows a certain trend. It is possible in the future that could change as now the customer is accustomed to fixed internet and utilizes it rather extensively. Therefore consumer could also become a driver of a scenario.
The other actors aren’t potential drivers of the mobile telephony market because the regulator is mainly a facilitator of the telecom sector which can’t act as a driver. And MVNO’s can’t also be a driver because they have mainly focused themselves on niches. Next to that they use the network of a mobile operator. Therefore if the MVNO will become a driver in reality it will be the mobile operator, whose network they are utilizing. Therefore these two actors can’t become a driver of a possible scenario.

The conditions with which the actors will have to deal are as following. In the future two mobile networks could be used for mobile voice, which have full coverage. That is the UMTS network and GSM network. These two networks create for all the actors a possibility to deliver their services at a various way. Next to the networks the type of services will matter. At the moment the voice and data services are delivered separately. According to the trends the possibility exist that IP integrated services will be delivered, because the networks will become IP based. Whether it will happen depends on the choice of the customer in the future and the other actors who could stimulate at a certain way those services.

- **Horizontal:** GSM/ UMTS coverage is a network that could be used to deliver mobile voice.
- **Vertical:** IP integrated services/ Separated service is the axis which also drives mobile VoIP. The VoIP providers could differentiate themselves by means of new services or applications.

![Figure 13: Scenario axis](image)

The scenarios are designed by means of the clustering of the uncertainties and trends. Four different scenarios are designed which show extreme situations that could occur in 2008. Those scenarios are labeled as following:
9.2 Scenarios

The scenarios are based on the actors which drive the scenario and the environmental conditions which could occur in 2008. There is looked at the four most obvious scenarios that could create a threat or a treat for the mobile operators. One remark has to be given and that is the research is based on the current structure of the market. Merges between mobile network operators and fixed network operators is not taken into account. It has to do with the uncertainty about the strategic behaviour of these operators. These scenarios are called Aggressive VoIP providers, mobile network operators rule, fixed network operators in the driving seat and mobile broadband services become successful.

9.2.1 Aggressive VoIP providers

In this case the VoIP providers are the drivers of this scenario. They have gained a network effect by means of extensively download of their software. This was possible because investors are prepared to invest in the VoIP providers. The VoIP providers then can focus more on marketing and obtain a large market share. Because of marketing they could be recognized as a brand and improve the perception regarding their brand. This counts especially for a VoIP provider such as Skype. Besides that, they also aligned with handset suppliers. That way they could deliver devices which have pre-configured VoIP settings. This way the VoIP providers will steer the mobile voice market. The other actors and conditions that play a role in this scenario are as following:

- Customers have downloaded their VoIP software on their PC or laptop and use it regularly. They have become accustomed with VoIP, peer-to-peer usage and the soft phone. Therefore they eventually want to use VoIP also on their mobile phone. That way they will be mobile all the time and not restricted to a certain area. And they aren't reluctant in using VoIP and downloading the software on their mobile phone which is required for usage of VoIP. Therefore the customer will want to switch completely to use his mobile instead of fixed usage. The main barrier is the price for the usage of data.
- The mobile operators have kept the price high to hinder the VoIP providers. So the voice prices are cheaper than the prices for usage of data. Yet, the mobile operators have rolled out UMTS fully. This means that people coverage of the UMTS network is approximately 80-90%.
- The devices are delivered by the VoIP providers. This is possible because of the alliance they have with the handset suppliers. This would mean that the VoIP providers will have to pay SAC.
- In this case the regulator will play a large role. OPTA is already promoting VoIP by allocating mobile numbers to VoIP providers for mobile usage and they can deliver emergency services by means of the network operator. The VoIP provider will have to pay a certain amount per emergency call. That will be an incremental cost for the VoIP provider. In the case of data prices the VoIP
provider could use as argument that the mobile broadband access is a bottleneck facility and as long all the mobile operators keep the prices for data usage high consumers will be reluctant to use mobile VoIP. Therefore the regulator can pursue the mobile operators to lower their prices for data usage at the level of the voice prices. This way it would become attractive for the customer to use also data.

9.2.2 Mobile network operators rule
In this scenario the mobile operator will be the driver of the scenario. That means that the mobile operator delivers his services at such a way that it’s attractive for the customer to use it. This is possible because there is high competition between the other mobile operators and MVNO’s. The prices for voice have become very low and the mobile operators try to differentiate by means of services or handsets. Only the prices to call to foreign destinations are still very expensive. It could become a reason for the customer to use VoIP for the international calls. This would mean that the mobile operator will lose earnings for the minutes that customer did call to foreign destinations. The other actors which also play a role in this scenario are as following:

- The customer is accustomed to VoIP on the fixed network, but doesn’t want to use it as an alternative of mobile telephony. Downloading software on their device isn’t seen as convenient by the customer. The customer could choose to call occasionally to foreign destinations by means of mobile VoIP. Mobile VoIP can be used by means of WLAN. This is possible because consumers have started to have WLAN at home, because they have a broadband connection and laptops with access to WLAN. The disadvantage of WLAN is that it is constrained in a certain area and if the customer wants to use hotspots of a network operator he will have to pay a fee. That way it could become very expensive for the customer, especially because he will have to find first a hotspot to be able to make a call. In that case GSM network would be the cheapest and qualititative the best choice. When the customer wants to call to foreign countries he can use his PC and use VoIP that way. The most PC’s are secured for computer virus. The fact that WLAN isn’t secured won’t create an additional risk for the consumer.

- Handset suppliers will supply devices which have integrated access to WLAN. It has to do with the fact that consumers want to use their WLAN at home at various manners. The customer then can purchase very easily a device which supports utilization of WLAN.

- The regulator will be very passive because there is already high competition. And customers do not experience any kind of discomfort.

- The VoIP providers won’t have any impact in this scenario. This has to do with the fact that it is more convenient for the customer to use VoIP on his PC or laptop then use their handsets for VoIP. Also because calling at home by means of their private WLAN is cheaper then using hotspots of a network operator.

9.2.3 Fixed network operator in the driving seat
In this case the fixed network operator or ISP is the driver of this scenario. The competition as well in as between the fixed and mobile market has increased. The fixed network operator or ISP will act defensive to protect his market share and increase profit. This could be done at two manners. One way is by means of the technology, named UMA which enables convergence between the fixed and mobile network. The fixed operator can align with a mobile operator and deliver his services. Or the fixed network operator doesn’t use UMA but deploy wireless LAN’s and devices which support WLAN and VoIP.
To be able to do that the fixed network operator will have to align with handset suppliers. That way he could deliver VoIP services by means of WLAN. The advantage for the customer is that he can call cheaper at the fixed part than on the mobile part. It results in negative impact for the mobile operator. The minutes that the customer will call normally will be reduced because the customer will now call more by means of his private WLAN or a WLAN in a public place which can be accessed for free. On the long term the mobile operator has also protected himself in the case of UMA from competition by aligning with the fixed operator or ISP. This way it has been able to differentiate himself from the other mobile operators.

- The fixed operator or ISP will promote heavily the UMA devices or devices which support WLAN. It is possible to promote it because UMA is standardized and the defaults that could occur will be solved. This way the customer will be enabled to use the converged model. The fixed network operator will also focus on deploying WLAN hotspots. That way the converged model will become more viable.
- Handset suppliers will develop devices which have UMA integrated and devices which support access to WLAN and make usage of VoIP easy. This would be possible by either pre-configured settings of mobile VoIP or integrated IP telephony. It depends on the choice of the fixed network operator how he wants to launch VoWLAN.
- For the customers who have a private WLAN at home UMA and voice over WLAN (VoWLAN) are viable alternative. Next to the pricing advantage the customer could also use advanced features which can’t be delivered by the mobile operators. This is possible because voice can be integrated with data. Beside that, the customer is already familiar with the brand of the network operator and the network operators will have to work on the perception of the brand. That way the customer will be prepared to use the converged model. When the two options are compared the customer would have more cost benefit from the VoWLAN alternative, because it could use to call by means of the WLAN when he is at home and be called by means of the GSM network.
- The regulator will create also a profitable situation for the converged model by allowing the VoIP provider to use either geographic numbers or mobile numbers at a nomadic manner. This way the customer won’t need different numbers to be in reach always. In the case of emergency services the network operators do not have to concern, because they have a network and the services can be delivered as it should according to the telecommunication law.

**9.2.4 Mobile broadband services become successful**

In this case the customers are the drivers of this scenario. The customers perceive mobile internet at the same way as they perceive internet on the fixed network. Therefore the customer is fully switched from fixed to mobile that way. The customer wants to use new mobile broadband services and other applications for his mobile internet. This is possible because the mobile operators promote mobile internet and the prices for data usage are very cheap. It doesn’t matter whether it is a money bundle or data bundle, it remains cheap. Besides that, he/she is accustomed to use applications on his mobile and VoIP on the fixed network. Therefore it won’t become a barrier for the customer to use VoIP on his mobile. The other actors create also certain conditions in which the customer gets the opportunity to use mobile internet easily and without any barrier.

- The high acceptance of mobile internet creates for the mobile operator an incentive to invest in his mobile broadband networks and smart devices which sustain several types of applications and services such as video telephony.
Besides that, they would also develop new services and applications that the customer can use. That way they will have their revenue.

- The handset suppliers have integrated IP telephony in the handsets and made their interfaces more user friendly for the usage of broadband services and applications.
- VoIP providers won’t have to be active to deliver their products. The customer will use it because it is already accustomed in using applications and downloading other services on the mobile internet.
- The regulator will not need to be active because the market has become competitive and the VoIP providers can easily access the mobile voice market.

The key concept of each scenario is placed within the quadrants, which were shown in figure 11. The concepts can be seen in figure 14.

![Figure 14: Scenarios in the axes](image)

**9.3 Impact of each scenario**

In this paragraph the impact of VoIP will be analysed. The impact is as well financial as qualitative. The financial impact per customer will be analysed by means of the empirical model which can calculate the financial impact. For each scenario the financial impact will be calculated per customer. That way the margin will become clear that the mobile operators will lose or earn. Besides that, there will be looked at the earnings of the mobile operators if the customer chooses for VoIP and the cost. This way the total financial impact will become clear per customer. The costs that won’t be taken into account are the network and departmental cost, because these costs go beyond the scope of this research. There will also be looked at the financial impact of the VoIP...
providers. This way it would become clear what the growing possibilities are for the VoIP providers. The qualitative impact is based on the competitiveness assessment and how the development will take place when these scenarios will occur.

### 9.3.1. Aggressive VoIP providers

In this case the customer needs an UMTS data bundle to be able to call to anybody anytime. The price of data usage will be regulated because the mobile operators have set the price high. As mentioned earlier the price is now approximately 45 euro inclusive a handset or else 59.50 euro without a handset. The price for the voice bundle of 200 minutes is 26.50 euro inclusive with a handset. The OPTA will regulate the data prices. This will be done on the basis of the interconnection cost. The interconnection cost to mobile networks is 0.12 euro. By multiplying the MTA tariff with 200 minutes, the price of the data bundles will be 24.75 euro per month. Besides that the VoIP providers will deliver their own devices. This way the cost of buying a suitable device will reduce for the customers who will use VoIP.

The score for each attribute won’t be similar as the values of the mobile operators. This has to do with the scenario that is designed. In the case of peer-to-peer and indirect access the user interface doesn’t becomes more user friendly. It has more to do with the fact that the customer has become accustomed to it and that way he/she can use it easily. In the case of peer-to-peer some other attributes have also achieved lower values. First of all the user experience is lower than the value of the mobile operator because the customer can’t call anybody. Only the persons, who have the software can talk to each other and peer-to-peer doesn’t deliver all the services that mobile operators do deliver, such as call diversion, etc. Next to that peer-to-peer configuration can’t receive a number from the NRA, because it doesn’t deliver services as a PATS.

<table>
<thead>
<tr>
<th>Quality attributes</th>
<th>Peer2peer UMTS</th>
<th>Indirect bypass UMTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverage</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>User experience</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>User interface</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Brand</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Numbers</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Quality scores</td>
<td>85</td>
<td>94</td>
</tr>
</tbody>
</table>

Table 18: results of the SMARTER model

By looking at figure 15 it becomes clear which business model the customer has to select. In that case the customer will choose for the indirect access model (Vonage). The only difference is that in the case of indirect bypass the customer has to pay additional cost when he calls to somebody who hasn’t VoIP software.
Figure 15: Results of the Pareto diagram of scenario 1

(Financial) impact

The selection of the customer results into the following situation for the mobile operator and VoIP provider for indirect access.

Table 19: Results for the financial impact per customer of as well the operator as VoIP provider

<table>
<thead>
<tr>
<th></th>
<th>T-Mobile GSM</th>
<th>T-Mobile used for VoIP</th>
<th>Vonage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>€ 624.00</td>
<td>€ 594.00</td>
<td>€ 261.35</td>
</tr>
<tr>
<td>Cost</td>
<td>€ 337.00</td>
<td>€ 0.00</td>
<td>€ 337.73</td>
</tr>
<tr>
<td>Margin</td>
<td>€ 286.27</td>
<td>€ 594.00</td>
<td>-€ 86.38</td>
</tr>
<tr>
<td>Variation</td>
<td></td>
<td></td>
<td>107%</td>
</tr>
</tbody>
</table>

The conclusion that can be derived from these results is that it would become more beneficial for the mobile operator in the sense that the SAC and interconnection cost will reduce. His margin has increased almost four times.

The VoIP provider will mainly earn from the customers who call off-net. This way they will receive mobile termination access tariff (MTA) but they have to pay for the interconnection cost. In this case they will also have to pay for SAC. Those are at the moment their main costs.

This scenario would have large impact on the mobile operators in the sense that almost all the customers who are enabled to use mobile VoIP want to use VoIP. This has to do with the fact that the customer wants to use mobile VoIP. Only the price would have effect on the choice of the customer. Yet, the regulator will regulate the data tariffs as mentioned in the scenario. That way the price could become more attractive for the customer as can be seen in table 19.
As long as the data prices remain higher or equal to the voice prices the mobile operator won’t have negative financial impact. It would be mainly beneficial for the mobile operator.

### 9.3.2. Mobile network operators rule

In this case the customer uses WLAN to call to foreign countries. The customer has his own WLAN. The incremental costs for the usage of WLAN are 1.60 euro per month and if the customer uses Vonage then the additional cost of them. The customer could also choose to use his fixed internet and call by means of his laptop or PC to call to foreign destinations.

The customer will need a voice bundle to be able to call in the Netherlands. It would be a voice bundle of 200 minutes for 26.00 euro. For the customer the cost per month will be 27.60 euro per month. The quality score won’t be relevant because the customer uses WLAN which has a sufficient voice quality. Besides that, the customer will only use it as a partial alternative. Therefore the customer won’t have a lot of requirements regarding the quality attributes. Also because the customer is accustomed to VoIP and the devices are available.

Normally the customer calls averagely 4 minutes to international destinations and the average cost per minutes are 75 eurocent per minute. So the customer will have to pay 29 euro per month if he calls monthly only four minutes to international destinations.

![Figure 16: Results of the Pareto diagram for scenario 2](image-url)
The customer will select for the fixed alternative. This way that would be the cheapest solution for the customer. The customer will only have to pay for his mobile subscription.

**Financial impact**

The results of the selection of the peer-to-peer configuration have impact on the mobile operator and could have impact on the VoIP provider which delivers peer-to-peer alternative. The results are mentioned in table 20.

<table>
<thead>
<tr>
<th></th>
<th>T-Mobile GSM</th>
<th>T-Mobile customers without international</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>€ 696.00</td>
<td>€ 624.00</td>
</tr>
<tr>
<td>Cost</td>
<td>€ 306.76</td>
<td>€ 297.16</td>
</tr>
<tr>
<td>Margin</td>
<td>€ 389.24</td>
<td>€ 326.84</td>
</tr>
<tr>
<td>Variation</td>
<td></td>
<td>-16%</td>
</tr>
</tbody>
</table>

Table 20: Financial impact for as well the mobile operator

The conclusion that can be derived from the analysis is that if the current situation is taken into account where the customer only calls 4 minutes to foreign destinations then the mobile operator will have a financial disadvantage when customers will use VoIP to call to foreign destinations. The mobile operator will lose 16% of his earnings in 2 year time.

The impact of this scenario isn’t high because the customer doesn’t want to use mobile VoIP. So the total impact will be low, because the VoIP providers have focused on niches and the earnings for the mobile operator in the case of calls to international destinations are already low.

**9.3.3. Fixed network operator in the driving seat**

The customer needs in this case a WLAN at home and the device. The device will be delivered by means of the VoIP provider who has an alliance with a mobile operator. The UMA devices will be delivered with a subscription of 2 years. This subscription will be a money bundle of 25 euro per month with which he can call cheaper on the fixed part. The customer would have more minutes to call when he uses his WLAN to call to somebody. Therefore the quality attributes will mainly have the same value as the mobile operator. The brand perception and recognition will be little bit lower than the value of the mobile operator because the customer isn’t used to the converged model.

<table>
<thead>
<tr>
<th>Quality attributes</th>
<th>T-Mobile</th>
<th>Integrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverage</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>User experience</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>User interface</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Brand</td>
<td>100</td>
<td>90</td>
</tr>
<tr>
<td>Numbers</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Quality scores</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 21: Results of the SMARTER model

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103 The price is based on the tariffs that are available at the moment. KPN has a subscription named internetplusbellen and the customer has to pay 15.50 euro per month for the fixed part and then approximately 17.50 euro to call 100 minutes with his mobile. The total cost would be then 27.50 euro. This way the UMA solution won’t be attractive. Therefore a price structure is created with which the customer has to pay less than 26 euro for 200 minutes and if the customer calls mainly by means of his WLAN than he will have more minutes to call. This structure works as the money bundles of Orange.
In the case of the VoWLAN the customer would have to pay a certain amount for his WLAN, which is mentioned above. Besides that the customer will need a voice bundle to when he calls outdoor. The customer calls almost 20% of his time at home so an average customer, who calls normally 200 minutes will call almost 150 minutes outdoor. That means that the customer will pay monthly 21.50 euro plus the 1.60 euro. In total the customer will pay 23.10 euro. Only in this case the user interface will play a role. The customer isn’t accustomed to use VoIP on his mobile. Therefore the value of the user interface will be 80. This has to with the fact that the fixed network operator will promote the WLAN devices and VoIP and try to make the devices as user friendly possible.

<table>
<thead>
<tr>
<th>Quality attributes</th>
<th>Integrated</th>
<th>VoWLAN Vonage n GSM</th>
<th>VoWLAN peer-to-peer n GSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverage</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>User experience</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>User interface</td>
<td>100</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Brand</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Numbers</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Quality scores</td>
<td>100</td>
<td>99</td>
<td>99</td>
</tr>
</tbody>
</table>

Table 22: results of the SMARTER model for the VoWLAN option in combination with GSM

The cost for the customer per month will be lower. As mentioned in paragraph 9.2.3 the customer will have to pay 25 euro for a money bundle. Normally the customer will pay for 200 minutes 26 euro. The values of the Pareto diagram are mentioned in figure 17.

![Figure 17: Results of Pareto for scenario 3](image-url)
The customer will choose for VoWLAN in combination with the GSM network. That way he would be able to call more for less.

In the empirical model the financial impact on the mobile operator and VoIP provider isn’t taken into account. This has to do with the fact that the cost structure of this model isn’t available (see paragraph 8.2). Therefore the qualitative impact plays a larger role in this scenario then the financial impact.

In two circumstances the mobile operator will have disadvantage from the converged model. Firstly, when the mobile operator aligns with the fixed network operator, he will lose minutes to the number of calls that will take place by means of a WLAN. In this case the impact would be low because the mobile operator will close a wholesale deal with the network operator or ISP. This way they can compensate the loss of minutes to the fixed part.

Secondly, the converged model could become a viable competitor. In particular when the VoIP provider could deliver advanced features with which it can differentiate itself from the mobile operator. This way the VoIP provider could have a larger impact, especially when new networks such as WiMAX will be deployed and WLAN becomes more available at public places for a low tariff.

The VoWLAN in combination with the GSM network is an alternative that could have large impact when the customer will choose to call mainly with his private WLAN and be called by means of his GSM network. The mobile operator will loose minutes because customers will use their own WLAN to call. This way the fixed network operator can compete strongly with the mobile network operator.

### 9.3.4 Mobile broadband services become successful

In the case of this scenario the customer will have to pay 10 euro per month for data access. It doesn’t matter which bundle he utilizes. The mobile operator will also deliver the devices. That way the SAC will remain.

The quality attributes won’t have all a similar value as the mobile operator. The user experience won’t be same in the case of the peer-to-peer configuration, because the VoIP provider doesn’t deliver the similar services as the mobile operator and the customer can’t call everybody, even the people who do not have VoIP software. Besides that, the brand perception doesn’t have to be improved. The customer is only accustomed to the fact that he can utilize the application easily. The perception that is connected to the provider depends on his origin and how the brand is marketed. In table 23 the values of the quality attributes are mentioned.

<table>
<thead>
<tr>
<th>Quality attributes</th>
<th>Peer2peer UMTS</th>
<th>Indirect bypass UMTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverage</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>User experience</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>User interface</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Brand</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Numbers</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Quality score</td>
<td>82</td>
<td>96</td>
</tr>
</tbody>
</table>

Table 23: Results of the SMARTER model

For the customer the usage of data becomes very attractive and the customer will select the indirect access (Vonage) VoIP provider. This has to do with quality score and the price which is much lower than the price of the mobile operator for 200 minutes (see
The customer can call unlimitedly with a data bundle which is a fixed fee. This way mobile VoIP becomes very attractive for the customer.

Figure 18: Results of Pareto diagram for scenario 4

**Financial impact**
After the selection of the customer the financial impact can be shown in table 24 for as well the mobile operator as for the VoIP provider.

<table>
<thead>
<tr>
<th></th>
<th>T-Mobile GSM</th>
<th>T-Mobile used for VoIP</th>
<th>Vonage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>€ 624.00</td>
<td>€ 239.98</td>
<td>€ 251.55</td>
</tr>
<tr>
<td>Cost</td>
<td>€ 306.76</td>
<td>€ 297.16</td>
<td>€ 40.57</td>
</tr>
<tr>
<td>Margin</td>
<td>€ 317.24</td>
<td>-€ 57.18</td>
<td>€ 210.78</td>
</tr>
<tr>
<td>Variation</td>
<td>-118%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 24: Financial impact for mobile operator and VoIP provider

In this case the mobile operator will lose earnings based on access to mobile internet. Of course the mobile operator will earn by means of the new broadband services and other applications, but these aren’t taken into account because of the high uncertainty. Therefore negative margin shows how much has to be earned by means of the services.

The financial impact for the VoIP provider is positive because the earnings are based on the customers who call off-net and interconnection cost result into the margin they can gain. This way the VoIP provider could gain advantages and grow.

The impact in general will be high because customers are prepared to use mobile VoIP. Besides that, the mobile operator itself has promoted the devices which could support...
VoIP and other applications. This scenario could become threatening for the mobile operators.

**Effectiveness of the scenarios**

The effectiveness of these scenarios can’t be determined because it is impossible to define the behaviour of the customer. In this research there is tried by means of valid methodologies to encapsulate its behaviour. Only in this research one customer is analyzed which calls 200 minutes per month. Therefore the whole customer base isn’t taken into account. Also it isn’t clear how the customer in reality will choose for the price quality ratio. This results into the fact that the effectiveness of these scenarios can’t be determined.

**Conclusion**

The conclusion that can be derived based on the analysis is that there can’t be said in general what the impact will be of these scenarios. This has to do with the fact that the behaviour of a customer is much unknown. The choices a customer would made based on price quality ratio could be very different than the scenarios has assumed. Therefore it could be given an indication that when these scenarios will occur as defined paragraph 9.2 then the following conclusions can be derived for one customer who calls 200 minutes.

As long as the prices of voice and data usage remain the same or differ little then the financial impact is low. Sometimes even positive for the mobile operator, especially when customers use VoIP and the mobile operator doesn’t have interconnection cost. One thing has to be taken into consideration and that is that the mobile terminating tariff (MTA) is a way to earn money. Only in the case of T-Mobile the interconnection cost are higher then the earnings. Therefore VoIP is beneficial for them and especially when SAC will be reduced. This could mean eventually that the mobile operator could act as an access provider.

On the other hand the converged models create a threat because especially in the case of VoWLAN the customer doesn’t need to do many additional activities to be able to use VoIP on his WLAN at home. The fixed network operator will promote this service at such a way that it will be attractive for the customer to use VoIP on his WLAN.

In short the key remarks per scenario are mentioned. The first and the last scenario are the most threatening scenarios in which the customer will choose very rapidly for mobile VoIP, especially because the customer is accustomed in using such an application. Only it depends on the pricing, the availability of the coverage and the devices whether it becomes a success. Besides that the environment should sustain these two scenarios. So few actors have to support VoIP that way it could gain a large market share. There are a lot of barriers before these scenarios will become feasible. Therefore these scenarios do not seem very apparent.

The second scenario has less impact on the financial position of the mobile operator. This has to do with the fact that VoIP providers have focused themselves on niches. Besides that, the mobile operators never earned a lot from the international calls.

In the third scenario it depends largely on the fact whether the customer will use the UMA devices, devices with integrated WLAN access, WLAN and are interested in advanced features. Besides that, the wireless LAN’s has to become available at more places and the tariffs to access these wireless LAN’s should become lower. Also the fixed network
operator could promote very strongly the converged model. This way it could gain a market share in the mobile voice market. Then not only UMA version will become more viable but also the VoWLAN version. In the case of VoWLAN the user interface for the usage of mobile VoIP should also become more user-friendly. UMA has more barriers then VoWLAN to become success full. The impact of the several scenarios is briefly shown in table 25.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>% of margin gross for the mobile operator towards the current state</th>
<th>% of cost advantage for customer towards the current state</th>
<th>Requirements for a sustainable environment for the driving actor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggressive VoIP provider</td>
<td>+107%</td>
<td>-5%</td>
<td>• VoIP providers should be active</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Customers should be prepared to use mobile VoIP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Regulator active</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Handset suppliers aligned with VoIP providers</td>
</tr>
<tr>
<td>Mobile network operator rule</td>
<td>-16%</td>
<td>-10%</td>
<td>• Mobile operator is active and differentiates by means of price</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• High competition in mobile voice market</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Customer perceives mobile voice as convenient</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Regulator passive</td>
</tr>
<tr>
<td>Fixed network operator in the driving seat</td>
<td>-</td>
<td>-4% (UMA)</td>
<td>• Fixed network operator active</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Wireless LAN’s public available</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-11% (VoWLAN)</td>
<td>• Regulator medium active</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Customer have WLAN at home</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Handset suppliers deliver devices with integrated WLAN access and IP telephony</td>
</tr>
<tr>
<td>Mobile broadband services become successful</td>
<td>-118% (without revenue of services)</td>
<td>-60% (without revenue of services)</td>
<td>• Customer wants mobile internet and new applications</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Mobile operator is active</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• VoIP provider is medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Regulator is passive</td>
</tr>
</tbody>
</table>

Table 25: The impact per customer per scenario
10. Strategies

The strategies that will be developed for each scenario are based on the competitive assessment, customer satisfaction researches and they are tested by means of the experience of the marketing department. For each scenario one or more strategies will be developed. The mobile operator has the possibility to choose whether he will react offensive or defensive to mobile VoIP. Therefore there will be looked at the several possibilities that the mobile operator could have and utilize when these scenarios would occur. One thing has to be taken into account and that is while designing these strategies there isn’t taken into account that merges could take place between mobile network operators and fixed network operators or even ISP’s.

10.1 Aggressive VoIP provider

This scenario is very threatening for the mobile operators. In this case the mobile operators have the option to act defensive or offensive. In the case they act defensive they could choose to protect themselves from the VoIP providers. Therefore they can develop strategies based on the following concepts:

- Closing the network or at least creating barriers for the VoIP providers by means of the network is an option. The mobile operators could use compressed codec’s or use portals to stop VoIP:
  - Portals could be set up as now the T-Zones area is set up for only usage of T-Zones. It is also possible that such portals are set up which do not allow the software of the VoIP providers such as Skype on their network. Vodafone has done that with Skype in Germany.
  - It also possible by means of pricing. The prices for data usage could become lower only there will be a data limit or block rounding.
    - In one way this could also have negative impact on the revenue of the mobile operator because customers want to use a bundle for which they only have to pay a certain amount and can use unlimitedly. That way the customer is prepared to use mobile internet extensively.
    - Block rounding could be set up for the data bundles that are made available for the customer to use. The block rounding could be done in time or data. So there could be a block round of 10 minutes. This way the mobile operator will receive his earnings back.

- Make arrangements with handset suppliers that the operating systems can’t have the possibility to download VoIP software, especially because VoIP is based on internet. Any kind of virus could enter the mobile phone by means of the VoIP software.

- Lobby with the NRA, regarding mobile VoIP. VoIP provider can bypass the mobile operators and when the customer will use mainly mobile VoIP that would burden their network and they have to invest extra to maintain their network.

The mobile operator could also act offensive. It means that the mobile operators will allow the VoIP providers on their network only with certain conditions. This way the mobile operators will have control on the VoIP providers. The mobile operators could the following:

- The mobile operators could offer the VoIP providers which deliver indirect access a whole sale offer. That way they can act as a mobile operator and deliver at the similar way their services by means of a whole package to the customer. Also an assortment of devices could be delivered when the VoIP provider will close an arrangement with the mobile operator. This way mobile VoIP would have larger
impact only the mobile operator will also earn from the VoIP provider, especially when they are successful and gain a large market share.

- The mobile operators could set up portals and deliver access to the customer for a certain amount when they want to use mobile VoIP. So the customer would have to pay an access fee for the usage of VoIP. This way the mobile operator will have control on the VoIP usage and will receive incremental earnings.

These are the several actions the mobile operator can do to either create barriers for mobile VoIP or allow them on their network. Each of these actions has different affect on the mobile VoIP. Besides that, it is possible that the NRA could act more aggressively when mobile operators create too many barriers for the VoIP providers.

10.2 Mobile network operators rule

In this scenario the total impact is very low of the VoIP providers. The mobile operators aren’t threatened at all for mobile VoIP. Only they will loose their earnings that they normal earn when customers call to foreign destinations. In this case the mobile operator could act offensive by trying to make internal calling more attractive. This can be done at the following:

- The mobile operators could choose for delivering money bundles. The customer then can choose how he wants to use his bundle. Whether he wants to call to national or international destinations or use data. Orange already does that and customers feel less reluctant to the bundle for international destinations.
- The mobile operators could reduce the tariffs to international destinations.

These are the main actions that a mobile operator can do to receive the earnings that he could loose to VoIP if he doesn’t react on the scenario.

10.3 Fixed network operator in the driving seat

This scenario could have large impact it depends how the fixed network operator and ISP enter the market and with which mobile operator he will align. In the case that fixed network operator or ISP aligns with T-Mobile the impact will be low for the mobile operator. It is low because they already have arranged a wholesale deal with the network operator. That way the network operator can use the mobile network of the mobile operator. And the mobile operator would receive money for the minutes they actually loose when the customer calls by means of WLAN.

Another possibility exists that another mobile operator aligns with the fixed network operator or ISP. This way the UMA business model could have more impact especially when the fixed network operator will deliver advanced features as mentioned in the scenario. Then the impact could increase. Therefore the mobile operator should also develop services which are comparable with the services that the VoIP providers already deliver on the fixed network. This way they could reduce the impact of the UMA model. Besides that they could also launch a bundle as Telfort has done with which the customer will call very cheap to certain destinations, in particular fixed numbers. That way UMA won’t be able to differentiate it self by means of pricing or services.

The mobile operator could also choose to manage the private wireless LAN’s of consumers at home. They can offer this service to the consumer. That way their WLAN will become secure and they could use several types of applications for a small amount of money. This way the mobile operator will act defensive and create barriers for as well the UMA version as for the VoWLAN version.
10.4 Mobile broadband services become successful

In this case the mobile operators will have to focus on new services for their mobile broadband networks. These services will mainly be their earnings and not voice. This is a very extreme scenario which could set the whole business model of the mobile operator up side down. The mobile operators do not have to act defensive because they want that the customer uses mobile internet and several applications. But they will act offensive. That way they could earn from each application, even of VoIP application. The actions that the mobile operator could do are as following:

- The mobile operators could develop by themselves a VoIP application. That way they could deliver the similar services as the VoIP providers and prevent that customer will use the applications of the VoIP provider.
- The mobile operator could arrange with the handset suppliers that the devices sustain applications such as VoIP and other applications which integrate voice and data. That way the mobile operators could deliver new services for their new mobile broadband networks and earn from the services.
- The mobile operators could offer the VoIP providers which deliver indirect access a whole sale offer. That way they can act as a mobile operator and deliver at the similar way their services by means of a whole package to the customer. Also an assortment of devices could be delivered when the VoIP provider will close an arrangement with the mobile operator. This way mobile VoIP would have larger impact only the mobile operator will also earn from the VoIP provider, especially when they are successful and gain a large market share.

These are the strategies the mobile operators could do when the future will seem to have the same path as the scenario has described.

Each strategy has a certain impact. The impact is determined how the mobile operators perceive the strategy and how this will have impact on their position. Besides that, it also depends on what the counter strategies could be of the VoIP providers. In table 33 the several strategies are mentioned per scenario. Also is there looked how the mobile operators react on the strategy.

Effectiveness of each type of strategy

Pricing is one of the types of strategies that are the most effective way to create for customers an incentive to choose for the mobile operators. Only when the mobile operators will act too defensive they could loose earnings. For example when they deliver data bundles with a limit then the customer won’t use his bundle for downloading other applications which uses a larger amount of data. The effectiveness is high because the VoIP providers can’t set the prices for data usage. The mobile operator is in that case fortified. But the mobile operator should be very sharp in setting up his prices to not loose revenue.

Delivering new services or becoming a service provider of WLAN, or VoIP of an access provider is a manner to act offensive and make for the customer services available that weren’t available. That way the customer won’t have a reason to choose for another provider. This way these strategies in each scenario could be very effective.

Setting up deals with the handset suppliers could be a fruitful cooperation when the way of looking at the scenario is offensive. If the mobile operator is very defensive then customers won’t be prepared to use those devices because they can’t download everything and they pay for the device. That way the mobile operators will cut themselves in the finger.
Closing the network for VoIP is not the most effective way to hinder VoIP providers. They can develop software which could be engineered that way that they either bypass those portals. Lobbying with the NRA is a strategy that would help because OPTA takes all the views into consideration. Only in the case of VoIP they want to push VoIP, because they believe it is a way to enhance the competition. Therefore these strategies could have very low impact.

| Scenario                        | Behaviour of mobile operator | Strategy                                                                 
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Aggressive VoIP provider</td>
<td>Defensive</td>
<td>Portals to stop usage VoIP software</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Data bundles with a limit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arrangements with handset suppliers for closed operating systems</td>
</tr>
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<td></td>
<td></td>
<td>Block rounding of in data or minutes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lobby with OPTA</td>
</tr>
<tr>
<td>Mobile network operators rule</td>
<td>Offensive</td>
<td>A wholesale offer for the VoIP provider, such as Vonage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Access fee to use mobile VoIP</td>
</tr>
<tr>
<td>Fixed network operator in the driving seat</td>
<td>Offensive</td>
<td>Alliance with fixed network operator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manage private wireless for consumers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Application service as McAfee does it</td>
</tr>
<tr>
<td></td>
<td>Defensive</td>
<td>Deliver also advanced features</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Have bundles which allow cheap calls to fixed destinations</td>
</tr>
<tr>
<td>Mobile broadband services become successful</td>
<td></td>
<td>The mobile operator could use VoIP themselves</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arrange with handset suppliers that the devices support VoIP and other applications</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A wholesale offer for the VoIP provider, such as Vonage</td>
</tr>
</tbody>
</table>

Table 26: Strategies and their impact
11. Conclusion and recommendations

The main question in this research has been: “What implication may VoIP have on the financial position of T-mobile?” Based on the competitive analysis it has become clear that mobile VoIP doesn’t have currently any impact on the financial position of T-mobile. This has to do with the fact that the entry barriers are very high.

To be able to use mobile VoIP, the customer needs a smart device, mobile broadband coverage and quality sufficient enough for mobile VoIP and numbers. This way the customer can be called by others.

In the case of VoIP the NRA won’t create hurdles for the VoIP providers, because they assume that VoIP will enhance competition at a positive way. Besides that, each mobile broadband network should qualify to certain requirements before it can be used for mobile VoIP. The two networks that can be used are UMTS network and WLAN. UMTS isn’t rolled out yet and WLAN is constrained to a certain area where the access point is placed. Also the penetration of the smart devices is very low at the moment. That way the customers aren’t enabled to use mobile VoIP. It results into the fact that mobile VoIP won’t have today large impact on the financial position of the mobile operator.

Therefore, there are designed several scenarios which represent the year 2008. The reason that this time horizon is chosen has to do with the fact that then the UMTS network will be rolled out fully, WLAN will become more available, the penetration of smart devices would be increased and the bugs in UMA and in the UMA devices will be resolved. The scenarios are labeled as following:

- Aggressive VoIP provider
- Mobile network operator rules
- Fixed network operator in the driving seat
- Mobile broadband services become successful

These are the scenarios that are analyzed. The conclusion that can be derived based on the analysis is that there can’t be said in general what the financial impact will be for T-Mobile. This has to do with the fact that the behaviour of a customer is very unknown. The choices a customer would made based on price quality ratio could be very different than the scenarios has assumed. There could be given an indication that when these scenarios will occur as defined than the following conclusions can be derived for one customer in specific who calls 200 minutes.

The first and the last have the most financial impact for that specific customer. The first one creates a financial benefit for the mobile operator because the prices won’t be reduced much and the interconnection cost and SAC will reduce when customer use VoIP. This way they would receive more revenues.

In the last scenario the impact will be negative because the customer won’t have to pay high price for access to mobile internet. This way the mobile operators will have to receive their earnings from the services, which they will deliver for mobile internet. That would also mean that the mobile operators will have to invest a lot in the new services to make them viable and attractive for the customer. Financially this scenario is very negative. The impact of VoIP will also be very high in this case because customers won’t be reluctant in using mobile VoIP.
The scenario, where the fixed network operator drives the scenario, has also financial impact per customer. Only it depends how the mobile operator positions itself towards UMA and whether the fixed network operator will deploy wireless LAN’s by himself to make his service more attractive. It could also use VoWLAN instead of UMA. This way the customer won’t have to wait particular for the integrated solution and would be cheaper off. A WLAN has as disadvantage it will always be constrained to the area where the access point is positioned.

And the second scenario has the least impact on the mobile operators, only financially it would matter when customers won’t call at all with their mobile to international destinations.

Therefore certain strategies are developed to retain the earnings that they receive currently. The strategies are recommendations that are given to T-Mobile at which way they could reduce the impact of each scenario and which strategy would have the most impact.

**Recommendations**

T-mobile is recommended to act at the moment defensive because VoIP isn’t a threat today. Yet, it has to take into consideration that by acting defensive it could loose revenue. Customer could choose to use mobile internet for more application and services then only for VoIP. Therefore an offensive behavior should be considered in the future when more researches have taken place and it would seem that the defined scenarios could occur.

In that case T-Mobile has to focus in specific on the first and last scenario, because it could have the largest impact per customer. Also the other two has to be taken into account. T-mobile should apply the followed strategies that could have the most effect, which are:

- Pricing
- Introduce new (mobile broadband) services
- Become a service provider of wireless LAN’s or other applications
- Deliver VoIP by itself.

T-mobile will be advised to research few aspects in further detail which aren’t done in this research because of the scope of the research and the time limit. First of all it would be important to analyze what the price elasticity is of a customer and how the customer base of T-mobile will react on VoIP. This way the whole financial impact for T-Mobile can be analyzed. That means that each price plan would have to be taken into consideration by T-mobile.

Next to that it is also important to know to which extent the quality price ratio is important for the customer. Then it would become clear how the customer will react on changes in the price quality ratio.
Appendices
Appendix: Scientific paper

Mobile VoIP enters the mobile market
Kanwal Khan

Abstract
In this paper will be elaborated how the voice over internet protocol (VoIP) providers, such as Skype and Vonage, could enter the mobile voice market and what their financial impact would be at the current mobile telephony market. The methodology that will be applied to analyze the competitiveness of the VoIP providers is the Porter model with his five forces. The five forces are the internal rivalry, supplier power, buyer power, substitution, and new entrants. In the case of mobile VoIP the VoIP providers have to bridge the entry barriers, before they could have any kind of impact on the mobile telephony market. The entry barriers are coverage and quality of mobile broadband networks for usage of mobile VoIP and the devices, which support VoIP. The mobile broadband networks, which can deliver sufficient quality today, are UMTS and WLAN. UMTS isn’t yet completely rolled out and WLAN is constrained to the area where the access point is placed. Besides that, the penetration of the smart phones, which could support VoIP, is very low. Nearly 0.9% of the customers have a smart device. Also other forces do not create a sustainable environment for mobile VoIP at the moment. Therefore the impact of the VoIP providers could be very low.

Keywords: VoIP, Porter model, competitiveness

1. Introduction
VoIP is a subject about which many researchers and consultants have written. They have analyzed either the quality aspects that are required to be able to deliver VoIP [1] or how VoIP could enter the telecom sector as Credit Suisse [2] has analysed. This research paper focuses on the Dutch mobile voice market and how the new VoIP providers could affect the financial position of the mobile operator. First I will elaborate briefly what VoIP is and what the research field is.

Voice over IP is a technology, which is based on the IP protocol of the Internet. This technology converts voice into digitized packets by an encoder. The encoding of the voice packets happens by means of voice codec’s such as G729 [1]. “A voice codec is a way how segments of the analog voice signal will be encoded into digital data streams” [3]. When a VoIP user calls to another VoIP client the call will be routed directly to the destination by means of the VoIP-protocols and if necessary also via a VoIP-server [4]. In the case of off-net calls a gateway will be required to be able to set up a call between a VoIP subscriber and a PSTN phone or GSM [5]. Off-net calls are calls which do not take place between two VoIP users.

VoIP can be used at several ways with which the VoIP providers could enter the mobile voice market. Two prominent business models of VoIP providers will become the focus of this research paper. Those are the Skype- and Vonage-model, named after firms, which have accessed the fixed telephony network [4]. The reason they are prominent is due to the fact that the consumers only need VoIP software on their devices and a mobile broadband connection, before they can use mobile VoIP. That way the VoIP providers can bypass the mobile operator and could enhance the competition in the mobile voice market [4].
The research field is as following. The main focus of this paper is the Dutch mobile voice market. With mobile voice market is meant that the customer can call anywhere with his mobile. Thereby is examined how VoIP providers could enter the mobile voice market. The VoIP providers who are selected as an example for this research are Skype and Vonage. They are selected because they have entered the fixed telephony market and already have to some extent impact. Customers over the globe use the services of Skype [6] and in UK, USA and Canada customers use Vonage [7]. The Porter model is selected because it shows by means of the forces how a new entrant can access a market and to which extent it can have impact on a market. The porter model is based on five forces, which are internal rivalry, new entrants, supplier power, substitution, and buyer power [8]. In the case of new entrants the entry barriers to enter the market will be examined. This way it would become clear how a new entrant could access the market. The internal rivalry is determined by means of the amount of players in a market, the size and the competitiveness in price or products. Supplier power is determined by means of the bargaining power of the buyer and the number of suppliers of homogeneous products. A product could have a substitute. A substitute is defined as a product which has the same function but is a different product. For example a car is a substitute of a train. The buyer power is determined by the bargaining power of the consumer and the price sensitivity. If the customer has high switching cost from one provider to another then his bargaining power is low. Besides that it lowers his buyer power when the customer is not only price sensitive. That way the customer won’t switch very rapidly from providers [8].

In this research paper first an overview will be given of each force and then the most crucial determinants for the VoIP provider will be worked out. Those determinants are the entry barriers of the force new entrants. These will be worked out in detail because the VoIP providers have to bridge the entry barriers before they can enter the mobile voice market. Therefore the entry barriers will be quantified. It will result into a clear view how high the entry barriers are and the results will be shown. The results will be discussed as certain assumptions are made to quantify factors. This clarifies how accurate the results are. In the last paragraph the conclusion will be derived.

2. Forces of Porter
Porter has a model for analysing competitive strategy using five forces which are internal rivalry, new entrants, supplier power, substitution and buyer power. Each of these forces creates either a barrier or a sustainable environment for competition by mobile VoIP [9]. The forces will be applied in the case when mobile VoIP will enter the mobile voice market.

Internal rivalry
The focus of this research paper is on the mobile voice market. Currently the rivalry between the players of the mobile voice market is high. There are nearly 27 mobile virtual network operators (MVNO’s) [10]. MVNO’s are operators who do not own a network. They have closed a wholesale deal with a mobile network operator. One of the most prominent MVNO’s is Tele2 who is active in both the fixed telephony market and the mobile telephony market. Next to the MVNO’s four mobile network operators are active in the mobile market [11]. Recently KPN announced a merger with Telfort [12]. This means that there are now four mobile network operators active in the mobile telephony market: KPN, Vodafone, T-Mobile and Orange. These fiercely compete with
each other by means of pricing tactics and new products and services. For example T-mobile has focused on mobile broadband by launching hotspots everywhere in the Netherlands. So the internal rivalry is high which creates for the VoIP providers a hinder to access the mobile voice market easily.

New entrants
Skype and Vonage are new entrants which have a different business model from MVNO’s and MNO’s with which they are entering the market. Vonage has a business model on the fixed network that allows the customer to use their services wherever a broadband connection is available. They only need the software or hook up an adapter for a fixed line [7]. In the case of Skype only downloads of software are required and a peripheral which supports the software [13]. When these providers want to enter the mobile voice market in a similar fashion, two entry barriers must be taken: 1. the customer will need a smart device with an operating system that isn’t disabled for the usage of certain applications, 2. the coverage and the quality of the mobile broadband networks should be sufficient for mobile VoIP.

Currently the mobile operators deliver the handsets with the subscriptions. In the case of the VoIP providers Vonage seems to be the only one which takes into consideration of delivering handsets for the usage of their services. Skype has mainly as focus to gain scale advantages by means of his proprietary software [13]. This way it could create a lock in effect as Microsoft has done with his software Microsoft Office. Everybody uses Microsoft even though it is very inefficient and there other software available which is handier. Next to these entry barriers the regulator of the telecom market could also create barriers. OPTA, the national regulatory authority (NRA) of the Netherlands sees VoIP as a way to increase competition in the telecom sector. Therefore they won’t create large barriers only access to numbers [14] and interconnection could become a hurdle for the VoIP providers [15].

The entry barriers will be analyzed and further examined to what extent these barriers could create a hurdle for the VoIP provider will be elaborated in paragraph 3.

Supplier power
There are in the mobile voice market two groups of suppliers one who delivers the products to the mobile operator, the handset suppliers and the other one are the dealers who sell the subscriptions to the customer and the handsets. Five large handset suppliers are in Europe. Those are Nokia, Motorola, Sony Ericsson, Siemens, and Samsung [16]. The number of these handset suppliers is small and the switching costs are low because the mobile operators have contracts with more than one supplier. So the mobile operator can purchase from any supplier any time the devices. This way the handset suppliers will act reciprocal towards the mobile operators because they are their buyers.

On the other hand it is also important for the handset supplier to track demand and be able to differentiate by means of new features or shapes of handsets. Inclusion of IP telephony, WLAN and other types of features could add value to their product. That way they could increase their market share [16]. For the dealer it is important to be able to earn back their cost. The mobile operators give them a commission for selling their subscription, which is sufficient for them to purchase devices and sell them ‘gratis’ in a bundle with a subscription of a mobile operator [17]. In the case of the VoIP providers they do not intend to give the dealer any kind of commission or devices. As long as the VoIP providers do not change their business model in this respect, they can’t gain the support of the dealer. Consequently, the supplier power is also
very low and doesn’t create yet any sustainable environment for mobile VoIP.

**Substitution**

VoIP is a substitute when it is used in combination with a WLAN. Otherwise it is an alternative which has seems to have the similar characteristics of mobile voice. The customer isn’t constrained to a location. The main difference between mobile voice and VoIP is that VoIP is IP based. Therefore mobile VoIP will be seen as an alternative. To be a complete alternative of mobile voice the VoIP provider would either have to imitate the business model of the mobile operators or introduce such advanced services that VoIP becomes attractive. At the moment their business model isn’t comparable with that of the mobile operators. They do not deliver subscriptions but the customer can use the web site to buy credits if he/ she want to call off-net. This manner is comparable with the prepaid of the mobile operators. Only the VoIP providers do not deliver the devices for the usage of VoIP. Next to that neither the services are fully comparable with the services of the mobile operator. Also the user interface of the devices, which the customer could use for VoIP, isn’t similar in usage as the GSM handset. For example a mobile digital assistant (MDA) or a smart phone does not have pre-configured VoIP settings. The customer would have to download that software to be able to use mobile VoIP. Then the customer would have to call with a soft phone. That is a phone that can be seen in the display of the mobile or PC and then the customer would have to dial by means of the buttons of the soft phone [18]. This way mobile VoIP can’t be a viable alternative of mobile voice.

**Buyer power**

The buyer power would be high when all the customers follow a certain trend. At the moment the customers are reluctant in using VoIP on their mobile because they mainly use their mobile phone for plain calling or SMS [19]. The customer uses more easily VoIP on their fixed internet than by means of their mobile phone. This has to do with the fact that customers do not have the urge nowadays to use mobile internet for regular use (historic data). In the future this could change. It depends on the development of the several forces and the actors which play a role in delivering mobile internet.

The fixed market on the other hand has grown and developed in delivering internet to the customer by means of several types of subscriptions. The customers are now accustomed to internet usage by means of the fixed network. Next to that, the prices for data usage are very high at the moment [19]. For the customer the prices are a very important aspect to choose for a certain provider [20].

Therefore the buying power for mobile VoIP is very low. As long as the trend doesn’t change and the customer does not want to use mobile internet VoIP won’t become viable.

Figure 1 depicts the several forces mentioned and the means by which they can create a barrier or a sustainable environment for mobile VoIP.
3. Entry barriers

In this section the entry barriers will be worked out into detail. First the mobile broadband networks should deliver sufficient quality. The quality is dependent on the latency [21], user up- and downlink [22] and the people coverage [23] of the mobile broadband networks. There are today three major network technologies, which are GPRS, UMTS and WLAN. GPRS has full coverage only the latency is very high and user up- and downlink has a very low bit rate [24]. The customer won’t be able to speak continuously with the listener. UMTS and WLAN (802.11b) have a lower latency also because in the case of WLAN the broadband connection to which the WLAN is attached has mostly a high bit pipe and low latency. 802.11b has a user up- and downlink of 4-6 Mbps [25]. WLAN has the disadvantage that it is constrained to the area where the access point is placed. Therefore WLAN can’t have full coverage in the Netherlands. UMTS has on the other hand the possibility to have full coverage only the roll out hasn’t taken place yet. KPN and Vodafone have started with rolling out in the dense urban areas their UMTS network as the license obliges them. The up-and downlink of UMTS is 64 to 220-330 kbps [24]. According to Skype minimal 24 kbps is required to make a VoIP call [6]. Therefore UMTS is a viable network. This results in the fact that WLAN delivers the best quality for mobile VoIP only it is restricted to a certain area. UMTS could have in the future full coverage. UMTS isn’t deliver sufficient quality for VoIP. This means GPRS can’t be used for mobile VoIP and UMTS isn’t available yet.

Next to the mobile broadband networks, devices are also required. The devices which are available and can be used
for mobile VoIP are MDA’s and smart phones. A MDA is a handset with which the customer can call and use it also as his digital assistant. Today most MDA’s, are delivered by mobile operators. The screen of the MDA is mostly a touch screen and the size of it is rather large screen. This way the customers could use easily the soft phone that will be required when the customer wants to use Skype or Vonage on his mobile. A smart phone is smaller and has the same size and shape as a mobile phone. So it is smaller than a MDA. Therefore the screen is also smaller and it isn’t a touch screen. This way the discomfort for the customer will increase.

Next to the user interface the availability and in particular the penetration of these devices is also required. Therefore the penetration of these devices will be examined. The penetration of these devices is based on the historic data that Strategic Analytics has acquired for West-Europe. The market that is defined in this research paper is the Dutch telecom sector. Therefore a correction will take place by means of the figures of GFK. By looking at the penetration figures I estimate how many customers would be enabled to use mobile VoIP.

The penetration of the MDA is defined by extrapolating historic data of sales of the MDA in West-Europe. By adding a trend line a formula can be set. The trend line resembles an exponential growth. This can be said based on the R square value of 0.9577. The growth of the PDA/MDA will be exponential. The formula for the penetration of the PDA’s/MDA’s is as following:

\[ Y = 0.0707 \times e^{0.5713 \times X} \times 0.11 \times 0.15 \]

Where Y is the sales of the MDA’s in millions and the X is the year in which the MDA’s are sold. The reference point for the value X is the year 2001.

In the case of the penetration of smart phones the R square value of the trend line is 0.9654. The formula will be as following:

\[ Y = 3.8701 \times X - 5.7881 \times 0.0039 \times 0.15 \]

Y is the sales of the smart phones in millions and the X is the year in which the smart phones are sold. The reference point for the value X is the year 2001. The results of these formulas will be mentioned in the paragraph 4.

The last barrier is regulation. The national regulation agency (NRA) promotes VoIP because it assumes that it would enhance competition in the Dutch telecommunications market. Therefore they will try to reduce the regulatory barriers only few aspects could create a barrier, which are access to emergency services and number allocation. Now the numbers are assigned according to the number plan. Geographic numbers can only be used for fixed locations; mobile number only for mobile use and personal assistance numbers are mainly used for the internal networks of corporations and now can be used for nomadic use [26]. With nomadic use is meant that the customer of the VoIP provider can use anywhere the number. So it isn’t constrained to a certain area or mobile usage [26]. Only the customer perceives the personal assistance numbers as a costly event. This way the customer won’t prefer to use these numbers. The VoIP providers can’t use the mobile numbers or geographic numbers for nomadic use. This means that the VoIP providers would have to orientate either on the mobile market or fixed market. Convergence in the usage of numbers isn’t approved yet by the NRA. Another disadvantage for the VoIP providers is interconnection cost. The terminating cost to a mobile network are 0.12 euro and to a fixed network 0.01 euro [27]. Terminating costs are the cost that an operator has to pay when his subscriber calls to somebody who utilizes the phone services form another operator. The VoIP providers can’t lower
their tariffs that way and compete with the mobile operators. It results into the fact that the entry barriers are high for the VoIP providers due to the technical and regulatory instruments.

4. Results

The entry barriers are very high for the VoIP providers. From the three networks that could be applied GPRS isn’t sufficient enough, UMTS isn’t rolled out yet, and WLAN has a limited coverage and that way a low utility. The values for each mobile broadband network can be seen in table 1.

<table>
<thead>
<tr>
<th>Mobile VoIP configurations</th>
<th>GPRS</th>
<th>UMTS</th>
<th>WLAN 802.11b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skype</td>
<td>-</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Vonage</td>
<td>-</td>
<td>+</td>
<td>++</td>
</tr>
</tbody>
</table>

Table 1: The mobile broadband networks in combination with mobile VoIP

The penetration of the smart devices shows whether customers are enabled to use mobile VoIP. By dividing the number of devices with the customer base of T-mobile, which is 2.24 million, the percentage of customer that is enabled becomes evident. In table 2 the results are shown.

<table>
<thead>
<tr>
<th>Devices for VoIP</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDA’s/MDA’s</td>
<td>11465</td>
<td>20299</td>
<td>35940</td>
</tr>
<tr>
<td>Smart phones</td>
<td>6676</td>
<td>7934</td>
<td>10198</td>
</tr>
</tbody>
</table>

Table 2: Penetration of the smart devices for Mobile VoIP

The regulatory barriers can’t be quantified. As mentioned in paragraph 3, the regulatory entry barriers are high, because the telephone numbers aren’t available for nomadic use and the terminating cost to mobile networks is high. The VoIP providers can’t lower their tariffs that way and compete with the mobile operators.

5. Discussion

The results which are based on empirical values of the parameters could be discussed. For example the bandwidth values that are given to the broadband networks are based on the theoretical value. Therefore it is possible that these values could differ as it has happened in practice with GPRS. For example GPRS had to deliver in first instance theoretically around 100 kbps [28] but now the theoretical value is set on 24-40 kbps, because GPRS had in practice a lower value.

In the case of the penetration figures, which are based on the trend line, the following remarks can be made regarding the stochastic R square value. This trend line is defined by the historic value of sold devices and the stochastic approach by means of the R square value. The value is very high but that doesn’t mean that the penetration figures could define accurately the future values. These could be changed by means of several changes in the business environment. For example the other forces of Porter could have a large impact on the penetration of the devices.
6. Conclusion

The conclusion that can be derived from the analysis is that the VoIP providers won’t be able to access the mobile voice market easily. A very small percentage of customers are enabled to use mobile VoIP. Not more than 0.9% of the customer can use VoIP on their mobile today. Additionally, the wireless broadband networks that are available either can’t deliver a sufficient quality or do not have enough coverage. Besides that regulation also creates barriers. The VoIP providers can’t use mobile or geographic numbers for nomadic use. That is important for them because the customer can access everywhere internet. So he/she should be able to use VoIP and the same number anywhere where a broadband connection is available. Also the interconnection cost, which each operator has to pay when off-net calls to mobile networks take place, is high. The VoIP providers can’t compete easily with the mobile operators by differentiating in price. Therefore the VoIP providers have to bridge very high entry barriers to be able to deliver their services on the mobile voice market.

References

[12] Citigroup smith Barney, Telfort acquisition, 28-06-2005
[13] Skype: putting the hype in VoIP, The Register, 18/04/2005
[14] Consultatie nummerbeleid voor VoIP diensten, OPTA, 30 november 2004
[16] Strategy Analytics
[18] VoIP A market introduction, First partner strategic and marketing research, 2004
[20] Customer satisfaction reports
[21] Latency is the travel time of a packet from one end-user to another
[22] User up and – downlink is a parameter which implies that what the data rate is when somebody or something upstream and downstream of data
[23] People coverage is defined as how many people of the total population have coverage
[26] Beleidsregels nummers voor VoIP diensten, OPTA, 11 april 2005
[27] www.opta.nl 02/09/2005
[28] D.Famolari et al, 1999
Appendix: Introduction

Figure 2: Value chain of the telecom sector

<table>
<thead>
<tr>
<th>Industry actors and their perceptions regarding VoIP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MVNO</strong></td>
</tr>
</tbody>
</table>
reason that their tariffs won’t be so low. But it is possible that the prices will reduce even more and eventually the competition become even at the mobile sector very high. Then only the size of the competition actors will play a role.

| Mobile operators | Mobile operators can have different positions within the telecom sector, because of VoIP. In the market there are at the moment five mobile operators, which have different strategies to approach the market. Therefore it is important to know that when VoIP providers enter the market they have a choice between five operators. All of them will ask different access fee and it is possible that other provider can gain strategic advantage by the letting the new VoIP providers access their network. On the other hand mobile operators can have large disadvantages when VoIP is delivered on the mobile phone. Those issues are mentioned in paragraph 2.2 where the issues were elaborated. |

| Fixed operators | The fixed operators already have to deal with VoIP at fixed telephony market in the form of VoDSL. At the moment there are a lot of companies which are using ADSL to deliver voice and data services at a low rate. Those companies are ISP’s and have taken over a large part of the fixed telephony market. Besides that the fixed operators must also compete with the cable operators who are delivering Voice services at a very low rate. This could lead to the fact that fixed operators will lower their voice tariffs to be able to compete with the ISP’s and cable operators. That way it is possible that the tariffs become so low that customers which use mobile phones will eventually choose for fixed telephony again. Hence the market position of T-Mobile could be endangered. Besides that for the fixed operators VoIP is also a threat because that way they will have another competitor with which they have to compete. Besides that a new VoIP provider can deliver at very low cost voice services and won’t need to invest a lot to be able to deliver VoIP services. |

| ADSL | These providers have the fixed broadband network and they can deliver leased lines to ISP's for example. That way the ISP's can deliver broadband connections to the (business) consumers. For the ADSL provider VoIP is mainly an advantage because then VoIP providers can use the connection or other ISP’s who will let the VoIP providers on their network. So ADSL providers have mainly advantage from VoIP, only not when they also compete in the fixed telephony market. Then VoIP is a threat. |

| Cable providers | Cable providers don’t have to deal with much competition, because until now no party has used their network to deliver cable services. On the other hand fixed operators such as KPN are starting with delivering TV channels through the computer. VoIP can also affect the cable providers because now also cable providers deliver voice services. And VoIP providers need broadband connection to deliver their VoIP services. That way the VoIP providers are also a threat for them. On the other hand the cable providers can also earn from the amount of data that is send over their network. |

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104 [http://www.kpn.com/kpn/show/id=431176/sc=a60807 07/02/2005]
**ISP**

ISP’s are the companies who provide access to internet for a monthly fee and deliver other services including a modem to be able to access the internet. There a lot of companies which function as ISP and those companies have also started to deliver voice services through IP. For them VoIP is for sure a rival because the VoIP provider will use almost the same technology that they apply only then they will use their network to deliver services to customers. On the other hand the VoIP providers can use their broadband connection to deliver the VoIP services.

**IP telephony providers**

IP telephony providers are mainly companies which have either an IP PBX or have a Centrex and deliver IP services to other companies. For these companies VoIP is an outcome. They can utilize VoIP to deliver at a more cost efficient manner voice and data services and other services that could be delivered because of VoIP. For example that an employee can leave a voice message behind for somebody who isn’t sitting at the moment behind his computer, etc. so VoIP is an opportunity for the IP telephony providers.

**VoIP providers, software suppliers and hardware suppliers**

The reason that these actors are grouped has to do with the product they deliver and to avoid repetition. For these actors the entrance of VoIP is an opportunity to enter the telephony market. After deployment of UMTS and the availability of other (mobile) broadband connection with a high speed VoIP can be applied. These actors have to deal with several hindrances, because customers aren’t used to VoIP and the usage of it, other actors are already positioned within the telephony market and the new VoIP providers have to prove themselves. Besides that, the most hardware suppliers of VoIP have prior engagement with the mobile operators for other business activities. Therefore these suppliers have to take into account their relationship with the fixed and mobile operators.

The VoIP providers are the one which aren’t actors who are already in the market. Those are the new providers which could become a VoIP provider but aren’t yet in the market.

**Handset suppliers**

VoIP creates for the handset suppliers an opportunity and a threat. This has to do with the fact that VoIP allows the handset suppliers to design new handsets which allow the usage of VoIP. On the other hand the disadvantage is that the most handset suppliers want to maintain their relationship with the mobile operators, because those give subsidies on the handsets.

**Gateway operators**

The gateway operators have to deal with a similar issue as the handset suppliers because they have also already several business relations with mobile operators, fixed operators and cable providers. Therefore it is necessary for them to analyze what advantage they have if they allow the usage of VoIP.

| Table 1: Actors perception within the telecom sector |

105 http://www.webopedia.com/TERM/I/ISP.html 04/02/2005
Appendix: Part 1

GSM

T-Mobile delivers his voice services currently by means of the GSM network. Therefore it is important to understand the technical architecture of the GSM network. The differences between the new generation networks and the currently used GSM network will then become apparent.

The GSM network is divided in several sub areas which have to operate with each other to enable a call set up. These areas are the Mobile station, base stations subsystem, networks subsystem and the operation maintenance center. Each of these sub systems has his several units. The mobile station is one unit, because that is the handset which a user needs to be able to set up a call. In this handset a subscriber identity module (SIM) card has to be placed to be able to use the GSM network. The base station subsystem consists of the base station controller (BSC) and the base transceiver (BTS)” (Dubendorf, 2003).

The network subsystem consists of the Mobile switching center (MSC), Visitor location register (VLR), Home location register (HLR), Authentication center (AUC), and Equipment identity register (EIR).

The definition of these units is as following:

- Base transceiver stations are a series of radio transmitters which connect the mobiles to a cellular network. Their task is (de-)coding and encryption /decryption of the channel.
- Base station controller; “a group of BTSs are connected to a particular BSC that manages the radio resources for them” (Dubendorf, 2003).
- Mobile switching centre manages the sub areas in which GSM operation is divided. Its main task is to coordinate the call set-up between two mobile GSM users or between a GSM user and a user of fixed telephony.
- Home location register is a database in which the mobile subscriber identity (IMSI), mobile station ISDN number (MSISDN) and current visitors register (VLR) address is stored. The HLR manages the information of each MS.
- Visitor location register (VLR) contains the current location of the MS and the selected administrative information from the HLR. The latter information is required to be able to control the call and provide the subscribed services.
- “Authentication centre (AuC) is a protected database which holds a copy of the secret key stored in each subscriber’s SIM card, which is used for authentication and encryption over the radio channel” (Dubendorf, 2003).
- Operating and maintenance center is a management system that oversees the GSM functional blocks. His task is mainly to control and maintain the MSC, BSC, and BTS.

The call on a GSM network is set up by means of these units that are defined above and the protocols which control the data flow and signalling. This way the end-to-end call can be enabled and communication between the interfaces can be sustained.

GPRS

Between the GSM network and the GPRS network there aren’t many differences. GPRS is an extension of the GSM network. Few parts are different which are required to enable data services and become efficient in setting up a connection (Wesolowski, 1999).
The novel elements next to the elements of the GSM network are the IP backbone, GPRS Support Nodes (GSN) and Serving GPRS support node (SGSN). The IP backbone is required for the flow of the data that is IP based. The GSN is meant to deliver the data packets and determine their route between a mobile station and external packet data networks. The task of SGSN is to deliver and receive packets to and from mobile stations in the SGSN service area (Wesolowski, 1999).

**UMTS**

UMTS is called the third generation network, because it is a follow up of the GSM and then the GPRS network. Therefore the core network of UMTS is also based on the GSM and GPRS network. Next to that there are two other main elements in the technical architecture of UMTS. That is the User equipment, which consists of a mobile handset, named mobile equipment (ME) and a UMTS subscriber identity module (USIM) and the UMTS Terrestrial Radio Access network (UTRAN). The UTRAN consists of two kinds of elements, which are the base stations, called Node B, and Radio network controllers (RNCs). These radio network controllers control the Nodes B connected to them and manage radio resources assigned to them (Wesolowski, 1999, page 391-395). The interfaces between the three main elements of UMTS are connected by means of protocols, which are available in several layers of the network.

**WLAN**

WLAN is a standard of IEEE, named IEEE 802.11. Each type of WLAN has different alphabetical letter behind 802.11. The most prominent WLAN type is the hot spot which is called 802.11b106; they are used in the free spectrum that is made available by the governments. These hotspots are configured as infrastructure based networks. The access points are connected to a wired network or other access points. “An Extended Service Set (ESS) is a set of two or more BSSs forming a single sub network”107. This way roaming can take place and connection with other wireless LAN’s can be provided. The wireless LAN standards are based on two layers, which are the physical and MAC sub layer. The physical layer is where the management of the air interface takes place by means of the direct sequence spread spectrum (DS-SS) technique. The MAC sub layer has as main tasks channel allocation, protocol data unit addressing, frame formatting, error checking, and fragmentation and reassembly of data blocks (Wesolowski, 1999, page 364-371).

<table>
<thead>
<tr>
<th></th>
<th>GPRS</th>
<th>WLAN</th>
<th>UMTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability</td>
<td>Low, because of fluctuation and voice gets an higher priority</td>
<td>Higher because it has a large bit pipe only fading effect results in low reliability for VoIP</td>
<td>High reliability, large bit rate when fully IP based. Otherwise QoS protocols are required, which are possible</td>
</tr>
<tr>
<td>Coverage</td>
<td>Full</td>
<td>Restricted to a location</td>
<td>In begin phase is the roll out</td>
</tr>
<tr>
<td>Latency</td>
<td>300-650 ms</td>
<td>120s-&lt;150ms</td>
<td>200 ms</td>
</tr>
<tr>
<td>Peak bit rate</td>
<td>14.4 Kbps</td>
<td>4-6 Mbps108</td>
<td>64 Kbps</td>
</tr>
</tbody>
</table>

106 solutions in VoIP over a 802.11 Wireless LAN, Wei Wang, IEEE, IEEE transfer on vehicle technology, vol. 54, no.4, January 2005
107 http://www.pulsewan.com/data101/802_11_b_basics.htm 21/05/2005
108 3G wireless with WiMax and Wi-Fi, Clint Smith, John Meyer, 2004, page 152
<table>
<thead>
<tr>
<th>User peak rate</th>
<th>24-40 Kbps</th>
<th>4-6 Mbps</th>
<th>220-330 Kbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>downlink</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>uplink</td>
<td>20 Kbps(^\text{109})</td>
<td>4-6 Mbps</td>
<td>64 Kbps</td>
</tr>
</tbody>
</table>

Table 2: Parameters of the mobile wireless broadband networks

Figure 3: MOS value for each codec\(^\text{110}\)

\(^{109}\) WiMax- "last Mile", WiFi Backhaul, Fixed Broadband Wireless Standard or 3G killer?, Strategy Analytics, March 2005, page 32

\(^{110}\) voice over internet protocol (VoIP), Goode, 2002, page 1498
Appendix: Part 2

<table>
<thead>
<tr>
<th>Bundles fixed fee</th>
<th>Price</th>
<th>Price handsets for customer</th>
<th>Net cost customer for 2 year subscription</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data bundle</td>
<td>€ 69.60</td>
<td>€ 450.00</td>
<td>€ 78.25</td>
</tr>
<tr>
<td>WLAN bundle</td>
<td>€ 19.95</td>
<td>€ 450.00</td>
<td>€ 38.70</td>
</tr>
<tr>
<td>UMTS bundle</td>
<td>€ 45.00</td>
<td>€ 0.00</td>
<td>€ 45.00</td>
</tr>
</tbody>
</table>

Table 3: Full substitution fixed fee prices

![Figure 4: The most called international countries and their tariffs versa VoIP tariffs](image)

VoIP providers are cheaper international than within Netherlands

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111 http://www.t-mobile.nl/persoonlijk/htdocs/page/telefoons_en_tarieven/ps1.43.asp 1/9/2005
### Appendix: Part 3

<table>
<thead>
<tr>
<th>Mobile operators</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Full substitution</strong></td>
<td>Revenue of voice</td>
</tr>
<tr>
<td></td>
<td>Revenue from mobile VoIP</td>
</tr>
<tr>
<td></td>
<td>Total minutes called by T-Mobile</td>
</tr>
<tr>
<td></td>
<td>Total mobile VoIP minutes</td>
</tr>
<tr>
<td></td>
<td>Percentage outgoing traffic for mobile to mobile</td>
</tr>
<tr>
<td></td>
<td>Percentage outgoing traffic for mobile to fixed</td>
</tr>
<tr>
<td></td>
<td>Cost voice</td>
</tr>
<tr>
<td></td>
<td>Cost for mobile VoIP in the case of UMTS</td>
</tr>
<tr>
<td></td>
<td>Margin</td>
</tr>
<tr>
<td><strong>Partly substitution</strong></td>
<td>Revenue voice</td>
</tr>
<tr>
<td></td>
<td>Revenue from mobile VoIP</td>
</tr>
<tr>
<td></td>
<td>Cost of voice</td>
</tr>
<tr>
<td></td>
<td>Margin</td>
</tr>
</tbody>
</table>

#### Table 4: Formula’s for the mobile operator

<table>
<thead>
<tr>
<th>VoIP providers</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Full substitution</strong></td>
<td>Revenue</td>
</tr>
<tr>
<td></td>
<td>Cost</td>
</tr>
<tr>
<td></td>
<td>Total mobile VoIP minutes</td>
</tr>
<tr>
<td></td>
<td>Percentage outgoing traffic for mobile to mobile</td>
</tr>
<tr>
<td></td>
<td>Percentage outgoing traffic for mobile to fixed</td>
</tr>
<tr>
<td></td>
<td>Margins</td>
</tr>
</tbody>
</table>
| **Partly substitution** | Revenue mobile VoIP | (% minutes called to fixed destinations * 0.04 * total VoIP minutes + % minutes called to mobile destinations * 0.13 * ...
### Table 5: Formula's for VoIP providers

<table>
<thead>
<tr>
<th>Mobile operators</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Full substitution</strong></td>
<td></td>
</tr>
<tr>
<td>Revenue voice</td>
<td>Euro</td>
</tr>
<tr>
<td>Revenue from mobile VoIP</td>
<td>Euro</td>
</tr>
<tr>
<td>Total minutes called by T-Mobile</td>
<td>Number of minutes</td>
</tr>
<tr>
<td>Total mobile VoIP minutes</td>
<td>Number of minutes</td>
</tr>
<tr>
<td>Percentage outgoing traffic for mobile to mobile</td>
<td>Percentage</td>
</tr>
<tr>
<td>Percentage outgoing traffic for mobile to fixed</td>
<td>Percentage</td>
</tr>
<tr>
<td>Cost voice</td>
<td>Euro</td>
</tr>
<tr>
<td>Cost for mobile VoIP in the case of UMTS</td>
<td>Euro</td>
</tr>
<tr>
<td>Margins</td>
<td>Euro</td>
</tr>
<tr>
<td><strong>Partly substitution</strong></td>
<td></td>
</tr>
<tr>
<td>Revenue voice</td>
<td>Euro</td>
</tr>
<tr>
<td>Revenue from mobile VoIP</td>
<td>Euro</td>
</tr>
<tr>
<td>Cost of voice</td>
<td>Euro</td>
</tr>
<tr>
<td>Margins</td>
<td>Euro</td>
</tr>
</tbody>
</table>

### Table 6: Dimension assessment for the mobile operators

<table>
<thead>
<tr>
<th>VoIP providers</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Full substitution</strong></td>
<td></td>
</tr>
<tr>
<td>Earnings</td>
<td>Euro</td>
</tr>
<tr>
<td>Total mobile VoIP minutes</td>
<td>Number of minutes</td>
</tr>
<tr>
<td>Percentage outgoing traffic for mobile to mobile</td>
<td>Percentage</td>
</tr>
<tr>
<td>Percentage outgoing traffic for mobile to fixed</td>
<td>Percentage</td>
</tr>
<tr>
<td>Margin</td>
<td>Euro</td>
</tr>
<tr>
<td><strong>Partly substitution</strong></td>
<td></td>
</tr>
<tr>
<td>Earnings mobile VoIP</td>
<td>Euro</td>
</tr>
<tr>
<td>Cost of voice</td>
<td>Euro</td>
</tr>
<tr>
<td>Margin</td>
<td>Euro</td>
</tr>
</tbody>
</table>

### Table 7: Dimension assessment for the VoIP providers

<table>
<thead>
<tr>
<th>Quality attributes</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Full substitution</strong></td>
<td></td>
</tr>
<tr>
<td>Coverage</td>
<td>Dimension less</td>
</tr>
<tr>
<td>User experience</td>
<td>Dimension less</td>
</tr>
<tr>
<td>User interface</td>
<td>Dimension less</td>
</tr>
<tr>
<td>Brand</td>
<td>Dimension less</td>
</tr>
<tr>
<td>Numbers</td>
<td>Dimension less</td>
</tr>
<tr>
<td><strong>Partly substitution</strong></td>
<td></td>
</tr>
<tr>
<td>Coverage</td>
<td>Dimension less</td>
</tr>
<tr>
<td>User experience</td>
<td>Dimension less</td>
</tr>
<tr>
<td>User interface</td>
<td>Dimension less</td>
</tr>
<tr>
<td>Brand</td>
<td>Dimension less</td>
</tr>
<tr>
<td>Numbers</td>
<td>Dimension less</td>
</tr>
</tbody>
</table>
Reference list

Books
- Wireless data technologies, Vern A. Dubendorf, 2003
- 3G Wireless with WiMax and Wi-Fi 802.16 and 802.11, Clint Smith, John Meyer, 2004
- Mobile communication systems, Krzysztof Wesolowski, John Wiley & sons, Ltd, 2002
- GSM and UMTS: The creation of Global mobile communication, Friedhelm Hillebrand, John Wiley & Sons, Ltd, 2002
- VoIP service quality measuring and evaluating packet-switched voice by William C. Hardy
- Strategy safari, Henry Mintzberg, Bruce Ahlstrand and Joseph Lampel, 1998
- Decision analysis for management judgment second edition, Paul Goodwin and George Wright, 1999, John Wiley and Sons
- Information systems, a management perspective 3rd edition, Steven Alter, University of San Francisco, 1999
- Competitive strategy, Techniques for analyzing industries and competitors, Michael E. Porter, 1980

White papers
- Voice over WLAN, Extriecom, white paper, 2003-2004
- Quality of service in WLAN networks, Radionet Finland, 2003
- WiMax- “last Mile”, WiFi Backhaul, Fixed Broadband Wireless Standard or 3G killer?, Strategy Analytics, march 2005
- Solutions in VoIP over a 802.11 Wireless LAN, Wei Wang, IEEE, IEEE transfer on vehicle technology, vol. 54, no.4, January 2005
- A technical white paper on Sage’s PSQM test, Renshou Dai, August 7 2000
- Wimax vs Wiwait: Will mobile also dominate broadband?, Arthur D Little, November 2004

Journals and reports
- Dicht op de huid van marktleiders, IT Commercie, mei 2005
- Citigroup smith Barney, Telfort acquisition, 28-06-2005
- The Dutch telecommunications market 2000, P.J.P. Ballon, PRO Verhoest, TNO rapport, 2000
- Morgan Stanley, Telfort merger, 28/06/2005
- Strategy Analytics
- De digitale economie 2004, CBS
- Dutch mobile operators, Telecom paper research, Dirk Bout, September 2004
- Voice over packet technology, Stratix, December 2003, VoIP options for OPTA
- IP Voice and associated convergent services, Analysus, 28/01/2004
- VoIP op het Nederlands elektronische communicatie markt, Nick Wennekers, 5/8/2004
- Voice over Internet protocol (VoIP), Goode, B.; Proceedings of the IEEE, Volume: 90, Issue: 9, Sept. 2002 Pages: 1495 – 1517
- VoIP A market introduction, First partner strategic and marketing research, 2004
- Quality VoIP – an engineering challenge, R J B Reynolds and A W Rix, BT Technology, 2001
- Toward an all -IP-based UMTS system architecture, Lieve Bos and Suresh Leroy Alcatel, IEEE 2001
- VoIP newsletter, Mercator capital, September 2004
- Beleidsregels nummers voor VoIP diensten, OPTA, 11 april 2005
- Dutch mobile virtual operators, D.Bout and E. Achterberg, research report, telecom paper, page 38 25/05/2005
- Mobile monitor, 2004
- VoIP marketing strategies in Australia, Daniel Swift, OVUM, February 2005
- FMC: Explaining CTP and UMA, OVUM, Cerri Pawsey and Jeremy Green, December 2004
- Fatphone, Mobile-voice-over-IP, First Boston, 28 April 2004, Europe Telecommunication Services
- The treatment of Voice over Internet Protocol (VoIP) under the EU regulatory framework, European commission, 2004
- Dutch mobile operators, 2004 H1, half year update June 2004, Telecom paper
- E.J. Dommering (1999), handboek telecommunicatierecht, pp. 3-52.

- Rapportage over de marktdefinitie van het afwikkelen van gesprekken op mobiele netten, Nma, 1/8/2002, page 3-5

- 3G wireless with WiMax and Wi-Fi, Clint Smith, John Meyer, 2004, page 152

Websites

- http://www.s3group.com/wireless_systems/wlan_qos/ 14/06/2005
- www.theregister.co.uk/2004/11/02/vonage_voip/print.html 18/04/2005
- http://wireless.engadget.com/entry/123400000200039335/ 17/06/2005
- http://news.zdnet.co.uk/communications/0,39020336,39202749,00.htm 17/06/2005
- http://www.threadwatch.org/node/1245 17/06/2005
- http://www.mitsuivp.com/cgi-bin/WebObjects/f1f2557f0f.woa/wa/read/104654449a9/ 02/08/2005
- www.arcchart.com/blueprint/print.asp?id=368 13/06/2005
- http://www.webwereld.nl/articles/35435 02/07/2005