

# Master Thesis Economics & ICT

Erasmus University Rotterdam

Author: X.R.C. Lahey  
Student number: 305609  
Thesis supervisor: dr. T. Tervonen  
Thesis co-reader: dr. Y. Zhang

3 August 2011

## **Competitive advantage of VoIP adoption: an exploratory study**



Author: X.R.C. Lahey BSc.

EUR Supervisor: dr. T. Tervonen

EUR Co-Reader: dr. Y. Zhang

## **Abstract**

Telephony is an essential technology in today's society. As we move into the digital age where technology increases in importance, telephony also moves along with us and is now being digitalized in the form of Voice over IP (VoIP). This research focuses on the impact of VoIP on the core business of Dutch organizations and the aspect of acquiring a competitive by using the technology. Due to the lack of previous research in this field, the research is exploratory. A study is conducted on VoIP by using a qualitative research method resulting in in-depth interviews with representatives from nine different organizations that have implemented VoIP. The empirical data is categorized and interpreted. Conclusions were drawn from the interpretation.

This research supports the view that VoIP introduces a level of competitive advantage into organizations that is mainly caused by cost savings. Also incompatibility issues with legacy systems are identified as the main obstacles when VoIP is implemented. The ability of VoIP to increase efficiency is discussed together with the viewpoint that future enhancements in communication technology can affect the core business of organizations depending on their market sector. Concerning the organizations interviewed for this research it is observed that VoIP has minimal influence on the core business (processes) of organization while the support processes are influenced to a greater extent.

## **Acknowledgements**

Writing this thesis was a long but educative journey. I learned a lot about the subject of my thesis and about qualitative research methods. This thesis would not have been written without the help of certain individuals. The people I would like to extend my gratitude towards are my supervisor dr. Tervonen and co-reader dr. Zhang from the Erasmus University of Rotterdam. They helped me with the selection of my topic and provided guidance during the writing of my thesis. Furthermore I thank all the people that I interviewed who provided their help and shared their work experiences with me. Without them, the current research would not have been possible.

# Table of Contents

Abstract .....	I
Acknowledgements .....	II
List of Figures and Tables .....	IV
Glossary .....	V
1 Introduction .....	1
2 Literature Review .....	4
2.1 VoIP Background and Development .....	4
2.2 VoIP Technical Description .....	6
2.3 VoIP Architecture .....	8
2.4 Implementing VoIP .....	11
2.5 Quality of Service .....	12
2.6 Reliability .....	14
2.7 Securing VoIP .....	16
2.8 VoIP and Competitive advantage .....	17
2.9 Cost benefit analysis .....	19
3 Research Methodology .....	20
3.1 Research Approach .....	20
3.2 Data Analysis Approach .....	22
3.3 Qualitative Content Analysis Category Development .....	24
3.4 Research Questions .....	26
4 Empirical Data .....	27
4.1 Higher Educational Organization I .....	27
4.2 Higher Educational Organization II .....	32
4.3 Government I .....	36
4.4 Government II .....	41
4.5 Government III .....	48
4.6 IT Organization .....	51
4.7 Petroleum Organization .....	56
4.8 Social Care Organization .....	60
4.9 VoIP Provider .....	64
5 Data Analysis .....	69
5.1 Category Overview .....	69
5.2 Categories CB .....	71
5.3 Categories BI .....	74
5.4 Categories CBA .....	76
5.5 Categories FUT .....	80
6 Conclusion .....	82

References.....	85
Appendix A: Interview Questionnaire.....	A1
Appendix B: Interview Questionnaire VoIP Providers.....	B1

## List of Figures and Tables

Figure 1.1: Worldwide VoIP dominance over communication markets (Werbach, 2005). .....	1
Figure 2.1: VoIP development (Hartpence, 2007). .....	5
Figure 2.2: Projected PBX shipments by platform (Sacker et al, 2006). .....	6
Figure 2.3: SIP based message flow with Authentication for REGISTER, INVITE and BYE messages (Zhang et al., 2007). .....	8
Figure 2.4: Tie Line connecting 2 remote offices (Vetteth & Joseph, 2009). .....	9
Figure 2.5: Simple VoIP Toll Bypass implementation (Vetteth & Joseph, 2009). .....	10
Figure 2.6: Coexistence scenarios for PSTN & VoIP (Varshney et al. 2002). .....	12
Figure 2.7: Cause of system unavailability (Walker & Hicks, 2002). .....	16
Figure 3.1: Inductive qualitative content analysis model for category development (Mayring, 2000). .....	25
Figure 4.1: Organizational VoIP network. ....	43
Figure 4.2: Call routing algorithms, VoIP vs. Analog. ....	59
Figure 4.3: Organizational network. ....	61
Figure 5.1: Relation between research questions and empirical data sections. ....	70
Table 2.1: Availability and corresponding down time (Walker & Hicks, 2002). .....	15
Table 2.2: Traditional vs. VoIP-enabled features (Sacker et al., 2006). .....	18
Table 5.1: Category matrix showing themes and their corresponding categories .....	71
Table 5.2: Effects on core and supporting processes .....	73
Table 5.3: Competitive advantage gained per organization. ....	78
Table 5.4: Competitive advantage gained per organization. ....	80

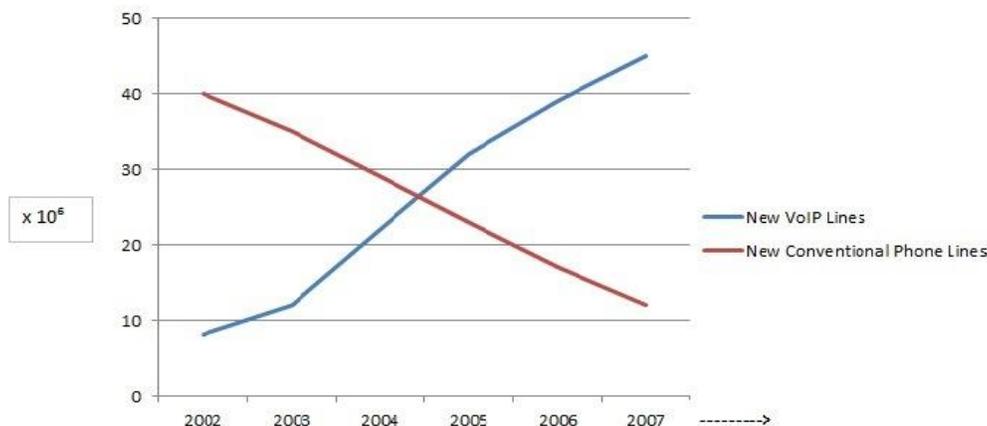
## Glossary

Gbit	Gigabit
GSM	Global System for Mobile Communications
IP	Internet Protocol
IWF	Interworking Function
LAN	Local Area Network
Mbit	Megabit
PBX	Private Branch Exchange
PSTN	Public Switched Telephone Network
QoS	Quality of Service
RTP	Real-Time Transport Protocol
SPIT	Spam over Internet Telephony
SIP	Session Initiation protocol
SIP UA	SIP User Agent
TCP	Transmission Control Protocol
TDM	Time-Division Multiplexing
UDP	User Datagram Protocol
VLAN	Virtual Local Area Network
VoIP	Voice over Internet Protocol
VPN	Virtual Private Network

# 1 Introduction

The modern society we live in today relies heavily on technology in order to function in an efficient way. This is reflected in, for example, the way we make an electronic payment at the supermarket with our credit/debit card, check-in online for our flight or make a phone call over the internet. Using the internet and the internet protocol (IP) to execute voice conversation is the general definition of voice over IP (VoIP). The IP protocol is basically a specific mechanism or set of rules for transporting data (packets) across a digital network. The functionality of VoIP is greater than just facilitating phone calls. VoIP could serve as a replacement for analog telephony for organizations and consumers alike (Hartpence, 2007). For the purpose of this thesis the definition of VoIP that is used from now on, is that it is a general term for digital phone based communication using multiple protocols in order to establish and conduct a communication process.

These days many organizations are receiving their phone calls by using VoIP instead of traditional phone systems (Wallingford, 2005). This ongoing trend shows a possibility that the general replacement of traditional telephone systems might happen in the future (Walters, 2002). The only thing that remains to be seen is when this will happen. The market penetration of VoIP is growing by the day for both the consumer and business sides. The rise of VoIP market dominance is further supporting the estimate that within the next 20 years, the global telephone network will run mainly on internet technology (Werbach, 2005). This is illustrated in Figure 1.1 which shows the growing trend of VoIP technology. VoIP's growing trend supports the idea that in the near future there might not be a distinction between VoIP and the phone network. The higher utilization of VoIP technology increases the overall importance it has in the daily tasks of consumers.



**Figure 1.1: Worldwide VoIP dominance over communication markets (Werbach, 2005).**

In the business world where effectiveness and efficiency play a large role in cost saving and acquiring competitive advantage, the integrity of the technology being used by the business is of considerable importance. Competitive advantage is seen as the strategic advantage that one organization has over its competitors when situated in a competition based environment. The majority of organizations have the acquisition of competitive advantage as one of their primary goals. This is not necessarily limited to the private sector. Competition and the need for competitive advantage also occurs in the public sector as public organizations (government) can have direct commercial competitors that perform similar activities.

With a lack of adequate performance from a public organization the government can decide to outsource activities to a commercial competitor. This causes the public organization to lose its importance and will lead to an eventual elimination of the organization. Although public organizations might focus less on gaining competitive advantage than their commercial counterparts, they must maintain a high level of performance and service. In short, competitive advantage is (to a certain extent) present in both the private and the public sector. The only exceptions are public organizations that do not have direct competitors in the private sector that perform similar services (Porter, 1998). Competitive advantage can in turn have a positive effect on the core business of organizations. The core business can be defined as an ideal concept which is used to describe the organization's primary activities (Kotler et al., 2009).

There appear to be numerous benefits for businesses that decide to implement VoIP, but by making the switch from their legacy phone systems, they also have to consider the changes that need to be made to their organization so that the new technology can be used to its full potential (Werbach, 2005). If implemented correctly, VoIP systems can benefit organizations by providing efficiency gains and lowering communication costs (Sacker et al., 2006). However, this new IP based communication system also provides vulnerabilities that need to be taken into account. Looking at the integrity of VoIP technology it is apparent that, as is the case with a communication technology that utilizes the internet and the IP protocol, security is an issue. Hackers have already struck and businesses are left to deal with the security vulnerabilities. There is a report that a business in Australia has incurred a phone bill of \$120000 when hackers infiltrated the network and made numerous international calls using organization's phone lines (SC Magazine, 2009). Securing IP telephony can be quite complex, with the need to maintain a certain quality of service (QoS) standard causing VoIP services to not be sufficiently secured or in some cases security will be completely absent. Adding security to the VoIP service often results in an increase of latency which hampers performance (Mazurczyk & Kotulski, 2006). The vulnerabilities make it important to assess one's system and know the weak links of the VoIP technology and the organization's own system before deciding to implement a VoIP solution (Kuhn et al., 2005).

Information about the influence that VoIP has on the organization's core business, taking into account both the benefits and the disadvantages, would produce greater knowledge on how the new technology could help organizations in obtaining a competitive advantage. It is likely that organizations will increasingly start to realize the strategic potential of VoIP. There are multiple benefits to using VoIP technology and it is seen as a possible tool organizations can use to acquire competitive advantage (Werbach, 2005). By researching the actual gain of any type of competitive advantage this technology has given organizations in the Netherlands, an evaluation of the business benefit of VoIP can be produced concerning its usefulness as a competitive technological tool in the Dutch business market. Currently almost no research has been conducted on the impact of VoIP on the core business of organizations in a Dutch setting. By conducting this research it adds to the already existing knowledge base and provides insight into the acquisition and use of new technology like VoIP to further business goals. This could lead to a better integration of (core) business processes and VoIP technology or a more result driven implementation of a VoIP platform. Ultimately this provides organizations with an enhanced manner of conducting their operations.

### **Research Objective**

The objective of this thesis is to gain insight into how VoIP influences the core business of organizations that implement it. Furthermore, the effects of this technology on business processes and the actual gain in competitive advantage are observed. Finally, the thesis provides recommendations on how VoIP technology utilization can be improved within an organization in order to support the core business processes and insight into the barriers preventing extended functionality implementation of VoIP is acquired. Whether organizations perform a cost benefit analysis before purchasing a VoIP system is also studied.

## **2 Literature Review**

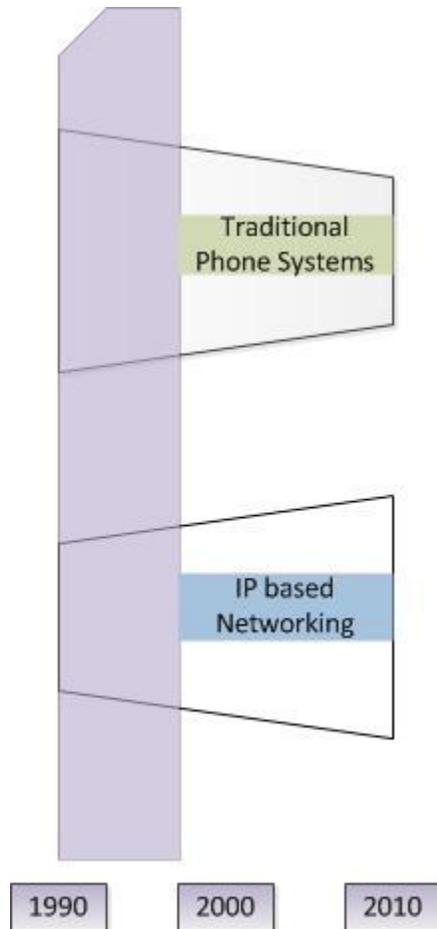
In this chapter a variety of literature is discussed which describes the information that researchers in the field have found concerning VoIP technology and related topics. Background information on the emergence and growth of new VoIP based communication technology is first discussed. Then a more general technical foundation of VoIP is described. The technical foundation is separated into a technical description of the VoIP technology that involves various protocols and an overview of the VoIP architecture that shows how VoIP is implemented in organizations. The general technical understanding is necessary in order to discuss the topics of the subsections that follow. These subsections focus on implementing VoIP, the QoS, the reliability of the new communication technology, security issues, the competitive advantage that VoIP can offer and the cost benefit analysis.

### ***2.1 VoIP Background and Development***

Communication has been simplified a great deal ever since Alexander Graham Bell's invention of the telephone. People have been utilizing the public-switched telephone network (PSTN) to place phone calls for more than a 100 years. VoIP was developed in the 1970's but it only found its commercial niche in the mid 1990's. Currently both the U.S. consumer and business VoIP markets have an annual demand increase of 1 billion dollars (Varshney et al., 2002). The slow commercial development of the VoIP technology is attributed to the lack of a reliable IP infrastructure and that previously, circuit-switched calling via the PSTN was a more reliable option. The PSTN was considered to be more reliable because early VoIP solutions were plagued by QoS issues.

When focusing on users from the business sector it can be said that they use a specialized system for routing incoming and outgoing calls in their buildings. This can be described as a private branch exchange (PBX) that functions as a departmental telephone switch for regulating communication traffic (Jiang et al., 2001). The main and most important differences with traditional telephony are that a VoIP solution uses a packet based PBX which means that all communication traffic occurs digitally (Vetteth & Joseph, 2009). Another difference is in the communication devices themselves which in a PSTN enabled setting would mean a traditional analog telephone whereas a VoIP solution would require the use of specialized packet based IP phones or softphones. These softphones generally accomplish the same goals as the IP phones but are not limited to specialized dedicated hardware and are basically programs installed on a computer that enable the execution of phone calls over the internet (Vetteth & Joseph, 2009). Using a softphone (program like Skype) to make a telephone over the internet is also considered to be VoIP as the general principles are the same.

## Current state of VoIP



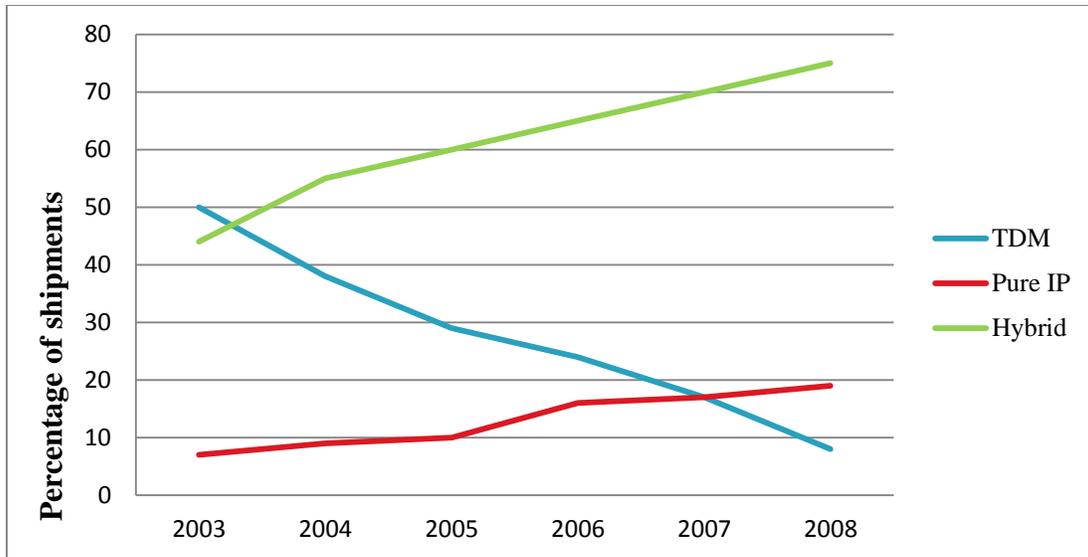
There exists a unique perspective on the VoIP development in which the focus lies on the change in communication technology standards that organizations use and the development of education criteria based on new technology standards. Figure 2.1 on the left shows the VoIP movement and development trajectory through the years.

In the past traditional telephony and standards/education based on this technology proved to be dominant. As internet and IP technology keep on evolving, the focus will move toward this type of technology. This is also the case for the development of new communication standards and communication technology education criteria.

Experts mention that currently we are in a transitional phase where traditional communication systems are being replaced by VoIP based ones. According to him this transition will not happen overnight and there are still multiple hurdles to overcome. For the time being the old and the new communication technology will still have to function side by side until complete market dominance by IP based communication solutions occurs (Hartpence, 2007).

**Figure 2.1: VoIP development (Hartpence, 2007).**

The situation where VoIP is rapidly penetrating the business market is shown in Figure 2.2. Here the projected PBX shipments for 2003 up to 2008 are depicted. A hybrid solution means that both traditional and VoIP systems are in use (temporarily). TDM represents the traditional phone systems in the figure and pure IP represents a complete VoIP implementation where no legacy systems are active. The decreasing line for legacy systems and the increasing ones for hybrid and pure IP solutions show that VoIP adoption is increasing and this is likely to continue for some time (Sacker et al, 2006).



**Figure 2.2: Projected PBX shipments by platform (Sacker et al, 2006).**

Despite this increase in the technology adoption rate, there are also factors which have a negative effect on VoIP use that should not be omitted. In some countries governments have a high level of interest and shares in the telecommunications industry. VoIP is a technology that cannibalizes the legacy systems, meaning that it replaces the traditional telephony system. By replacing the old technology VoIP can have a less desirable effect on some government owned telecommunications revenues and therefore they may try to slow down the spread of VoIP by imposing certain types of regulations (Meisel & Needles, 2005). An example is one where large revenue losses from landlines due to businesses migrating towards VoIP services, is becoming a primary motivation factor for an increase in regulation of the services provided by VoIP (Del Bianco, 2006). As time passes even the regulatory barriers will most likely be overthrown as the need to innovate or risk falling behind takes over and governments find themselves allocating resources to further develop their national communication networks with VoIP technology.

## **2.2 VoIP Technical Description**

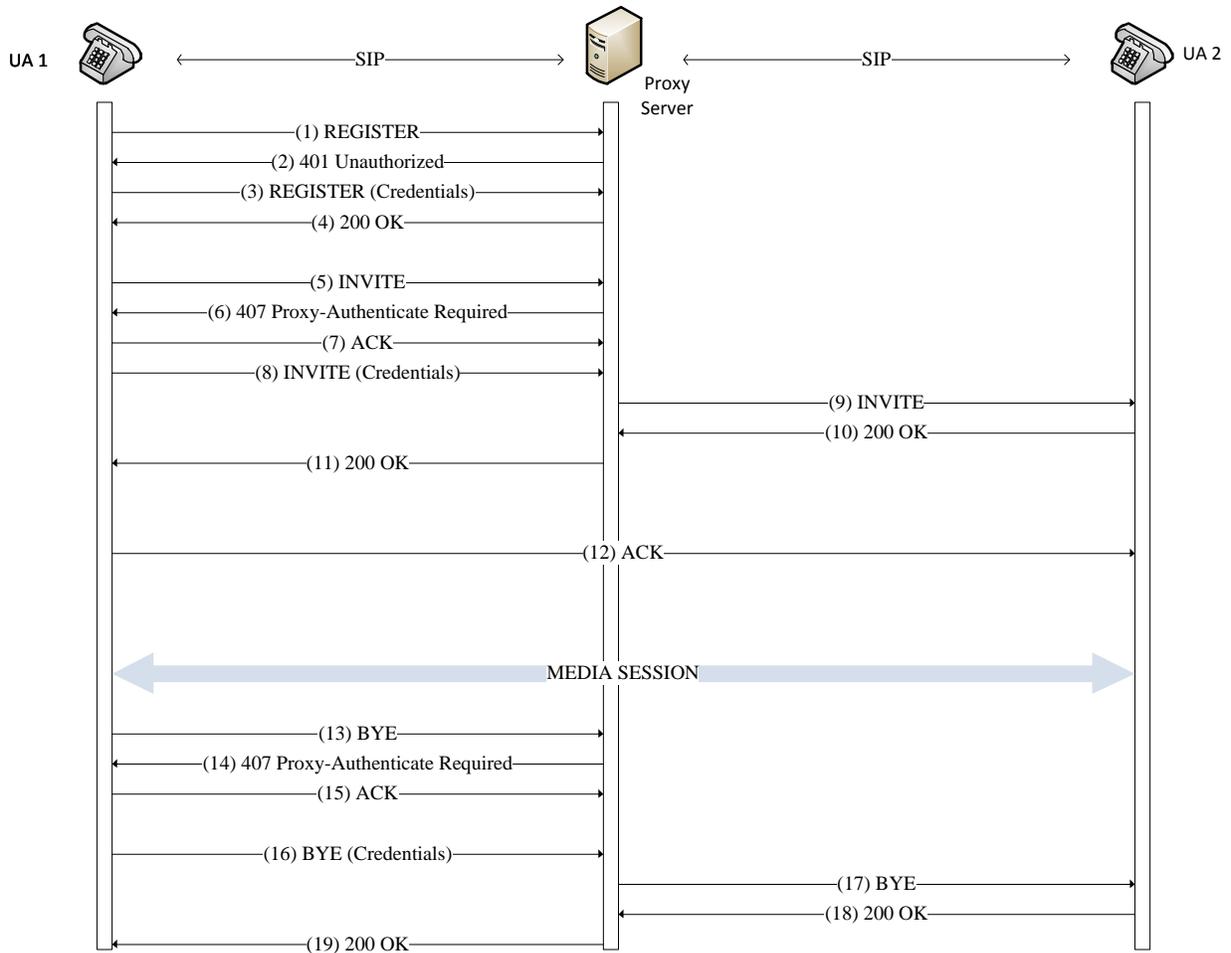
As previously mentioned, VoIP allows for voice communication to occur over the internet or a network by using a variety of network protocols. These network protocols are seen as basic procedures or rules for initiating, transferring and conducting traffic on a digital network. For the transfer of data, VoIP systems make use of the internet and the IP or the user datagram protocol (UDP) to transfer their digital information. The UDP protocol is a simple transport protocol used for transferring data but it is unable to correctly reassemble data-packets that are received in an incorrect order. UDP favors a speedy transfer of data rather than detecting the correctness of

data. The protocol that handles the transportation of voice based data is the Real-Time Transport Protocol (RTP) and utilizes UDP as a foundation which means that RTP, just like UDP, is not capable of reassembling data packets that are received in an incorrect order. RTP also favors speed but is more reliable than UDP as it has mechanisms to detect issues that can affect QoS (Kuhn et al., 2005).

This description of the protocols used in VoIP is a simplified description of the workings of this technology as there are also various session initiation protocols involved in the communication process. The session initiation protocol (SIP) is defined as a specialized protocol for signaling, presence and instant messaging and can be used in a multitude of multimedia sessions (Sinnreich & Johnston, 2001). It was accepted in 1999 by an organization that maintains and develops internet standards, namely the Internet Engineering Task Force (IETF) (Johnston, 2009). In a nutshell SIP can be seen as an internet protocol that makes use of the internet architecture in order to fulfill its functionality. The protocol is more specifically used for creating, modifying and terminating a (multimedia) session between two or more internet endpoints. Normally VoIP implementations utilize a variety of protocols in order to function correctly. Specific network configurations and the experts conducting the implementation determine which protocols are used for the VoIP system. The protocols that have gained to most popularity due to their good reputation are the SIP and RTP protocols (Zhang et al., 2007).

SIP is the principal defining factor for the communication interaction between SIP User Agents (SIP UA's) and different types of servers that can have a variety of functionalities such as redirecting transmissions or registering them. Sometimes there is also a proxy server involved that functions as an in-between device for the UA to transfer SIP messages to the end locations. The SIP UA's represent an internet endpoint and can for example be a SIP based phone (VoIP communication device). In order to start, manage or end a VoIP session a SIP UA is required to send a SIP request message to a SIP Server. After this message is received and registered the server sends back a special coded reply message to the SIP UA. This coded message has a field that indicates the status and outcome of the message (Zhang et al., 2007).

An example of a SIP based message flow between two SIP UA's and a proxy server is depicted in Figure 2.3. In this illustration there is an authentication scheme for three types of messages (register, invite and bye). Their purposes are clearly indicated by their names. The main purpose of this example is to help show the message interaction mechanism in a system that utilizes SIP.



**Figure 2.3: SIP based message flow with Authentication for REGISTER, INVITE and BYE messages (Zhang et al., 2007).**

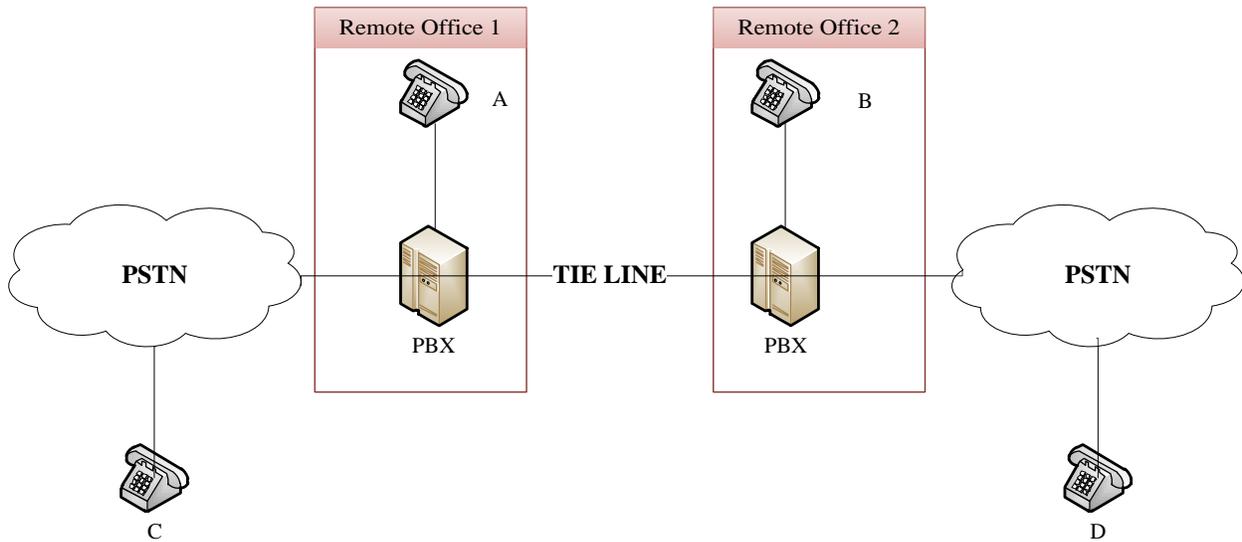
### 2.3 VoIP Architecture

Now we explore the three most important methods for realizing a VoIP network.

#### Toll Bypass

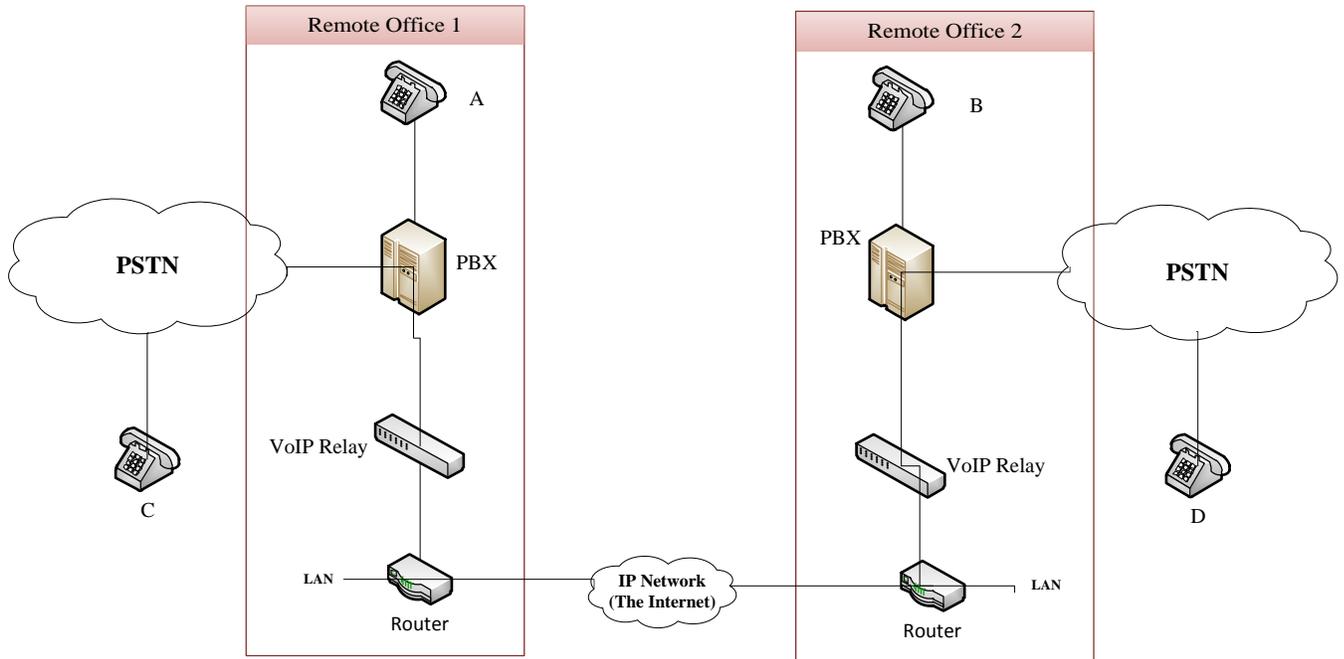
This is basically a method for communications to occur between branch offices of an organization by using an IP network (the internet) instead of specially leased analog telephone lines to transport communication data (Vetteth & Joseph, 2009). This is also a hybrid solution where analog and VoIP phones can be used. Figure 2.4 provides an example of a traditional setup where two remote offices communicate with each other using a special leased telephone line which is called a tie line. Telephones A and B are phones within their respective offices

while phones C and D are phones situated on lines outside the organization network and require communication through the PSTN. All intra-organization phone communication between remote offices is conducted by utilizing the leased tie line.



**Figure 2.4: Tie Line connecting 2 remote offices (Vetteth & Joseph, 2009).**

Now we explore an organization communication setup using toll bypass. With this configuration the digital characteristics of VoIP are used to create an alternative to the leasing of communication lines between branch offices. The Tie lines are replaced with an IP network which can in some cases be the internet. Figure 2.5 shows how a network using toll bypass is configured. The PBX's at the branch offices need to be disconnected from an external leased line and connected to VoIP relays that translate the communication data into a suitable format for transportation across an IP network. These relays are then connected to routers that are linked to an IP network and local area network (LAN) within the branch office. In Figure 2.5 phones C and D are on external lines while phones A and B are within their respective branch offices. If someone from remote office 1 (phone A) calls remote office 2 (phone B) the call will be linked through the PBX to the VoIP relays and then using the router it will travel across the IP network until it reaches the other office. There the reversed trajectory is completed so that it reaches phone B.



**Figure 2.5: Simple VoIP Toll Bypass implementation (Vetteth & Joseph, 2009).**

### **Total IP Telephony network**

This option involves every device being connected to the network via a local area network (LAN) connection. Within the organization there are only two types of devices, namely IP based VoIP phones and PC softphones. A network like this can allow for a higher usage of PC to PC communications by using specialized software in order to make calls or communicate via real time chat programs. When an organization decides to implement this option it is required to replace almost all the current telephone equipment. A Total IP Telephony network can be relatively expensive and is not often employed (Vetteth & Joseph, 2009).

### **IP enabled PBX**

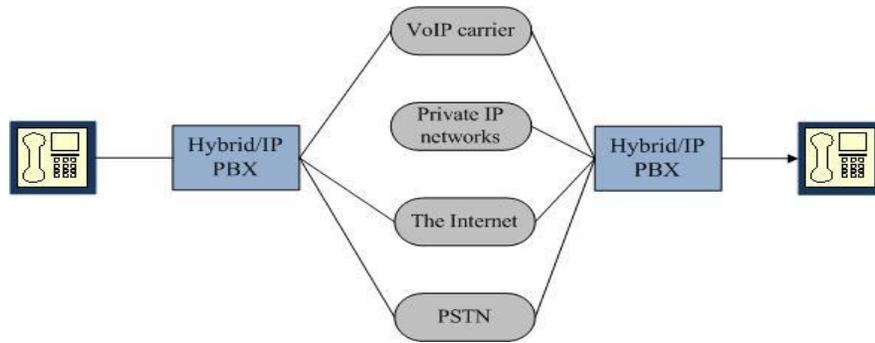
This is a frequently selected option for implementing a VoIP solution in an organization. It involves making an upgrade to the PBX in order to support the transport of digital data and does not require any of the current cables and handsets to be replaced. The PBX needs to be updated in order to be able to function with the IP protocol and connect to the internet. This is the only piece of equipment that needs to be altered. Any telephone that is connected to the PBX will appear as an IP telephone to the outside world. Many IP telephony suppliers provide cost effective upgrade packages for PBX's allowing them to handle IP based traffic. There are also

pure IP based PBX's in existence that do not support analog telephony but focus completely on digital telephony. Making an organization's PBX IP enabled provides an intermediate method for implementing VoIP (Vetteth & Joseph, 2009).

## ***2.4 Implementing VoIP***

The concept of migrating from a circuit switched PBX to packet-based communication is utilized when an organization implements VoIP. There are assumptions that traditional phone systems that utilize the PSTN and VoIP solutions will coexist for some time, resulting in a hybrid system that incorporates both technologies. The coexistence scenarios of VoIP and traditional communication technology are important as they are currently being used by organizations. These scenarios need to be well understood and implemented (Varshney, et al., 2002). Organizations that already have legacy telephone systems in place are not usually inclined to disrupt their daily operations in order to implement a VoIP system from scratch because this disruption can cause additional costs to be incurred. Furthermore a sunk costs scenario can occur where an organization is irrationally hesitant about introducing a new VoIP communication system because this would mean replacing the old system which was already an expensive investment (Hamdi et al., 1999).

Additional considerations need to be taken in account before a VoIP implementation is considered as there are operational differences between VoIP technology and the PSTN's traditional systems (Vetteth & Joseph, 2009). The network configuration and that of its devices needs to be taken into account before a VoIP implementation is started in order to facilitate a smooth transition to a new IP based communication environment. Figure 2.6 illustrates various scenarios for the interworking of traditional phone systems and VoIP technologies within a single hybrid network (Varshney et al., 2002). It is imperative that the importance of the planning phase of a VoIP implementation project is not underestimated (Walker & Hicks, 2002). Research has been conducted identifying the correlation between the thoroughness of the initial planning of a VoIP project and the success rate of the project. The research concluded that a well-developed planning phase is an important success factor for a VoIP project. Many IT projects involve time constraints and have the possibility to spiral out of control in terms of costs and time; a VoIP project is no different (Hamdi et al., 1999).



**Figure 2.6: Coexistence scenarios for PSTN & VoIP (Varshney et al. 2002).**

## 2.5 *Quality of Service*

A crucial aspect of VoIP is the QoS which indicates the delay and latency factor that users can encounter while using this service (Kuhn et al., 2005). Latency can be described as the time required for data to travel from the source and reach the destination (Tucker, 2004). An acceptable QoS is one of the most important requirements of a VoIP network as any additional benefit that the new technology provides could be seen as marginal if it could not at least provide the same speech quality and reliability as traditional telephony. The main problem with VoIP QoS is that it is affected to a large degree by the network security mechanisms in place. This can produce complications in a VoIP setup which results in the blocking or postponement of call setups, encryption-produced latency and delay variation (jitter). The following items are a description of the main network issues hindering VoIP.

### **Latency**

It is logical that the objective of a system is to keep the latency as small as possible. It would not be practical to have large delay variations between sending the information and receiving it as this would undermine the entire concept of real-time communication especially when it comes to telephony (Tucker, 2004). With the PSTN, maintaining a low level of latency was not difficult. VoIP has some additional challenges as practical lower bounds to latency exist (Kuhn et al., 2005). In order for VoIP to deliver the same QoS as the PSTN it will need to operate with a similar latency. The PSTN has a functional latency level of 150 milliseconds (ms) which is also the goal that VoIP must meet in order to remain competitive (Metha & Udani, 2001). This latency requirement places increased importance on the successful delivery of data packets as there is little room for error.

## **Jitter**

Jitter refers to inconsistent delays of data packets which transport VoIP information, and is frequently caused by situations where there is a low level of bandwidth available in the data network. Ultimately these inconsistencies in delay variations are more damaging to the QoS than the actual delays. The problem with these delay variations is that it causes data packets to be processed in a different order than they were transmitted which results in an incorrect or useless messages.

In order to control jitter, buffers can be created to keep packet traffic at an acceptable uniform level. These buffers are data traffic control mechanisms that are capable of detaining and releasing (flushing) data packets according to the needs of the network. Buffers need to be created at key points in the network in order to remain effective and they are required to release their data packets at least every 150 ms to avoid causing additional latency. It is also important to realize that certain security elements have not been designed to support a high level of QoS which has a detrimental impact on the improvement of jitter. VoIP data packets have a small delivery window which means that there is an even lower level of tolerance for any inconsistent delays in packet traffic (Metha & Udani, 2001).

## **Packet loss**

This can mean the actual losing of a data packet or a data packet becoming useless. VoIP technology has a high level of intolerance towards packet loss as it is a real-time communication technology. Packet loss can be caused by a network with a surplus of latency that results in data packet's arriving too late at their destination which requires them to be exchanged by other packets. Another cause of packet loss is jitter. This occurs when a buffer designed to mitigate inconsistent delays in network traffic already releases its surrounding packets while other packets that belong to the sequence are being restrained by the buffer, ultimately making these delayed packets useless (Kuhn et al., 2005).

The loss of a single data packet in itself does not have a negative effect on VoIP QoS; however the problem is that packets are usually lost in groups and not individually (Kuhn et al., 2005). The detrimental effects that cause packet loss affect all data packets that are being transmitted at a similar time. This in turn causes the loss of packets on a broader scale which reduces the QoS significantly. In a study that was conducted about the difference between QoS in VoIP networks and the PSTN, it was exposed that a small percentage of packet loss has the capability to lower the QoS of a VoIP network to a level that users would find unacceptable. Even when the latency level of VoIP networks was below the 150 ms level, a 5 % packet loss rate resulted in user dissatisfaction (Sinden, 2002). This highlights the importance of combating packet loss within

VoIP networks which can possibly be done by increasing the bandwidth in data networks and introducing redundant information that ensures packet delivery. Redundant information can be described as producing extra information that is not normally required for network functionality but that can be used in cases where “normal information” is missing. A data packet can for example be checked for the order in which it was sent by checking the redundant information that was added to it (Kuhn et al., 2005).

## **Bandwidth & Effective Bandwidth**

Every network is required to be available if attempts are made to make use of it. VoIP networks have an additional implementation issue that needs to be overcome as all traffic is conducted on a data network normally only designed for a certain amount of data traffic. With the addition of voice data these networks can become congested resulting in degradation of the service. This congestion of data is also referred to as bandwidth congestion (Kuhn et al., 2005).

The bandwidth of a VoIP network is negatively influenced by measures taken to secure the network. Furthermore the percentage of the bandwidth transporting data in comparison to the total bandwidth used is also adversely affected. This relation between bandwidth transporting data and the total bandwidth utilized is called effective bandwidth (Barbieri et al., 2002). This brings us back to the discussion of finding the balance between the required level of security and maintaining an acceptable QoS standard.

## **2.6 Reliability**

The PSTN offers a very high level of reliability due to countless years of utilization and innovation. Users have grown accustomed to this service reliability standard and will likely not be satisfied with anything inferior. This poses another challenge for VoIP technology as it is required to meet at least the reliability standard that is set by the PSTN in order to be accepted by users (Walker & Hicks, 2002). In this case reliability is simply defined as the most basic functionality of telephony technology: whether you actually hear a dial tone when you pick up the phone. With the PSTN this is almost always the case, which makes it very reliable because the overall system availability is high. System availability can be described as:

*Availability* = Mean time between failures / total time

*Mean time between failures* = average time between each outage or failure of a system

*Total time* = mean time between failures + mean time to repair the failures of a system

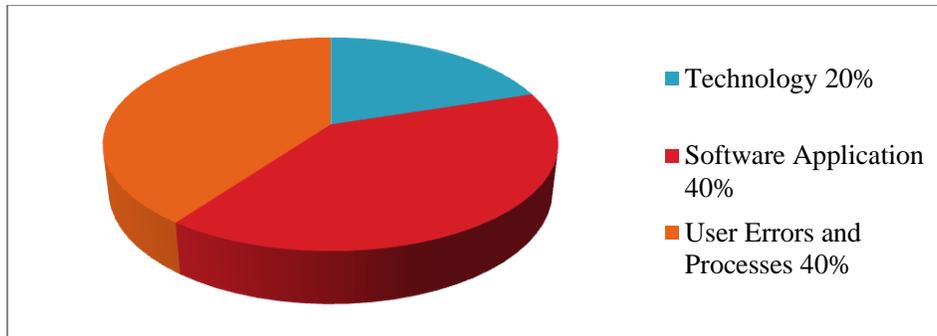
To calculate the reliability of any system first the availability percentage must be determined (Walker & Hicks, 2002). Table 2.1 provides an illustration of how various availability percentages coincide with annual downtimes for a system. A high availability percentage of 99%

can be misleading as it leads to an annual downtime of more than 3 days. For a communication technology such as VoIP which in some cases might be used for emergency purposes (hospitals and law enforcement) this level of system unavailability is unacceptable.

**Table 2.1: Availability and corresponding down time (Walker & Hicks, 2002)**

<b>Availability</b>	<b>Cumulative Downtime per Year</b>
99.000 %	3 days, 15 hours, 36 minutes
99.500 %	1 day, 19 hours, 48 minutes
99.900 %	8 hours, 46 minutes
99.950 %	4 hours, 23 minutes
99.990 %	53 minutes
99.999 %	5 minutes
99.9999 %	30 seconds

System reliability of data networks is a legitimate issue when compared to the reliability of the PSTN. Since VoIP practically uses this very same data network in order to operate and transfer data, its availability will in most cases be equivalent to that of the network it is utilizing (Kuhn et al., 2005). Data networks are afflicted by random downtimes, network capacity problems, software problems and other difficulties. Figure 2.7 provides a general description of the causes of the unavailability in data networks. These are categorized in three main problem areas; technology, software applications and user errors & processes. Problems relating to technology are often found in the hardware that is used, network links, environmental issues and natural disasters. Software applications can cause problems due to glitches and performance problems. User errors and processes can cause disruptions due to faulty change management procedures and a lack of process consistency (Walker & Hicks, 2002). The problems affecting the data networks that VoIP technology uses need to be resolved if the new communication technology is to prosper.



**Figure 2.7: Cause of system unavailability (Walker & Hicks, 2002).**

It is important to realize that other systems and applications running on a data network do not need to meet the availability level of the PSTN as only the VoIP component is required to meet this standard. It has to be noted that the PSTN availability level is about 99.999% (Walker & Hicks, 2002). Following this line of logic, measures can be taken to ensure that the VoIP technology meets high level availability requirements while the other systems are exempt from this. Achieving this can be done by focusing on the reliability of VoIP components separately (VoIP servers and IP PBX's) and on the reliability of the network components (Kuhn et al., 2005).

## ***2.7 Securing VoIP***

As with many new technologies that are utilized in the transfer of possibly sensitive information, security remains an important issue. The security risks to the VoIP technology are therefore also frequently scrutinized. Despite the numerous benefits that can be achieved with VoIP, it appears that its security still remains a major deterrent for organizations to implement the technology (Hung & Martin, 2006). The threats occur in the form of people gaining unauthorized access to the enterprise's PBX or the voice mail systems and thus acquiring free telephone calls that the organization has to pay for later (Shell & Dodge, 2002). This can even occur because the perpetrator has a strong desire for revenge, blackmail or greed. With the Internet, users have to constantly monitor which websites they visit, what is downloaded and how to secure their systems or else they could be the victim of a number of threats e.g. viruses, worms, malware etc. To a certain degree this is also true for VoIP since it makes use of the same protocol as the Internet, namely the IP protocol, making it susceptible to threats (Hung & Martin, 2006). Such a threat can be Spam over Internet telephony (SPIT), which disrupts the day to day workings of organization employees by making telephones ring as many times as one would receive a spam e-mail. SPIT involves an employee receiving several unwanted phone calls that interrupt his tasks (Endler & Collier, 2007).

One of the problems of VoIP technology is that the security vulnerabilities extend to a larger domain than with traditional phone systems. This means that the IP network that VoIP utilizes

needs to be designed, implemented and operated with a high level of security in mind (Hung & Martin, 2006). There are numerous basic requirements that need to be considered and adhered to before buying any VoIP implementation (Kuhn et al., 2005). These can be divided into functional security requirements and technical security requirements. An example of a functional security requirement is that only the service provider has access to sensitive statistical data and this should not be available to unauthorized third parties. A technical security requirement would be the encryption of all connections between objects in the network. An interesting aspect is that there is still no uniform platform for securing VoIP, making basic security implementations important (Hung & Martin, 2006).

It is almost impossible to make any system 100% secure but security must be of a sufficient level to prevent the overall majority of threats (Shell & Dodge, 2002). In the case of VoIP, adding a high level of security that enables entire communication sessions to be authenticated and encrypted could have a negative effect on the QoS. Most security solutions involve one or more sections of the VoIP network and will usually add an additional delay. This makes the use of standard security solutions that are currently being used in traditional data networks non-viable for VoIP networks. Examples are firewalls and data encryption mechanisms (Kuhn et al., 2005). A business needs to take a strategic decision and make an appropriate assessment as to what the threat level is, the costs associated with additional security and retaining an adequate QoS for the VoIP system that ensures a balance between operational performance and security (Tucker, 2004).

## ***2.8 VoIP and Competitive advantage***

There are various factors influencing the adoption of VoIP by the business community. VoIP functions as a digitalization of communication data that can easily interact with the Internet and be transported over it. This allows the communication data to be stored, manipulated and combined with other data that can then be transported to any device that has a connection to the Internet. It is believed that VoIP will serve as a unifying platform for various business applications. In essence it is predicted that VoIP will support new communications functions that are not yet present today (Werbach, 2005).

There are aspects of VoIP that can incite organizations to move towards the new technology. For a comparison we can look at the findings of a VoIP pilot program that was conducted by the Intel Corporation. Table 2.2 displays a comparison of traditional phone features and the VoIP features. VoIP provides some new features like Unified Communications which is the integration of real-time communications such as instant messaging, IP telephony and call conferencing with non real-time communications such as SMS messaging and e-mail. In the future organizations seek to broaden the functionality of the VoIP phone system by using all types of custom applications

that can run on the IP phones and can be specifically designed to serve to the needs of the organization (Sacker et al., 2006).

According to the pilot program that was conducted by the Intel Corporation, there was a significant increase in the productivity and performance of employees that were using the VoIP solution in comparison to those that still utilized traditional phone solutions. For example, repetitive tasks, such as accessing voicemail, are completed faster when using a VoIP solution. The performance increase provided by the new technology results in a net productivity gain which translates back into cost savings for the organization (Sacker et al., 2006).

**Table 2.2: Traditional vs. VoIP-enabled features (Sacker et al., 2006)**

<b>Traditional Features</b>	<b>VoIP-Enabled Features</b>
Hold	Fax
Transfer	Follow me
Mute	Unified Communications
Conference	Remote call management
Redial	Inbox voicemail
Forward	Automated attendant
	Presence information
	Directory access
	Click to call
	Click to conference
	Screen pop

Toll bypass can be used by organizations in order to lower their communication costs, especially when multiple branch offices are involved. Normally organizations lease communication lines (Tie lines) between two offices in order to communicate directly. This option can be expensive,

as these tie lines are required for every separate branch office in order for (secure) communications to occur. Another disadvantage of this option is that payment of the lease amount is required regardless of the level of usage of the communication line (Vetteth & Joseph, 2009). With toll bypass no extra communication costs are necessary as the organization's own data network is used for transportation which would allow the organization to acquire a certain level of (competitive) advantage over a competitor in terms of costs.

Concretely VoIP provides a more cost effective alternative to traditional telephony and thus organizations that have implemented it enjoy cheaper communication and operational costs in the long run (Vetteth & Joseph, 2009). The extent that the previously mentioned benefits influence the core business of various organizations depends heavily on the nature of the core business processes. An organization in which the core business processes are heavily intertwined with communication technology, such as a call center or a technical support company suffers a greater impact from VoIP than for instance a construction company. An explanation could be that phone based communication is one of the principal business processes in a call center and VoIP provides a cheaper and more efficient way to perform it. This enables the organization to gain an advantage over its competitors which still use traditional telephony. For a construction company the impact of VoIP can be of a lesser extent as phone based communication is not normally seen as a core business process but falls more into the supporting process category. Nevertheless even in a supporting role VoIP can provide efficiency gains and added functionality that directly and indirectly add value to organization and its processes. Ultimately this allows it to acquire a competitive advantage over its rivals (Werbach, 2005).

## ***2.9 Cost benefit analysis***

As is the case with new projects that require a significant investment in terms of resources and manpower, there is always the question of how to accurately select an option that will lead to the most value for the organization. The term "value" is used loosely in this context as its definition can vary significantly depending in the individual or organization in question. Organizations can decide to generally see value as a greater level of payoff in terms of financial resources or as an improvement that affects their business processes in some way. Selecting the option (e.g. project) which will perceivably lead to the most value for the organization is not the only requirement in the selection process as the level of value gained needs to be relativized with the amount of costs incurred. It would be a bad managerial decision to purely focus on the level of value gained. As an example, project one might have a high payoff with a larger amount of costs while project two has a slightly lower payoff with substantially lower costs. In this case the choice should be made to go with project two despite its lower payoff because the gain for the organization is relatively larger when the costs are also considered. The entire selection process for choosing the option with the most value for the organization while taking the costs into account, is referred to as a cost benefit analysis (Mishan & Quah, 2007).

### **3 Research Methodology**

The objective of this research is to identify in what manner VoIP impacts the core business of organizations within the Netherlands. The aim is identifying changes brought about by VoIP implementations, such as the effect on costs, business processes and the vulnerabilities that the new technology brings along. The question whether a cost benefit analysis has been performed by organizations before engaging in the adoption of VoIP is reviewed and the limitations to the VoIP functionality within the organizations are outlined. The first section focuses on the general research approach by providing information about the research method, why it was selected and how the empirical data was gathered. Furthermore the procedure and the model that were used for the data analysis are thoroughly explained.

#### ***3.1 Research Approach***

There are two forms of research that are widely used in the academic world. These are quantitative and qualitative research methods. The selected research method usually depends on what the researcher is familiar with and his skill as neither research type is generally considered better than the other (Blumberg et al., 2008). In this case the decision has been made to focus on a qualitative approach rather than quantitative one. Therefore research instruments that are considered more quantitative in nature, e.g. surveys, will not be used to pursue the research questions. A general description of quantitative and qualitative research is provided below.

#### **Quantitative research**

This research method utilizes quantitative information to study the phenomenon in question. Quantitative information essentially means that it seeks to quantify the research data which can take the form of numbers and figures. This quantifiable data is then usually used in statistical models in order to support/disprove a research question or hypothesis. The main importance of quantitative research is the data measurement process because this provides the foundation for the statistical analysis (Blumberg et al., 2008)

#### **Qualitative research**

In contrast to the other quantitative research method, qualitative research focuses on qualitative information for inspecting the phenomenon. Such information is usually in the form of words and narratives. It provides a different approach to studying complex phenomena and for some cases it is viewed as the most adequate method to be used (Blumberg et al., 2008). Qualitative research involves the utilization of data that is qualitative in nature, such as interviews,

documentation and participant observation, in order to study and provide the answers (Myers, 1997).

### **Why qualitative?**

The reason for the selection of a qualitative research method is founded in its characteristics and the type of phenomenon that is studied. Qualitative research is a method that is better suited for studies when quantifiable data is not available or is harder to acquire. Often quantitative research takes the form of a case study which is a method for conducting research that involves an in-depth study of an individual, a particular group or phenomena (Blumberg et al., 2008). In this study the “phenomenon” to be studied is VoIP and its impact on the core business of Dutch organizations. Although VoIP is not so much a direct observable occurrence (phenomenon), its development and market progress can be defined in terms of quantitative and qualitative measurements. With “VoIP phenomenon” the occurrence and development of the VoIP technology as a whole is meant.

Due to the lack of similar research in the field of VoIP, this study is characterized as exploratory. In order to conduct qualitative exploratory studies the only generally accepted approach is the use of a case study. Furthermore the research approach is defined as an exploratory case study of an interpretive nature. This interpretive nature is exploited when the various experiences of professionals with VoIP are interpreted by using interviews and questionnaires (Benbasat et al., 1987).

### **Research Instruments**

Participant observation and in-depth interviewing are major types of qualitative research methods (Bogdan & Biklen, 1994). Due to the limited amount of time that is available for the research, the choice was made to perform in-depth interviews to acquire data. Since the research questions are clearly defined, the study is more focused on gathering information with the intent to answer the questions. The research instrument used is an interview questionnaire. There are two versions of this questionnaire. One is meant for organizations that have implemented VoIP in order to enhance their organization (these are clients) and the other one is meant for VoIP providers that offer VoIP as a service. The questionnaires are presented in appendices A and B.

Data gathering is an essential part of the research process and is carried out by having several interviews with key personnel who have enough knowledge of the VoIP systems currently in place within the organizations. The interviews are the main source from which information is gathered from the organizations and are of a semi-structured nature allowing the participant to

explain his own story and move on to subtopics while not straying too far from the general research questions. The instrument that is used in the semi-structured interviews is an interview guide that contains several key questions that are essential in the process of answering the main research questions.

In this research, nine organizations were interviewed:

- 2 educational organizations
- 3 government organizations
- 2 commercial organizations that operate in different market sectors
- A social care organization
- A VoIP provider

### ***3.2 Data Analysis Approach***

The empirical data that was gathered during the interviews is displayed in the following chapter. In order to produce a more affective overview, the data is segmented per organization into different subsections that correspond with the topics from the questionnaire that was utilized during the interviews (appendices A & B). The categorized empirical data is simply a detailed description of the answer given by the people that were interviewed in the organizations. Chapter 4 displays the data in a categorized form and chapter 5 analyses the data and produces the results of this study.

Before the empirical data can be analyzed a decision must be made concerning the data analysis method to be utilized. It can be considered more difficult to select and execute an adequate data analysis method for qualitative research as, in contrast to quantitative research, the distinction between data gathering and data analysis is not always well defined. For example, the questions that are used in questionnaires during interviews and the researcher's own presumptions largely determine the results. The analysis and the data have a profound effect on each other. For this reason it would be considered better to mention modes of analysis instead of data analysis. A mode of analysis is a specific approach used for gathering, analyzing and interpreting qualitative data (Myers, 1997).

For this study the choice has been made to employ qualitative content analysis in order to analyze the empirical data and produce research results. A qualitative content analysis is a method for analyzing text based data where the role of the researcher is highlighted during the construction of the meaning of texts. Furthermore emphasis is put on the creation of categories from the analyzed text and on the recognition of the importance for understanding the implication of the context in which an object being analyzed appears (Bryman, 2004). Basically the method involves the researcher analyzing the text (data), creating categories that have significance for the research questions and then making inferences based on these categories.

When the categories are analyzed, the researcher may employ more quantitative methods in order to draw the necessary conclusions. Such a quantitative method is, for example, the counting of the frequency with which a certain category appears in the text thus providing insight into its overall importance (Kohlbacher, 2006).

Qualitative content analysis is adapted from classical content analysis which is essentially a quantitative method. The classical version uses the category system as a core and counts the number of occurrences per category in order to draw some type of conclusion. In contrast to the qualitative version, the researcher's role and interpretation are not used in the analysis and the categories are far less developed. Qualitative content analysis seeks to overcome the limitations of classical content analysis by utilizing a systematic, theory guided method for text based analysis using a category system (Kohlbacher, 2006).

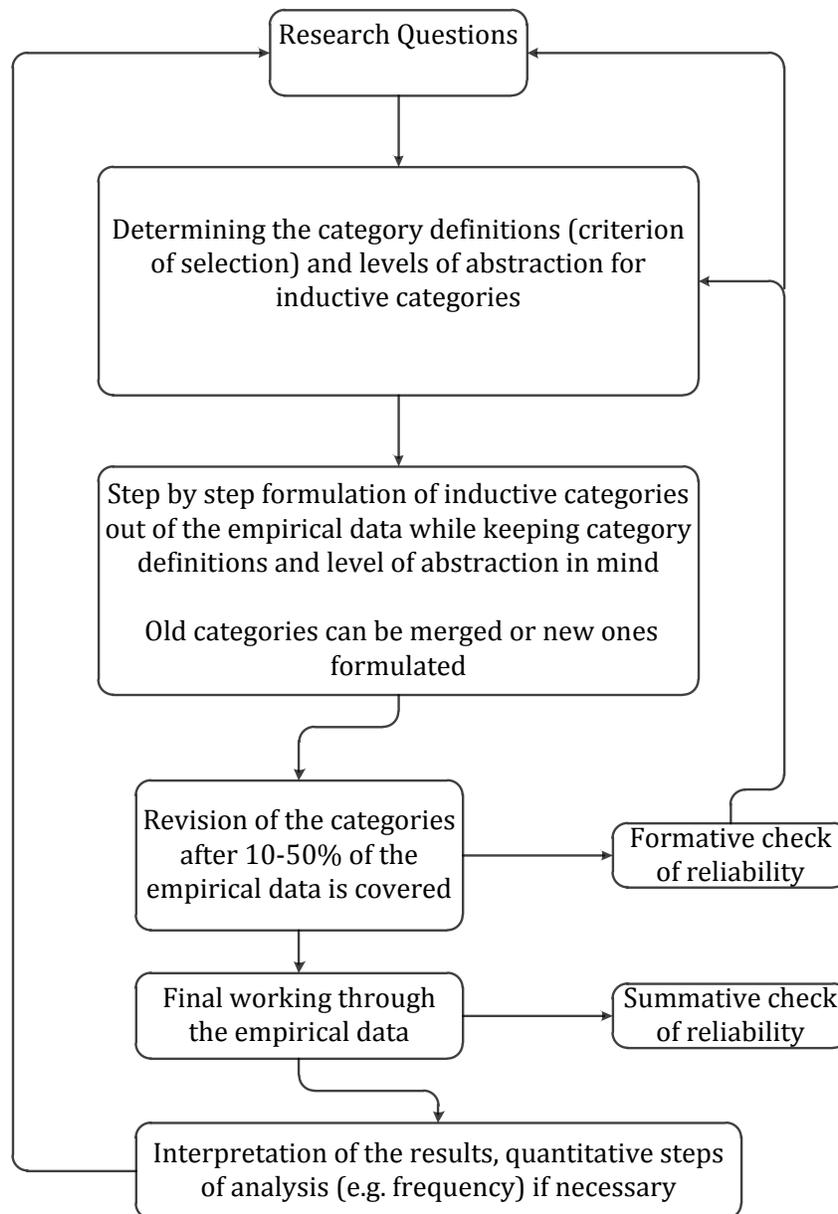
In qualitative research has not been around for as much time as quantitative research and therefore there also exist fewer data analysis techniques that can be used in order to perform a qualitative analysis. Furthermore qualitative research can sometimes be more abstract than quantitative as case studies are often used for conducting exploratory research where multiple changes can occur during the research process. Quantitative research has a multitude of statistical models and analysis techniques available; however these are not suitable for exploratory case studies. In this study qualitative content analysis was selected because it is one of the most widely accepted techniques employed in order to perform a text based qualitative analysis on documents. The technique was selected based on its popularity for being used in qualitative studies of a similar nature. It was also relatively easy to adapt a qualitative content analysis model to suit the needs of this study (Titscher et al., 2000).

Other possible techniques for conducting a qualitative analysis were conversation analysis and another method known as narrative and metaphor. Conversation analysis focuses more on the verbal exchanges during an interview and is centered on the assumption that the meaning of certain topics is formed by the context in which the verbal exchange takes place. Narrative and metaphor focuses on letting the interviewee recite facts that are relevant to the research questions ultimately letting him produce a type of story. This story can be verbal or text based. The research will then proceed to analyze the story (narrative) and strive to isolate vital information while taking into account metaphor and other hidden implications that were made by the interviewee (Kohlbacher, 2006). These other qualitative analysis techniques are generally considered less popular and more abstract than content analysis and integration with a category system would not have been possible since the interviews were conducted in a manner that is more appropriate for content analysis. There was less focus on the general context of the interview exchange and more emphasis on answering the questions in the questionnaires.

### ***3.3 Qualitative Content Analysis Category Development***

The category system is crucial in order to perform a qualitative content analysis. Now an explanation will be given how these essential categories are to be constructed. Figure 3.1 provides a model for a step by step construction of the categories which are needed for content analysis. The model is slightly adapted for this specific study but is mostly based on a theoretical model that was developed by an expert in the field of qualitative research. An inductive approach to category development is used in this model. This means that criteria are created in order to define categories based on the theoretical background of the subject being researched (in this case VoIP) and the research questions. This phase is done in order to determine the parts of the empirical data that will be used and are considered important. After the criteria are acquired, the empirical data is analyzed and categories are cautiously removed on a step by step basis. Feedback loops are used in order to review the categories and check them for reliability. This process eventually produces the main categories that are used for the analysis (Mayring, 2000).

To be more concrete, the qualitative content approach to category development first reviews the research questions and uses them as the foundation to start the coding process. This involves the detection of important information from the empirical data and adding it to a corresponding category. Without the coding process, information cannot be accurately filtered from the text based empirical data. The categories are created early on in the data analysis process by using an iterative process (checking relation with research questions) and need to be revised several times before the end result is satisfactory. This iterative process of checking the categories can be seen in Figure 3.1 where the formative check and the summative check of reliability are performed. Eventually all the important data is allocated to a category after which the interpretation process can begin. This step requires the researcher to interpret the categorized results and make inferences while also taking into account the frequency with which certain empirical data facts keep reoccurring. Facts that reoccur with a greater frequency imply that they have a higher level of importance.



**Figure 3.1: Inductive qualitative content analysis model for category development (Mayring, 2000).**

In order to start analyzing the empirical data and developing categories an important fact needs to be taken into account. The fact being, that the data that was collected is based on the questions that were stated in the questionnaires (research instruments). Although there are two questionnaires (organizations and VoIP providers) they are essentially the same; the core information is similar with only the perspective differing. The data analysis views all nine organizations in a single context while at certain points the alternate perspective of the VoIP provider is used to highlight important fragments.

### **3.4 Research Questions**

The main research question of the thesis is:

*What is the impact of VoIP technology on the core business of Dutch organizations?*

To be able to answer this question, numerous interviews were held with different organizations that utilize VoIP technology. The data gathered from these encounters was analyzed and the following sub-questions were addressed:

- From an organization's perspective how does VoIP differ from analog communication solutions?
- To what extent is the functionality of VoIP utilized in organizations and what are the obstacles to implementing VoIP features?
- How can VoIP utilization be improved in order to enhance the support of the (core) business processes?
- Does VoIP give organizations a competitive advantage?
- In the future, what effect will new communication technology have on the core business of organizations?

## 4 Empirical Data

This chapter gives a description of the empirical data that was gathered during the interviews. Due to confidentiality issues the names of the interviewees and organizations are not mentioned in this thesis. However some operational information of the organizations is mentioned, as it provides an important perspective on the empirical data. This operational information is for instance the sector the organization operates in and the size of the organization in terms of employees.

In “description of the organization and interviewee” facts concerning some operational information about the organization are given along with an explanation of the interviewee’s background. Then the “interview results” are provided. The interview results contain a detailed overview of the answers provided by the interviewee at the organization concerning the topics in the questionnaire. This information originates directly from the person that was interviewed and has not been influenced by any other factors.

### 4.1 *Higher Educational Organization I*

#### **Description of the organization and interviewee**

The first interview was conducted at a university that is internationally renowned for its economics and management faculties. It has over 20000 students that attend it and require education services. The total staff employed amounts up to around 3700 people. This university consists mainly of multiple faculties that are concentrated and situated on an educational campus. Besides buildings that are located on the campus there are also separate external locations that are linked to the university’s network and are a part of the organization.

The person that was interviewed is a key figure at a prominent university. He is a senior manager who had a leading role when the VoIP system was implemented in the organization. He has multiple years of work experience with the management of the information systems that are used in the organization. The VoIP system is overseen by him which gives him the unique ability to give valuable insight into its workings and its integration with current information systems that are utilized at the university. The opinions of this person are based on his experience with working in the organization and the VoIP system.

## Interview Results

### **VoIP and the core business**

The core business is centered on providing an education to the student population of the organization. Education is seen as a service and the students provide payment (tuition fees) to make use of it. The Dutch government gives subsidies to the university allowing tuition fees to remain low and also provides a financial bonus per graduated student. This university does see its education process as a core business process but also focuses heavily on the research it produces through its academic research staff. Due to its good reputation it attracts talented researchers from different countries who in turn provide the university with high level research. So in short the core business of the organization is seen as both providing education to the student population and conducting research which produces valuable results that can be published in academic journals. Supporting processes are basic activities that any large organization requires. These are for example human resources, salary & payroll services and the IT department. The most important supporting processes that have been influenced by VoIP are those conducted by the IT department.

The basic process of communication remained the same; the difference was that every call took place over the university's IP network. The VoIP network did not require a separate cable network, like the analog phone network, in order to function. This meant that when a lot of moving of personnel took place, the process of providing the employee with the same number configuration was vastly simplified for the IT department. Previously with the analog network, the physical cable had to move along with the employee if he wanted to retain the phone number. This often proved to be cumbersome and expensive. With VoIP the telephone numbers can be assigned and managed by using specialized software. This makes it easier to let an employee keep a specific number when he moves to another location inside the organization.

When changes need to be made to employee telephones these can be made by the employees themselves via a web-interface. In the old system all changes made, for example call forwarding, number migration, etc. had to be done by the telephone system administrator in the IT department. By streamlining this process overall efficiency and employee flexibility are increased. One interesting feature of the VoIP system is that it makes creating call group structures easier. These are call groups that are used for instance at the secretary office. These call groups can be created and edited via special software allowing for greater functionality and flexibility.

Features of VoIP at the organization are:

- Basic IP calling functionality
- Management software support for IP numbers

- Call group structures

The interviewee mentioned that from a general perspective the VoIP system had a very large acceptance level at the university. This meant that the majority of the employee's were positive about the system and did not resist its implementation. However when the university provided special courses for employees in order to learn more about using the VoIP system, there was very little interest.

### **VoIP barriers and improvement**

The implementation of the VoIP network at the university was done in steps so that during the transition period a hybrid network consisting of both analog telephone systems and VoIP systems was present. This hybrid system did not always function efficiently and some organizational disorder and employee dissatisfaction were encountered. These factors disappeared when the VoIP system was functional and the old system was replaced completely.

One major disadvantage of the VoIP system is that during a power outage the IP telephones will cease to function, leaving employees unable to communicate. This was not the case with the analog telephone network. Not being able to communicate during a power outage is a great inconvenience for the organization but there are also safety issues involved. Some special telephone lines need to adhere to rigorous safety protocols and have to be functional at all times. This is the case for all emergency phones in the elevators. These are also connected to the VoIP network. However they have a special back up power source that will keep them operational during any power outages.

Within the university network there are two separate parts. These are the data network and the VoIP telephony network and they are separated from each other. This is done by means of a separated virtual area network. The network also makes use of virtual routers and there exists a virtual firewall between the data portion of the network and the VoIP section. This virtual firewall ensures that no threats can jump from the VoIP section of the network in order to compromise the data portion and vice versa. The VoIP network utilizes two IP centers that according to the interviewee have a high availability rate. No encryption mechanisms have been employed. The benefits of encryption have been weighted against the costs of implementing such features and in the case of this organization it appears that the choice has been made to eliminate encryption to lower the costs. It seems that security vs. QoS and costs are important factors for this organization when deciding to implement new VoIP features.

The interviewee also highlighted the fact that there needs to be a balance between security and costs. Too much security would result in a major rise in costs and also lower the QoS of the VoIP network. This would occur with only a minor gain in overall security protection. Furthermore there are options for securing every phone with a password but for simplicity reasons this has not

(yet) been implemented. The security of the network at the university is a continuous process that has not experienced an outage since 2005. Antivirus programs and firewalls are constantly kept up to date in order to provide protection against threats.

The organization has a network based completely on Cisco hardware which on occasion resulted in hardware incompatibility issues. Before and during implementation it was crucial to run tests whether the network infrastructure based on Cisco hardware would be compatible with new VoIP systems and not result in other hardware and software incidents. This possible incompatibility between network infrastructure and VoIP systems is considered a potential barrier as in a worst case scenario it would result in organization wide communications loss. During the interview it was specifically mentioned that standardization of a network infrastructure is an important factor when employing an organization wide technology change which is the case with a VoIP solution.

Further difficulties that arose during VoIP implementation can be attributed to specialized needs of users, the need to educate users about the new system and some minor resistance from certain users. According to the interviewee it is also difficult to utilize and chose new information systems due to the rapid development of the IT industry which to a certain degree dictates the requirements of organizations. One more important factor that played a crucial role with the acquisition of the VoIP system was the estimation of the total cost of ownership (TCO). The TCO is a financial estimate that provides assistance with the identification of direct and indirect costs of a product or system. Management identified this as an important factor as the financial estimate gave a dependable indication of direct and indirect costs associated with the VoIP system. In terms of improvements that could be made to the VoIP system the interviewee mentions that Unified Communications could be implemented. This would provide staff with a broader range of functionality to meet their communication requirements. Password encryption is feasible and might be required in the future as security threats keep on evolving. One more improvement point for this organization would be to employ a higher degree of centralization concerning its numerous IT systems. Currently the faculties have separate systems running which sometimes causes inefficiencies when making changes and minor problems occur when they want to integrate functionality with the VoIP system.

### **Competitive advantage and cost benefit analysis**

The decision to migrate from the standard analog telephone system to a newer VoIP system was taken by upper management in the year 2004 during the construction of a new faculty building. The university found itself in a situation where the new building had to be added to the current university network. At the time the current analog telephone system was already quite old, having functioned for the last fifteen years. After an initial cost calculation was performed by KPN telecom (major national telecom provider) it was concluded that the choice of keeping the current system or investing in another newer system was cost neutral. Eventually upper

management chose to follow the direction the market was going towards, with the main players like Cisco and Avaya, all developing VoIP solutions.

The VoIP system was implemented in 2005 while other legacy systems still continued functioning in parallel to the new one, creating a hybrid situation. Eventually VoIP gradually branched out and in 2007 the formal step towards VoIP was taken within the university. From a short-term perspective VoIP was seen as being costly but the more long term strategic view used by management saw long term cost savings and added services that would prove to be beneficial for enhancing employee efficiency and broaden capabilities in general.

According to the interviewee, main cost saving was the fact that no separate analog cable network was necessary anymore as telephones were able to function by using the IP network cables. Furthermore cost saving was acquired from the more lucrative (university perspective) service contract with KPN. Costs under the service-contract of the new VoIP system have been halved when compared to the old analog system. Other savings were found in the fact that per employee it costs less to make calls and that the depreciation cost of the VoIP technology is lower.

A thorough cost benefit analysis was not performed in the acquisition process of the VoIP system. This was because higher management did not adequately consider the implementation costs of the system and did not take it seriously. During the construction of a new faculty building the decision about whether to implement VoIP, the hardware usage and selecting a service provider was postponed as long as possible. The IT department kept on insisting that higher management needed to make a timely decision as preparations were required before implementation of any new system could commence. Higher management waited until the last minute before selecting a VoIP service provider which severely limited their choices as any additional delays in their implementation scenario would cause them unacceptable financial losses. Ultimately Cisco was selected to deliver the VoIP system as their implementation solutions were already being used at other educational organizations and the current hardware at this organization was also Cisco based meaning that compatibility issues would be minimal. If the decision was not postponed until time ran out, other VoIP providers could have been chosen to possibly deliver a more lucrative option.

## **Future**

The interviewee mentioned that although currently the university does not make use of the full capabilities of VoIP, there are plans for the future use of additional services where employees can make use of custom applications on their IP phones and utilize Unified Communications capabilities which integrate webcam, instant messaging and IP telephones. The interviewee mentioned specifically that the role of Unified Communications will take on a more important role in future technology developments concerning VoIP where further integration between real

time communication systems will take place. This also includes the use of VoIP in mobile communications. These developments have the potential to influence the processes and core businesses of organizations. It is considered hard to accurately predict the level of change new communication technology will bring concerning the manner in which organizations conduct their business.

## ***4.2 Higher Educational Organization II***

### **Description of the organization and interviewee**

The second interview was conducted at an internationally well-known technical university. This organization has a large emphasis on technology since it is a technical university. The university campus consists of an entire district with multiple buildings clustered together. It is a fairly large organization which provides education to approximately 10,000 students and has a total of over 3000 academic and supporting staff. Larger organizations usually have more resources which can be an important factor when deciding to adopt a new technology like VoIP (implementation can be expensive).

The person that was interviewed at this organization is an ICT specialist who has knowledge of the implementation and functionality of the VoIP network and systems that are present at the university. The ICT specialist is experienced with the VoIP system and works regularly with the technology. He bases his opinions on various years of work in the organization both as a systems administrator with the IT department and as a user of the VoIP technology.

### **Interview Results**

#### **VoIP and the core business**

The core business of this educational organization is to provide academic knowledge to local and international students and researchers. The supporting business processes are:

- Human resources (HRM)
- The IT department (ICT)
- Facility management (FM)
- Education & Student Affairs (ES)

Only the basic form of VoIP has been implemented at the organization. Additional features are being considered and it is the organization's desire to add additional functionality.

Features of VoIP at the organization are:

- Basic IP calling functionality
- Management software support for IP numbers
- Call group structures

The VoIP telephony has improved the service times of support processes. Before the implementation of VoIP, when an employee requested a new telephone accompanied with a number it took approximately 1 week to process everything (from the request till the delivery of the telephone). Now this process takes about 1 day. Certain support processes have been made more efficient while telephone communication within the organization and to parties located outside the organization's network have been made more cost effective.

The extra possibilities of the VoIP phones are not used within the organization. In a practical sense, the VoIP-phones are still seen as normal telephones that simply work via a digital network. People are more inclined to use the telephone rather than e-mail, because they can leave a voice message behind. Call forwarding is also used now by everybody in the organization. All calls can be diverted to a mobile phone or to another (VoIP) phone. Since 2008 there are no complaints about the telephony service. This is because everything works as it is supposed to. No major problems involving the VoIP technology have occurred. VoIP phones are not restricted to a room. When an employee moves to another room, he or she can take the VoIP phone and plug it in his new office. After reconfiguration is done by using special software that manages the VoIP numbers, the employee can make calls using his own number while working in another room.

### **VoIP barriers and improvement**

Implementing additional features or extending the features of the current VoIP platform is not a business priority now, because the employees only use the VoIP platform to call and be called. Extra features (e.g. integration with Microsoft office suite, office communicator suite etc.) is not needed.

There were a few issues during VoIP implementation. These problems have been fixed by updating the software on all VoIP telephones and on the VoIP gateway. The issues are as follows:

- 1) Low throughput speed between computers and servers (login took 15 minutes; file transfer throughput was below the 100 mbit specification.
- 2) VoIP-telephones didn't forward the data IP-address to computers creating configuration problems resulting in overhead for the IT department.

In 2007 during the implementation of the new technology, the organization experienced VoIP as a bottleneck, because the internal switch in the VoIP phone reduced the data speed from 100 mbits to 10 mbits. This meant that users experienced a reduction in the quality of the service provided by VoIP. Even though this was only a temporary implementation issue, it reduced the performance of employees and reduced the overall acceptance of VoIP technology within the organization. Essentially this meant a temporary reduction in the efficiency and quality of processes that relied on phone based communication (examples: student service center & HR). After a firmware update of the VoIP data center and all VoIP phones, general operational quality was restored and it functioned in a proper way.

Another disadvantage of VoIP in the organization is that the technology can sometimes cause temporary bottlenecks that become a nuisance. When computers are being used for research; every single extra mbit of network is needed. When there is a lot of data traffic the VoIP phone disrupts the continuous flow of data (the download and upload speed fluctuates a lot). The VoIP phone is only 100 mbit and all outlets are 1 gbit capable. This means that VoIP functions with a data speed that is actually only 1/10th of the maximal capabilities available. When performing tasks that require the transfer of large amounts of data over the network, the slower VoIP phones have a negative effect on the transfer rate. Currently this does not pose a great disadvantage but in the future when the organization might decide to broaden VoIP functionality with custom applications that function on the VoIP telephones and which are more data intensive, then speed issues could occur. One more minor hindrance for the IT-department is that it is impossible to read out the information of a VoIP phone, because the internal switch of the VoIP phone hides this information. This creates a minor problem that can be dealt with by using a workaround solution (using a special application) although it does produce some overhead for the IT-department. Last but not least, the fact that VoIP requires power in order to function did create some problems as additional fail-safe mechanisms need to be implemented. In the event of a power outage communication systems are required to remain operational. In the end it was not difficult to install back up power units for VoIP servers and hardware but the issue did require some effort before it was resolved.

The main issues with acquiring additional functionality for the VoIP platform can be attributed to the identification of general user needs. It is considered hard to predict if an additional feature for VoIP will actually be used and appreciated by the end users or ignored. Furthermore there are also fears that the integration of new VoIP features with the current hardware and network configuration could cause undiscovered incompatibility problems. These potential problematic issues could cause a disruption of the support processes resulting in overhead for the IT department. All of this eventually results in additional costs for the organization while the (perceived) benefits might be minor. Of course the costs of any additional technology would also be considered a factor that can be a barrier if the costs are very high.

An (enhanced) call conferencing platform would be a great practical benefit to the organization. This VoIP system could be made to support audio (video would also be possible) conferencing. Highly dedicated wideband VoIP conference phones are able to provide multiple people with the ability to participate in a cost effective conference call (using VoIP) at different distances while still maintaining a normal speech volume. Another improvement option would be the possibility to tie conferencing functionality into other applications by using IP collaboration. This would allow anyone participating in the conference call to synchronize calendars, share presentations, exchange files and basically also share his personal desktop with the other participants. This is a practical example of Unified Communications which the organization would like to acquire in the future. The ideal of Unified Communications is to facilitate the convergence of different types of communication technology in order for them to work together. Ultimately this would mean that they integrate on a level. One communications system would be able to process phone calls, voice mail, e-mail, real-time messaging, video and other communications while different applications are constantly aware of each other.

### **Competitive advantage and cost benefit analysis**

Using the implementation of VoIP the organization was able to lower the TCO of running a telephony platform within the university. Old telephones (PSTN) have been replaced by VoIP telephones and this had a reduction of costs:

- Reduction of telephony outlets. Old PSTN outlets were converted to LAN-outlets.
- By converting PSTN-outlets, more computers have been installed on the campus
- Reduced use of extra cables, because one Ethernet cable is enough for communication (IP+VoIP).

With the introduction of VoIP in 2007, the organization has saved a lot of resources, for example, money and manpower. The introduction of VoIP changed the way of installing new phones in the organization, because the network lines/cables are already there. It is now a matter of requesting an internal number and coupling this number to the VoIP phone. VoIP has the added benefit that the organization is less depended on the KPN network (national phone network). The new service contract with KPN is beneficial to the organization in terms of costs since these have been significantly reduced in comparison to the previous analog telephone system. The IT department is now being run by fewer employees. Before the introduction of VoIP, the organization employed more people in total. Thus VoIP ensures that certain processes require less time and manpower to be completed which in turn translates into cost savings. The telephone costs are reduced with the VoIP system, because for each employee the IT department can control to which numbers an employee can dial (for example: only numbers in the organization, only numbers in the local area etc.

Competitive advantage is perceived to a certain degree as the organization believes that the chosen VoIP solution is more cost effective in the long run while providing the possibility for additional functionality. The resources that are saved because of the VoIP system can be reallocated to other departments allowing for a more effective utilization of the organization's budget to maximize its performance. This enhances the organization's capabilities to use its resources to acquire an advantage over its competitors (doing the same thing better and/or cheaper).

A cost benefit analysis was performed before acquisition of the VoIP system. An analysis was also performed based on which VoIP provider delivered the best support and hardware in order to integrate with the current systems in place. All this was done before an organization governing resources for educational organizations (CvB), made resources available for the implementation of VoIP. Ultimately the choice was made not to select the most cost effective provider but to go with one that delivered the best support contract and provided hardware that had almost no compatibility issues with systems that were in place. This provider also had a good and long business relationship with the organization as it provides almost all the network hardware that is used in the organization.

## **Future**

The interviewee states that according to him the future is already here, with the new features of VoIP communication. This means that he believes the integration of real-time communications like instant messaging, IP telephony, call conferencing etc., is on the rise and will define how communication is performed in the future. In a couple of years he expects that VoIP will also take over the mobile sector (no more GSM frequencies). All voice devices will be connected by IP. For the time being, VoIP will be integrated with the gsm frequency. He believes that new technology will further improve the business processes of organizations but there will be a point where no more improvement can be achieved by applying new technologies.

## **4.3 Government I**

### **Description of the organization and interviewee**

The third interview was conducted at a Dutch municipality. This municipality is a government organization which has a fair amount of bureaucracy that could prove to be a limiting factor when new technologies like VoIP are introduced. The organization is a midsize Dutch municipality that borders one the major metropolitan areas of the Netherlands. The municipality provides service to approximately 50.000 inhabitants.

The ICT specialist was present during the implementation phase of the VoIP technology at the offices of the municipality. He also worked at the ICT department's service desk. This means that he has in-depth knowledge concerning the shortcomings and implementation aspects of VoIP in the Dutch municipality. The specialist bases his opinions on his experiences with the VoIP technology and the people in the organization.

## **Interview Results**

### **VoIP and the core business**

The core business process of this organization is providing protection and governmental support/service to the citizens of a municipality. This governmental support can be wide ranging. It can include providing assistance with the acquisition of certain permits, licenses and providing information services to citizens. The process of providing assistance to citizens by phone is considered one of the core processes as many calls are received on a daily basis. This activity is conducted by their dedicated service desk. VoIP managed to make this service desk operate more efficiently by making rudimentary tasks like call forwarding easier. Also call management software can now be used which provides greater configuration possibilities and offers statistical recording capabilities. These statistics can for instance be number of calls received by certain employees, or the subject of the calls. This information can then be used by management in their decision making process.

Features of VoIP at the organization are:

- Basic IP calling functionality
- Management software support for IP numbers
- Call group structures
- A digital telephone book
- Remote access to VoIP numbers

The actual method of communication was not changed on a fundamental level. At first the only difference that employees could see was the use of the new Cisco manufactured IP telephones. VoIP was not installed directly in the entire organization but implementation occurred incrementally. After the entire organization was utilizing the new technology and the platform was stable, users could enjoy the other capabilities of VoIP.

A digital phone book was one of the new features employees could use. Users expressed that this simplified their tasks since many calls needed to be forwarded internally and now this can be done easily by a search in the digital telephone book. The digital telephone book has employees registered alphabetically by last and first name. With VoIP people could use the new call

forwarding features that enabled them to easily configure their IP phone to forward all incoming calls to another IP phone or a cellular device. Furthermore now it is possible to call from any location in the world to a specific internal number and remotely configure forwarding options for a telephone number. Although this feature is not often used by employees, having the option does create more flexibility.

Implementing VoIP simplified employee relocation within the organization. With the old system the analog telephone line had to be physically moved when the employee changed location and needed to keep the same number. With the new system this is no longer required. Another of the added features is that group monitoring via specialized software is possible so that users can see who is logged into specific telephones and the duration. Call forwarding by making specialized group configurations which enable employees to more efficiently take-over incoming calls if their colleagues are unavailable, is now possible. This makes employees work more efficiently.

### **VoIP barriers and improvement**

One of the main downsides of the VoIP technology was the lack of stability during the implementation phase. According to the interviewee there were major availability and QoS problems during the implementation of the new technology. This organization chose to have the VoIP implementation done in a number of stages thus creating a hybrid environment where both the old and the new communication technology were present.

During implementation it was not uncommon for an organization wide failure of the VoIP system to occur due to hardware/software incompatibilities and configuration issues. This left a significant number of employees unable to communicate with each other. At some moment in time employees even had two types of phones on their desks. One IP based and one analog phone for use in case the VoIP system failed again. This caused confusion when calls needed to be forwarded since no decisions had been made about call forwarding and number retention.

The problematic situation was resolved when VoIP was fully implemented and the old technology replaced completely, but it still left a bad impression on the employees. This made them less accepting of the new technological changes in the organization. However after a period of uneventful use, the majority of the employees did not mind using VoIP and some even became positive when viewing the new possibilities it presented. Another issue that was not accounted for properly during the implementation was that VoIP phones are basically IP powered meaning that they receive their power through a low power signal that travels via the network cable. This implies that when there is a power outage no phone communication can be used. Although the municipality did not have a significant amount of numbers that need to be available at all times, this obstacle did require the last minute introduction of changes to certain contingency plans and the acquisition of additional emergency backup power supplies. These in

turn needed to be reconfigured which further delayed the implementation process which was already behind schedule.

The level of employee resistance to new technology should in this case not be underestimated. Due to the organization wide problems during the VoIP implementation there is a significant level of resistance to the introduction of new features or changes to the VoIP system. Lower and midlevel management expresses its concern towards problems that can be caused by implementing changes in the VoIP system. Another obstruction in their phone processes is unacceptable as the last obstruction caused phone unavailability in the organization, including the service desk. The unavailability of the service desk in turn caused citizens to complain about the lack of service from the organization. All of these factors have had a negative effect on budget allocations and evaluation results from the central government concerning the municipality. In short employee resistance is a legitimate obstacle that needs to be dealt with if higher management wishes to introduce additional VoIP features.

There are also practical issues involved. The introduction of new features to the VoIP technology needs to meet high standards of security as the network of the municipality houses sensitive private information about its citizens. This information is protected under Dutch law which means that security is important and any changes to the network need to be closely tested and evaluated. New features or changes to the current VoIP/data network are required to be benchmarked for compatibility with certain government standards as the government intends to further integrate the networks of numerous municipalities and other government organizations.

The interviewee mentioned that at this time there are no planned improvements for the VoIP system but a possible promising addition would be the implementation of Unified Communications which would further integrate real time communication technologies allowing them to further provide online assistance to citizens using chat programs that can be linked/integrated with their phone based service desk.

### **Competitive advantage and cost benefit analysis**

In 2009 the Dutch municipality started the implementation project that would replace the existing analog telephone system with a VoIP system. This decision was mainly made based on the fact that the organization needed to upgrade their existing telephony system and that VoIP appeared to be the direction in which the market is moving. The existing system was quite old and maintenance costs were also high. Management thought that the support delivered for the VoIP solution by the provider would be of better quality and last longer. The support contract from the provider for the old telephony system was not cost-effective for the organization.

The opportunity to save on telephony costs in the long run contributed to the decision to implement VoIP. Although according to the interviewee the total costs of implementation (VoIP)

where quite large in comparison to the old implementation costs (legacy telephone system), the organization decided that the long term cost savings, greater efficiency and functionality that VoIP has, outweighs the initial disadvantages. This is a government facility which does not openly compete with other entities such as is the case in the private sector. In terms of competitive advantage the interviewee mentions that the municipality is able to use its budgetary resources more efficiently, especially focusing on cost effectiveness in the long run. The freed resources (saved due to cost savings) allow it to reallocate them to other areas which allow the municipality to provide additional or better service to its citizens.

The decision to use VoIP was not completely made by the municipality alone as the Dutch government in general already had plans to upgrade its communication infrastructure as they deemed it important to remain technologically up to date. Municipalities have some level of influence on the decision concerning the actual date of implementing new systems but the central government does impose deadlines on them. In this case a cost benefit analysis was performed by the municipality as well as the central Dutch government in order to determine the best provider. Although cost of implementation was an important issue, they also looked at service contracts and hardware specification. Hardware and overall compatibility with other government networks was an important factor as any incompatibilities would cause problems should the government decide to integrate their networks in the future. Eventually not the cheapest provider was chosen but one that has significant experience with providing VoIP to government facilities and utilizes hardware with an acceptable level of compatibility with other networks. The provider's name is Mitel.

## **Future**

The interviewee sees that in the next couple of years VoIP will control the majority of the commercial market and replace the existing analog telephony systems. According to him the possibilities that VoIP can provide will be instrumental in its acceptance by the business community. Long term cost saving and the added flexibility by using special applications that run on the VoIP platform will prove to be very attractive. He foresees that Unified Communications will have an interesting effect on organizations that provide phone based services or remote support as the new technology has the potential to drastically change their processes. For organizations that do not have core processes that include telephony and where VoIP is seen as more of a support process, any future communication technology would at most make processes more cost effective or provide greater flexibility to users. The direct effect on core processes would however be seen as minimal.

## **4.4 Government II**

### **Description of the organization and interviewee**

The organization coordinates healthcare services for citizens within a specified protection zone of the Netherlands. It protects and strives to improve the overall health of the population both in everyday life and in crisis situations. Furthermore the organization tries to limit the risks of treats to the general health of the public. Its activities are performed on a regional basis while coordinating lower level healthcare services on a municipal level. The organization has multiple branch offices and localized healthcare facilities under its direct supervision culminating in a total of approximately 60 locations within its designated control region. After various fusions with other smaller healthcare providers the organization protects and offers its services to an estimated 800.000 inhabitants while employing 900 people in its staff.

The interviewee is the manager of the IT department that provides support and maintains hardware/software for the entire organization. He has many years of experience in a leading role and within the organization and has overseen many implementation projects. He has principal knowledge of the VoIP system that is currently being implemented within the organization. This knowledge originates from his close involvement with the higher management decision to adopt VoIP technology and his role in coordinating the proper implementation of the new communication technology.

### **Interview Results**

#### **VoIP and the core business**

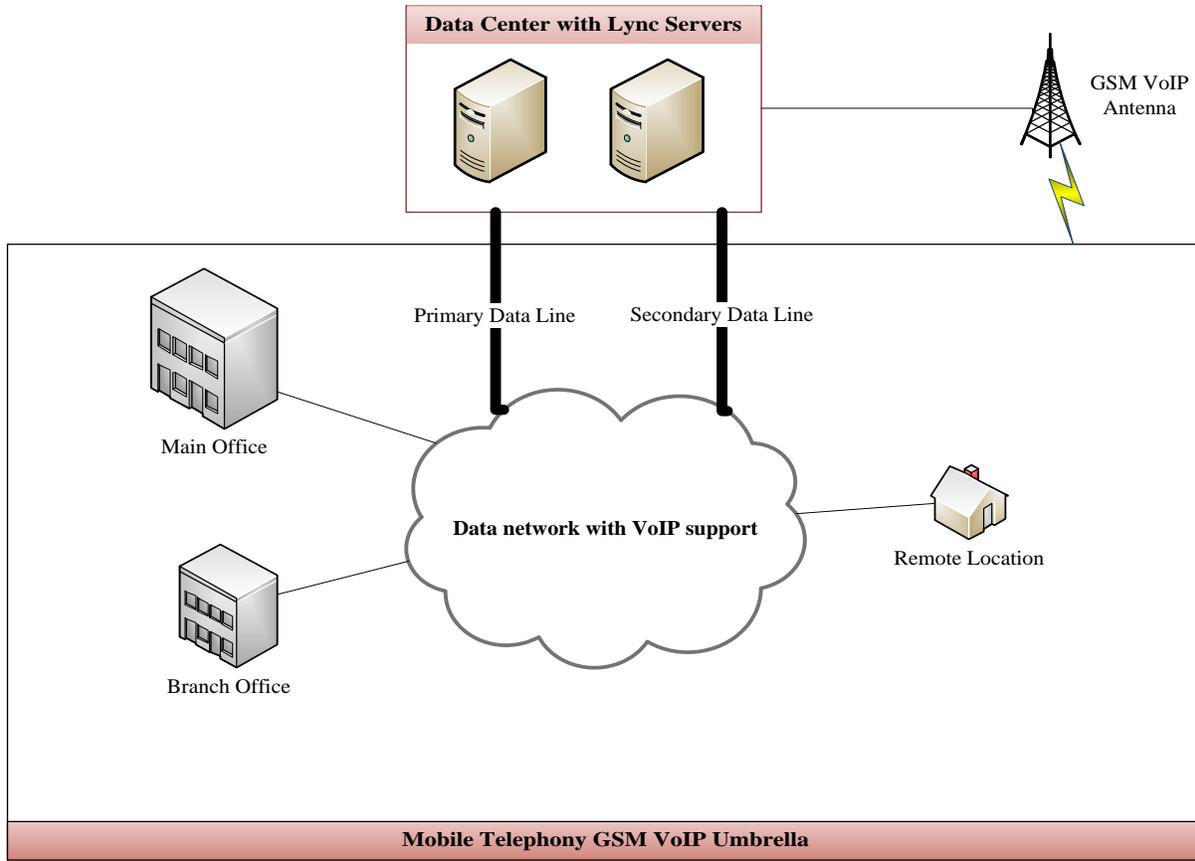
Telephone based communication is more than just an important support process in this organization, rather it should be said that telephony is a critical factor in maintaining proper operation of the core processes. These processes focus primarily on providing healthcare to citizens of a predetermined region in the Netherlands and maintaining the health of those citizens. Coordination of emergency and first responders during a time of crisis is also one of the organizations' primary objectives. These primary processes and the objectives could not be completed without the assistance of telephony and VoIP. Currently the organization is in a hybrid situation where both PSTN based telephony and VoIP systems are present. The objective of the implementation project is to incrementally replace to old telephone system with a VoIP system that supports the use of mobile telephones. This means that the ultimate objective of the implementation project is to allow a large group of employees to have mobile telephones which route all call traffic through the VoIP network. A basic number of stationary VoIP devices will be present in specific locations such as a secretary's office or consultation helpdesk but the primary goal is to have a predominantly mobile based VoIP implementation.

Features of VoIP at the organization are:

- Basic IP calling functionality
- Call group structures
- Management software support for IP numbers
- VoIP using GSM with mobile phones (currently being implemented)
- VoIP encrypted solution

Since the VoIP implementation project is still ongoing, the only real change for employees has been the introduction of a select few VoIP phones in order to test functionality and network integration. The actual method of communication has not been affected. Furthermore a test group of employees have been given mobile telephones (some also have normal VoIP phones) which route all traffic through the organization's VoIP network. The goal is to test the functionality and user satisfaction with the new mobile approach. Currently there are no functionality and integration problems concerning the VoIP implementation and the interviewee mentions that in the next three months all legacy phone systems will be replaced by VoIP. Furthermore there has been chosen for a high standard of encryption for data and voice traffic as this is an organization that handles sensitive data such as patient information. This data is protected under Dutch law and securing it cannot be neglected.

The new VoIP system is a step towards the further centralization of the organizations IT systems. This operational centralized administration of information systems is preferred by the IT department and higher management. One of the additional objectives of the VoIP implementation is to facilitate the further integration of the numerous branch offices and other locations by using a single network for both communication and data traffic which is delivered by a single provider yet administrated (to a certain degree) by the organization's own internal IT department. The acquisition of the communication system was negotiated to be a fixed price solution, meaning that a single price is paid for the complete implementation of the VoIP system which includes consultancy fees but not communication hardware such as VoIP telephones.



**Figure 4.1: Organizational VoIP network.**

Figure 4.1 provides a representation of the organization’s current network configuration. The cloud in the middle symbolizes the data network that also provides support for VoIP traffic. All the branch offices and locations of the organization are connected to the data network. In total there are about 60 locations connected to the network. The figure shows three types of locations:

1. Main office which supports up to 150 employees
2. Branch office which supports 80 employees
3. Remote location which supports 10 employees

The numerous servers that contain the organization’s data and support the VoIP system are located in an “offsite” data center. This means that the servers are not housed in one of the organization’s locations but are situated in a specialized server room underneath a major hospital structure. The specialized server room or data center contains a large amount of servers and other technical equipment that do not belong to the organization. In order to maintain a high level of technical support and acquire an infrastructure that provides all the necessary contingency features, it was deemed more cost effective by the organization to lease a limited amount of

space within the data center. This provides all the benefits of a large modern data center while only having to pay a fraction of the monthly maintenance and operational costs.

The data center has servers which are physically present, however there are also virtual servers running which facilitate the use of various applications. These virtual servers are completely software based and do not require separate hardware machines in order to function. This means that a single hardware-based server can run multiple virtual servers. This organization has 15 virtual servers operating. The most important server for the VoIP system is the Microsoft Lync Server which is situated in the data center. The Lync server is basically the communication server which enables and supports the organization wide use of real-time communication technology which at the present time is limited to the utilization of VoIP within the organization. There is one functional Lync server already in place and a second one is being installed to further support the increased number of users as the VoIP system gradually replaces the legacy telephone system. The second server will also function as a load balancing mechanism to ensure VoIP QoS.

The servers in the data center are connected to the rest of the organization's data network via a primary and a secondary data line. Under normal circumstances this primary data line functions as the main connection between the data center and the data network, while the secondary data line is in a non-operational "dormant" state. If for some reason the primary data line stops functioning, then the secondary will automatically become operational and take over, meaning that it is essentially a back-up system. The secondary data line only has 60 % of the bandwidth capacity of the primary data line which results in the organization experiencing a decrease in speed when computer related tasks are performed. A failsafe measure which prioritizes the allocation of bandwidth to the VoIP section of the network ensures that even when transfer speeds are reduced, the QoS of the VoIP system will not be affected. This measure ensures that the VoIP section of the network will always have priority over that data section when it comes to the allocation of bandwidth. The VoIP implementation is meant to support the use of mobile telephony. In order to achieve this, the entire organization is covered in a "VoIP umbrella" which captures all mobile phone traffic by utilizing multiple VoIP antenna's and makes sure call data gets routed through the organization's VoIP network. This is also depicted in Figure 4.1.

### **VoIP barriers and improvement**

This particular VoIP system, which is predominantly a mobile implementation, utilizes a number of novel technologies. This has the possibility to cause unforeseen problems as there are currently not any adequate reference cases available that describe to use of a similar VoIP system. The interviewee mentioned that this fact makes it a high-risk implementation project which has the potential to cause bugs in the software and hardware that can negatively influence the daily operations of the organization. This is also the reason why a pilot approach is used where a limited number of employees are utilizing the new technology in order to detect and

contain possible faults in the VoIP system. The implementation of VoIP at the organization is closely being monitored by Microsoft and HP in order to be used as a reference case for future similar implementation projects.

One of the main barriers encountered with the current implementation was the lack of an adequate reference case. This meant that IT-personnel had to learn most things from the beginning and using a trial and error approach which slowed down the implementation speed. Also employees were required to receive training courses for using VoIP phones and receive additional info concerning the VoIP implementation. The required training courses were time consuming and employees did not fully understand the concept of VoIP and what it would mean for their daily tasks. This caused a temporary resistance to the new technology by the employees as they were uncertain about the changes they would have to deal with and did not want their current way of performing to be altered. The problem was later resolved after further information/education and assurance from higher level management was given that the changes incurred by employees would be kept to a minimum. The problem with employee acceptance was thus taken care of however it did hinder the implementation project by causing additional delays.

Additional barriers that affected the VoIP implementation were caused by numerous adaptation issues with the hardware and software that was already in place. These issues were considered to be only a minor problem and did not greatly affect the overall implementation project, however they did need to be resolved quickly otherwise the VoIP system would not function correctly. An example of such an issue is the specification of certain network routers that are used within the organization. VoIP uses PoE (Power over Ethernet) which basically means that the VoIP phones draw their power from the organization's network via their network connection to a wall outlet. Not all of the network switches are capable of fully supporting PoE which means that all of these devices have to be replaced if VoIP is to function. Furthermore a limited number of network connection wall outlets are available in certain office locations therefore additional network switches are used to connect more devices. A problem arises because VoIP uses PoE which will not function if the VoIP phone is connected via a switch. Every VoIP phone needs to be directly connected to a PoE capable wall outlet otherwise the phone will not power-up. Besides the hardware problem due to VoIP's use of PoE there is also a problem caused by the fact that VoIP needs power in order to operate. The continuous use of the communication system is essential for the organization's activities which means that VoIP availability needs to be very high. Steps have already been taken to resolve these issues so that when VoIP fully replaces the traditional telephone system within the organization no problems of this nature will be present.

The interviewee described that the organization's data network has bandwidth issues that cause employees to complain about a slow down when they are working on their computers. The organization uses a virtual desktop approach called Citrix, to allow personnel to log-on to their

workspace. This workspace implementation means that all applications are virtualized and are installed on special servers which then transmit the virtual workspace information to employee computers. In short, this approach is data intensive and can cause excessive bandwidth to be used on the data lines which can have a negative effect on VoIP QoS. Currently a priority mechanism is installed on the data network which ensures that during data transmissions VoIP data attains high priority. This solution is meant to resolve the VoIP QoS issue and during testing phases it has been proven to work.

Currently the organization is still finalizing the VoIP pilot program and does not plan to implement any additional VoIP functionality on a short term basis. There are plans to introduce a chat program and integrate this with VoIP in order to assist employees with their daily tasks. VoIP will also be linked with the organization's e-mail system. This means for example that when someone sends their contact information at the bottom of an e-mail message, you would just need to click on the employee name and the system would automatically start dialing the number. Furthermore there are plans to provide employee presence information in real-time. This "presence" shows whether an employee is logged in to his workstation or is available to be contacted. All of this is basically a first step towards implementing Unified Communications which according to the interviewee is likely to be implemented in the future.

### **Competitive advantage and cost benefit analysis**

As this organization is a government organization the interviewee highlights that direct competition between rival organizations, which does take place in the private sector, is not a major issue. There are, however certain private organizations that provide similar health-care related services. These organizations are the only direct competitors the organization has but they are far smaller in size and do not possess government support and similar financial resources. This organization does receive pressure from the government and the citizens to maintain a high standard of service and to constantly keep making improvement as citizens (customers) constantly desire more efficient / additional services.

In terms of an increase of competitive advantage the interviewee mentions that improvements have been gained which have a positive effect on the service standard delivered to citizens (customers). The purchase price of the new VoIP system was 60 % of the original purchasing price of the legacy telephone system yet operational costs were about the same. The older system needs to be replaced as it cannot meet capacity requirements anymore. Although the purchasing price is significant, with the same level of operational costs and with additional functionality that increases overall efficiency the interviewee is confident that the VoIP system contributes to the advance of the organization's competitive advantage.

Arguments in favor of this opinion are that the VoIP system provides a more cost effective way for communication to be performed both within the organization as with third parties which

allows additional resources to be allocated towards other activities (this can increase the service standard). The VoIP system provides the possibility for 500 conversations to take place simultaneously which increases its availability in emergency situations. This increased availability is a new requirement issued by the government and the organization is compelled to comply. The legacy telephone system is unable to support 500 conversations simultaneously. The VoIP system has increased capacity capabilities which allow the use of 2000 telephone numbers and provides rerouting mechanisms in case of caller overloads which can route calls to another call center (likely to be used in emergency situations). As the organization is currently expanding and the legacy system cannot keep up, the additional capacity provided by VoIP is a necessity. Furthermore the mobile implementation of VoIP provides employees (health-care professionals) with increased accessibility (they can be easily contacted when working in different locations). From a technical viewpoint the VoIP system allows for an easier integration of networks with other organizations. This is something that is likely to take place in the near future as the organization is expanding. A smooth integration means less overhead incurred by the IT department and facilitates sustained productivity.

Because this is a government organization and the implementation costs for the VoIP project exceed a specific amount, according the European legislation special measures needed to be taken that allow third parties equal opportunities to make bids for the contract. The interviewee mentions however that a direct cost benefit analysis was not thoroughly performed as higher management desired to facilitate a swifter implementation as the legacy system was already showing capacity problems and was considerably outdated. The VoIP phone hardware was delivered by Aastra Technologies while the Lync servers are Microsoft hardware. The implementation and consulting activities are performed by a third party that is specialized in implementations projects while HP and Microsoft also provide consulting activities as they view this particular implementation project as a reference case. The organization chose a third party implementation expert based on recommendations provided by Microsoft as for the most part, Microsoft hardware like the Lync server is used. The telephones that are delivered by Aastra Technologies are also optimized to work with the Microsoft Lync server technology.

## **Future**

For the future the interviewee foresees the further integration of communication technologies such as is already demonstrated by Unified Communications. The use of smart PDA's and tablet PC's will increase within organizations and depending on the sector and manner of utilization, innovations in communication technologies have the potential do provide extra capabilities to organizations which can allow them to conduct their business more efficiently. Extra functionality gained by communication technology can also be used to provide additional services to customers such as payment methods using cellular telephones and checking-in to a

flight using a smart phone. These facts all have the potential to drastically influence an organization's core business.

#### ***4.5 Government III***

##### **Description of the organization and interviewee**

This organization is one of the most important information brokers for the Dutch ministry of public health and is the principal agency that executes tasks concerning healthcare legislation and registration in the name of the ministry. The organization was created in the year 2000 due to a fusion of numerous other smaller government organizations under direct supervision of the ministry of public health. Although the organization has numerous responsibilities related to maintaining public health, one of the most important tasks is maintaining the donor register and administering the security of patient and healthcare provider information.

The organization has a main office in The Hague (seat of the Dutch government) and 2 branch offices in other locations in the Netherlands. It employs approximately 200 employees throughout its various offices. A vital department of the organization is its front-office where individuals and establishments can ask for assistance with using certain security tools and software that are produced by the organization. The front-office also provides assistance to healthcare professionals that need to access secure databases which house patient information. Furthermore, the front-office checks for social security number fraud and healthcare insurance fraud when suspicions are voiced by municipality workers or healthcare providers. All of the tasks that are performed by the front-office rely heavily on telephony in order to function. The front-office is setup in call center configuration with 15 dedicated agents to provide telephone based assistance. Telephony in the organization is completely VoIP based since a wide scale VoIP implementation project 4 years ago. The VoIP provider for the communication system and hardware is Mitel.

The interviewee at this organization is a senior front-office coordinator with multiple years of experience. He was present during crucial periods where many changes were being conducted in the organization, including the introduction of VoIP. In total, he has about 20 years of experience working within the government. Furthermore, he has first-hand knowledge of the workings of the VoIP system and he was also someone that provided valuable information that influenced the course of the VoIP implementation, which ultimately had an effect on which features of the VoIP system were implemented in the organization.

## Interview Results

### **VoIP and the core business**

The core business of this organization is managing of health-care related information such as the donor-register and other sensitive patient information. This core business is supported by the front-office that provides crucial assistance towards authorized organizations, health-care providers and individuals. VoIP initially did not greatly alter the way in which communication is performed within the organization as telephony use still basically remains the same. The real change for employees has been the additional login procedures for IP telephones, call group configurations and digital telephone book. The telephone based communication has become more cost-effective within the organization. The front-office experiences the most benefit of the VoIP system as they rely heavily on it in order to provide telephone based assistance towards customers. The interviewee mentions that VoIP has made the front-office more efficient; however the general core business of the organization where sensitive information is managed is not affected by VoIP.

Features of VoIP at the organization are:

- Basic IP calling functionality
- Management software support for call monitoring and IP numbers
- Call group structures
- A digital telephone book
- Remote access to VoIP numbers

In its most basic form, digital IP based telephony is installed in the organization. Management software is installed which allows managers to view real-time VoIP information such as which employee is logged in to his VoIP phone and how long they are on the phone. A manger can also use the management software to listen in on a phone conversation being conducted by a front-desk agent. This is meant to allow managers to gain an insight into the quality and employee performance of the front-office. The organization values the quality of its service towards its clients as a top priority. An unfavorable review from its clients could result in the organization losing its position as the main information broker for the Dutch ministry of public health. A digital telephone book is available on the VoIP phones that allow easy call redirecting within the organization. Functionality is also available for remote access to VoIP numbers. This means that an employee could call a specialized number and then use his VoIP phone login information to configure call forwarding and other options. This functionality is often used for the night shift. The front-office is required to be available 24 hours a day.

## **VoIP barriers and improvement**

The initial problems encountered during the implementation of the current VoIP system were of a more technical nature. No major issues existed during the implementation phase of the VoIP system but minor problems did. These minor problems had to do with integration issues between the network hardware and the VoIP system. The main source of interference was caused by hardware incompatibilities and performance abnormalities. This caused numerous delays with the VoIP implementation. The problems were however of a minor nature and got resolved on a short term basis. The interviewee highlights the additional fact that some employee discontent was encountered for a short time (2 days) because the QoS of the VoIP system was not adequate. This was a problem encountered by a handful of employees. It occurred because the VoIP system still had to be calibrated. After the calibration was performed no further QoS issues existed. Installing contingency mechanisms to guarantee VoIP availability in case of a power outage was a crucial requirement because the organization must be able to provide continuous service to clients. Maintaining VoIP availability was not difficult to achieve after additional power supplies were installed but the issue was required to be resolved quickly otherwise the VoIP implementation could not be completed.

The organization has no plans to upgrade the VoIP system at this time. The interviewee describes that the implementation of additional features will not occur on a short term basis because at this time higher management does not foresee a major additional benefit if these features are installed. Basically implementing additional features at this time would only provide marginal benefits while incurring disproportional costs. However one feature does prove to be promising and is being considered for implementation by management. This would be the introduction of Unified Communications. There is a proposal to introduce a chat program within the organization which can be used by employees to facilitate communication but also by the front-office to increase the level of support delivered to clients. Unified Communications would integrate the VoIP system with the real-time chat program in order to increase efficiency and upgrade the service standard. The implementation of this idea is still being considered by higher management as budgetary issues could impede the financial feasibility of the proposal at this time.

## **Competitive advantage and cost benefit analysis**

The interviewee states that the influence of VoIP on the core business is marginal at best. Communication has become more cost-effective but the cost savings are not significant enough to have any large influence on the organization in general. Only the front-office experiences a significant increase in efficiency while other departments still remain operating at the same levels. Even though this organization is a government organization and direct competition between rival organizations is a rarity there are other organizations seeking to acquire licenses to provide similar services for the Dutch ministry of public health. A negative performance review

for this organization could mean that the government would outsource the information brokering tasks to third party organizations. This is the reason why maintaining a high level of service towards the clients is very important. Despite the cost savings and higher efficiency of the front-office that VoIP provides, the interviewee perceived only a minimal influence of the new communication technology on the competitive position of the organization.

Before the VoIP system was implemented a thorough cost benefit analysis was performed by the organization. The analysis procedure was outsourced to an independent technology firm. The analyses needed to meet additional strict requirements as the costs for the VoIP implementation project would be financed by the Dutch Government entirely. The organization was required to submit a complete substantiated proposal for the implementation to the government which thereafter still needed to be approved by the ministry. The interviewee mentions that the entire process involved a large amount of bureaucracy and took almost a year to be completed before implementation could actually commence. Other considerations were that the legacy telephone system was significantly outdated and the operational costs of maintaining the system were becoming too high. When the legacy systems needed to be replaced, management saw VoIP as the logical choice as the market was also moving towards this technology.

## **Future**

The interviewee mentions that advances in communication technology will have a variable effect on the core business of organizations. Both businesses and consumers will benefit from advances in communication technologies. For organizations where communication technology only has a minor supporting role, advances in communication technology will have less of an affect. While for other organizations it could greatly influence their core business. These influences can in some cases be negative as is shown by the removal of printed newspapers and the increase of digital newspapers being facilitated by the internet and the rise of e-readers. The interviewee also mentions that further integration will take place between different communication technologies and that the principle of Unified Communications has a possibility of being widely utilized in the future.

## **4.6 IT Organization**

### **Description of the organization and interviewee**

The organization where the interview was conducted is a midsize ICT organization that has a healthy growth ratio with a relatively informal culture, minimal bureaucracy and is open-minded when it comes to adopting new technology. The organization has been placed at number 167 in the list of top 500 organizations in the Netherlands with the best all-around image. It has offices at multiple locations across the Netherlands. The headquarters of the organization is located in

Delft while branch offices are situated in Amsterdam, Utrecht, Enschede and Eindhoven. Furthermore the organization employs approximately 700 people and has clients from almost every market sector.

For this interview an ICT specialist was asked for his knowledge and opinions pertaining to the VoIP technology in his organization. He works with the VoIP technology on a daily basis, has a wide understanding of its functionality and the processes associated with it. The specialist bases his opinions on his experiences with the VoIP technology and the people in the organization. He has knowledge of the specific functionality of the VoIP system within the organization and has been using the technology for a significant amount of time. His knowledge of the VoIP communication system can provide insight into the way in which it is implemented in his organization.

## **Interview Results**

### **VoIP and the core business**

The main processes of the organization are the delivery of IT services to local clients. This can range from providing personnel for helpdesk outsourcing to consultancy and the implementation of complex information systems. They also provide remote support to their clients in order to maintain appropriate functionality of the client's systems. This remote support is done by a specially configured skilled service desk that is setup similar to a call center configuration. Another important process is that of account management which basically ensures the continued introduction of prospective clients and maintain adequate business relations with current customers. Telephony is a crucial factor for account management and the service desk. Furthermore the organization's different locations are connected to a single dedicated network to facilitate easier data sharing. The VoIP system which is provided and maintained by Cisco is integrated into this network.

Features of VoIP at the organization are:

- Basic IP calling functionality
- Management software support for IP numbers
- Call group structures
- A digital telephone book
- Password protected user accounts

One of the main changes for the internal IT department of the organization was the difference in the way that new employees received their telephone numbers and employee number retention upon relocation. By using the special software for managing certain parts of the VoIP network

(Cisco Call Manager), telephone numbers can be easily created and coupled to users on the network. These users can then be assigned to special call groups that have a separate configuration that is required for them to complete their tasks. The user accounts are coupled to a specific telephone number and contain information such as the name and function of the employee. Furthermore these accounts are password protected. With this account the employees can login to any VoIP phone in the organization and use their own number.

Particularly the ability to assign telephone numbers to employees in a matter of minutes caused a great increase in productivity and reduced the completion time of certain tasks. With the analog system it normally took three days before a new employee could get a phone number assigned to him. This is now reduced to approximately 15 minutes. Also when an employee is relocated but his number needs be retained, it can simply be configured with the Cisco call manager software so that his number is still coupled to him. Before VoIP, when there was a request for relocation requiring phone number retention, a physical telephone line had to be moved which cost a significant amount of time and money. Now this task requires fewer resources to be completed. This saved significant costs and time when a new branch location was added to the network because the configuration of numbers and specific call group setups could be done by using specialized software rather than the cumbersome process of assigning numbers on a traditional PSTN configuration.

With Cisco Call Manager software employees can be allocated to special call groups. These call groups simplified the tasks and increased productivity in certain departments within the organization. For example the “remote assistance” group (Totaal Beheer) which is a sub department of the service desk where clients receive remote assistance from IT specialists via phone. Call grouping made redirecting and call forwarding more efficient. These are options that are used very often by the service desk.

A digital telephone book exists where all users are registered by their last name. According to the interviewee this feature was welcomed by employees and is used on a daily basis in the organization. By using this phone book they can easily look up colleagues and call them or forward a call. Also a list of external customers and organizations is available for direct selection. Ultimately the only significant difference in the actual processes was encountered by the internal IT department and the service desk, the rest of the organization still uses their phones in the same manner only now they have additional functionality which makes performing their tasks easier and provides greater flexibility. The process of using a phone is not made different yet the factors surrounding the use of a phone such as costs and functionality are changed by the introduction of VoIP in this organization.

## **VoIP barriers and improvement**

The interviewee mentions that there were not any serious complications during implementation. There was a hybrid situation present during implementation. This meant that both the VoIP and the older telephone system were functioning side by side. This caused some isolated incidents which involved employees not being able to receive calls or having the wrong number assigned to them. However this did not occur often during the implementation phase and the issue was resolved after VoIP was fully functional in the organization.

Another issue that is problematic is that all VoIP communication devices are dependent on electricity which means that when a power outage occurs communication is impossible. For some specialized areas in the organization there is a requirement by law to have a functional phone during emergencies. In these areas a special back up power source has been installed to adhere to the legal requirements. Backup power units have also been installed to secure communication in key areas (server rooms, elevators). Although power outage does not occur frequently, the inability to make phone calls does need to be taken into consideration. With the old telephone system, phones did not need external power to function.

According to the interviewee the only barriers to the implementation of additional features of VoIP are technological issues and the balance between costs and benefits. In order for any additional features added to the network first the benefits would need to be analyzed and then the costs need to be considered. Also the integration of the new feature into the current system would need to be thoroughly tested in order to minimize the chances of errors that could disrupt the organization's processes. To summarize the barriers are considered to be costs, technology and level of perceived benefits to the organization.

Currently the organization is content with its VoIP communication system and does not plan on pursuing any short term implementation projects to change the system. However the interviewee does mention that a strong possibility exists that in the near future the organization will utilize Unified Communications in order to better facilitate their support services to the clients. This would integrate some of their real-time communication technologies allowing for the integration of webcams, instant messaging and telephones.

## **Competitive advantage and cost benefit analysis**

The organization decided to switch to VoIP in 2006/2007 because management wanted a newer communication system that provided more flexibility and options. According to the interviewee VoIP was seen as the logical choice because management saw its growth in the commercial market and was interested in the possible benefits it could provide. There was also the fact that maintenance costs for the old telephone system were becoming more expensive.

The actual implementation of VoIP did incur huge financial costs but the organization is now saving more money than before. This is because the support and service contract from the provider is more cost effective for the organization. On an annual basis they do incur lower costs because of VoIP. The relatively high costs for implementing the new VoIP technology was the sole reason the organization did not decide to switch to the new platform sooner. This is a midsize organization with fewer resources than its larger corporate counterparts. Apart from the prospect of cost saving in the long run, the added flexibility and the possibility for utilizing applications that run on the IP telephones were also reasons that the organization chose to switch to VoIP.

The organization perceives a competitive advantage when compared to its competitors that still utilize the PSTN. The costs for telephone traffic have decreased and combining this with the additional savings due to a more efficient service contract from the provider means that there is a significant decrease in operational costs originating from telephony in the organization. To a certain degree these benefits are overshadowed by the high initial implementation costs of the VoIP system but ultimately in the long run a net savings is achieved. These additional resources can then be re-invested where required in order to gain maximum benefits. It was neither the goal nor the expectation of the organization that instant cost savings and competitive advantage would be acquired. The aim was to achieve these goals in the long term by functioning more efficiently with the same resources while at the same time utilizing a more flexible communication platform that is capable of providing additional future functionality. The interviewee mentions that they were fortunate that no major problems occurred during the implementation which would have jeopardized their daily operations, possibly increasing their costs. The availability of their service desk is crucial as this also influences the level of confidence that clients attribute to the organization.

A thorough cost benefit analysis was performed by the organization before an implementation trajectory was started. Multiple VoIP providers were approached and asked to submit an offer. Compatibility with legacy hardware was not that much of an issue since the organization was in the process of renewing its networks. This meant that the organization could adapt rapidly if new hardware change were required. Initial costs and the long term service contract were important criteria in the VoIP provider selection process. Ultimately Cisco was chosen because they provided the best support contract and offered the most inexpensive implementation planning. The interviewee mentions that Cisco offered a deal that included both implementation support, telephony hardware and a 5 year support contract for a sum that was 10 % less than the other competitors.

## **Future**

The interviewee expects that in the next couple of years VoIP will control the majority of the commercial market and replace the existing analog telephony systems. For the organization he

estimates a broadening of the VoIP features that will be used. He expects that Unified Communications will be used more and that custom applications will be installed on the IP phones to provide additional support with employee activities. The general trend of communication technology would be that there is a further integration or convergence of different types of technology like telephony (also mobile), text messaging programs and e-mail. This is also supported by the evolution of mobile telephones which can nowadays both receive and send e-mails while running chat programs and even perform video conferencing using built in digital cameras. Advances in communication technology can influence the way organization operate or how they approach their clients.

#### ***4.7 Petroleum Organization***

##### **Description of the organization and interviewee**

This organization is an international energy supplier that primarily deals with the production and distribution of gas and oil. Although the corporate headquarters is situated in Canada, the organization has numerous branch offices throughout the world, including the Netherlands. The main administrative command center for locations outside of North America is based in London. The service desk that assists users with computer related problems and provides application support is also situated in London. The Netherlands branch has an office in The Hague and maintains operational authority over three offshore drilling platforms located in the North-Sea. The organization has approximately 4500 employees.

The interviewee is an IT manager of the Netherlands branch office and has several years of experience working within the organization. He was present during the VoIP implementation and he is also one of the principal supervisors of the VoIP project for the Netherlands branch. The interviewee was involved during every step of the VoIP implementation which consisted of tasks such as the initial selection of a VoIP provider, implementation consultants and contract approvals.

#### **Interview Results**

##### **VoIP and the core business**

The main activities of this organization are centralized around the discovery and acquisition of the fossil fuels, oil and gas. The procured oil and gas are refined and distributed to other parties by this organization. It is a multi-national organization with offices worldwide. Support activities include human resources, IT departments, the salary administration, communications department and the international service desk which is located in London. Every branch office has a separate IT department which handles the daily rudimentary tasks of assisting employees with computer

related activities. The IT department coordinates with the international service desk in London to assist employees with more advanced issues such as access to specialized software for drilling platforms and computerized designing.

The interviewee states that little has changed after the introduction of VoIP in the organization. The core business processes have not been affected. The supporting business processes have been influenced to a certain degree. Communication within the organization has generally been made cheaper and more efficient; especially contacting international offices is easier and more cost-effective. The IT departments and the international service desk have incurred the greatest changes as they have to maintain and manage the VoIP system. They use specialized software in order to create VoIP numbers, call group structures and to manage the rest of the VoIP system. The basic form of phone based communication has not been changed in the organization; the only mayor difference that is perceived by employees is VoIP based phones instead of analog phones. There is a digital phonebook available which employees find very useful. Furthermore the VoIP system has been integrated with a chat program and webcam functionality to assist employees during conference calls. When employees receive a message in their VoIP voicemail box an e-mail notification is sent to the employee's e-mailbox.

Features of VoIP at the organization are:

- Basic IP calling functionality
- Management software support for IP numbers
- Call group structures
- Integration with chat program
- E-mail notification for voicemail
- Digital phone book

### **VoIP barriers and improvement**

The overall implementation of the VoIP system was done in steps to ensure that communication did not suddenly cease to function. This meant that a hybrid scenario was temporarily present in the organization where the analog and VoIP systems where functioning side by side. According to the interviewee there were no significant problems during the VoIP implementation. He attributes this to the costly and thorough analysis that was performed by a technology consulting firm that was hired to assist with the acquisition of the VoIP system. The consulting firm advised the organization from the very beginning of the implementation project and handles subjects such as hardware selection but also managerial subjects such as business-IT alignment.

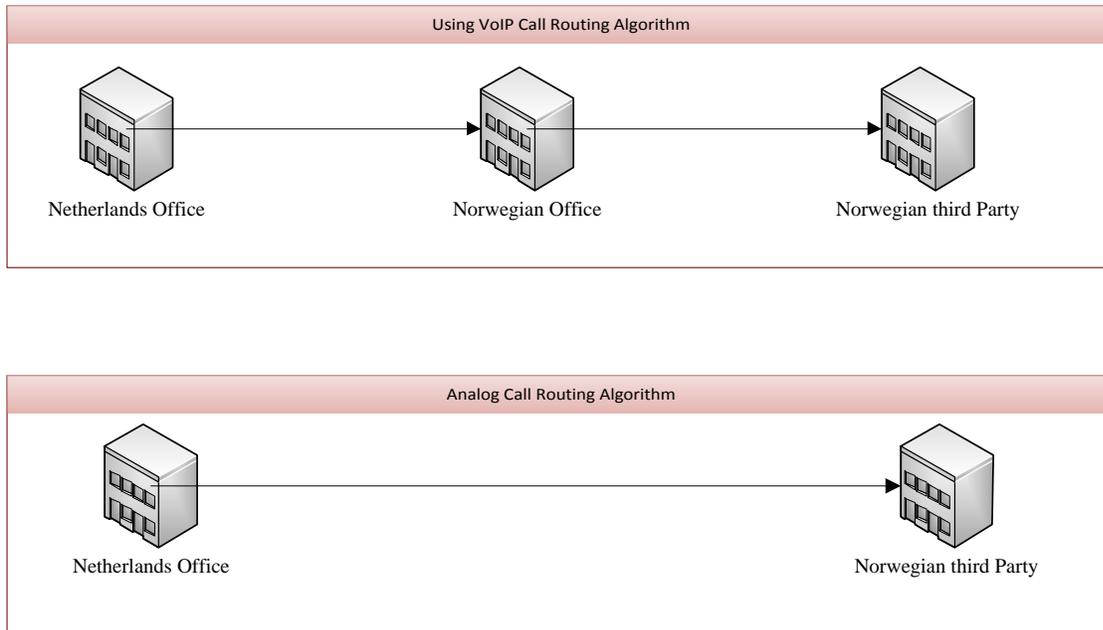
Although there were not really any technological problems with the implementation project, higher management did require a lot of time to make an unbiased decision about the VoIP project and the level of functionality that would be used in the organization. At the time the new

communication system was being considered, management needed to provide a justification for the high acquisition costs of the VoIP system. This justification was made difficult due to the vague results of the initial added-value analysis of the new communication system.

The interviewee states that there are no plans at this time to perform any upgrades to the VoIP system. The current VoIP implementation works within the desired parameters. Furthermore management still wants to postpone any changes to the VoIP and data networks as there is currently a reorganization taking place. This reorganization would make implementing changes difficult, causing some departments and branch offices to disappear or be sold to other parties. A possible future enhancement to the VoIP system could be the routing of the organization's cellphone traffic through the VoIP network which would reduce mobile costs significantly. The introduction of Unified Communications would also be desirable as such a concept is already being used within the organization on a lower scale. Making a dedicated Unified Communications platform which integrates the VoIP system with a chat program, the e-mail system and webcams is desirable.

### **Competitive advantage and cost benefit analysis**

The interviewee mentions that the VoIP system has been positively received within the organization and that from his perspective competitive advantage has been achieved to a certain degree. Phone based communication has been made more efficient and cost effective within the organization due to VoIP. The cost benefits are especially noticeable considering the high amount of phone calls which are placed to international destinations. These long distance calls are frequently made on a daily basis to branch offices and third parties to coordinate the acquisition and distribution of oil and gas.



**Figure 4.2: Call routing algorithms, VoIP vs. Analog.**

Figure 4.2 displays the workings of the algorithm used by VoIP to route international calls. This routing algorithm ensures that the call is routed in such a manner that the least amount of costs are incurred. Using an analog call routing algorithm the system establishes the shortest (direct) connection to the destination which is not always the cheapest option. An example is shown in Figure 4.2 which demonstrates a call originating from the Netherlands branch office which has as its destination a Norwegian third party. With VoIP the call is first routed to a branch office in Norway and then transported to the third party. This way the call is routed within the organization's network before being redirected to another destination which reduces international call fees.

A thorough costs benefit analysis was performed by an external consulting firm before the implementation of the VoIP system was started. The consulting firm made numerous revisions to the proposal for the implementation project as the initial proposal that also covered the cost benefit analysis where considered to be insufficient for higher management. Eventually a revised proposal was accepted which included a recommendation for a VoIP provider. The provider Mitel met the organization's criteria as it promised to deliver the VoIP hardware and only required minor changes to be made to the current data network. This meant that hardware incompatibilities were kept to a minimum. Other providers also gave reasonable bids but these were less cost effective and their hardware suffered from more compatibility issues with the organization's legacy systems.

## **Future**

The interviewee highlights the increase in the importance of mobile communication devices. Smart phones and devices such as Apple's IPAD are constantly being enhanced with additional capabilities. This development could have wide ranging effect on the manner in which organizations conduct their business and thus also on the business processes of these organizations. Personal communication devices such as smart phones are now capable of running different software applications that can be used by organizations to provide a broader range of services to clients. Mobile banking which enables one to check his account information or make payments using a smart phone with a specialized application is an example of a new development which can change processes in organizations. This is especially so for banks which would need to alter their information systems in order to support mobile banking. Advances in communication technology can have a lot of influence on organizations but the sector an organization operates in and the desires of the clients will play a major role in deciding the manner in which new communication technology is used and the level of influence it has.

## **4.8 Social Care Organization**

### **Description of the organization and interviewee**

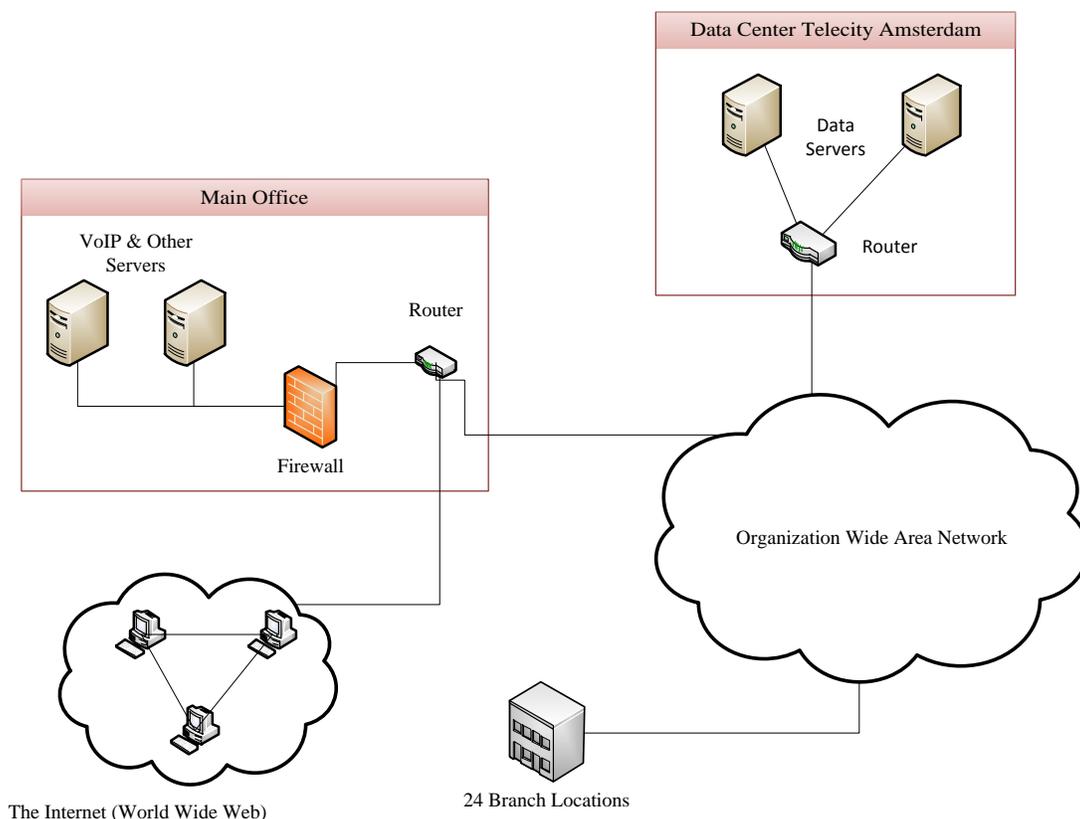
The organization provides a wide range of care services to people with a disability (clients). These disabilities can be physical, mental or both. It is the aim of the organization to provide its clients with adequate care so that they can attain or maintain a functional role in society. The care provided to clients can be altered to suit individual needs and is thus not standardized. The organization has multiple locations in the province South-Holland with the largest concentration being in and around The Hague where the main office is situated. Some of the other locations consist of offices but the majority are composed of living units where special care supervisors provide assistance to clients who are living in the unit. The organization has approximately 950 clients and 325 employees that are spread out over more than 100 locations.

The person that was interviewed is a senior IT professional which has been working in the organization for numerous years. He was involved with the initial planning and implementation phase of the VoIP project and has extensive knowledge of the communication system's functionality and the organization's network. This knowledge is gained due to his daily use and management of the IT and VoIP systems within the organization.

## Interview Results

### VoIP and the core business

The core business process of this organization is providing quality care to its clients. This involves tasks performed by qualified healthcare professionals that supervise clients under their care. Support activities include standard departments such as human resources. Although IT only plays a supporting role in this organization it is a necessity as it assists the healthcare professionals in their primary tasks. IT allows employees to give efficient and high quality care to clients. The tasks provided by healthcare professionals can vary greatly depending on the needs of the client. A task can be a simple supervision role where clients are looked after and offered guidance in their daily lives. It can also include routine client sessions with a psychiatrist.



**Figure 4.3: Organizational network.**

In Figure 4.3 the organization's network is displayed. The VoIP and some other servers are housed in the main office which is protected through a firewall. The main office is connected to the rest of the organization wide network and also to the internet. For financial reasons all data servers are housed in a giant server park called "Telecity Amsterdam". The facility has servers from multiple organizations and provides a high quality (off-site) location with security for a reasonable price. It is ideal for organizations that do not have the capital or room to house their

own servers. Having the servers in a completely different location is a method that is often utilized to ensure business continuity if a disaster befalls the organization. The data center is connected via leased lines to the organization wide network. Furthermore there are 24 branch offices directly connected to the organization's network.

The organization was considering upgrading the telephone network when the introduction of VoIP was proposed by the KPN telecom organization. The interviewee mentioned that VoIP has not affected any processes within the organization. This is partially due to the fact that the implementation of VoIP in this organization is limited to a pilot program which was introduced for test purposes. Furthermore there are major technical difficulties with the current VoIP implementation which as of yet have not be resolved. These technical difficulties make an organization wide implementation impossible and thus the legacy communication system is still the primary system used communication.

The VoIP pilot program is implemented in a department (4<sup>th</sup> floor) of the main office. The IT department manages the system using special managed software to assign IP numbers and create call group structures. However due to technical difficulties the VoIP functionality is not working correctly.

Features of VoIP at the organization are:

- Basic IP calling functionality
- Management software support for IP numbers
- Call group structures

### **VoIP barriers and improvement**

A pilot program for the VoIP implementation was used for testing the stability and functionality of the VoIP system. A pilot program is basically a test phase where new technology used first used with a select group of people in order to make an evaluation of the technology. The main plan was to detect and remove problematic issues with the VoIP system and later when system stability was acceptable to incrementally replace the legacy communication system with VoIP. The technical difficulties encountered with the pilot program makes replacing the legacy telephone system an impossibility (currently), as the QoS and reliability are not sufficient to sustain an adequate level of operation for the organization.

The technical difficulties of the VoIP system vary and originate partially from hardware incompatibilities with the current network hardware and other (as of yet) undiscovered hardware and software abnormalities. This causes the VoIP system to randomly stop functioning for short periods of time which makes phone based communication during these "black out" periods impossible. There is a constant non removable echo when calls are made using the VoIP system. KPN made a recommendation to install different hardware which would remove the echo

problem, however after following this advice the organization still experiences the same echo problem. The interviewee mentions that the VoIP provider (KPN) is still investigating the cause of the echo problem and is unable to detect the cause which makes the problem significantly worse. Another problem is caused by the interaction between the current computer work environment (Citrix) and the VoIP system. Using VoIP in other locations causes a problem as the Citrix provider does not guarantee the proper functionality of the computer work environment if VoIP data is transported over the network alongside normal data. This could mean that employees in branch locations can experience slowdown and other problems with their computers.

Before any semblance of an advantage can be gained from the VoIP system, the various issues plaguing the system need to be resolved as soon as possible. The interviewee proclaimed that it is useless to consider upgrading the VoIP system when it is still not operating properly. When the system is functioning correctly, then the first step would be to slowly remove the legacy communication system and replace it with VoIP. The concept of Unified Communications is known to the interviewee but he does not consider it a feasible option in the near future as the perceived additional benefit of such functionality is minimal in this organization. The idea of implementing an upgrade to the VoIP system, which would make routing mobile phone traffic through the network possible, is something that can be beneficial in the future. This is however only if the current VoIP implementation can be fixed in order to operate correctly.

### **Competitive advantage and cost benefit analysis**

According to the interviewee there is no perceived gain in terms of competitive advantage due to the numerous technical issues that keep the VoIP system from functioning correctly. He states that to a certain degree the introduction of the VoIP system has even weakened the organization's position in the market. This is caused by the problems with the VoIP system that make it unusable which ultimately leads to a loss of resources such as manpower and money. Countless hours have been wasted by personnel to make the VoIP system operational and financial losses are incurred due to hardware purchases and consulting fees. In short the VoIP implementation has encountered runaway costs (is over budget) and is still not usable.

A cost benefit analysis has been performed before the initial acquisition of the VoIP system. A VoIP platform was proposed by KPN and the organization acknowledged the proposal due to the aging legacy communication system that needed to be upgraded or replaced. KPN made a lucrative offer to the organization which included low implementation costs and a cost effective long term support contract. The interviewee mentions that the cost benefit analysis was performed by KPN which was the same organization that proposed the initial implementation. In retrospect a conflict of interests was evident but this did not hinder higher management from accepting the cost benefit analysis report and giving the contract to KPN. No other organizations were requested to make a bid for the contract as higher management was very satisfied with the

low implementation costs and the lucrative long term support contract provided by KPN. The implementation project was not completely a fixed-price project as a specific budgetary threshold existed which meant that in the event of unforeseen circumstances (technical problems for example) all costs above a certain threshold had to be covered by the organization and not the VoIP provider. This clause in the contract, which was partially neglected by higher management, is one of the major causes of the runaway costs effect of the VoIP project. The interviewee states that ultimately the organization is somewhat fortunate as they only implemented the VoIP system in a single department which limited the negative effects. If an organization wide implementation was immediately performed the results would have been much worse.

## **Future**

The interviewee notes that advances in communication technology will have the potential to change the way organizations operate. An example of this is the recent rise of social media like Facebook and Twitter which has a profound effect on certain organizations. Especially marketing organizations adapt their business processes to make full use of social media in order to gain access to a broader audience. This essentially created an entire new niche market in which social media is extensively used to come into contact with prospective clients. New developments in communication technology will most likely not benefit all types of organizations as some do not perceive any additional benefit due to operating in a specific market sector. To make a real world comparison, a marketing organization can benefit greatly from the development of social media while an organization that practices offshore-drilling will hardly find any use for it. Organizations should also be aware of possible faults with new communication technology and make thorough evaluations before deciding to implement a new technology. The results of a failed implementation can have wide ranging consequences that could negatively influence the business processes of the organization.

## **4.9 VoIP Provider**

### **Description of the organization and interviewee**

This organization is one of the major players in the global networking and telephony market. It enjoys wide ranging recognition in the business community, has been nominated for numerous awards and was ranked first place for its performance with Unified Communications and enterprise telephony in 2009. Furthermore the organization is represented in over 33 countries and is currently a close second in the global VoIP market segment. On a global level it has approximately 21000 employees. In The Netherlands the offices of this organization are located in three locations throughout the country, namely Nieuwegein, Vianen and Rijswijk.

The person that was interviewed at this organization is a senior account manager who has various years of experience with the local telephony market. He has extensive knowledge of the products the organization produces and the services that are offered. Furthermore due to his years of experience maintaining business relationships with Dutch organizations he possesses a basic understanding of the general preferences that local businesses have. This allows him to accurately indicate and discuss the overall trend of the Dutch telephony market.

## **Interview Results**

### **VoIP and the core business**

In the last five years organizations in the Netherlands have become increasingly aware of VoIP and confidence in the communication technology has risen substantially. In general Dutch organizations have a tendency to be slightly risk averse which makes them less inclined to rapidly introduce new technologies which can normally contain hidden faults. Due to the increased market penetration of VoIP, an abundance of reference cases and knowledge, VoIP has gained a strong market share in the Netherlands. The trend is that most large organizations in the Netherlands currently have a VoIP platform or are considering implementing one. Smaller organizations are more hesitant about introducing VoIP as the implementation costs can be high while the added functionality might not be completely utilized. The approximate market share of VoIP (for all providers) in the Netherlands can be described as being between 40-50 % for the business market.

Due to the global financial crisis many organizations postponed their plans to upgrade their communication systems and are now deciding to implement a VoIP communication solution. Usually VoIP implementations are performed incrementally in which a temporary hybrid scenario exists. This means that the legacy communication system is functioning alongside the VoIP system in order to ensure communication continuity within the organization. A feature that is often requested when VoIP is introduced is an upgrade to the PBX which makes it able to transfer digital data using the organization's data network. A pure IP telephony platform, where the PBX hardware is completely removed and software performs the telephony routings tasks, is not often requested as such an implementation is more expensive. Simple IP calling functionality using VoIP phones which transport data over the organization's data network is a feature which most organizations desire. Besides basic IP calling functionality, organizations usually request management software in order to be able to control and configure their own VoIP network to a certain extent. A digital telephone book is also an often requested feature among Dutch organizations. Furthermore a VoIP feature which is gaining popularity in the Netherlands is the use of Unified Communications.

The VoIP features that are installed in organizations can have an effect in the core business of the organization in which it is used. The level of change incurred by the core processes is strongly dependent on the individual circumstances of the host organization. Factors such as the market sector of the organization, management culture, technological and budget constraints all have an influence on which VoIP features are implemented and how they are used. From a general perspective it can be said that VoIP does help making some processes more efficient while requiring less financial resources. The interviewee mentions that the way VoIP influences the core business of organizations differs.

### **VoIP barriers and improvement**

Often organizations have difficulty with accurately assessing the added benefit of additional VoIP functionality. Organizations do realize that VoIP is more than just a form of “digital telephony” but additional functionality is still perceived as being more of a technological accessory instead of a tool for optimizing processes. The interviewee mentions that this is a mentality issue that is still present today but it is currently disappearing as more research conducted in the field of VoIP and communication systems. Another barrier that seems to prevent organizations from implementing additional VoIP features is the probability for compatibility issues with current hardware/software that is used within the organizations. To a lesser extent costs seem to hinder organizations from using new VoIP features. After finishing a lengthy implementation trajectory and investing a significant amount of funds in a VoIP system, organizations want to see some return on investment and usually prefer to wait before making any changes (installing new VoIP functionality) to their communication system.

During an implementation project one of the frequently occurring issues is hardware and or software incompatibility with the legacy systems. The probability for an incompatibility problem to arise during the course of a VoIP implementation is high as not all organizations have an up to date infrastructure for transporting data on their networks. Often organizations utilize certain software that is crucial for their daily business processes that can create issues when VoIP data is also transported over the same data network. Due to data intensive processes or an outdated network infrastructure, QoS issues with VoIP can occur that delay the implementation project and incur additional costs. According to the interviewee, a few years ago there were more problems concerning VoIP systems as strange abnormalities occurred after implementation was performed. Examples of such abnormalities are:

- The sudden start of printers when a VoIP call is received
- Being unable to print when VoIP call are performed
- A persistent echo that randomly appears during a call

Most of these issues have been resolved with advances in VoIP technology but some still occur on occasion. In terms of general improvements that could be made to VoIP systems, it is hard to measure the general needs of all organizations as their operational requirements differ greatly. An implementation of a Unified Communications solution is considered by many organizations to be a possible next step for VoIP functionality. Although not many organizations have actually implemented it, many are considering using it in the future and are actively monitoring the development of the Unified Communications functionality.

### **Competitive advantage and cost benefit analysis**

Most organizations perceive a certain level of competitive advantage when compared to rival organizations who have not implemented a VoIP system. VoIP must not be seen as a tool for automatic instantaneous benefits. Organizations which gain the most out of a VoIP system have usually done thorough research and testing before implementation and see VoIP as a long term strategic investment rather than a short term fix. The interviewee mentioned that in the Netherlands, the number one reason for organizations to migrate towards VoIP is cost-savings while added functionality and flexibility fall into second and third place.

According to the interviewee, Dutch organizations in general perform an exploratory cost benefit analysis. However the thoroughness of such an analysis differs per organization. Many organizations higher an independent specialized consulting firm before conducting a costly implementation of a VoIP system. There are also organizations who neglect to consult independent third parties or decide to conduct only a superficial analysis which heightens the risk of problems later on during a VoIP implementation. The reasons for such behavior are hard to determine although a lack of an adequate timetable for the consideration of a VoIP system is a factor. This means that shortcuts are taken by management in the decision making process in order to make implementation projects start faster. Another explanation is simply bad management. The interviewee highlights the importance of following proper testing and evaluation procedures as IT projects are notorious for having a runaway costs effect and VoIP implementation projects do not differ in this aspect.

### **Future**

Advances in communication technology can have wide ranging effect on the manner in which organizations conduct their business. Most likely communication technology will drastically change some business processes, other processes will disappear completely and some might hardly be affected. The specific market sector organizations operate in will determine to a certain extent what level of change the business processes will incur due to advances in communication

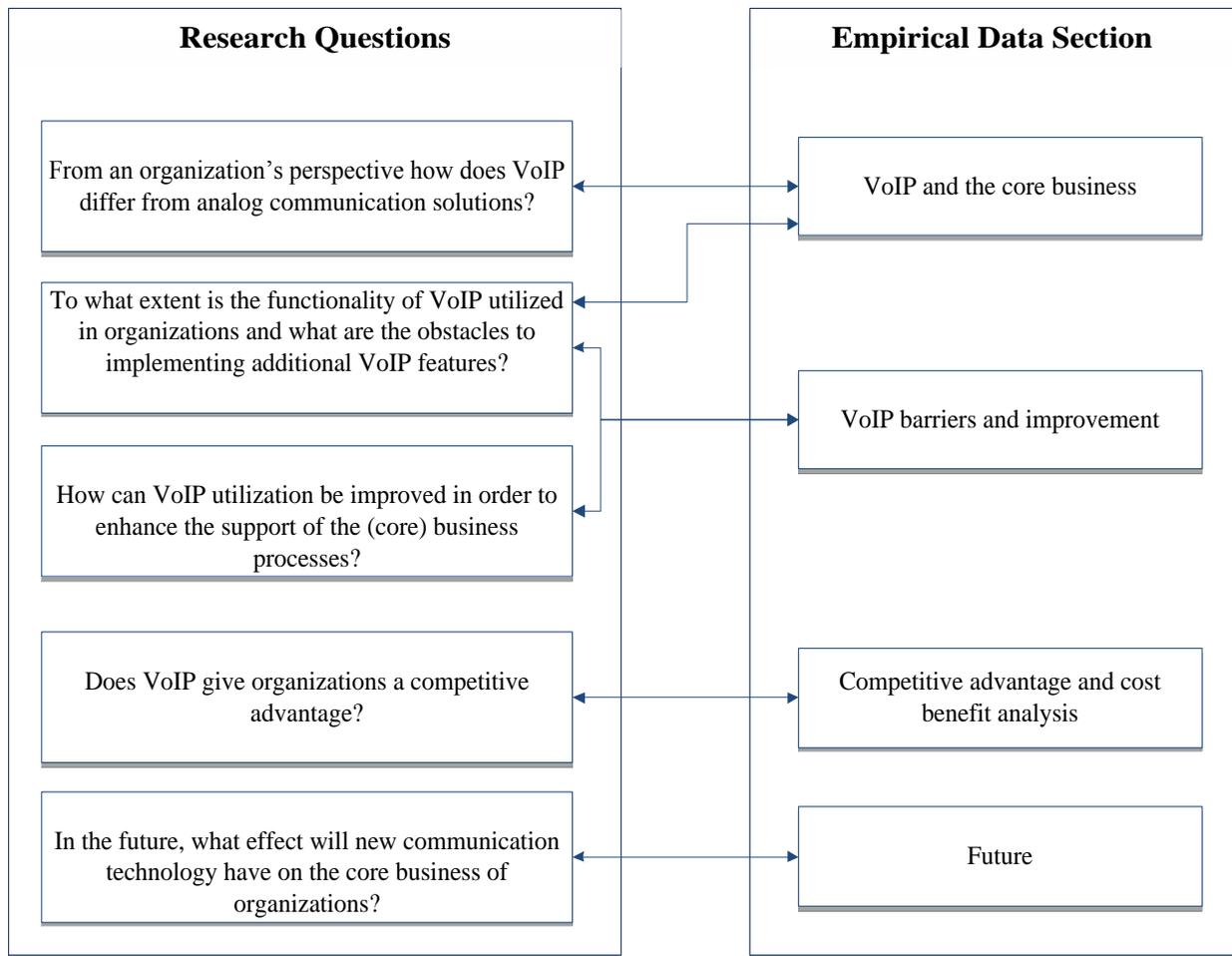
technology. When looking back at the appearance of the Internet, one can say that new communication technologies can create entire new markets for organizations to master. These new markets are defined by newly developed communication technology which in turn influences the core business processes of the organizations operating in these markets.

## 5 Data Analysis

In this chapter the empirical data that was collected from the interviews at the various organizations is analyzed in order to produce results that are important for finding the possible answers to the sub and the main research questions. The first part will focus on the categories for the qualitative content analysis and their relation to the empirical data sections. The rest of the chapter focuses on the explanation and interpretation of the categories while considering the research questions.

### 5.1 *Category Overview*

Figure 5.1 provides a detailed overview of how the research questions are related to information in the empirical data. Each section of the empirical data is directly based on one or more corresponding research questions. The arrows represent mutual influence between the research questions and the corresponding empirical data sections. The empirical data sections must not be seen as similar to the categories that are needed for the data analysis as they are too general and do not provide any additional information pertaining to the research questions. The empirical data sections have a function for being viewed as “themes” that can be utilized in order to make category development easier. Per theme one or more categories are produced and explained. This ensures a systematic approach to the category development process and maintains a connection with the research questions. The selection of categories by using the themes is basically the same as determining the criteria for category selection as depicted in Figure 3.2.



**Figure 5.1: Relation between research questions and empirical data sections.**

In the subsections that follow, the categories that were found by analyzing the data are separated based on the four themes that correspond to sections of the empirical data. These themes are shown in Table 5.1 which represents a category matrix. For simplicity reasons abbreviations have been made for the themes, presented in parentheses after each theme in Table 5.1.

**Table 5.1: Category matrix showing themes and their corresponding categories**

Theme	Corresponding Category
VoIP and the core business (CB)	VoIP increases functionality & efficiency
	VoIP's overall effect on organizations varies
	Typically only basic VoIP functionality is implemented
VoIP barriers and improvement (BI)	Incompatibility issues with legacy systems are frequent barriers
	Unified Communications is perceived to improve VoIP utilization
Competitive advantage and cost benefit analysis (CBA)	Competitive advantage gained due to VoIP is often caused by cost savings
	A thorough cost benefit analysis is not always performed
Future (FUT)	Influence of future communication technology is dependent on market sector of the organization

## 5.2 Categories CB

### VoIP increases functionality & efficiency

The empirical data from the nine organizations provides strong indications that support the notion that (under normal circumstances) VoIP increases the overall functionality of an organization's communication system and that some level of efficiency gain is achieved. The functionality increase was observed at the majority of the organizations as they all utilized special management software to control their VoIP system. The management software increased the efficiency for IT departments and the mobility for normal employees. Educational organization II particularly mentioned the gain in efficiency for the IT department as an advantage. Government organization II is a good example of the added functionality of a VoIP

system as it uses a mobile implementation of VoIP that allows users to be completely mobile in a cost effective manner while performing their tasks.

The efficiency that is gained due to the introduction of VoIP within an organization is not necessarily directed at the core business processes, but must be seen as a general increase in the efficiency with which phone based tasks are performed. When more phone-based tasks are performed by people, the probability for the efficiency and functionality improvements to have an effect on them will increase. The efficiency gain does not have to be large as the majority of the organizations experienced only small increases in their support processes. However the improvement was noticeable and was probably caused by the introduction of VoIP.

A noticeable detail was that there appears to be no direct correlation between the level of added VoIP functionality utilized and the amount of efficiency gained. Simply put, more VoIP functionality does not automatically translate to more efficiency. An actual efficiency gain would be related more closely to the specific type of added functionality utilized (Unified Communications for example), the types of processes that exist in an organization and the level of integration between the VoIP functionality and the processes. The fact that VoIP generally increases functionality and efficiency to some degree in organizations is not a new discovery as this was also supported by previous research (Sacker et al., 2006).

### **VoIP's general influence on organizations varies**

The empirical data shows that accurately describing the general effect of VoIP on organizations is not easily done. This is because the general manner in which VoIP influences an organization that has implemented the technology is not always the same. Besides the observation concerning a possible increase in flexibility and functionality due to VoIP, other more significant changes cannot be directly attributed to VoIP. The data shows that the influence of VoIP on an organization can in some cases be considered minimal as there are no major changes to an organization in terms of the manner in which it conducts its business. In this context a major change would entail any alteration of the core business processes of an organization that have either a positive or negative effect on the operating capabilities of the organization. Changes in support processes, although present, are not considered to be large enough to significantly alter the core business processes.

In order to get a more accurate overview of the effects of VoIP on core and support processes within organizations, Table 5.2 can be used as a reference tool. The table shows the interviewed organizations grouped together according to their market sectors and whether VoIP had any level of influence on the core and supporting processes. Nine data samples are not sufficient for making strong conclusions according to quantitative analysis standards. However, the table does provide a strong support for the viewpoint that core business processes incur practically no

change due to VoIP while support processes do. The table shows that only the VoIP provider did not directly produce information that disproves any effect of VoIP on the core processes. The VoIP provider mentioned that the effect on the core business processes varies depending on the type of business an organization is conducting. It is likely that the VoIP provider is biased in its view since it delivers VoIP as a service.

**Table 5.2: Effects on core and supporting processes**

<b>Organizations Interviewed</b>	<b>Effect on Core Processes</b>	<b>Effect on Supporting Processes</b>
2 Educational Organizations	No	Yes
3 Government Organizations	No	Yes
2 Commercial Organizations (operating in different market sectors. Not telephony dependent sectors)	No	Yes
A Social Care Organization	No	Yes (negative)
A VoIP Provider	varies	Yes

One could argue that the reason that VoIP has minimal influence on the core business processes is due to the fact that the core business of the organizations that were interviewed did not make use of telephony. It is probable that as the organizations in the empirical data did not operate in market sectors where the core business was dependent on phone based technology, VoIP had no effect on their core business processes. The VoIP provider was the only organization in the empirical data that has a significant dependency between VoIP and its core processes, but the organization was interviewed with an emphasis on its clients and not on the organization itself. A prospective conclusion would be that there needs to exist a correlation between the level of core business process dependency on VoIP and influence that VoIP has in these processes. The greater the dependency on VoIP, the more the core business process can be affected by it. Ultimately what is implied by the empirical data is that the influence of VoIP on the core business processes of organizations has the potential to differ per organization but that the general effect remains marginal.

In contrast to the core business processes, the support processes in organizations are generally influenced more by VoIP. Especially IT departments and departments where telephony is used repeatedly in daily tasks (e.g. helpdesk, secretaries etc.) are effected. The empirical data shows that IT departments incur the highest level of change due to VoIP. This is logical as these

departments have to support and manage a VoIP system thus changing the way they normally operate. From Table 5.2, while focusing on the social care organization from the empirical data, it is clear that the support processes in that organization were negatively influenced by VoIP. This was caused by a faulty implementation where numerous hardware and software compatibilities plagued the VoIP platform.

### **Typically only basic VoIP functionality is implemented**

When approaching the subject of VoIP functionality, the empirical data shows that organizations tend to only install basic VoIP functions. Although the functionality of the VoIP systems at the organizations from the empirical data differs, there were always specific functions that repeatedly showed up. These are:

- Basic IP calling functionality
- Management software support for IP numbers
- Call group structures

The basic functionality is the minimal requirement necessary in order to utilize a VoIP system and manage it. It is worth mentioning that the empirical data shows that the use of a digital address book is a frequently implemented feature. However, it appears that additional VoIP functionality is not widely utilized in the organizations that were interviewed. Such as custom applications for VoIP phones or routing mobile phone communications through a VoIP network (has been implemented in government organization II). While taking the market sector of the various organizations and their core business into account it is likely that the organizations consider to have no need for additional VoIP functionality as they will likely not use it on a sufficient scale for it to be worth the implementation effort.

### **5.3 Categories BI**

#### **Incompatibility issues with legacy systems are frequent barriers**

The majority of the organizations in the empirical data experienced a wide range of problems when they started implementing and using their VoIP systems. The most frequent reoccurring problem was incompatibility between hardware and software systems currently in place and the new VoIP system, which caused irregularities. These irregularities lead to the disruption of the VoIP system and other processes within the organization. To be more specific, such irregularities usually slow down the completion time of processes in organizations which translates into (temporarily) higher costs and lowering of the service standard towards clients. VoIP requires

specific hardware in order to function correctly. It also needs a sufficient allocation of network bandwidth in order to maintain its QoS. Hardware incompatibilities were problematic because in some cases quick solutions were required. The fact that VoIP does not function without power also caused problems. Legacy communication systems based on the PSTN do not necessarily need external power. This forced organizations to utilize additional measures in order to allow VoIP to function in times of need by installing back up power units.

All organizations from the empirical data first encountered incompatibly problems with their legacy systems when they started implementing their VoIP systems. This was not unexpected as the VoIP technology is still considered new and the organizations had legacy communication systems that were relatively old (10+ years in some cases). Combining these two aspects with the fact that organizations usually introduce VoIP incrementally (hybrid situation with both systems functioning in parallel), the probability for compatibility issues to arise is high. Combining new technology with an older one does not always lead to a stable environment, technology wise. Despite that the organizations had compatibility problems when they started implementing; the majority of them overcame problematic issues. Except for the social care organization, the rest of the organizations have fully working VoIP systems (or are almost done with implementing). This means that their implementations were completed successfully from a technical perspective.

Not all organizations experienced the same level of problems concerning hardware and software incompatibilities. Some encountered minor issues that could quickly be resolved. This was the case at government organization III. In contrast, the social care organization suffered severe hardware and software incompatibilities that ultimately led to the VoIP implementation being a failure. There are various reasons for the fact that some organizations had more incompatibly problems than others. Likely sources are the specific legacy systems. Organizations have different systems for conducting their daily tasks. These specific systems can cause problems when they interact with a VoIP system that operates on the same digital network. Bandwidth issues must also be taken into account as VoIP demands additional performance from an organization's digital network as it shares the network together with other systems. Government organization II shows that an organization's systems that work on the same network as VoIP can cause bandwidth issues to occur. Additional time is required during the planning phase of a VoIP implementation as problems that are detected early on can be dealt with swiftly instead of having them manifest later and disrupt the implementation and processes in an organization. This can lead to a loss of resources like with the social care organization. Furthermore a good way for detecting problems with VoIP systems (or any IT system for that matter) is running actual trials where the system is working according to daily operational parameters (pilot program). Such a trail program was used in government organization II and the social care organization to detect problems with the VoIP system early on. This method helped to impede the loss of further resources by the social care organization due to implementation issues.

## **Unified Communications is perceived to improve VoIP utilization**

Now we look at possible improvements that could be made to the VoIP systems at the organizations. Regarding the organizations from the empirical data, it is apparent that although they have improvement suggestions, no organization is actually in the process of implementing an upgrade to their VoIP system. One of the reasons for the lack of initiative for upgrading VoIP systems was that most of the organizations have just recently implemented a new system or are in the processes of completing the implementation. A VoIP implementation is a large investment in terms of resources and organizations are not willing to make additional contributions while still expecting a return on investment from the previous (VoIP) implementation.

In addition there appears to be a lack of transparency concerning VoIP improvements and their added value for organizations. To be more precise, organizations do not see the added value (for their situation) that additional VoIP improvements could bring. It should be taken into account that the organizations from the empirical data have a low level of integration between their core business processes and VoIP system. This means that (at the moment) they tend to see a VoIP system as a more sophisticated communication system but not as something that can alter their way of operating in their market sector. This viewpoint contributes to their current lack of motivation for improving their VoIP system as they do not perceive significant benefits for themselves. Furthermore introducing changes to a VoIP system has the potential to introduce new stability and compatibility problems.

Despite the fact that the organizations are not currently conducting any improvements concerning their VoIP systems, almost all of them mentioned the prospect of utilizing Unified Communications as a logical next step for improvement. The petroleum organization mentioned the idea of introducing a mobile VoIP platform for routing mobile telephone call data through the VoIP network. Government organization II is already implementing such a mobile VoIP platform. This idea has the potential to improve the capabilities of a VoIP system within certain organizations but it is not an upgrade that is being considered by the other organizations in the empirical data. Most likely the unpopularity of a mobile VoIP platform is attributed to the perception that it will provide little added value for organizations. The IT and the government organization II from the empirical data have started the integration of some of their communication systems according to Unified Communications principles and experience agreeable results.

## **5.4 Categories CBA**

### **Competitive advantage gained due to VoIP is often caused by cost savings**

From a business perspective VoIP does not differ much from any other IT systems when it comes to the IT strategy: management is often not interested in the specific technical aspects of

the technology but is more concerned with acquiring the additional value that the technology can produce for the organization. VoIP can also be seen as a tool that management can use in order to acquire a competitive advantage. The empirical data shows that not all organizations focus exclusively on acquiring a competitive advantage when purchasing a VoIP system. Government organization I implemented VoIP because its legacy systems were outdated and needed to be replaced quickly.

An additional factor that plays a role is that for some organizations (i.e. government organization I and higher educational organization I) their legacy systems are past their expected lifetime (service life) and it is a necessity to replace them. This leads to VoIP being a logical choice due to its popularity and support from various service providers. In this case purchasing a VoIP system is “forced” upon the organization due to their current systems no longer being able to meet the organization’s operational standards. This shows that the decision to move towards VoIP is not motivated solely by the desire to acquire competitive advantage. To an extent VoIP’s high market dominance level and utilization by service providers can exercise a type of “market pressure” on organizations that entices them to favor a VoIP solution. It is conceivable that this favorable attitude towards VoIP as a communication solution is strengthened when an organization observes competitors implement such a technology and succeeding. Eventually this can force an organization to reevaluate its legacy communication systems and consider VoIP in order to remain at an equal technological level as its competitors.

**Table 5.3: Competitive advantage gained per organization**

<b>Organization</b>	<b>Competitive Advantage Gained</b>	<b>Main Reason</b>
Higher Educational Organization I	Yes	Cost Savings
Higher Educational Organization II	Yes	Cost Savings
Government Organization I	Yes	Cost Savings
Government Organization II	Yes	Performance gain & Cost Savings
Government Organization III	Yes (but only marginal)	Cost Savings
IT Organization	Yes	Cost Savings
Petroleum Organization	Yes	Cost Savings
Social Care Organization	No (negative influence)	Implementation problems
VoIP Provider	Yes	Cost Savings

When purely focusing on the fact whether or not an organization attains any level of competitive advantage after implementing VoIP, the empirical data shows a development. Table 5.3 displays the competitive advantage gained per organization and supports the concept that VoIP allows organizations to gain a competitive advantage. It should be noted that the exact measurable gain can differ per organization from a minimal to a large one. It is likely that the nature of the core business processes and the type of VoIP functionality implemented have an influence on the level that is gained. So basically it depends on an organization's core activities and market sector, to what extent it can utilize VoIP to gain an advantage over its competitors. Although Table 5.3 shows that the majority of organizations acquired a competitive advantage of some sort, it also highlights cases where only a minimal one is gained (government organization III) and where a negative one is acquired due to implementation problems (social care organization).

According to Table 5.3 the main reason that the organizations gained a competitive advantage after introducing VoIP was due to cost savings. Government organization II also listed performance gain as a contributor to its increase. This could be caused by the high level of VoIP functionality that is used in that organization as it is the only one from the empirical data to introduce a mobile VoIP platform. Excluding the social care organization, the others all mentioned that costs savings was the main driver behind the gain in competitive advantage. This was caused by:

- Lower operational costs (telephony)
- The possibility for organizations to reallocate freed up resources (due to cost savings) to other critical departments that can enhance an organization's core business processes.

Ultimately these factors lead to an organization acquiring an advantage over its competitors. The VoIP provider pointed out that an important reason for organizations to pursue a VoIP system was costs savings (strategic long term perspective). This also had the effect that they acquired a certain degree of competitive advantage.

### **A thorough cost benefit analysis is not always performed**

A VoIP solution is a complex and expensive system that requires a significant amount of preparation before implementation can be considered. Putting sufficient time into the planning phase of a VoIP project and allowing tests to be conducted has the potential to reduce the amount of problematic issues that arise further down the road during a VoIP implementation. The empirical data shows that most VoIP problems occur during the implementation phase and can cause significant disruptions of an organization's processes which in turn lead to a loss of resources. Any organization planning a VoIP implementation should strive to mitigate implementation issues as much as possible (in a cost effective manner).

Table 5.4 shows that the majority of the organizations in the empirical data performed a cost benefit analysis before considering the implementation of a VoIP system. The thoroughness of such a cost benefit analysis however is questionable as not all organizations performed an analysis of the same level. Particularly in the case of the social care organization the cost benefit analysis could have been considered biased as it was performed by the some organization that provided the VoIP system. The VoIP provider mentioned that in the Netherlands organizations on occasion conduct merely a superficial analysis in order to cut corners and accelerate the decision making process. Table 5.4 demonstrates that there are organizations that perform no cost benefit analysis at all. This occurred with two of the organizations in the empirical data.

**Table 5.4: Competitive advantage gained per organization**

<b>Organization</b>	<b>Cost Benefit Analysis Performed?</b>	<b>Main Reason For Not Performing Analysis</b>
Higher Educational Organization I	No	Management fault
Higher Educational Organization II	Yes	
Government Organization I	Yes	
Government Organization II	No	Management fault
Government Organization III	Yes	
IT Organization	Yes	
Petroleum Organization	Yes	
Social Care Organization	Yes (not 100% dependable)	Management fault
VoIP Provider	Yes (but not always)	Management fault

When focusing on the fact that some organizations perform a superficial cost benefit analysis and some no analysis at all, it is clear from Table 5.4 that the cause in all cases is a management failure. At times management does not allow for sufficient time to consider all options for a VoIP implementation, thus forgoing possible options that can provide greater value to the organization (opportunity costs). Often management also decides to choose a VoIP service provider based on a previous positive relationship. Although this is not completely incorrect, management should also consider other organizations that might provide equal or better service and should not limit its choices from the start. Ultimately the fact that a number of Dutch organizations decide to not perform a cost benefit analysis or only do a superficial analysis can put these organizations at a greater risk of incurring a loss of resources due to implementation issues or missing out on more lucrative offers from other providers.

### **5.5 Categories FUT**

**Influence of future communication technology is dependent on market sector of the organization**

When considering the effects of new developments in the field of communication technology on the manner in which organizations conduct their business it is not easy to find a definite answer. The reason for the difficulty in determining the extent of the changes new developments can bring is caused by multiple factors. There are many organizations that operate in different market sectors and utilize a wide range of processes. Even between organizations that operate in the same market sector significant changes in the way they conduct their core processes may exist. Taking these factors into account it is considered improbable that an accurate estimate can be made concerning the extent of the impact that novel communication technology can have on organizations in general. This is even more so when the exact nature of new technological developments can only be speculated upon at this stage. The interviewees at the organizations in the empirical data mentioned their belief that new developments in communication technology have the potential to greatly affect the manner in which organizations conduct their business. The market sectors of organizations play an important role in determining the level of influence of new developments. This viewpoint is strongly supported by the social care organization and the VoIP provider.

## 6 Conclusion

This thesis aimed to discover the impact of VoIP on the core business of Dutch organizations. An emphasis was put on exploring the possibility for organizations to acquire a competitive advantage by using VoIP. A qualitative research methodology was used for conducting the research which involved performing in-depth interviews at nine organizations. For analyzing the empirical data a qualitative content analysis was performed. This involved the creation of a category system to segment the data into important parts in order to answer the research questions.

In terms of functionality and efficiency, VoIP is a superior platform when compared to traditional phone systems. Older systems have separate analog landlines that make a reconfiguration of the network (in the case of reassigning phone numbers to different locations) difficult. VoIP is more flexible and allows for a reconfiguration of the network by using specialized software such as Cisco call manager. The functionality that an analog phone system has is also limited when compared to VoIP. Older systems provide only basic functionality. The new technology provides more options that employees can use to make their task easier. Digitalized telephone books, remote telephone configuration and Unified Communications are some of the added functionality that VoIP introduces. Besides the faded functionality, VoIP also provides efficiency gains in the support processes of the organizations that implement it.

With a traditional phone system costs are usually incurred every time a phone call is made. Reconfiguration of the analog network also requires resources. VoIP does not need a separate network in order to be implemented. This saves the organization the cost of constructing a separate network dedicated to VoIP. Furthermore VoIP provides organizations with a more cost effective manner for conducting their communications by lowering operational costs and allowing access to more lucrative service contracts by providers.

It is likely that a correlation exists between the level of influence that VoIP has on the core business processes of an organization and the market sector it is operating in. The main changes incurred due to VoIP were focused on the support processes within organizations. Generally the core business processes of organization were not affected by the introduction of VoIP as long as there was no high level of integration between the core business processes and communication technology.

VoIP functionality in organizations was mostly limited to the basic functions, such as:

- Basic IP calling functionality
- Management software support for IP numbers
- Call group structures

The majority of the organizations from the empirical data only implemented the basic VoIP functionality in order to allow their systems to function and to be able to manage them. It could be speculated that the organizations had recently undergone expensive implementation projects and were not motivated enough to purchase additional upgrades for their VoIP system. It was probable that they first wanted to obtain a return on invest from their systems before deciding to implement upgrades. Furthermore it was also the case that the organizations perceived little added benefits by introducing new VoIP features. This perception discouraged organizations from considering the implementation of any additional VoIP functionality. Despite this negative viewpoint, Unified Communications was seen as a feature that organizations would likely implement in the future. In contrast to other VoIP features, Unified Communications was perceived by many organizations to enhance their systems, benefit their support and possibly their core business processes.

The problems that were experienced by organizations due to VoIP were commonly limited only to the implementation phase of the communication system. The main obstacle encountered during implementation was the incompatibility between VoIP and the organization's legacy systems. The majority of the problems were resolved after the VoIP system attained stability. Following this, organizations usually experienced a certain level of competitive advantage. The amount gained varied and was likely dependent on the extent of integration between the core business processes and VoIP technology. The main cause of competitive advantage gains in organizations was due to cost savings. Furthermore cost savings was identified to be an important reason for organizations to migrate towards a VoIP system.

Before the organizations from the empirical data considered acquiring a VoIP system, the majority first performed a cost benefit analysis in order to make an assessment. The thoroughness of such an analysis was considered questionable as there had been cases where it was only performed superficially. A few organizations did not perform a cost benefit analysis at all. The reasons for performing a superficial analysis or avoiding it completely were attributed to flawed management decisions. On occasion management wanted to cut corners and accelerate the decision making process by avoiding the cost benefit analysis or performing it only superficially.

Organizations mentioned that new developments in communication technology have the potential to greatly affect the core business processes of organizations. Some organizations are likely to perceive only a marginal change due to new developments while others will undergo significant changes to their core business processes. It was implied that the extent of the influence of these new developments was dependent on the market sector of an organization.

Ultimately it was discovered that VoIP had almost no effect on the core business of the organizations from the empirical data. This might have been caused by the low level of integration between VoIP and the core business processes of the organizations. It could be

possible for VoIP to have greater influence on the core business of organizations that have different core business processes than those in the empirical data. The number of organizations that were used to acquire data for this study was not enough to make any credible conclusions for all organizations operating in the Netherlands.

### **Research Limitations and Future Research Suggestions**

This study has some limitations that need to be taken into account. First this research does not seek to research or make any assumption about the more advanced technical aspects of the VoIP technology, nor does it focus on the general technical aspects of communication technology. The research utilizes a managerial approach and is meant to provide an insight into the possibility for organizations to acquire a competitive advantage by using VoIP technology. In order to retain the scope and due to the time constraints of this research only a relatively small number of organizations were interviewed. Future research could include performing an exploratory case study in order to assess the relative added benefits for organizations that introduce Unified Communications. Further quantitative study could be conducted by interviewing a wider range of organizations that operate in different sectors of the economy (larger data sample) and focusing more on the measurable competitive advantage gained (or lost). This could then be used to make a comprehensive statistical analysis on what the exact measurable gain in competitive advantage is due to VoIP.

## References

- Barbieri, R., Bruschi, D., & Rosti, E. (2002). Voice over IPsec: Analysis and Solutions. *18th Annual Computer Security Applications Conference*, (p. 261).
- Benbasat, I., Goldstein, D. K., & Mead, M. (1987, September). The Case Research Strategy in Studies of Information Systems. *MIS Quarterly*, *11*(3), pp. 369-386.
- Blake, E. (2007). Network Security: VoIP Security on Data Network: A Guide. *Proceedings of the 4th Annual Conference on Information Security Curriculum Development* (pp. 177-183). New York: ACM.
- Blumberg, B., Cooper, D. R., & Schindler, P. S. (2008). *Business Research Methods*. Berkshire: McGraw-Hill Education.
- Bogdan, R. C., & Biklen, S. K. (1994). *Qualitative research for education : an introduction to theory and methods*. Boston: Allyn and Bacon.
- Bryman, A. (2004). *Social research methods* (2 ed.). New York: Oxford University Press.
- Del Bianco, M. (2006). Voices Past: The Present and Future of VoIP Regulation. *Journal of Communications Law and Policy*, *14*(2), 365-402.
- Endler, D., & Collier, M. (2007). *Hacking VoIP Exposed: Voice over IP Security Secrets and Solutions*. New York: McGraw-Hill.
- Goode, B. (2002). Voice over Internet protocol. *Proceedings of the IEEE*. *90*(9), pp. 1495-1517. IEEE.
- Hamdi, M., Verscheure, O., & Hubaux, J.-P. (1999). Voice Service Interworking for PSTN and IP Networks. *IEEE Communications Magazine*, *37*(5), 104-111.
- Hartpence, B. (2007). Curricular Response to the Real Time Data and VoIP Tidal Wave. *Journal of Computing Sciences in College*, *22*(6), 37-42.
- Hung, P., & Martin, M. V. (2006). Through the Looking Glass: Security Issues In VoIP Applications. *Proceedings of the IADIS International Conference on Applied Computing*, (pp. 416-420). San Sebastian.
- Jiang, W., Lennox, J., Schulzrinne, H., & Singh, K. (2001). Towards Junking the PBX: Deploying IP. *International Workshop on Network and Operating System Support for Digital Audio and Video (NOSSDAV)* (pp. 177-185). New York: ACM.

- Johnston, A. B. (2009). *SIP: Understanding the Session Initiation Protocol*. Norwood: Artech House Inc.
- Kohlbacher, F. (2006). The Use of Qualitative Content Analysis in Case Study Research. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, 7(1), Retrieved May 4, 2011, from <http://www.webcitation.org/5zPu4qCcU>.
- Kotler, P., Keller, K., Brady, M., Goodman, M., & Hansen, T. (2009). *Marketing management*. London: Prentice Hall.
- Kuhn, D., Walsh, T., & Fries, S. (2005). Security Considerations for Voice Over IP Systems. *NIST Special Publication 800-58*. Gaithersburg, MD: National Institute of standards and Technology.
- Mayring, P. (2000). Qualitative content analysis. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, 1(2), Retrieved May 12, 2011, from <http://www.webcitation.org/5zPuVAmim>.
- Mazurczyk, W., & Kotulski, Z. (2006). *New VoIP Traffic Security Scheme with Digital Watermarking*. Berlin: Springer Berlin / Heidelberg.
- Meisel, J., & Needles, M. (2005). Voice over Internet Protocol (VoIP) Development and Public policy Implications. *Info*, 7(3), 3-15.
- Metha, P., & Udani, S. (2001). *Overview of Voice over IP*. Technical Report MS-CIS-01-31. Department of Computer Information Science. University of Pennsylvania.
- Mishan, E., & Quah, E. (2007). *Cost-benefit analysis* (5 ed.). New York: Routledge.
- Myers, M. D. (1997, June). Qualitative Research in Information Systems. *MIS Quarterly*, pp. 241-242.
- Porter, M. (1998). *Competitive advantage: creating and sustaining superior performance: with a new introduction*. New York: Free Press.
- Sacker, M., Santaiti, M., & Spence, C. (2006). *The Business Case for Enterprise VoIP*. Intel Corporation.
- SC Magazine. (2009, January 22). VoIP Hackers Run up \$120,000 Phone Bill at Perth Business. *SC Magazine for IT Security Professionals*.
- Shell, B., & Dodge, J. (2002). *The Hacking of America*. Westport: Quorum Books.
- Sinden, R. (2002, January). *Comparison of Voice over IP with circuit switching techniques*. Department of electronics and Computer Science. Southampton University.

- Sinnreich, H., & Johnston, A. B. (2001). *Internet communications using SIP: delivering VoIP and multimedia services with Session Initiation Protocol*. New York: John Wiley & Sons Inc.
- Titscher, S., Meyer, M., Wodak, R., & Vetter, E. (2000). *Methods of text and discourse analysis*. London: Sage.
- Tobin, P., & Bidoli, M. (2006). Factors Affecting the Adoption of Voice over Internet Protocol (VoIP) and Other Converged IP Services in South Africa. *South African Journal of Business Management*, 37(1), 31-40.
- Tucker, G. (2004, October 26). *Voice Over Internet Protocol (VoIP) and Security*. New York: SANS Institute.
- Varshney, U., Snow, A., McGivern, M., & Howard, C. (2002). Voice over IP. *Communications of the ACM*, 45(1), 89-96.
- Vetteth, A., & Joseph, D. (2009). *Voice Over IP A Comprehensive Study*. Retrieved March 23, 2011, from CiteSeerX - Scientific Literature Digital Library and Search Engine: <http://www.webcitation.org/5zPvP5f90f>
- Walker, J., & Hicks, J. (2002). *The Essential Guide to VoIP implementation and management*. NetIQ.
- Wallingford, T. (2005). *Switching to VoIP*. O' Reilly & Associates, Inc. .
- Walters, S. M. (2002). *The New Telephony*. Upper Saddle River, New York: Prentice Hall.
- Werbach, K. (2005). Using VoIP to Compete. *Harvard Business Review*.
- Zhang, R., Wang, X., Yang, X., & Jiang, X. (2007). Billing Attacks on SIP-Based VoIP Systems. *Proceedings of the first USENIX workshop on Offensive Technologies*. WOOT '07.

## **Appendix A: Interview Questionnaire**

In this section the questions that were used to gather data during the interviews are depicted.

- 1) What are the core and supporting business processes of the organization and how have they been affected by the introduction of VoIP?
- 2) Which features of VoIP have been implemented in the organization?
- 3) What are the barriers preventing the implementation of additional features and what difficulties were encountered implementing current VoIP features?
- 4) Which improvements could be implemented in order to acquire greater benefit from VoIP in the organization?
- 5) Is there a perceived competitive advantage by the organization after the introduction of VoIP?
- 6) Has any type of exploratory cost benefit analysis been performed before acquisition? Please elaborate why.
- 7) In the future, what affect do you think new (communication) technology will have on the (core) business processes of organizations?

## **Appendix B: Interview Questionnaire VoIP Providers**

- 1) Which features of VoIP are frequently implemented in client organizations and how do they affect the (core) business?
- 2) What are the barriers preventing the implementation of additional features and what difficulties were encountered implementing current VoIP features for your clients?
- 3) Which improvements could be implemented in order to acquire greater benefit from VoIP in the organizations of your clients?
- 4) Do you think your clients perceive a competitive advantage after the introduction of VoIP?
- 5) Has any type of exploratory cost benefit analysis been performed before acquisition?  
Please elaborate why.
- 6) In the future, what effect do you think new (communication) technology will have on the (core) business processes of organizations?