ELECTRONIC COMMUNICATION CONTINUITY PLANNING FROM THE PERSPECTIVE OF AN INDIVIDUAL

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ELECTRONIC COMMUNICATION CONTINUITY PLANNING FROM THE PERSPECTIVE OF AN INDIVIDUAL

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Declaration

I, Jacques Fouché (207006274), hereby declare that the dissertation for Magister Technologiae in Information Technology is my own work and that it has not previously been submitted for assessment or completion of any postgraduate qualification to another University or for another qualification.

Jacques Fouché

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I dedicate this dissertation:

- In loving memory of my grandfather, Johannes Hendrik Fouché. Thank you for believing in me.

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Chapter 1: Introduction

“Communications are an integral part of the Nation’s health and safety, economy, and public confidence” (U.S. Department of Homeland Security, 2011).

1.1. Background

1.1.1. A Brief History on Communication

Communication has come a long way since the 1800s. Historically, long distance communication was generally conveyed by a written message, for example by means of a courier. These couriers were generally men on horseback or birds such as pigeons. Although the use of couriers to deliver messages was effective, when faced with time constraints as in the case of urgent messages, this method was inefficient.

To address the need to deliver urgent messages, a faster, more reliable means of delivery was required and, subsequently, the telegraph was developed. The electronic messaging capability of the telegraph was first publicly demonstrated in 1838. Since this first-ever message there have been constant advancements in the field of electronic communication (Campanella, 2007). One such advancement was the telephone. The telephone was first demonstrated to the public in 1876 and used vocal transmission to communicate among users (Campanella, 2007).

Although wireless communication technology was in great demand, the benefits of the telephone were only available to those who were close to a telephone. Consequently, in the 1980s the mobile phone was introduced to address this shortcoming. The mobile phone allowed for continuous connectivity, enabling users to be connected to the voice network at all times. Use of mobiles has since become pervasive (Taylor, Waung, & Banan, 1996). As a result of this continuous connection via wireless communication, people today have developed a dependency on being connected.

In terms of electronic communication, voice services have remained prevalent. However, many forms of electronic communication are now transmitted in the form of data. In this regard, the Internet revolutionised communication by allowing the transmission of data and the introduction of a wide range of services dependent on the transmission of data.

1.1.2. The Origins of the Internet

The idea of the Internet or "galactic network" was first recorded in 1962 and the Advanced Research Projects Agency Network (ARPANET) concept was developed in 1966. In 1969 the first computer was connected to ARPANET and, by the end of 1969, four computers where connected to it. ARPANET is regarded as the early Internet (Leiner, Cerf, Clark, Kahn, Kleinrock, Lynch, Postel, Roberts, Wolff, Stephen, 2009).

From this modest early stage, the Internet opened up numerous opportunities. One of these opportunities was email. In 1988 the first sustainable email link in South Africa was created in Grahamstown at Rhodes University. The first IP address in South Africa was also granted to Rhodes University in the same year (Lawrie, 1997; Lombaard, 2003). In South Africa, various universities collaborated to connect to each other and ultimately connect to the Internet (Lawrie, 1997).

From these humble beginnings, modern society has grown very dependent on communication technology, specifically the Internet. This is illustrated by the fact that more than 34% of the planet is now connected to the Internet (Miniwatts Marketing Group, 2012). Modern businesses also incorporate communication networks that provide communication with staff, clients and suppliers. The use of these communication technologies provides the clear advantages of real-time communication and the availability of data on demand. In light of the above, communication technology can be classified as being core to the modern way of living and doing business. Moreover, communication technology is considered core to and an integral part of the Internet, which is totally reliant on this underlying communication infrastructure (U.S. Department of Homeland Security, 2011). Taking the importance and criticality of communication technology and Internet-related services into account, it can be claimed that communication networks are indeed critical to the modern way of communicating, socialising and conducting business.

1.1.3. Defining Critical Infrastructure

A critical infrastructure can be described as “multifaceted systems of systems comprising hardware, software, data and people; operating under various policies and procedures, and economic, legal, social, political and ethical constraints” (Shenoi, 2008). Furthermore, critical infrastructure in the United States of America (USA) is defined as “the assets, systems, and networks, whether physical or virtual, so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national economic security, public health or safety, or any combination thereof” (Department of Homeland Security, 2011).

Thus, in order to be considered critical infrastructure, infrastructure has to be vital to at least one of the following four national functions:

- national defence
- economic security
- public health and safety
- national morale

Of these four functions, communication is considered vital to national defence and economic security. For this reason, communication technology can indeed be considered as critical infrastructure (Moteff, Copeland, & Fischer, 2003).

Over the past 25 years, the communication sector has evolved from a provider of voice services to a diverse and interconnected industry utilising multiple transmission systems. Accordingly, the transmission of voice services has become interconnected. These multiple transmission systems depend on each other to carry traffic from the source to the destination in order to facilitate communication in the communication technology sector (U.S. Department of Homeland Security, 2011).

In total, the United States identifies 18 sectors of critical infrastructure. The sector this research will focus on is communication technology. Communication technology, as critical infrastructure, is defined by the United States Department of Homeland Security as “an integral component of the U.S. economy as it underlies the operations of all businesses, public safety organisations, and government” (U.S. Department of Homeland Security, 2011).

Thus, communication technology is classified as being of national importance and, therefore, as critical infrastructure. Obviously, the Internet is totally dependent on the underlying communication technology and, therefore, can also be seen as critical. Disruptions in communication technology can have debilitating effects on individuals and businesses, and this will be discussed in the following section.

1.1.4. Critical Infrastructure Disruptions

Estonia, a country lying on the Baltic Sea and one of the former Soviet republics, also known as "E-stonia" for its adoption of communication technologies, was crippled by a cyber-attack that first occurred in April of 2007. During this onslaught, mission critical infrastructure was attacked, such as telephone exchanges, mobile phone networks, banking and government websites. The effects of the cyber-attack forced the major news outlet to sever international Internet connections, cutting Estonian news off from the rest of the world. With financial, news and government websites shut down, Estonia came close to a complete digital collapse (Ashmore, 2009; The Christian Science Monitor, 2011). These cyber-attacks were primarily launched over the Internet and used Denial of Service (DoS) and Distributed Denial of Service (DDoS) attacks to disrupt services (Czosseck, Ottis, & Talihärm, 2011).

Estonia has a high reliance on information systems, with communication technology being used for voting, education, taxes and banking, among other things. Astonishingly, 95% of banking transactions in Estonia are done electronically (Ashmore, 2009; Shackelford, 2009). Therefore, a digital collapse would have resulted in massive social disruption *(Shackelford, 2009; The Christian Science Monitor*, 2011). This just goes to illustrate the dependency the country and its people experience on communication technology.

In the last 25 years, communication technology in South Africa has been actively trying to follow suit. Various communication technologies, such as the mobile phone and the Internet, have been introduced and have since become prevalent. These technologies have subsequently been adopted into the personal and professional lives of many South Africans. With the adoption and integration of these new technologies, dependency on them tends to expand rapidly in a society. Hence, the sudden disappearance of communication technology has the potential to cripple a country or result in a digital collapse.

1.1.5. Communication Technology as Critical Infrastructure

"The Internet has revolutionized the computer and communications world like nothing before" (Leiner, et al., 2009).

The national scope of communication as critical infrastructure is described in section 1.3. However, communication can be seen as critical to modern organisations and individuals; thus, communication technology as critical infrastructure will be discussed as it pertains to the above mentioned scopes of organisations and individuals.

In section 1.3 four national functions were mentioned. These four functions are initially related to the national scope. However, they can also be used to relate to both the organisational scope and the individual scope of communication.

Loss of the services provided by communication technology can affect countries, organisations, society and/or the individual. Moreover, such communication technology could potentially be vital to a national function as well as being vital to the business functions of an organisation or to the activities of an individual. Although the affected areas of a crippled communication technology may not be great enough to affect the national scope, they could be large enough to affect the vital functions required by an individual or organisation.

In modern-day society the benefits of technology are seen everywhere. These benefits range from instant access to money from any automatic teller machine (ATM), to being able to communicate with family and friends using a mobile phone from almost anywhere in the country. A popular method of communication is email, with 3,1 billion email accounts worldwide and an average annual growth of 7% expected. Another popular communication method is instant messaging (IM) with 2,6 billion accounts worldwide and an average annual growth of 11% expected (The Radicati Group, inc., 2011).

Thus, this usage and growth would seem to show that society is growing used to and becoming reliant on these services. Consequently, as individual independence on communication technology increases, availability is critical. However, if availability is taken into account, communication technology has proven less than reliable under all circumstances. Subscribers to the largest cellular network in South Africa, Vodacom, were disconnected from its network on 24 July 2011 for the second time that month. The first incident resulted in degraded services, disconnected users and a delayed Unstructured Supplementary Service Data (USSD) pre-paid airtime recharge system (SAPA, 2011). The second incident resulted in subscribers being disconnected from the network for both SMS and calls for the entire day (Muller, 2011a).

1.2. The Problem Statement

Based on the above discussion, the problem statement for this dissertation can be stated as: the dependency on communication technology that the modern-day individual experiences, exceeds the guarantee that current communication technology provides.

1.3. Research Objectives

The main objective of this research project is to provide a framework that could be used to improve the accessibility of current communication technology from the perspective of an individual.

Related to the main research objective stated above, the secondary objectives of this research project are to

- determine what technologies play a part in the communication technology used by an individual
- determine to what extent communication technology can be deemed as critical to an individual
- determine which of the four critical infrastructure functions are affected by communication technology from the perspective of an individual
- recommend a framework to improve the accessibility of electronic communication technology for an individual.

1.4. Importance of the Study

It is beyond doubt that technology has changed the way people in modern society live their daily lives. While a modern society eagerly adopts new technology, the loss of the services provided by these technologies is hardly ever considered. Therefore, this research project will evaluate the importance of communication technology and how critical it is for an individual. Furthermore, this research will provide a framework to improve the availability of current communication technologies from the perspective of the individual.

1.5. Research Methodology

The objective of this research is to provide a framework that improves connectivity for electronic communication technology users. The research moves from a real-world problem to a solution by addressing the research objectives and thereby creating an artefact in the form of a framework. It is for this reason that design science research has been selected as the primary paradigm. Design science can be defined as follows: "Design science creates and evaluates IT artefacts that are intended to solve identified problems" (Hevner, Ram, Park, & March, 2004). The research methodologies chosen and the reasons for their use will be discussed in more detail in Chapter 2.

1.6. Delineations and Limitations

This research project will focus on South African communication technology as critical technology for the modern-day individual. This research project will provide a framework to explore methods to improve the efficacy of South African communication technology for the individual. The research will focus on the individuals' communication needs and the means available to them to achieve greater communication service levels. This research will not provide a means for improving the technology or infrastructure itself; however, it will provide a means for utilising the available communication technology more efficiently.

1.7. Preliminary Chapter Outline

The following is a brief description of the content of each chapter contained in this research document.

Chapter 1: Introduction

This chapter provided an introduction to and a background on the field of study. Furthermore, it discussed the relevance of the research, the research problem statement and the stated objectives.

Chapter 2: Methodology

In chapter 2, the research methodology used to conduct the research is discussed. It also considers the methods used to collect and analyse the data obtained by the research.

Chapter 3: Communication: Past, Present and Future

Chapter 3 focuses on electronic communications of the past, present and future. The historical and current electronic communication technologies that have been and are being used to communicate are discussed in order to determine the future of electronic communication and the way in which it could affect the individual.

Chapter 4: Electronic Communication Technology as Personal Critical Infrastructure

In this chapter, current communication usage trends are discussed in more detail. A case will be made for the notion that communication technology has become an important part of individuals' lives and now facilitates the fulfilment of the basic human needs, thereby becoming critical to an individual.

Chapter 5: Towards a Higher Service Guarantee

In this chapter the Communication Technology Higher Availability Guarantee Framework (CTHAG) is developed to address disruptions in electronic communication from the perspective of the individual. An individual's communication needs are considered by means of a dependency analysis and a risk analysis. From the results of these analyses, a continuity plan will be derived.

Chapter 6: Evaluation and Testing

Chapter 6 discusses the framework developed in Chapter 5 and subsequently evaluates, demonstrates and documents this framework.

Chapter 7: Conclusion

This chapter will provide an overview of and a conclusion to the research and will also discuss the limitations of the study.

Chapter 2: Methodology

2.1. Introduction

As mentioned in Chapter 1, electronic communication has become very important, if not critical, to individuals. Electronic communication has undoubtedly changed the way individuals communicate, conduct business, entertain themselves and live today. As the use of electronic communication has become more pervasive, a growing dependency is being fostered. It is for this reason that the availability of electronic communication and the services it provides should be made as accessible as possible.

Hence, it can be argued that a real-world problem exists, one which this research project aims to address. This problem can be defined as:

> ***The dependency on communication technology that the modern-day individual experiences exceeds the guarantee that current communication technology provides*** (see the problem statement in section 1.2).

In order to address this problem, research objectives have been set. As has been shown, the problem statement states a real-world problem and the objectives have been set in the form of a solution to this problem. As mentioned in Chapter 1, the research methodology and the methods used were carefully chosen to address the objectives of the research project. The research paradigm, methodology and supporting research methods will thus be introduced, motivated and discussed in the rest of this chapter.

2.2. Research Design

The research design is based on the nature of the relevant problem statement and the set objectives, as presented in this research study. In this section, the research paradigm will be discussed and, in the following subsections, the related research methodology and the research methods used will be discussed in more detail.

There are many design science interpretations. These are listed in the following table together with the related research steps and tasks.

Author/Year	Steps	Design Science Activities/Steps/Tasks presented in the paper						
Nunamaker Jr, Chen, & Purdin (1991)	5	Construct a conceptual framework	Develop a system architecture	Analyse and design the system	Build the (prototype) system	Observe and evaluate the system		
Walls et al. (1992)	2	Design Product				Design Process		
	7	Meta-requirements	Meta-design	Kernel theories	Testable design product hypotheses	Design method	Kernel theories	Testable design process hypotheses
March & Smith (1995)	2	Build	Evaluate					
Rossi & Sein (2003)	5	Identify a need	Build	Evaluate	Learn	Theorize		
Hevner et al. (2004)	7	Design as an artefact	Problem relevance	Design evaluation	Research contributions	Research rigour	Design as a search process	Communication of research
Vaishnavi & Kuechler (2004)	5	Awareness of a problem	Suggestion	Development	Evaluation	Conclusion		
Aken (2004)	4	Choosing a case	Planning and implementing interventions	Reflecting on the results	Developing design knowledge to be tested and refined in subsequent cases			

Cole, Purao, Rossi, & Sein (2005)	4	Problem definition	Intervention	Evaluation	Reflection and learning				
Venable (2006)	4	Solution technology invention	Theory building	Artificial evaluation	Naturalistic evaluation				
Peffers, Tuunanen, Rothenberger, & Chatterjee (2007)	6	Problem identification and motivation	Define the objectives for a solution	Design and develop-ment	Demonstra-tion	Evaluation	Communication		
Gregor & Jones (2007)	8	Compulsory					Optional		
		The purpose and scope	Constructs	Principles of form and function	Artefact mutability	Testable propositions	Justificatory knowledge	Principles of implement -ation	Expository instantiation
Salvatore, March & Storey (2008)	6	Identification and clear description of a relevant organisational IT problem	Demonstration that no adequate solutions exist in the extant knowledge base	Development and presentation of a novel IT artefact that addresses the problem	Rigorous evaluation of the IT artefact enabling the assessment of its utility	Articulation of the value added to the knowledge base and to practice	Explanation of the implications for IT management and practice		

Pries-Heje et al. (2008a)	4	Risk Evaluation in DS Research							
		Risk identification	Risk analysing	Risk treatment	Risk monitoring				
		Evaluation Activity							
Pries-Heje et al. (2008b)	8	Ex ante naturalistic design process	Ex ante naturalistic design product	Ex ante artificial design process	Ex ante artificial design product	Ex Post naturalistic design process	Ex post naturalistic design product	Ex post artificial design process	Ex post artificial design product
Baskerville, Pries-Heje, & Venable (2009)	7	A specific problem is identified and delineated	This problem must then be expressed as a specific set of requirements	The specific problem is systemically abstracted and translated into a general problem	General solution design (a class of solutions) for the general problem	General design requirements are compared with the specific problem for fit	A declarative search is then made for the specific components that will provide a workable instance of a solution to the general requirements	An instance of the specific solution is constructed and deployed into the social system	

Table 2.1: Design science activities steps and tasks (Alturki, Gable, & Bandara, 2011).

2.2.1 Research Paradigm

According to Hevner and Chatterjee (2012), design science is all about solving real-world problems, which result in a solution in the form of an artefact. As this study meets these criteria, design science was therefore used as the research paradigm.

All the authors listed in Table 2.1 follow different, but related approaches to design science. Although Hevner and Chatterjee (2012), set the general approach and paradigm for design science, Peffers, Tuunanen, Rothenberger, and Chatterjee (2007) present a research methodology that can be used within this paradigm. This methodology, as presented in Table 2.2, was followed in this study.

2.2.2 Research Methodology

As has already been mentioned, design science was chosen as the overarching paradigm for this research. Various other methods were also implemented to achieve the goals of the chosen design science interpretation and, ultimately, to achieve the research goals of this project. Table 2.2 shows the chosen set of steps in design science, together with a description and their application to this research project.

Steps	**Description**	**Application**
1. Problem identification and motivation	This step involves defining the research problem and justifying the value of a solution.	This study identifies the dependency of the modern-day individual on communication technology which exceeds the guarantee that current communication technology provides. The value of a solution is justified in Chapters 3 and 4.

Steps	Description	Application
2. Define the objectives for a solution	Here the objectives of the solution should be deduced from the problem definition.	The objective of the solution is to provide an individual with the knowledge needed to achieve a greater level of connectivity, as discussed in Chapter 5.
3. Design and development	This step governs the creation of the artefact.	In Chapter 5 a framework is created to address the research problem identified.
4. Demonstration	The artefact should be demonstrated by solving one or more instances of the problem.	The framework is demonstrated by means of a field test and a confirmatory focus group. The demonstration is documented in Chapter 6.
5. Evaluation	Here the ability of the artefact to support a solution to the problem is observed and measured.	The framework is evaluated by focus groups as discussed in Chapter 2.
6. Communication	This step involves communicating the problem and its importance, the artefact, its utility and novelty, the rigour of its design and the effectiveness for relevant audiences.	This step is satisfied by the writing a conference papers, which are included as Appendix A.

Table 2.2: Design science research steps: description and application

2.2.3 Research Methods

This section will discuss the research methods used in this study in more detail. The primary research methods used were a literature study, argumentation, experimentation and focus groups. These research methods will now be discussed in more detail.

Literature Study

A literature study is a critical, factual overview of the published work that is related to the investigation being carried out. Furthermore, it provides a theory base and an analysis of particular subject matter (Hofstee, 2006). The literature study was used to identify the problem situation and also to design the first version of the framework, which comprised the solution.

Argumentation

Argumentation will be conducted as described by Toulmin, "movement from accepted data, through a warrant, to a claim". Accordingly, where data is considered evidence, the claim is considered the conclusion and the warrant carries the accepted data to the disbelieved (Toulmin, 2000). Argumentation was used to argue for the different versions of the solution as the artefact was refined.

Experimentation

The idea behind an experiment is to try something out and note the effects. An experiment can be conducted under controlled conditions or in the field. This study made use of both an experiment under controlled conditions and a field experiment. Both of these experimentations where done in accordance with the interpretation of Olivier (Olivier, 2009). Experimentation was used to determine the effectiveness of the proposed crude manmade signal booster.

Focus groups

It is important that design science research should go through an iteration process. As Hevner, Ram, Park and March (2004) state, "thorough evaluation of the artefact is crucial". It is for this reason that the evaluation step will be conducted by means of a focus group. In order to define and design focus groups, clear research goals must be identified. In the case of design science research, the goals are to design, improve and evaluate the artefact and its utility. Therefore, the goals of the focus groups are to improve and evaluate the artefact and its utility. Seen in this light, traditional focus groups need to be adapted to meet the goals of design research. Subsequently, in this research changes were made to the traditional focus group in that, firstly, exploratory focus groups (EFGs) and, secondly, confirmatory focus groups (CFGs) were used. With regard to the evaluation of the artefact, EFGs study the artefact in order to suggest improvements to the design. They also continue to evaluate the artefact until a satisfactory result has been achieved. Once the results and their improvements have been incorporated into the design, the artefact is released for field testing. For this field testing, CFGs were used to establish the utility of the artefact in the field (Hevner & Chatterjee, 2012).

Figure 2.1 gives a diagram of the use of focus groups in design science research.

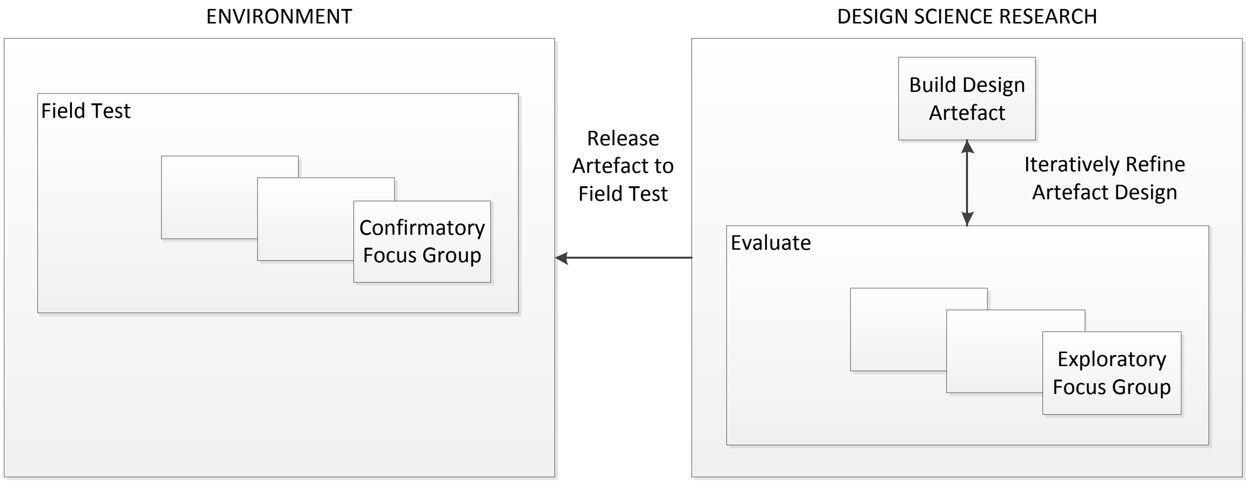

Figure 2.1: Focus groups in design science research (Hevner & Chatterjee, 2012)

The focus group methodology in design science research consists of eight main steps. Figure 2.2 gives a diagram of the steps involved in the focus group process.

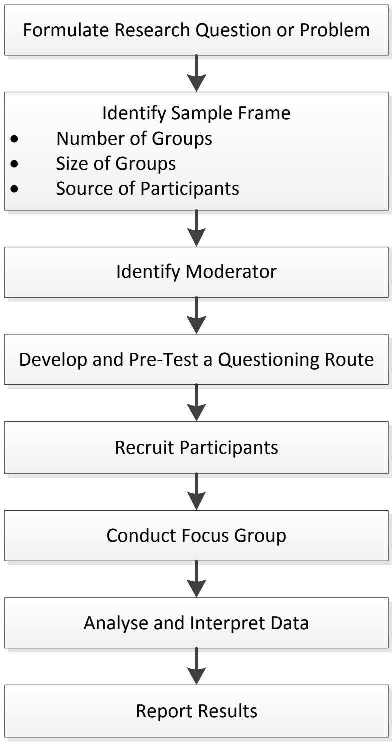

Figure 2.2: Focus group steps (Hevner & Chatterjee, 2012)

Each of the steps in figure 2.2 will now be discussed in more detail.

1. Formulate Research Question or Problem

As already mentioned, it is important to identify clear research goals. When developing an artefact using design science research, the goals are to improve the artefact design and evaluate the artefact's utility (Hevner & Chatterjee, 2012).

2. Identify Sample Frame

In order to identify the sample frame, three additional steps are required. These are to identify the number or type of focus group, the number of participants in each of these groups and, finally, where to recruit the participants for these groups (Hevner & Chatterjee, 2012). Each of these steps will now be discussed in more detail.

2a Number of Focus Groups

There is no way to determine how many focus groups to run. However, it is suggested that there should be a minimum of one pilot focus group, two EFGs and at least two CFGs (Hevner & Chatterjee, 2012).

2b Number of Participants

It is suggested that groups should have a lower boundary of four and an upper boundary of twelve. This is due to the fact that small groups require greater participation by each member while larger groups can lead to “social loafing” (Hevner & Chatterjee, 2012).

2c Participant Recruitment

The selection of participants should not be random; they should be selected on the basis of the suitability of their characteristics to the topic being discussed. Moreover, the participants should be potential users of the proposed artefact.

3. Identify Moderator

In selecting a moderator for the groups, such a moderator will need to possess various skills. Firstly, he or she will need to have a clear understanding of the technical aspects of the artefact; secondly, the moderator should have respect for the participants, be able to communicate clearly, both orally and in writing, be able to listen and have the self-discipline to control personal views and display a friendly manner with a sense of humour.

4. Develop and Pre-Test a Questioning Route

It is important to set the direction for the group discussion in a focus group; this is done by following the questioning route. Accordingly, the direction your group discussion goes in should be closely aligned with the research objectives of your topic. The questions should number no more that twelve per two-hour session, as well as being ordered from the general to the more specific and in order of relevance (Peffers et al., 2007).

In terms of a designed artefact, this means starting off with a general explanation of scenarios in which the artefact could be applied. This will then be followed by a description of the artefact and how it should be used. Finally, a scenario is described in which focus group participants will be able to test and evaluate the artefact.

In the case of an EFG, the “rolling interview guide” could be used. According to this method, an initial script is created to use with the first EFG. However, this script is subsequently changed for the following EFG based on the outcome of the previous EFG.

5. ***Recruit Participants***

The participants are recruited as per discussion in subsection 2c.

6. ***Conduct the Focus Group***

Participants are generally seated in a U-shape to encourage collaboration and allow for artefact demonstration. Furthermore, the more assertive and expert participants should sit next to the moderator and the least talkative participants should sit directly across from the moderator. The sessions may be video and/or voice recorded, which may require the completion of consent forms. An observer may also be present in the focus group to record the interactions among and disposition of participants. The moderator does not participate in the focus group.

7. ***Analyse and Interpret Data***

There are various techniques that can be used to analyse and interpret qualitative data. As has already been mentioned there are two types of focus group, EFGs and CFGs, and the methods used to interpret the discussions of these focus groups display many of the same challenges. Therefore, the method selected for analysis and interpretation will be the same for both groups (Hevner & Chatterjee, 2012).

8. ***Report Results***

Reports can be drawn up by creating an account structured around the main themes identified. This can be done by using short quotes to illustrate specific points or quoting longer passages to give a sense of the original conversation.

Accordingly, in this research study, focus groups were used to evaluate and refine the framework, which comprised the final artefact and represented the solution.

Framework

A framework is a theoretical concept that articulates the systems and processes that are included in this theoretical concept. This theoretical concept furthermore illustrates the way the components of this concept may relate to one another (Cadenasso, Pickett, & Grove, 2006). The final solution of this study is presented in the form of a framework.

Figure 2.3 depicts a graphical representation of the research design for this research project.

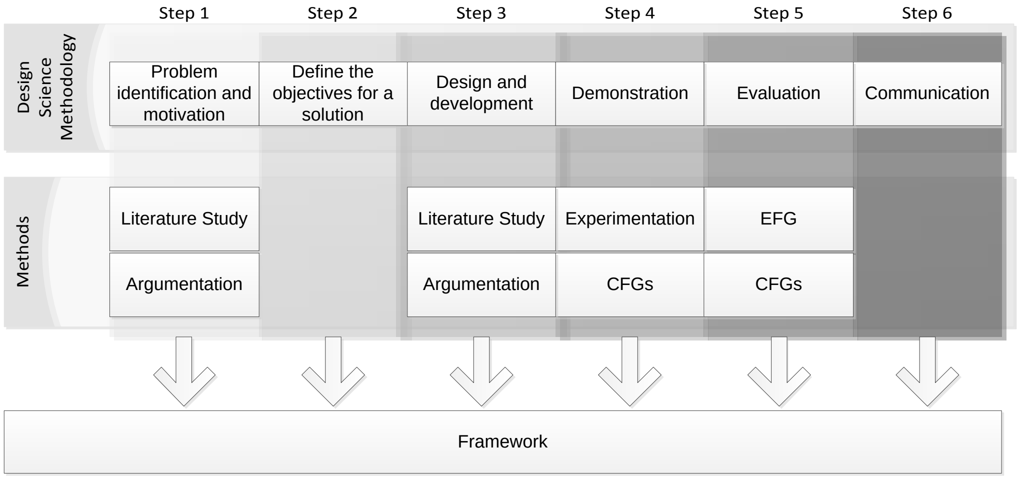

Figure 2.3: Research design

The research methods used for this investigation will be presented later in the dissertation as they are used.

2.3. Conclusion

This chapter discussed the details of the research methodology used in the research project and gave reasons for the choice of methodology. The problem statement was formulated and the appropriate research methods to reach the solution envisaged were selected. These methods and methodologies include design science, as the overarching methodology, together with the use of focus groups. These methodologies also subsequently enable the creation, evaluation and demonstration of an artefact in order to address the primary goal of this research project.

Chapter 3: Communication: Past, Present and Future

"By now the new information technology – Internet and e-mail – have practically eliminated the physical costs of communications" (Drucker, 2001).

3.1. Introduction

Communication has become a vital part of most people's lives. Modern-day individuals use communication technology for many purposes, for example, to perform banking transactions, pay taxes online and even work from home using the Internet or a Virtual Private Network (VPN). Electronic communication has become part and parcel of the way such individuals live. This integration of technology into the lives of everyman has manifested over many years as electronic communication, which has grown from humble beginnings to where it is today. The growth and adoption of electronic communication will be discussed in the following sections. The objective of this chapter is to provide a chronological history of the development of electronic communication infrastructure over time. This is important as it will provide reasons why communication technology has become such an integral part of the lives of modern individuals.

3.2. History of Electronic Communication

In the following subsections the history of communication will be discussed briefly. In addition, some historical implementations of the various electronic communication technologies will be mentioned and placed in context.

3.2.1. The Electronic Telegraph

The first form of electronic communication was publicly demonstrated in 1838 in Baltimore, Maryland in the USA. This communication was in the form of an electronic telegraph, created by Samuel F.B. Morse (Campanella, 2007). The electric telegraph used Morse code, which is comprised of dots and dashes representing the alphabet, and could therefore be used to transmit messages (Wehle, 1932). Accordingly, Morse code dots were represented by short electronic pulses and dashes by slightly longer pulses. These pulses where sent over copper wire from one point to another.

This copper wire comprised the infrastructure that the telegraph used. In the infant stages of the electronic telegraph, it was predominantly used to send news for media and government. However, it was later used for personal and business use (Albion, 1932; Adler & Rodman, 1901). With the growing adoption of the telegraph, its underlying infrastructure needed to be developed further. However, the problem with the telegraph was that it did not make optimal use of its fairly expensive underlying infrastructure. In essence, it was a point-to-point communication device that could only send messages between two fixed devices (Clarkson, 2004). As already mentioned, the telegraph was a wonderful invention that enabled the transmission of data and messages very quickly over long distances from point to point; however, the relatively expensive infrastructure could certainly be utilised more efficiently for a wider range of services. It was in terms of this initiative that the telephone was developed.

3.2.2. The Telephone

The telephone was used publicly for the first time in 1876. The telephone enabled spoken messages to be transmitted significantly faster than Morse code, as no translation of code was necessary (Monahan, 1947; Campanella, 2007). This development led to further infrastructure growth as more and more copper was laid to connect subscribers (Monahan, 1947). With the development of circuit switching technology this copper infrastructure was used more effectively. “Circuit switching” is a term used to describe a circuit (copper path) that could be reused to create a temporary dedicated connection for the duration of a call, thus reducing redundant paths (Verizon, 2011). To illustrate the use of circuits, one can compare it to the tracks used by trains to reach various destinations simply by reusing and switching paths. The early infrastructure consisted of copper wire stretching from an exchange to the houses of subscribers. The exchanges were operated by manual switchboards: When a subscriber picked up the phone, they would be connected to their local exchange and staff would, in turn, connect the subscriber manually to their intended subscriber on the switchboard. This process was subsequently automated to include a dial on the subscriber’s telephone. Users were now able to connect effortlessly with one another providing they were in close proximity to a telephone connected to the exchange. However, being close to a telephone was not always possible as many people spend a vast amount of time travelling between locations.

Being connected while travelling required an alternative form of communication technology and, consequently, this resulted in mobile phone technology and, subsequently, the mobile phone.

3.2.3. The Mobile Phone

The mobile phone was developed in the 1980s. It uses wireless technology to communicate with base stations. A base station is a site where antenna and other electronic communication equipment are placed on a radio tower to create a cell in a cellular network. Such a cell can typically connect many subscribers over a distance of up to 50 kilometres. Each cell can support certain wireless technology generations or standards based on the communication equipment supported (Taylor, Waung, & Banan, 1996).

First generation wireless technology (1G) was the original standard developed for the mobile phone. The voice quality of 1G was significantly lower than its successors and the 1G networks were only capable of voice transmission (Dahlam, Parkvall, Skold, & Beming, 2008).

As the 1G network had many limitations, advanced technological developments resulted. In 1991, the second generation (2G) cellular network was launched in Finland. The 2G network added short message services (SMS), digital conversation encryption and peak data rates of 9.6 kbps. The 2G network was launched as a Global Systems for Mobile Communications (GSM) standard and provided data transmission services over mobile communication networks (Dahlam et al., 2008).

The second half of the 1990s saw the introduction of packet data over cellular systems. This packet data technology was given the name General Packet Radio Service (GPRS) and was introduced in GSM. GPRS provided data rates of 56 to 114kb/s in the 2.4GHz band (Dahlam, Parkvall, Skold, & Beming, 2008). With improved voice quality and added services, such as SMS and GPRS, the user experience was improved and the methods of electronic communication available were significantly extended.

The 2000s saw further drastic improvements in the mobile communication networks as well as the launch of the third generation (3G) network. 3G followed 2G and 2.5G technologies. The 2.5G network provided standards that are between the 2G and 3G networks. These standards include GPRS, Enhanced Data rates for GSM (EDGE) and the Universal Mobile Telecommunicating System (UMTS) (Sauter, 2009).

The two main standards of 3G are UMTS and CDMA2000. 3G has a transfer rate of 384kb/s for devices in rapid motion and a minimum of 2Mb/s for stationary and slow moving users (Banitsas, 2006; Yang, 2004).

High Speed Packet Access (HSPA) is a third generation technology often referred to as 3.5G. This 3.5G technology is used in networks based on Universal Mobile Telecommunications System (UMTS) technology. HSPA is a collection of the two mobile telephony protocols, High Speed Downlink Packet Access (HSDPA) and High Speed Uplink Packet Access (HSUPA). These mobile telephony protocols are capable of delivering data rates of up to 14 Mbps on HSDPA and up to 5.8 Mbps on HSUPA (Furht & Ahsen, 2009).

UMTS is one of the 3G mobile communication technologies that are currently being developed into 4G technologies (Furht & Ahsen, 2009). These fourth generation technologies will be discussed in section 3.3.2 under current mobile phone technology.

The mobile phone has thus matured from a low quality voice network to a multi-communication tool that allows superior voice communication and extended data services. As seen from the success of the mobile phone, wireless technology has enormous opportunities for both vendor and user. However, the wireless communication technology mentioned above only serves mobile phones. Although the mobile phone is an effective wireless communication technology and has the capability of voice communication and data communication, it is not always cost-efficient or suited for a specific scenario. Therefore, cheaper alternatives and other wireless solutions are actively being developed.

3.2.4. Wireless LAN/MAN Technologies

Wireless Local Area Network (WLAN) emerged in the early 1980s. WLANs were developed for personal computers (PCs) to share resources and peripherals among users. The resources shared have been extended over time to include shared access to the Internet (Lehr & McKnight, 2003).

Today, laptops, printers, PCs, mobile phones and many more devices incorporate one or more wireless technologies to communicate with one another or to connect to the Internet. To manage this wireless communication interoperability, wireless standards have been developed by the Institute of Electrical and Electronics Engineers (IEEE) (Dubendorf, 2003). IEEE 802.11 and IEEE 802.16 will subsequently be discussed, as Wi-Fi (802.11) and Wi-MAX (802.16) are wireless communication technologies commonly used to access the Internet.

3.2.4.1. IEEE 802.11 (Wi-Fi)

In 1997, the IEEE 802.11 standard, often referred to as Wireless Fidelity (Wi-Fi), was approved by the Standards Activities Board (SAB) and published for the first time. The 802.11 standard defines a medium access control (MAC) and physical layer (PHY) specification in terms of two groups, the MAC and PHY. The 802.11 was initially intended for the Local Area Network (LAN) environment. However, today this standard is often used in "hotspots" to provide Internet to customers (Bernardos, Soto, & Banchs, 2008; Dubendorf, 2003). The IEEE has approved a number of standards in the 802.11x Ethernet families. The 802.11 standard will not be discussed in further detail as it was extended to the 802.11a standard. However, the following standards will be discussed in more detail:

- 802.11a, Project 802.11a was an extension of the 802.11 standard and supports data rates of up to 54 Mbps. The 802.11a standard operates in the 5 GHz band with a range of 150 feet (45.72 metres). The IEEE 802.11a was officially published as a standard in 1999 (Escotal.Com, 2010; Lemstra & Hayes, 2009).

- 802.11b, Project 802.11b was created as an addition to the 802.11 standard that supports data rates of up to 11 Mbps. The 802.11b standard operates in the 2.4 GHz band with a range of 300 feet (91.44 metres). The IEEE 802.11b was officially published as a standard in 2000 (Escotal.Com, 2010; Lemstra & Hayes, 2009).

- 802.11g, Project 802.11g was created as an addition to the 802.11 standard that supports data rates of up to 54 Mbps. The 802.11g standard operates in the 2.4 GHz band with a range of 300 feet (91.44 metres). Specifications for the IEEE 802.11g were released in 2003 (Escotal.Com, 2010; Lemstra & Hayes, 2009).

The IEEE has also approved a number of other standards. The standards mentioned above are commonly used to connect to an access point. Therefore, for the purpose of this study no further 802.11x standards will be discussed. The IEEE 802.16 standard, often referred to as Wi-MAX, will be discussed in the following subsection.

3.2.4.2. IEEE 802.16 (Wi-MAX)

As mentioned above there are numerous IEEE 802 standards. Among these standards the 802.11x and the 802.16x are the leading standards used in wireless communication technology.

The 802.16, or so called Worldwide Interoperability for Microwave Access (Wi-MAX) standard, was first released in 2001 and published in 2002. As with the 802.11 standard, the 802.16 standard defines a medium access control (MAC) and physical layer specification in terms of two groups, the MAC and PHY. As already mentioned the 802.11x was created for the LAN environment. However, the 802.16x was created for the Metropolitan Area Network (MAN) environment with the intention of creating a standard that could be used in wireless broadband as an alternative to fixed lines. This alternative could be used to connect to its LAN counterpart, the 802.11x standards, in order to provide Internet to end-users (Radha Krishna Rao & Radhamani, 2008). The following 802.16x releases will be discussed briefly:

- *802.16d* – the 802.16d is a modified version of the 802.16a and 802.16c standards. As with the 802.11a, it operates in the 2 to 11 GHz frequency band. In this frequency band it is capable of operating at a maximum distance of 16 kilometres with data rates of up to 75 Mbps.

- *802.16e* – the 802.16e was built to support mobile users. This standard allows mobile subscribers working in the 2 to 6 GHz frequency to connect to the network. In this frequency band, 802.16e is capable of reaching a maximum distance of five kilometres and data rates of up to 37 Mbps. A significant advancement has been made to this standard, the 802.16m, which will be covered in section 3.3.3.2 as a current Wi-MAX technology.

Many communication technologies have been discussed in the preceding subsections. These technologies serve to keep modern-day individuals connected to one another. However, the Internet is arguably the underlying communication technology of the future. In the following section the history and growth of the Internet is discussed.

3.2.5. The Internet

The Internet has changed the way individuals today live their lives. Today the Internet is used for online purchases, banking, news, communicating with one another and many other tasks and services. However, the Internet was not always used for, or capable of delivering, the tasks and services that current users have grown accustomed to (Kittler, 2004; Zhang, 2011).

The Internet, its users and technologies have grown enormously since its inception in the 1960s. In 1962 the idea of a “galactic network” was formed. This galactic network grew into what is today most commonly known as the Internet. The early Internet was created by Advanced Research Projects Agency (ARPA), a US Defense Department unit. At that time the Internet was branded as the Advanced Research Projects Agency Network or ARPANET. The first computer was connected to the Internet in 1969 (Leiner, et al., 2009).

Forty-two years after the connection of the first computer to ARPANET, the Internet had grown to connect 2 095 006 005 people worldwide (Miniwatts Marketing Group, 2012).

As seen from the information provided in the section above, communication technology is constantly evolving; therefore, the current and most prevalent electronic communication technologies utilised in South Africa today will be discussed in the following sections.

3.3. Current Electronic Communication Technology

The history and historical implementation of electronic communication has been discussed briefly in the previous section. It has been seen that electronic communication has evolved and matured over time. In a modern society there are many methods of communication and, as the needs of individuals increase, communication technology developments increase to supply the growing demand.

Therefore, the current electronic communication methods and implementations used in South Africa will be discussed in this section.

3.3.1. The Telephone

Currently, there are two fixed-line operators in South Africa, namely, Telkom and Neotel. Until the start of 2007, Telkom was the only fixed-line operator and as such had total control over South Africa's telecommunication sector, owning its entire infrastructure. Telkom provides lines for voice transmission over analogue lines and provides data transfers over digital subscriber lines. However, in 2007, Neotel entered this market and is expanding its own infrastructure to increase its market presence. Neotel is South Africa's first converged telecommunication network operator, offering voice, data and Internet over one connection. Nevertheless, Telkom is currently the sole provider of the so-called "last mile" to connect subscribers to an Asynchronous Digital Subscriber Line (ADSL) port at Telkom's Digital Subscriber Line Access Multiplexer (DSLAM's) (Telkom SA Limited, 2010; Neotel, 2010).

From a technological perspective, fixed-line telephone communication has experienced significant development in the past decade. However, there have been numerous developments to the underlying infrastructure of the fixed-line telephone in South Africa. The major driver behind these infrastructure developments can be accredited to the Internet. As of September 2010, Telkom had 4 234 000 subscribers of which, as of December 2010, 731 500 are also ADSL subscribers (Muller, 2010a; Etherington-Smith, 2010). Thus, it can be seen that fixed-line subscribers are demanding more from their electronic communication providers, namely converged networks and innovative services that allow for more than mere electronic voice communication.

3.3.2. The Mobile Phone

Currently there are five mobile operators in South Africa: Virgin Mobile, MTN, Cell C, Vodacom and 8.ta (Muller, 2011b; Virgin Mobile SA (PTY) LTD, 2011).

In the South African cellular networks the most current network technology in use is HSPA+ with trial rollouts of LTE networks in some parts of the country (Muller, 2011c; Vodacom, 2011). The current communication technologies will be discussed in the remainder of this subsection.

HSPA Evolved (HSPA+) is a wireless broadband standard defined in the Third Generation Partnership Project (3GPP) Release 7. It provides data rates up to 56 Mb/s on the downlink and 22 Mb/s on the uplink. The technology delivers a significant increase in battery life on mobile devices and a drastically faster wake-from-idle time delivering a true always-on connection (Furht & Ahsen, 2009).

Long Term Evolution (LTE) is defined in the 3GPP Release 8. Although LTE is often marketed as 4G, it is actually a 3.9G. The LTE specification provides downlink peak rates of at least 100Mb/s, an uplink of at least 50 Mb/s and a latency of less than 10 ms (Furht & Ahsen, 2009).

Since the end of 2009, LTE mobile communication systems have been a natural evolution of GSM (Global System for Mobile communications) and UMTS (Universal Mobile Telecommunications System). The ITU (International Telecommunication Union) has used the term “IMT-Advanced” to identify mobile systems the capabilities of which go beyond those of IMT 2000 (International Mobile Telecommunications) (Rumney, 2009).

LTE Advanced goes far beyond the capabilities of IMT 2000 and can support peak data rates of up to 1 Gbps downlink and 500 Mbps uplink. These increased speeds are achieved with the use of Multiple Input Multiple Output (MIMO) multiple antenna technology. With the use of this multiple antenna technology up to eight downlink antennas and four uplink antennas are supported in LTE-Advanced (Kottkamp, 2010; Dahlam, Parkvall, Skold, & Beming, 2008).

According to ABI research (Lee J. , 2011), in the contest for 4G, the next generation of mobile broadband, LTE, is predicted to have 115 million subscribers as opposed to 59 million for Wi-MAX by 2015.

3.3.3. Wireless LAN/MAN Technologies

Currently, there are numerous providers that offer Wi-Max or Wi-Fi connections. Wi-MAX is predominantly used as a last-mile alternative to provide broadband access in South Africa. However, with the new 802.16e or Wi-MAX 2 standard this could change. With Wi-MAX 2 being acknowledged as a 4G standard, this wireless technology could be used in the mobile communication market. Wi-Fi connections are often seen as “hotspots” at airports, coffee shops and other locations. With the release of 802.11n standard, this wireless communication standard now offers far greater data rates and better coverage for the LAN environment. The current 802.11x and 802.16x standards will be discussed in the following subsections.

3.3.3.1. IEEE 802.11 (Wi-Fi)

In a modern city you will not have to search far for a Wi-Fi hotspot sign. These signs can be found in shopping centres, coffee shops, universities and airports, among others. Hotspots offer wireless Internet connections on the 802.11b/g or 802.11n range, as modern wireless access points and wireless access devices support these standards (Cisco, 2011).

The latest Wi-Fi standard is the 802.11n. In 2007 the 802.11n technology was provided by Airgo Networks. However, the standard was only approved on 11 September 2009 by the IEEE. The 802.11n standard can provide data rates of up to 600 Mbps and can operate in both the 2.4GHz band and the 5 GHz band with a range of 300 feet (91.44 metres) (Escotal.Com, 2010; Lemstra & Hayes, 2009).

To utilise these Wi-Fi technologies, location owners can buy managed solutions. Managed solutions are offered by Internet Solutions (IS), the leading African Internet Protocol-based Communications Service Provider, in partnership with AlwaysOn, South Africa’s largest Wi-Fi hotspot provider. One of these owners is Airports Company South Africa (ACSA), the largest airports authority in Africa. Together, ACSA, IS and AlwaysOn provide Internet hotspots at many airports (Airports Company South Africa, 2011; Internet Solutions, 2011).

Airport hotspot access is just one area where Wi-Fi technology is utilised. Hotspot access can be used at many locations with the purchase of data and users can buy data through various systems. These systems could be an embedded billing system of a third party-managed Wi-Fi solution or alternative means such as websites or prepaid cards. Hotspots signs, as seen in figure 2.1, are notifications of Wi-Fi Internet access (Axxess, 2011).

Figure 3.1: Hotspot access (Axxess, 2011)

AlwaysOn Internet at hotspots is an effortless and convenient way to connect to the Internet. However, this wireless solution is only available for the LAN environment with limited range. To solve this problem an alternative wireless technology is used. In the following section the wireless alternative, Wi-MAX, and its current implementations will be discussed.

3.3.3.2. IEEE 802.16 (Wi-MAX)

Wi-MAX has evolved immensely since the first development of the 802.16 standard. The current standard, 802.16m, was developed with mobility in mind. However, the 802.16m can be implemented in mobile or stationary devices. The 802.16m will be reviewed and current implementation options discussed.

The 802.16m (Wi-MAX 2) was approved as a standard by the IEEE on 31 March 2011. The IEEE 802.16m was built on the 802.16e standard to offer significant improvements in data throughput and coverage while maintaining backward compatibility with the 802.16e standard. These improvements are achieved without the use of additional bandwidth or transmission power, but by using a combination of smart antenna technology and a multi-channel approach. With these improvements the 802.16m is capable of up to 300 mbps and a coverage area of 50 square kilometres per access point. The 802.16m is known as an advanced mobile broadband wireless standard and is approved by the IEEE and the ITU (International Telecommunications Union) as an official 4G standard, alongside LTE Advanced (IEEE-SA, 2011; Lee J. , 2011; Reed, 2010).

4G is a term used to describe 802.16m implementations. However, it becomes clear when viewing current South African implementations that Wi-MAX's 4G implementations are not yet available in South Africa. Wi-MAX as a last-mile connection (as mentioned in section 3.3.1) is available via companies such as Telkom and Neotel. Neotel offers Wi-MAX download data rates of 1, 2, 5 and 8 Mbps and upload data rates of 768 Kbps, 1.6, 2, 3 Mbps respectively. Telkom, on the other hand, offers a wireless coverage map to view coverage areas. Figure 2.2 provides an example of the Wi-MAX coverage offered by Telkom in Port Elizabeth.

Figure 3.2: Telkom Wi-MAX coverage map (Telkom SA Limited, 2011).

The above mentioned connections all attempt to provide a connection to a core network that will ultimately provide Internet access.

3.3.4. The Internet

The Internet has become a household name for most modern families with a penetration rate of 34,3% globally (Miniwatts Marketing Group, 2012). For South Africans the penetration rate was reported at a little more than 10% at the end of

2009 (World Wide Worx, 2010a). However, recent numbers suggest that this number is now more likely to be 20%, including mobile Internet access. In South Africa, the Internet is accessed predominantly via mobile networks such as cellular networks and through fixed line networks with ADSL technology. At least six million mobile subscribers have access to the Internet on their mobile phones (World Wide Worx, 2010b). As mentioned in section 3.3.1, Telkom's fixed lines amounted to 731 500 ADSL subscribers in September 2010 (Muller, 2010a).

Current Telkom Digital Subscriber Line (DSL) line synchronisation rates are in three increments:

- fast DSL, up to 384kbps
- faster DSL, up to 1024kbps
- fastest DSL, up to 4096kbps/10016kbps (maximum rates are exchange dependent) (Telkom SA Limited, 2011).

The mobile Internet market data rates are set up in many more increments. These increments in mobile data rates exist as the mobile network is affected by many more factors than just fixed lines. These factors include the protocols in use, signal strength and the movement of mobile users as mentioned earlier.

3.4. The Future of Electronic Communication

Lars Reichelt, the former CEO of the South African mobile communications company Cell C, said

> IP is where the future lies for South Africa, for work, for education, for health, for civil services. South Africa has an incredible opportunity to leap-frog into an IP/Cloud world and Cell C is doing its part to put the foundations in place: Network first, services next, innovation thereafter (Muller, 2011d).

According to the National Institute of Standards and Technology (NIST), the Cloud is

> a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and

released with minimal management effort or service provider interaction (Mell & Grance, 2011).

Furthermore, Cloud Computing has three service models: Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). These service models will now be discussed briefly:

- *SaaS*. Allows a provider's applications to run on the cloud infrastructure. The applications are accessible from various client devices such as web browsers (Mell & Grance, 2011). One simplified example of SaaS is access to the email service provided by Gmail.

- *PaaS*. Allows the consumer to deploy consumer-created or acquired applications on the cloud infrastructure. The consumer does not manage the underlying cloud infrastructure but can control the deployed application (Mell & Grance, 2011). An example of this is to build applications on a platform of choice over the Internet with a PaaS provider such as force.com (Salesforce, 2012)

- *IaaS*. Allows the consumer to use processing, storage, networks and other computer resources. Consumers do not manage the underlying cloud infrastructure but they have control over the operating system, storage and deployed application and could be granted limited control over network components such as firewalls (Mell & Grance, 2011). An example of this service is use of the GoGrid IaaS (GoGrid, 2012)

The future of electronic communication appears to lie in IP-based services and Cloud Computing (the Cloud). However, in South Africa, mobile technology should be added to this list, as mobile service providers have a much higher penetration rate than fixed-line service providers. This higher penetration rate is mainly due to a lack of infrastructure and the cost of ownership of fixed lines.

Cloud-based services are being offered for a fee or as a free service. Large organisations such as Amazon and Google have been investing a vast amount of time and resources in the Cloud arena. Google provides SaaS services such as Gmail (email), Google Calendar, Google Docs etc (Google, 2011), while Amazon provides Amazon Elastic Compute Cloud (Amazon EC2) that serves as PaaS and IaaS (Amazon, 2011).

The Cloud opens up many exciting opportunities, for example, streaming video sites such as www.youtube.com is familiar to most internet users. However, the Cloud now enables users to stream television programmes on demand; www.hulu.com is one of the websites that provides such a service. Furthermore, Cloud Computing enables users to stream live radio shows or listen to music on demand. Well-known music-on-demand websites are: www.last.fm and www.spotify.com.

However, the Cloud is only possible if sufficient bandwidth exists and until recently this was not the case, although international and local bandwidth capacity has exploded in South Africa over the last couple of years. This bandwidth addresses the network requirements that Lars Reichelt was referring to in section 3.4. With the network swiftly moving into place and paradigms such as Cloud Computing available, the stage has been set for innovation.

With the growing IP presence of mobile operators and with the growth in local and international fibre capacity, the stage is set for a truly connected society. South Africa is getting ready to “leap-frog into an IP/Cloud world”. However, while the services offered by communication technology grow, so too does the dependency on these communication technologies that the modern-day individual experiences.

3.5. Conclusion

Electronic communication has changed the way individuals communicate. From the humble beginnings of the initial electronic communication infrastructure to the electronic communication devices and services in use today, these communications have been adopted into society and indeed the individual’s everyday life. As a result of this adoption, a dependency is being unconsciously fostered. As society moves closer to a truly connected IP/Cloud world, individuals are using electronic communication to complete more and more tasks. In effect, electronic communication has become important for meeting an individual’s basic human needs. This dependency and the basic human needs are further discussed in Chapter 4.

Chapter 4: Electronic Communication Technology as Personal Critical Infrastructure

"Communications is at the heart of e-commerce and community" (Whitman, n.d.).

4.1. Introduction

Communication has always been of the greatest importance for humankind; although as discussed in Chapter 3, the methods used to communicate have changed radically over the years. This is as a result of the developments and advancements in technology. In today's "connected" culture, it is difficult to imagine life without some sort of electronic communication, and various electronic communication services, such as the Internet, have become integrated into almost every facet of the modern individual's life (Haythornthwaite & Wellma, 2002). As these electronic communication services are generally integrated they facilitate many utilities. From a business perspective such utilities, or the value required from these services, could be to provide increased profits or global reach (Apulu & Latham, 2011).

From an individual's perspective, on the other hand, electronic communication could provide utilities that are of an economic or more personal nature. One example of such a personal utility is social acceptance, which can be obtained through some of the social networks available today. This need for social acceptance is one of humankind's basic needs (Maslow, 1943). Electronic services that individuals integrate into their lives have different meanings and purposes for different people, as individuals value things not merely for their function, but also for what they mean to them and those around them (Lewis, 2008). Therefore, this chapter will discuss the value of electronic communication technology to the modern individual. This chapter investigates the electronic communication used in a modern society and discusses the way in which individuals experience electronic communication. Finally, a comparison is made between electronic communication as critical infrastructure and Maslow's hierarchy of human needs theory.

4.2. Electronic Communication in Modern Society

Various methods of electronic communication are used in a modern society. One example of such a method is electronic mail or email as it has become generally known. As of 2011, it was estimated that there were 3,1 billion email accounts worldwide and an average annual growth of 7% is expected. Another popular communication method is Instant Messaging (IM), with 2,6 billion accounts worldwide and an average annual growth of 11% expected (The Radicati Group, inc., 2011).

The social media have also undergone enormous growth in the past few years, with some social websites, such as Twitter, Facebook, Google+ and LinkedIn, having experienced a significant increase in the number of users. Some examples of the growth of social media will be discussed briefly. The social network, Facebook, experienced 37% growth in 2011, which moved its users from its 585 million users at the beginning of 2011 to 800+ million users towards the end of 2011. Furthermore, this growth amounts to an average growth of seven users per second (Socialbakers, 2012a). Another social network, Twitter, had more than a 100 million active users by September 2011 (Twitter, 2011). In September 2011, the social networking site, Google+, entered the arena and reached 50 million users in just 88 days (Allen, 2011).

It is important to note that social networking is not just limited to personal use. Facebook is “growing its importance in inbound marketing strategies for brands and businesses globally” (Socialbakers, 2012a). As small and medium-sized enterprises (SME) are now using the social media as a marketing forum to connect with users worldwide, this has led to a shift in use form the personal to the commercial in social networking sites. Furthermore, customer relationship management (CRM) has also shifted its attention to social media. Taking this into account, it could be argued that businesses are moving to where the customers are (IBM Global Business Services, 2011). “The question is no longer should we be doing social media, it’s are we doing it right?” (Qualmann, 2010). With the rapidly increasing social network user base, of which Facebook is an example with 812 million users, it is clear that social media and social networking sites are indeed where the people are (Socialbakers, 2012b). For this reason businesses are showing increased interest in Internet-orientated business solutions, which make use of a social media presence, websites, blogs and many other forms of online communication. In January 2011, a survey conducted by Rockbridge Associates showed that 42% of small businesses rated Internet business solutions as extremely important as opposed to the 33% who stated this in June 2010 (Rockbridge Associates, Inc., 2011). Thus there is a definite growth in the belief that Internet-based business solutions are core to SMEs. It can thus be concluded that with a large user base and the rapid growth in social media user numbers, an online presence has become a necessity to a business in the modern age.

Currently, the mobile and smart phone market is prospering; in fact, smart phone sales have surpassed personal computer sales, as can be seen from Figure 4.1.

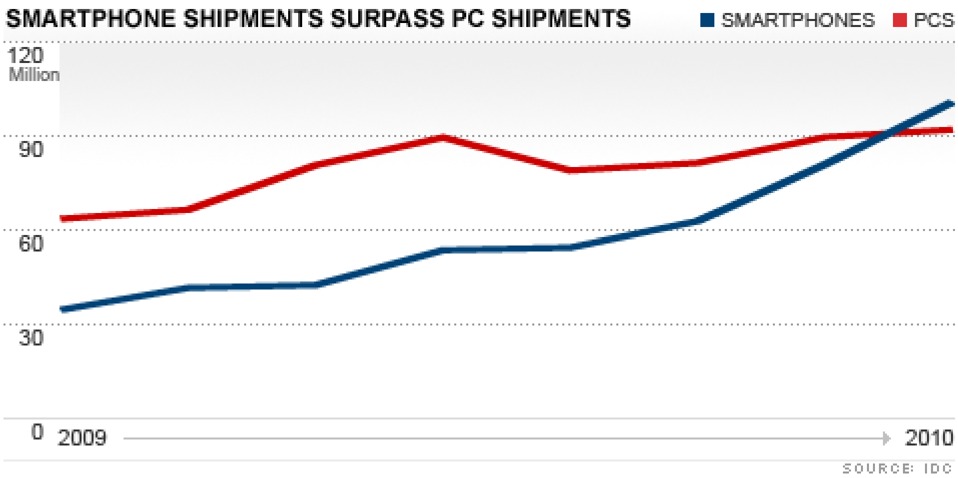

Figure 4.1: Smartphone sales (Goldman, 2011)

"The trend is also indicative of a sea of change in the kinds of devices people are using for their everyday computing needs" (Goldman, 2011).

As a result of this growth, many companies now provide a mobile implementation or even a mobile application to access their services. First National Bank (FNB), one of the largest banking service providers in South Africa, offers an Android, Apple, Blackberry and Nokia Symbian application for accessing online banking via a smart phone (First National Bank, 2012). Furthermore, many popular communication applications, such as Windows Live Messenger, Google Talk and Skype, have mobile implementations. Revisiting the social networks, social networking sites such as Facebook, Twitter, Google+ and MySpace also have mobile applications to allow easy access from mobile devices; an example of which can be seen in the Android market (Google, 2012a; Google, 2012b).

The following are examples of mobile device usage on social networking sites. In Europe, social networking via mobile devices grew 44% from 2010 to 55,1 million users in September 2011. In addition, Twitter.com reported 115% year-on-year growth in its European users accessing their service from a mobile phone from September 2010 to September 2011 (comScore, 2011). In South Africa, the number of South African Twitter users has multiplied by 20 in a matter of a year. As of mid-2011 the South African Twitter user base was 1,1 million. However, in South Africa the leading social network contender remains MXit with approximately 10 million users (World Wide Worx, 2011). MXit, a Mobile Instant Messaging (MIM) platform, attributes its success to the fact that it is capable of functioning on more than 3000 different mobile handsets, ranging from the most basic mobile phones to smart phones (MXit, 2012). However, with the rise in smart phone user numbers these users might opt in future for different services as they will have many more social networking options than merely MXit.

A recent study by Ericsson found that 40% of Android and iPhone smart phone users use their phones while they are in bed before they go to sleep at night. Furthermore, 35% of these check their email or Facebook account in the mornings before getting out of bed (Greengard, 2012). Michael Suman, the research director of the Centre for the Digital Future at the University of Southern California, has remarked that there is a pervasive breakdown in etiquette among communication technology users. Suman says: “Today, people think it is okay to text in the middle of dinner, at a meeting, in class, where ever. They text while you’re talking to them …” (Greengard, 2012). All of these facts contribute to the argument that people have grown very dependent on communication services and therefore on their mobile phones.

The mobile devices used by individuals can serve to facilitate the need to be socially connected at all times. Jeremy Copp, comScore Europe vice-president for Mobile, states: “The rate of growth in daily social networking usage has surpassed even the rate of growth in total social networking adoption among mobile users, suggesting that the behaviour is becoming even more ingrained into people’s daily mobile lives” (comScore, 2011). It can thus be seen that users are no longer satisfied with a confined stream of information or a limited connection; users have unconsciously fostered a need for information to be at their fingertips at all times. It is no longer enough to be connected; modern individuals want to be connected all the time.

4.3. Electronic Communication and the Human Experience

In the previous section the adoption of electronic communication by society, businesses and individuals was discussed. Furthermore, the argument was made that as a result of the rapid growth in social networks, the need to be constantly connected is growing. This need can be observed particularly in users continually accessing services, such as social networks, from their mobile devices. This observation is further supported by the growing number of users accessing email and IM from a growing smart phone user base. In this section it will be argued that electronic communication has been adopted into most parts of the modern individual's life. The adoption of electronic communication stems from many factors, including social norms. Social norms can place pressure on individuals to adopt something, for example a technology. This adopted technology can then become a 'locked-in' habit as it serves to facilitate some of the basic human needs.

Social norms can be viewed as pressure from the social environment to conduct oneself in a particular way. Therefore, social norms can pressurise individuals to adopt something, such as a technology, to ensure that one does not "fall" behind (Lewis, 2008). Once something is adopted, in this case a technology, the technology can become part and parcel of your being, thus locked in (Shove, 2003).

In Figure 4.2 below, the escalating consumption of technologies and practices are illustrated by means of a ratchet.

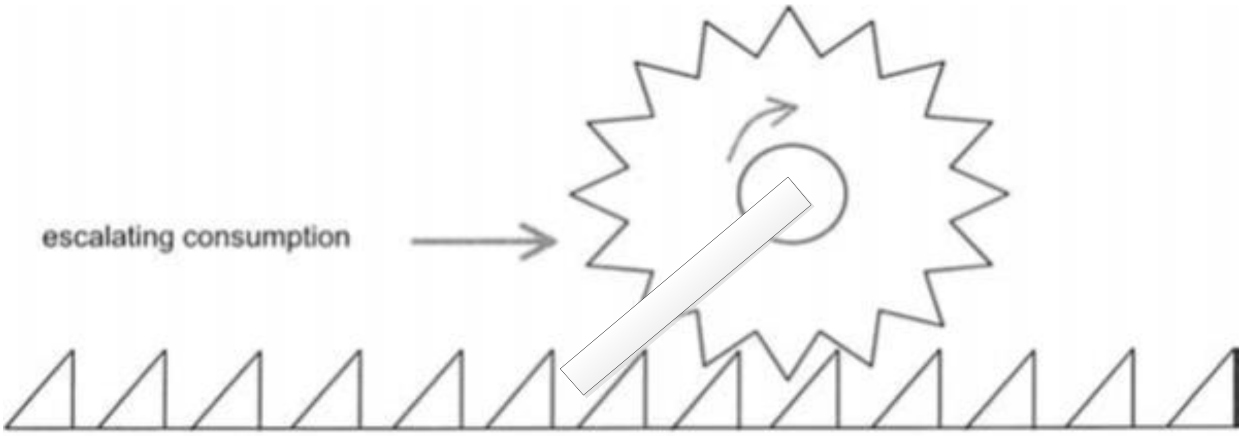

Figure 4.2: Escalating consumption (adapted from Shove, 2003)

The ratchet represents the impossibility of moving backwards in terms of technology adoption and practices. Additionally, the figure shows how a technology, if accepted as a social norm, becomes a locked-in habit (Shove, 2003). Existing lifestyle choices are closely linked to an individual's self-image, social standing and purpose (Lewis, 2008).

It can be argued that for something to be important to an individual, it must make a significant difference in their life. In addition to this, the difference that is made must be of importance and be deemed as an improvement to the individual. Therefore, something is important to an individual if it makes a significant difference that is of importance to an individual (Frankfurt, 1982).

To determine what is important to an individual, Maslow's hierarchy of needs comes to mind. According to Maslow, there are five levels of human needs. These levels are depicted in Figure 4.3 below.

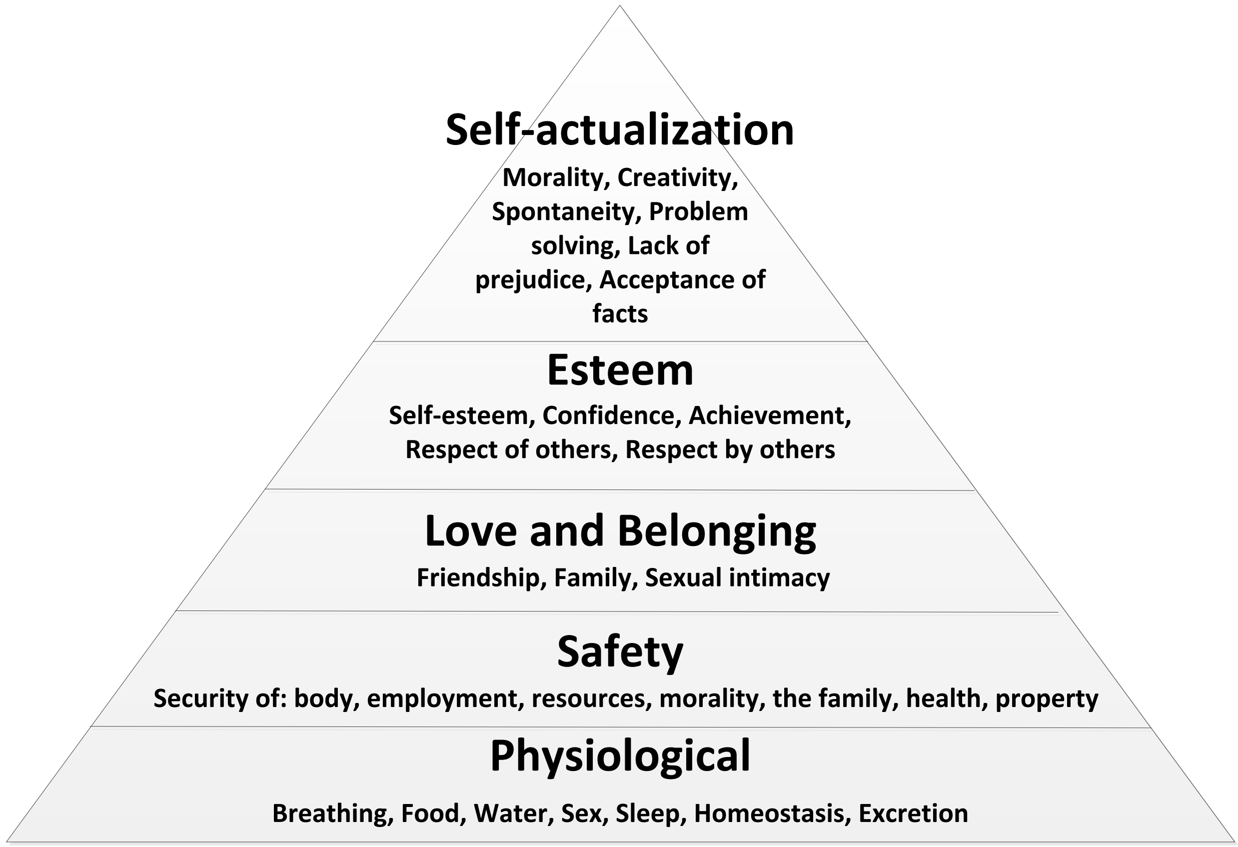

Figure 4.3: Maslow's hierarchy of needs (Maslow, 1943)

In the figure above, the hierarchy of human needs is depicted as a bottom-up pyramid; with the bottom of the pyramid being the primary and most basic human needs. Lower level needs, starting with the physiological need, have to be satisfied to a varying extent before higher level needs become of concern for the individual (Maslow, 1943).

A brief description of each of the levels of needs follows:

- *Physiological*

  These needs embrace all the basic needs for human survival and include the need to sleep and to eat (Maslow, 1943; Dictionary.com, 2012).

- *Safety*

  The need for safety can be defined as the need for a predictable, orderly world, the desire to be taken care of and to feel safe; for example, to have a secure employment that provides medical services and resources that allow the individual to feel safe and secure (Maslow, 1943).

- *Love and belonging*

  The need for love and belonging can be described as a hunger for affectionate relationships and a place in a group. It is important to note that the need for affection is an interactive need requiring both giving and receiving love.

- *Esteem*

  Esteem refers to the need for self-respect and to be respected by others. This can further be described as a need for achievement and confidence, to feel important, recognised and appreciated (Maslow, 1943).

- *Self-actualisation*

  This is described as the need to become more than one is; to achieve all that one is capable of. This level of need will manifest in different forms depending on a person's personality and traits. For example, a musician will have the need to be creative and make music (Maslow, 1943).

Of these five levels of human needs, the focus will be on the second and third levels, namely for *safety* and *love and/or belonging*. This focus will be in terms of examining these needs as they relate to electronic communication networks, as described in the previous sections. The two levels of the hierarchy mentioned, that is, *safety* and *love and/or belonging,* will be discussed in more detail.

From a psychological perspective, *safety* is the second level of the human needs hierarchy (Maslow, 1943) and feeling safe and secure is very important to the individual, as demonstrated by its place in Maslow's hierarchy. From a technology perspective, for years electronic communication has provided a sense of *security*, which has derived from being able to call for help. Furthermore, as the telephone has developed into its current mobile form, it too provides this sense of *security* (Leung & Wei, 2000, p. 309). The mobile phone now enables an individual to call for help when needed from almost any location worldwide.

The world is home to seven billion people and of these seven billion people there are currently almost six billion mobile-cellular subscriptions (ITU Telecom World, 2012). Having access to a mobile phone has made a significant difference to the way in which individuals communicate. As the majority of individuals now have access to mobile phones, most now experience the sense of security from carrying such a phone. This sense of security stems from the comfort provided by being able to call for help. Thus, the mobile phone as a communication technology is a core agent of the second level human needs in Maslow's hierarchy, namely, that of safety.

However, the mobile phone is not the only agent facilitating an individual's need for *safety*. In March 2011, after disaster struck Japan in the shape of an earthquake and tsunami, social media was used to notify individuals of the recovery effort and evacuation areas. As a high-profile cyber personality blogger from Japan put it: "when someone *tweeted* 'we need 600 rice balls here', they were delivered within an hour. Social media went from being a communications tool to a lifeline" (McCafferty, 2011).

In another incident, a 43-year-old South African woman and her 10-year-old son where forcefully held by robbers who broke in to her home. The robbers then took her phone. However, the woman managed to update her Facebook status from her laptop after she had managed to free herself and her son. This status was seen by a friend and subsequently her husband and the police were informed. The robbers fled the scene soon after the Facebook status updates were read and the police arrived (SAPA, 2012). This is a good example of social media providing safety-related information and thus contributing to individuals' safety.

From the above it becomes evident that communication technology can provide a sense of safety. In addition, it can provide critical information to facilitate an individual's physical safety and wellbeing. Thus, it can be argued that communication technology, specifically the use of mobile phones, has become critically important in the modern age. The critical importance of communication technology in terms of safety relates not only to the individual point of view, but also to a communal point of view.

The need for *love and belonging* comprises the third level of the Maslow's human needs hierarchy (Maslow, 1943). This level of need is extensively catered for by communication technology. On this level, the individual experiences the need for friendship, thus encompassing the social activity level of Maslow's hierarchy. Even the most misanthropic individual is an inherently social creature (Lewis, 2008); everybody seeks some sort of social belonging.

The individual self exists in relation to social conversations. Furthermore, it has been suggested that individuals are the sum of their social interactions (Stinger, 1982, p. 58). This means that individuals are influenced by their social interactions. Additionally, these social interactions shape an individual over time. Therefore, it could be argued that, if social media is used often for the purpose of social interactions, social media shapes the self. Furthermore, the individual self is constantly changing through his or her social interactions, as mentioned above. Thus, social media can be an important social tool, rendering the individual capable of changing the individual self.

“The task of constructing and maintaining symbolic meaning is itself a social one” (Lewis, 2008). The symbolic meanings that something has for individuals can serve to create and maintain a personal identity. The things individuals use and display serve to define their persona (Lewis, 2008).

Individuals can submerge themselves in social networks to maintain such a persona. This submergence is often not by choice, but rather as a result of habit or comfort. Such behaviour often stems from the collective level or social practices rather than at the individual level of intention-based or value-based behaviour (Jackson, 2005, p. 63).

Furthermore, one in five people have had a romantic or sexual relationship that started online, as reported by a European marketing consulting company, Euro RSCG. In addition, 49% of American adults know someone who started a relationship online (Stern, 2012). Therefore, using communication technology to socialise, or start or maintain relationships has become important to many.

As mentioned above, for something to be important it must make a significant difference that is of value to an individual’s life. Furthermore, if the individual then uses communication technology to the extent that it becomes a foundation that facilitates this human need, then communication technology is clearly very important to that individual. Thus, in conclusion, communication technology has grown into a significant and essential component of the modern individual's quest for love and belonging.

From the arguments above, it is clear that modern-day electronic communication technology can feed into and meet the needs of the second and third levels of Maslow's hierarchy, namely, *safety* and *love and belonging*. Therefore, a lack of communication technology could result in an individual feeling insecure and experiencing feelings of loss in terms of love and belonging. With this in mind, the question can be asked as to whether electronic communication technology can indeed be classified as critical infrastructure from the individual's perspective and, if so, what needs to follow as a result?

4.4. Electronic Communication as National Critical Infrastructure

The term "critical infrastructure" has been well-defined from a national perspective. In this section electronic communication will be discussed in terms of national critical infrastructure and will be related to national functions.

In the USA, critical infrastructure is defined as

> the assets, systems, and networks, whether physical or virtual, so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national economic security, public health or safety, or any combination thereof (Department of Homeland Security, 2011).

Thus, in order to be considered as critical infrastructure, infrastructure has to be vital to at least one of the following four national functions:

- national defence
- economic security
- public health and safety
- national morale

Of these four functions, communication is considered vital to national defence and economic security. For this reason communication technology can indeed be considered critical infrastructure (Moteff, Copeland, & Fischer, 2003). From a national perspective, modern-day communication technology is classified and treated as being critical, as it is core to numerous services and functions affecting national defence and economic security. Furthermore, if infrastructure is considered critical to a nation, it is generally protected by predefined and tested security plans and measures. It can be seen that critical infrastructure, by its very nature, is critical and therefore requires well-rehearsed plans for its protection. From a national perspective, this is certainly the case in the USA, where a well-developed critical infrastructure plan is in place. This plan is known as the National Infrastructure Protection Plan (NIPP). The following figure is a representation of the Critical Infrastructure and Key Resources (CIKR) framework that forms part of the NIPP. The USA makes use of the NIPP to improve and enhance the protection of CIKR.

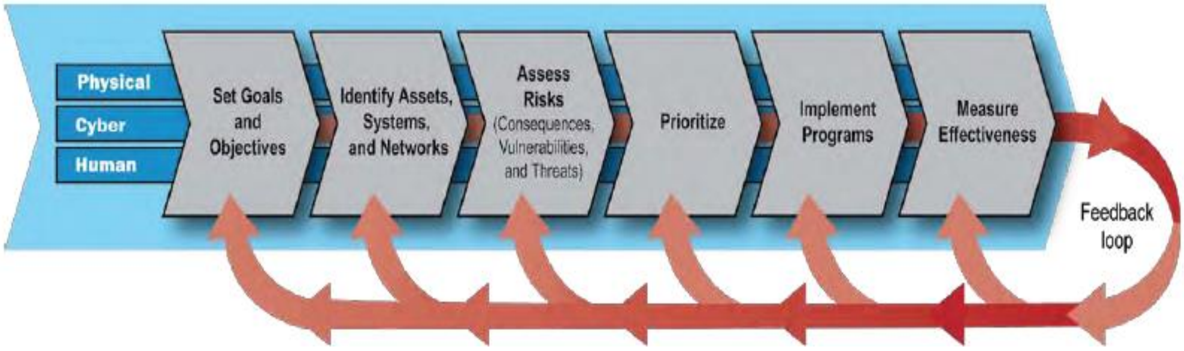

Figure 4.4: Risk management framework (Department of Homeland Security, 2009, p. 27).

Figure 4.4 depicts the way in which the identified critical infrastructure should be assessed and prioritised, a protection plan put in place and its effectiveness measured.

As depicted in Figure 4.4, there are six steps in the NIPP framework shown above. Here is a brief description of these steps:

1. *Set goals and objectives*. In the first step specific outcomes and targets are defined.

2. *Identify assets, systems and networks*. This step includes identifying the assets that could be considered critical.

3. *Assess risks*. In this step direct and indirect risk and known vulnerabilities to various attacks are identified.

4. *Prioritise.* During this step, risk and risk associated with mission continuity are evaluated and priorities are created on the basis of risk and the greatest return on investment.

5. *Implement protective programmes and resiliency strategies*. The appropriate measures to mitigate the identified risk are selected based on the priorities.

6. *Measure effectiveness*. Metrics are used to evaluate the progress and effectiveness of the protection plan (Department of Homeland Security, 2009, p. 28).

These steps, identified from the NIPP framework, can be extrapolated to mitigate risk for the individual in improving the availability of their communication technology. Therefore, if communication technology is identified as critical from the individual's perspective, as argued earlier, sound, well-rehearsed protection and continuity plans should be identified and implemented by the individual

4.5. Electronic Communication as a Personal Critical Infrastructure

As stated above, in the USA communication technology is classified as national critical infrastructure. This is not in fact limited to the USA, but holds for any modern developed country. Such infrastructure is considered critical to the nation as it is vital to at least one of the four national functions. However, these national functions can arguably be extrapolated to include personal or individual functions. From this point of view, communication technology is vital to personal functions such as the following:

- *Self-defence*

  Self-defence is the ability to defend oneself from various forms of harm, such as physical harm.

- *Economic security*

  Economic security occurs when one has a sufficient and stable income that allows for a sustainable standard of living.

- *Health and safety*

  Health and safety refer to the physical wellbeing of an individual and the provision of services that ensure an individual's health and safety.

- *Morale*

  Morale can be defined as an individual's or group's emotional or mental state, as seen by the exhibiting of confidence, cheerfulness, zeal, willingness to perform tasks and so on (Dictionary.com, 2012).

It is also important to note that each individual may have a unique level of dependency on electronic communication technology, as individuals have unique personalities and unique needs. Therefore, the degree to which the above-mentioned functions are affected by electronic communication may vary. The following section will relate some of the above-mentioned functions to Maslow's hierarchy of human needs.

4.6. Human Needs and Critical Infrastructure Functions

In this section, Maslow's human needs hierarchy and the critical infrastructure functions are aligned. This alignment is done in an attempt to show how critical infrastructure functions are related to human needs. From this alignment one would be able to argue that the critical infrastructure functions, from a communications technology point of view, can be classified as critical to individuals.

Aligning to economic security

Aligning safety needs to the economic security function

In accordance with Maslow's work, an individual will seek out economic safety or security. This economic security will be in the form of employment that offers means to provide insurance of various kinds, such as medical, dental, unemployment, disability and old age (Maslow, 1943).

Aligning to health and safety

Aligning safety needs to the health and safety function

In accordance with Maslow's work, an individual will use economic means to secure insurance, such as medical and dental.

Aligning physiological needs to health and safety function

"It should be pointed out again that any of the physiological needs and the consummator behaviour involved with them serve as channels for all sorts of other needs as well" (Maslow, 1943).

Some of the basic human needs categorised under physiological needs are food, water and sleep. It is obvious that to be healthy and to live, humans need these three basic things (Maslow, 1943).

In Figure 4.5, three of the four critical infrastructure functions are aligned to Maslow's human needs hierarchy.

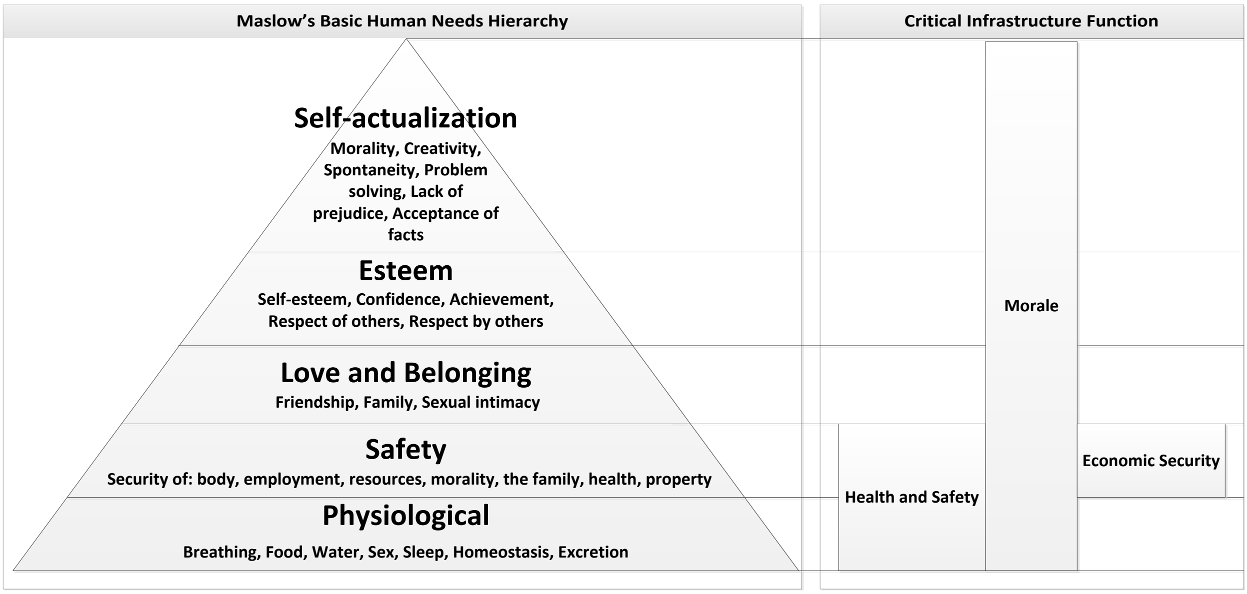

Figure 4.5: Alignment of the basic human needs and critical infrastructure (CI) functions

From this it can be seen that the national functions can be related to Maslow's hierarchy of human needs. These functions serve to identify national critical infrastructure. Therefore, aligning these functions with Maslow's basic human needs indicates the way critical infrastructure functions can be related to basic human needs and, ultimately, that communication can be regarded as critical infrastructure to an individual.

Aligning to morale

Aligning all levels of Maslow's needs to morale

In the instance of morale, all five levels of the hierarchy will be related to this function. Morale can be aligned to the entire hierarchy, as the way an individual's needs are met determines their personal morale (The Human Givens Institute, 2012).

From the alignment above and by relating Maslow's human needs, such as, *safety* and *love and belonging,* it can be argued that communication networks can be widely classified as personal critical infrastructure. Furthermore, as seen from the national critical infrastructure and the USA's NIPP, if infrastructure is identified as critical to national functions it should be protected. Therefore, if a communication network is identified as critical to personal functions, it should indeed be protected in a proper manner.

4.7. Conclusion

It has been argued that communication is important to individuals and to the wider society. Furthermore, various needs, such as the need for communication, are increasingly being met through electronic communication. As has been described in this chapter, these days electronic communication has been integrated into the lives of many people. This integration is often a result of social norms or social pressure. However, once a technology has been integrated or adopted into an individual's life, it can become a habit or a comfort, consequently becoming locked in to the individual's life. Once a technology, such as electronic communication has become locked in, if it becomes unavailable the loss can to a greater or lesser extent be detrimental to the individual. From a psychological perspective, the adopted technology can facilitate a user's basic needs, such as *love and belonging* and *safety*. Additionally, these also form part of morale and communication technology services can serve to facilitate economic and health and safety needs. Therefore, as communication technology serves to facilitate many of the modern-day individual's needs, thereby becoming a necessity and in fact critical, its availability should be maximised.

Chapter 5: Towards a Guarantee of Higher Availability

“Technology does not produce miracles, but connectivity, even in modest amounts, changes lives” (Eric Schmidt, Google Executive Chairman).

5.1 Introduction

In the previous chapter it was proposed that communication technology has become critical infrastructure to many individuals. Therefore, because communication has such an important place in people’s lives; precautions should be taken to provide a higher service guarantee. In this chapter, a framework will be proposed to provide individuals with the means to guarantee higher communication availability. This chapter will describe the components and implementation of the proposed framework.

5.2 The Communication Technology Higher Availability Guarantee Framework (CTHAG)

In Chapter 4, it was argued that electronic communication technology has become critical to most modern individuals. It is for this reason that the services required from communication technology should be made as available as possible. To achieve this, the Communication Technology Higher Availability Guarantee (CTHAG) framework has been developed. This framework was developed from theory and the concepts stemming from SANS 31010:2010, SANS 25777:2010, CobiT 4.1 and the National Infrastructure Protection Plan (NIPP). The following diagram, Figure 5.1, is a graphical representation of the CTHAG framework.

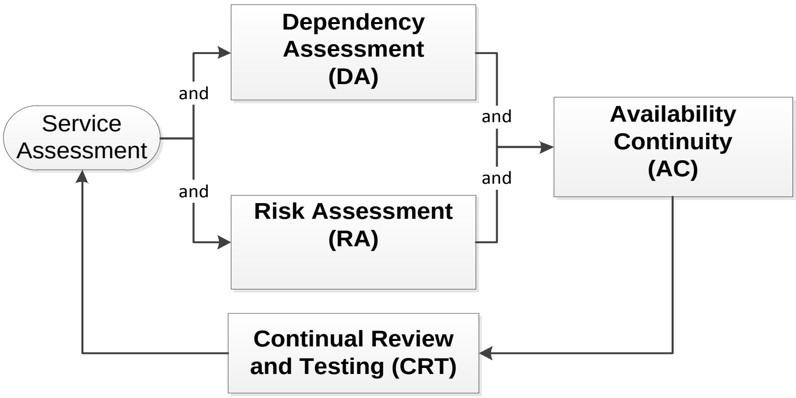

Figure 5.1: Communication Technology Higher Availability Guarantee (CTHAG) Framework

For the rest of this chapter the term "service" refers to a service an individual utilises by means of electronic communication. Typical examples are email, voice communication, SMS, social networking services, instant messaging, online banking and suchlike.

The objective of the framework is

- to identify all the individual services, as described above, used by an individual
- to determine the dependency the individual experiences on any of these services
- to determine the risk that any of these services might be interrupted
- to devise a continuity plan for each of the highly dependent, high risk services.

This should result in the increased availability of each of these services.

The CTHAG framework will now be discussed in more detail. This framework consists of four major processes: dependency assessment (DA), risk assessment (RA), availability continuity (AC) and continual review and testing (CRT). It should be noted that the service assessment element in the framework represents the current service being assessed. A brief overview of these processes will follow.

The dependency assessment aims to determine the level of dependence an individual has on the particular service selected. The risk assessment then aims to determine what the current risk level for the selected service is. The results of the dependency assessment and the risk assessment then allow the individual to determine the level of availability guarantee required of the assessed service. The continuity plan in section 5.5.2 should then be followed in order to address the identified risks and meet the availability required from each identified service. The service should then be reassessed at regular intervals as discussed in section 5.6. This framework should then continue to be used to assess each of the major electronic communication services, for example SMS, social networking services or email, used by that individual. The following section will discuss the dependency assessment process in more detail.

5.3 Dependency Assessment (DA)

As mentioned in section 4.5, the level of dependency an individual experiences on electronic communication may vary. It is for this reason that a dependency assessment is required to determine the level of dependence an individual has on the services they require. In this section the dependence the individual has on communication technology will be assessed to help determine the adequate level of service guarantee required. To determine the eventual level of availability guarantee required an individual requires a dependency level. The dependency level (DA2) will be derived from the dependency assessment; this will then be incorporated with the risk level (RA3), to be determined at a later stage. The following is a graphical representation of the dependency assessment components that will form part of the CTHAG framework.

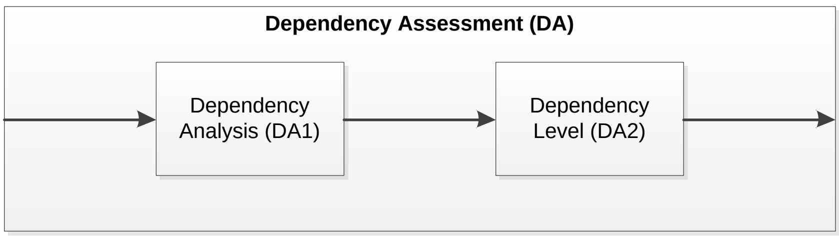

Figure 5.2: Dependency assessment process

The components of Figure 5.2 will be discussed in the following subsections.

5.3.1 Dependency Analysis (DA1)

In CobiT 4.1, the control objective DS4 (Ensure Continuous Service) states that attention should be focused on services most critical to the continuity plan. Furthermore, the recovery of less critical services should be avoided or have a lower priority to ensure that prioritised business needs are met (IT Governance Institute, 2007). It is therefore clear that important or critical services *must* be identified. To identify these important or critical services the dependency level of each item must be ascertained. The establishment of the lesser or greater critical service priority will enable cost-effective service guarantees *appropriate* to the level of dependency. For example, the more important a particular service is to the particular individual, the higher the eventual level of availability guarantee ought to be. Having selected a critical service to assess, the individual should determine their dependency level with regard to that service.

5.3.2 Dependency Level (DA2)

To establish the level of an individual's dependency on electronic communication services, he or she will have to determine their own dependency on each particular service. To determine their dependency the individual should consider some of the following key factors:

- The number of hours the service is generally used in a day
- The number of hours of availability that is generally required from the service on any given day
- The number of hours of availability generally preferred from the service on any given day
- How the loss of a particular service can affect one's
    - health and safety
    - economic security
    - morale.

These examples are some of the questions individuals could ask themselves in order to determine his/her level of dependency on electronic communication technology services. A dependency level can be qualitatively assigned as follows: high (3), medium (2) and low (1). The individual would then consider the four key factors mentioned previously. After having completed the dependency analysis, thereby establishing their dependency level on the service being assessed, individuals should be able to determine how their dependence will influence the level of service guarantee required. Figure 5.1 shows that the level of availability continuity is determined by completing the dependency and risk assessment. The next section will address the risk assessment component of the framework.

5.4 Risk Assessment (RA)

In this section, the risk assessment component of the CTHAG framework will be discussed. The first step in the risk assessment component is risk identification. The risk identification will determine what events may negatively affect the communication technology services used by an individual. A risk analysis will then be conducted to determine the probability of an event affecting the communication technology services used by an individual and the impact it will have on that individual. The probability and impact will then be used to determine a risk level. The risk level represents the current level of risk on which the relevant service is rated. The NIPP assesses risk (R) by rating it as a function of consequence (C), vulnerability (V) and threat (T); therefore, R = f (C, V, T) (Department of Homeland Security, 2009, p. 32). However, the risk assessment will primarily be conducted in accordance with the qualitative assessment in SANS 31010:2010. The succeeding steps roughly correspond with the third step of the NIPP framework, *assess risks*. A graphical representation of the risk assessment process that will form part of the CTHAG framework is found in Figure 5.3.

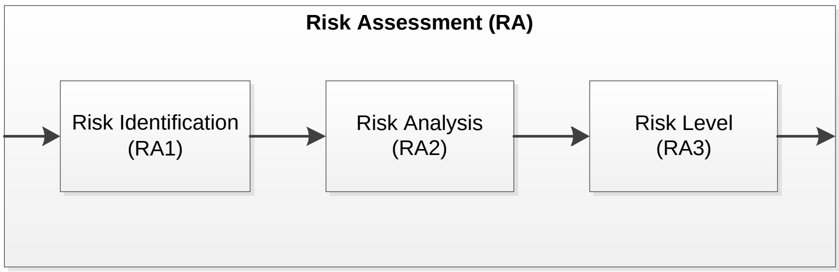

Figure 5.3: Risk assessment process

The process of risk assessment is displayed in Figure 5.3 and will be discussed in the following subsections.

5.4.1 Risk Identification (RA1)

The process of risk identification includes finding the cause and the source of a risk (SANS, 2010). This step entails the *vulnerability* and *threat* aspects of the NIPP, that is, the *assess risk* process of the NIPP framework. The threat here relates to the source and the vulnerability relates to the cause of any risk. SANS 31010:2010 identify three methods for identifying risk:

1) Evidence-based methods, examples of which are checklists and reviews of historical data.

2) Systematic team approaches where a team of experts follow a systematic process to identify risks using a structured set of prompts or questions.

3) Inductive reasoning techniques such as the Hazard and Operability method (HAZOP) (SANS, 2010).

It is important to note that the following figure, Figure 5.4, serves merely as an example of risk identification and that these are not the *only* categories of risks involved. The following figure presents a risk identification tool that could be used in conjunction with the SANS 31010:20120 methods to determine the risks an individual could face.

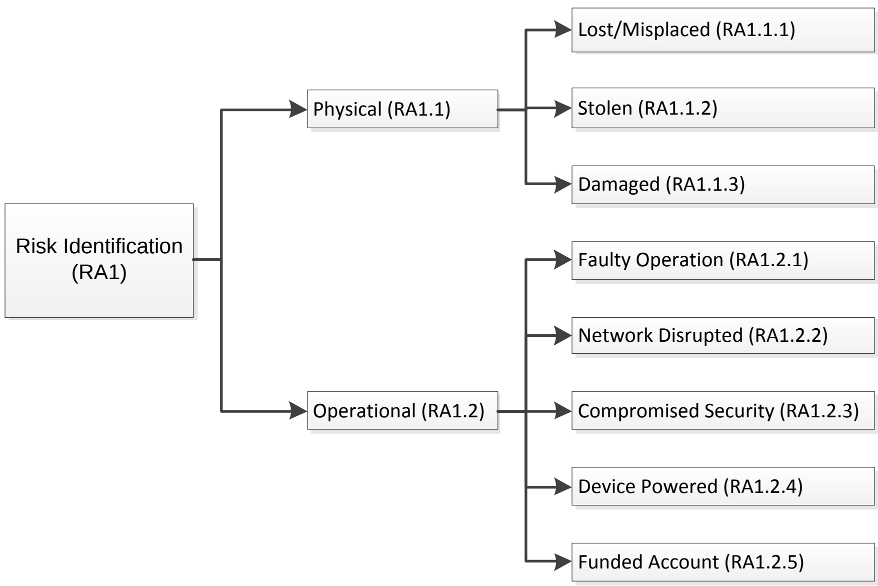

Figure 5.4: Example Risk identification steps

In Figure 5.4, two categories of risk relating to personal electronic communication are depicted; that is, physical and operational. Each of these categories has a number of possible risks associated with them. These will now be discussed in more detail.

For the rest of this chapter, the term “device” refers to the hardware used to establish electronic communication. With regard to the physical risk category (RA1.1), three risks have been identified. These risks are as follows:

- *Lost/misplaced (RA1.1.1).* This occurs where the device is currently not physically available owing to being temporarily misplaced, or lost.
- *Stolen (RA1.1.2).* In this case, the device is currently not physically available as it has been stolen.
- *Damaged (RA1.1.3).* A damaged device refers to a device that has been physically damaged. Examples of this include a cracked screen or water damage.

If individuals are exposed to these risks they may be only temporary affected, because, for example, the lost device might be found. However, this is still capable of causing a disruption of service.

With regard to the operational risk category (RA1.2), the following five possible risks have been identified:

- *Faulty operation (RA1.2.1).* Faulty operation is where the device is not operating as described by the manufacturer, which results in the required functions being unavailable.
- *Network disruption (RA1.2.2).* A network disruption can be described as a network not currently able to process subscriber requests successfully.
- *Compromised security (RA1.2.3).* In this case, if the security of a device is compromised, the requisite services could become unavailable, or the device could have faulty operation or it could be an information security risk.

- *Unpowered device (RA1.2.4).* An unpowered device is a device for which no power source is available, thereby rendering it unusable.

- *Unfunded account (RA1.2.5).* If an account is unfunded, there are no funds available and the device will not be able to use any network services.

These descriptions of potential risk relate to the use of communication devices. After the risk identification step, a risk analysis should be conducted on each of the risks identified.

5.4.2 Risk Analysis (RA2)

Risk analysis can be described as the process of developing an understanding of the risk involved. A risk analysis also determines the probability and the impact of an identified risk. The risk level will be identified in a qualitative manner based on probability and impact as per SANS (2010). Furthermore, the risk level is represented by a numeric value varying from 1 to 9, but this step will be discussed in more detail in subsection 5.4.5. The following figure, Figure 5.5, is a graphical representation of risk analysis.

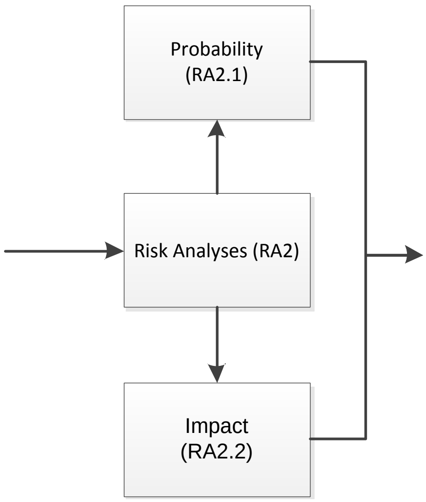

Figure 5.5: Risk analysis steps

The risk analysis step will be discussed in the following sections.

5.4.2.1 Probability (RA2.1)

NIPP refers to the measure of *vulnerability* as the probability of a successful attack, given that an attempt is made. However, in the case of an individual's communication technology, it is likely that there may be other factors to consider. In accordance with SANS 31010:2010, there are three methods of determining the probability of a risk. Summarised descriptions of these methods are as follows;

1) *The use of relevant historical data to deduce the probability of a future incidence*. If there is a low or zero frequency of occurrences, then the estimation of probabilities becomes very uncertain.

2) *Probability forecasting using predictive techniques*. According to this technique, simulation can be used to generate the probability of failure, or the failure and success rates could be used.

3) *Expert opinions to estimate probability*. Experts should draw on all relevant and available information. A number of formal methods for judging probability by creating the appropriate questions to ask are available, such as the Delphi approach (SANS, 2010).

For the purpose of this research, and due to the limited availability of experts and time constraints, option 1) and 2) will mainly be used to determine probability, although, as suggested by SANS 31010, option 3) could also be used. The following diagram is a depiction of the risk tool probability step.

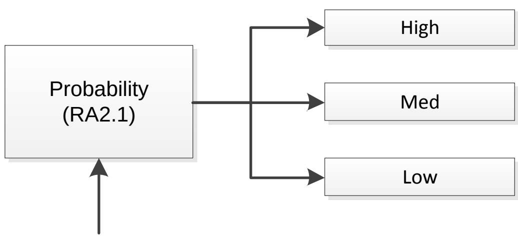

Figure 5.6: Probability steps

The identified probabilities for this tool are high, medium or low. Furthermore, each of the identified probabilities has a numerical value associated with it. These numerical values are used in conjunction with the numerical values of the impact step to obtain the risk level. A short description of each of these and the associated numerical values will now follow.

- *High (3).* The probability is high if it is very likely that an identified risk will result in an incident.
- *Medium (2).* The probability is medium if the identified risk is neither likely, nor unlikely.
- *Low (1).* The probability is low if the identified risk is unlikely to result in an incident.

After the probability of an incident has been estimated, the impact of a successful incident should be estimated.

5.4.2.2 Impact (RA2.2)

This step correlates with c*onsequence* and the resulting impact. The NIPP describes a *consequence* as being in one or more of four categories. These categories are public health and safety, economic, psychological and governance. Furthermore, these consequences can be related to the four national functions of critical infrastructure. These are national defence, public health and safety, economic security and national morale (Moteff, Copeland, & Fischer, 2003).

Figure 5.7 gives a depiction of the risk process impact step.

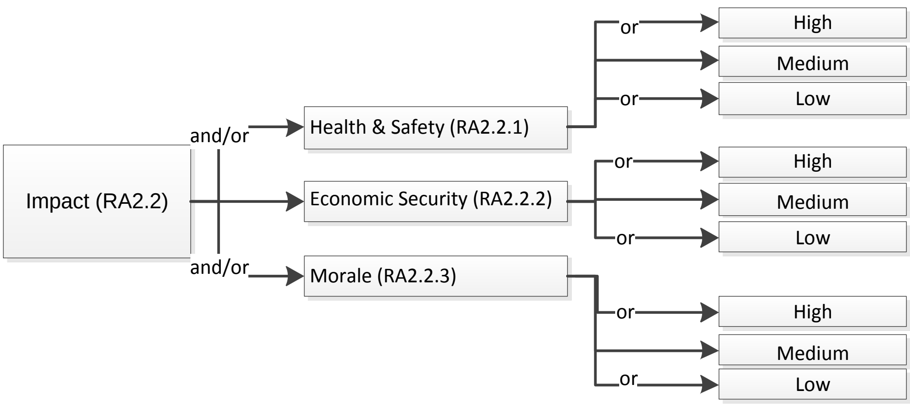

Figure 5.7: Impact steps

The impact that critical infrastructure has on national security in the US has previously been mentioned. The level of impact that such infrastructure has on national security describes the national impact category (Moteff, Copeland, & Fischer, 2003), this level can, however, also be used to describe a personal impact category. It is for this reason that health and safety, economic security and morale were used in the risk tool. Although these have been discussed in Chapter 4, for the sake of readability it will be repeated here.

- *Health and safety (RA2.2.1).* Health and safety refers to the physical wellbeing of an individual and the provision of services to ensure an individual's health and safety.
- *Economic security (RA2.2.2).* Economic security refers to a condition where an individual has a sufficient and stable income that allows for a sustainable standard of living.
- *Morale (RA2.2.3).* Morale can be defined as the emotional or mental condition of an individual or group, as seen in the exhibiting of confidence, cheerfulness, zeal, willingness to perform tasks etc. (Dictionary.com, 2012).

Each of these possible impacts has an impact level associated with it. The impact levels and the associated numerical values are as follows:

- High = 3
- Medium = 2
- Low = 1

As previously mentioned, more than one impact can be associated with a particular service. If more than one impact is associated, the highest impact level is used as the level. Furthermore, as discussed in subsection 5.4.2.1, the numerical results of the impact and probability steps are multiplied by each other. The result of this multiplication is seen as the risk level. The following subsection will discuss the risk level process in more detail.

5.4.3 Risk Level (RA3)

Risk level is the level of risk an individual requires from the particular service under scrutiny. To identify the level of risk, an individual would complete the risk identification (RA1) and risk analysis (RA2) steps of the CTHAG framework. Furthermore, the risk level can be calculated by assigning values to the respective levels of probability and impact. Therefore, values can be assigned in the following manner (High = 3, Medium = 2, Low = 1). Following the SANS 27005 risk calculation convention (SANS, 2009), these numbers are then multiplied by each other to produce a value between 1 and 9.

The value obtained reflects the risk level required. The following is an example of such a completed risk assessment of a single service:

Risk Assessment					
Service assessed	**Identified risk**	**Probability**	**Impact**	**Impact level**	**Risk level (Range 1–9)**
Service being assessed	Network disrupted	Medium (2)	Economic security	Medium (2)	4
			Health and safety	Low (1)	2
	Stolen	High (3)	Economic security	Medium (2)	6
			Health and safety	Low (1)	3
			Morale	High (3)	9

Table 5.1: Risk level assessment

Table 5.1 demonstrates an assessment of a selected service to establish a risk level, which is done by completing the risk assessment (RA) process of the CTHAG framework. After completing this process, as well as the dependency assessment (DA) process, the service continuity strategy can be established.

5.5 Availability Continuity (AC)

In the following section, service guarantee and continuity plans will be proposed and discussed. In order to plan and achieve a higher level of service guarantee, the dependency assessment (DA) and risk assessment (RA) processes will be evaluated to indicate what level of availability guarantee is ideally required. The continuity plan will consist of various layers ordered from Layer 1 to Layer 6; furthermore each layer will include identified dependencies, challenges and solutions. By tracing the required service down to Layer 1, the individual will then use these layers to help determine what solutions to implement. The dependency assessment process will help individuals to determine their dependency on each service used. Subsequently, the result of this could be used to establish what risk assessments to pursue and how many solutions should be implemented at each layer.

The risk assessment process will determine the extent of risk that is associated with each service. Furthermore, the risk assessment will help determine what solution layers to implement in the continuity strategy. The result of the combination of the dependency assessment and the risk assessment will then be used to determine what continuity strategies and layers need to be focused on. For example, a high dependency on a high-risk service at Layer 6 (Internet services) could result in most or all solutions on all layers being implemented. More details on the continuity step will follow in subsection 5.5.2. The result of the availability continuity process will be a continuity plan for pursuing the required service guarantee. The following is a graphical representation of the availability continuity process and will form part of the CTHAG framework.

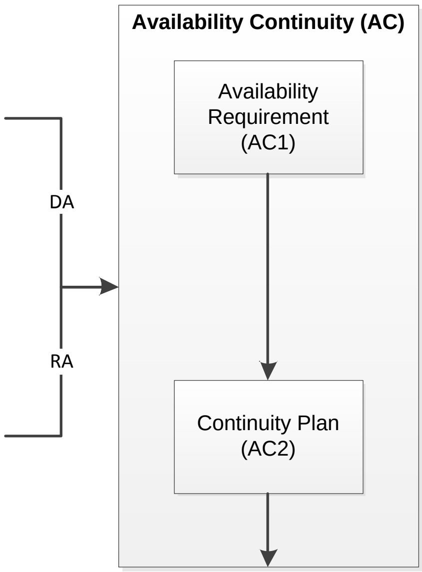

Figure 5.8: Availability continuity process

The process depicted in Figure 5.8 will be discussed in the following subsections.

5.5.1 Availability Requirement (AC1)

This step, availability requirement, is a step of the CTHAG framework and is intended to determine the level of availability that an individual requires. This requirement can be derived by using the availability requirement matrix, as depicted in Table 5.2.

The following is a brief direction of the use of the availability requirement matrix. Accordingly, the availability requirement can be determined by matching the numerical value of the dependency assessment (DA) to the numerical value of the risk assessment (RA) in a matrix (see Table 5.2). The availability requirement is expressed in the following manner:

- H = High
- M = Medium
- L = Low

The following table was established by using guidelines from the SANS 27005:2009 standard.

Assessment	**RA**									
DA	*Value*	1	2	3	4	5	6	7	8	9
	1	L	L	L	L	M	M	M	H	H
	2	L	L	L	M	M	M	H	H	H
	3	L	L	M	M	M	H	H	H	H

Table 5.2: Availability requirement matrix

After completing Table 5.2, thereby obtaining the availability continuity level required from a particular service, measures need to be taken to achieve this required level. To achieve this level of availability continuity, a continuity plan will be constructed based on the individual's needs that have been identified.

5.5.2 Continuity Plan (AC2)

In order to ensure the availability and continuity of the required ICT infrastructure, an organisation could use the South African standard SANS 25777:2010, which provides organisations with ICT continuity guidelines. However, some of these principles can be generalised to meet the individual's needs. For example, a proactive continuity plan could be drawn up in terms of which measures are taken to avoid or minimise disruptions, or a reactive plan in terms of which measures are taken to minimise disruptions *after* they have occurred. In accordance with SANS 25777:2010, there are four main phases involved in an ICT continuity strategy:

1) Understand the ICT continuity requirements.
2) Determine ICT continuity strategy.
3) Develop and implement ICT continuity strategies
4) Exercise, test, maintain, review and improve (SANS, 2010).

A brief description of these phases will now be provided. Firstly, understanding the ICT continuity requirements involves an understanding of normal ICT configuration requirements. These requirements should then be categorised according to priorities. In addition, this involves determining the gap between current ICT continuity capabilities and the required continuity requirements for each critical ICT service (SANS, 2010).

Secondly, an approach for implementing the required resilience, protection and recovery procedures should be defined. In this step, costs and benefits should be considered along with the risk *appetite* of the organisation. Moreover, the ICT continuity strategy should provide for any probable risk as well as the effects of possible disruptions (SANS, 2010).

Thirdly, implementing the chosen ICT strategies, along with the necessary phases required to support the implementation, is required in developing and implementing ICT continuity strategies. This step may include training to ensure that skills/knowledge gaps are minimised. Implementation may also include the selection of the appropriate technologies required by the chosen strategy (SANS, 2010).

Fourthly, the exercise, test, maintain, review and improve step aims to ensure that the strategies chosen actually work as expected and when required. The recovery and resilience capabilities should also be tested and documented. In addition to this, the maintain, review and improve procedures are also done to deal with any changes. As the individual's requirements change, so too will the ICT requirements and the ICT continuity plan needs to be updated accordingly. Additionally, the documented tests should be reviewed, and identified improvements should be implemented where required (SANS, 2010).

In order to meet an individual's electronic communication requirements, the following communication technology continuity framework has been developed. This framework (Figure 5.8) includes the continuity plan step of the CTHAG framework. Figure 5.8 can be used to establish an ICT continuity plan in accordance with the four main phases of SANS 25777:2010, as described above.

Furthermore, it should be noted that the ICT continuity procedure should be treated as an ongoing lifecycle. An individual will need to determine what his/her personal ICT requirements are by establishing the availability requirement (AC1); after which, he/she can use Figure 5.8 and subsequently Figure 5.9 to devise a continuity plan. The details pertaining to the development of the continuity plan will be discussed in the following section and figures. After an ICT continuity plan has been developed, it should be implemented, tested, maintained and reviewed.

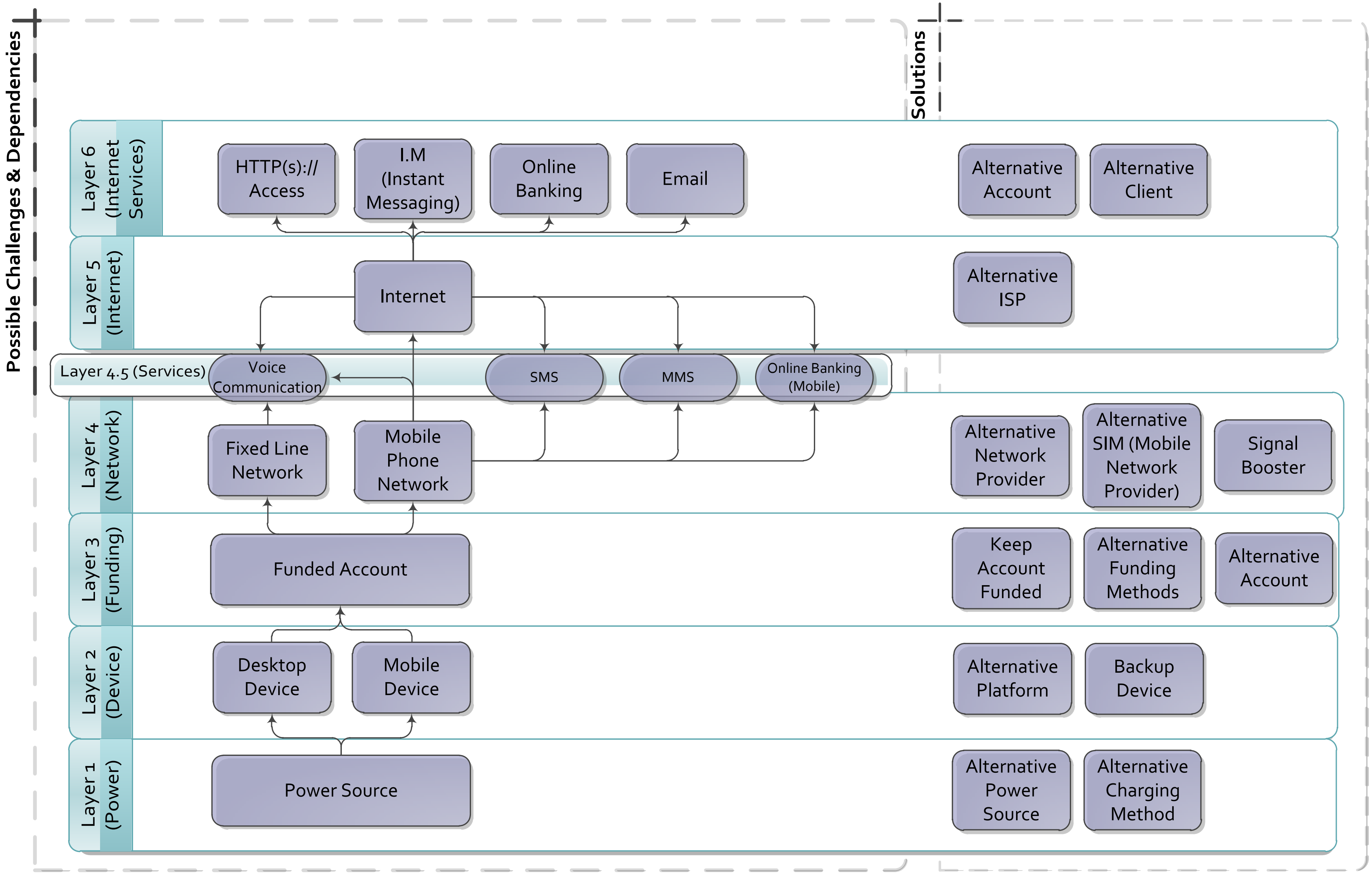

Figure 5.9: Communication technology continuity framework

The framework depicted in Figure 5.9 represents continuity planning; it comprises six layers and is arranged in order of dependence. For example, Layer 2 requires Layer 1 in order to operate. Accordingly, Layer 1 provides a source of power for the communication device in use; Layer 2 is concerned with the physical device being used to communicate with; Layer 3 is involved in the funding of an account on a communication network. At Layer 4 the network type used by the device is considered; Layer 5 is dedicated to the Internet as a service; and Layer 6 comprises a grouping of services that an individual may be dependent on. Figure 5.9 will now be discussed in detail.

Layer 1 (power). As previously mentioned this is the base layer. This means that all the other layers are dependent on this layer for operation. As all devices are dependent on a power source, it is important to note that there are two main types of power source; either a power outlet, such as an AC wall-mounted power outlet, or a DC battery. Once the individual has determined on which power source they are dependent, they should address the challenges that might be faced at this layer.

To address some of the challenges at Layer 1, an individual using a power outlet could use an alternative power outlet. This alternative power outlet could be an alternative wall-mounted power outlet or an outlet provided by a generator. In this regard, there are many generator variants, such as solar, wind turbine or fuel-powered generators. These generators could provide a power outlet or could, in turn, charge a battery bank, which coupled with an inverter could provide an alternative power outlet.

If an individual is dependent on a battery as a power source, it should be noted that a chargeable battery is dependent on a power source, such as an AC power outlet, to charge it. However, there are many other methods for charging a battery. Alternative charging methods include mobile solar battery chargers or car chargers. Car chargers can use a Universal Serial Bus (USB) port and many modern mobile devices are capable of being charged by a USB cable and a USB port. Furthermore, USB ports can be found on desktop devices and mobile computing devices, such as tablets, laptops and netbooks. Therefore, mobile devices that can be charged by means of USB can also be charged by any of the previously mentioned devices.

These mobile devices provide power to the USB port even while under battery power, thereby allowing charging of devices while powered by their own battery.

In addition, there are various methods to reduce power consumption or extend battery life under certain conditions. Some of these will now be discussed. The first is operating temperatures. If devices are operated at optimum temperature an individual could obtain the maximum available power from the battery of their mobile device. Although there are many different battery compositions, there are some general rules for the batteries used in mobile electronic communication devices, some of which will be briefly discussed here. The ideal operating temperature for most battery types is at 20 °C (80 °F). Colder temperatures increase the internal resistance and in effect slow down the internal chemical reactions. At certain lower temperatures, a battery will have a reduced discharge rate. Therefore, an unused battery stored in these lower temperatures could result in longer discharge time, which in turn could result in longer use when warmed back up to ideal operating temperatures.

In contrast, higher temperatures reduce the internal resistance and in effect speed up the internal chemical reactions, resulting in a brief improvement in battery performance. However, it is advisable to use this method only in cases of emergency, as its continued application could reduce the service life of the battery (Buchmann, 2012; Energizer Battery Manufacturing Inc, 2008).

The second method is to reduce the power consumption. To further extend a device's battery life an individual could install a power-saving application or change device settings manually to reduce the power consumption.

There are several settings that could allow for *less* power consumption in a device. Some of these settings include turning off unnecessary or unneeded functions, or changing the default settings. These changeable settings include

a) dimming the display brightness

b) setting background image and themes to black

c) turning device sounds softer or off

d) turning vibrate function off

e) turning wireless off

f) turning Bluetooth off

g) turning Internet synchronisation off

h) switching to 2G or 3G

Examples g) and h) will now be discussed further. In addressing g), if an individual uses Internet synchronising services, such as email or weather forecasting applications, turning the synchronisation of these services to manual, or setting the synchronisation time to be less, often results in less power consumption. Furthermore, in addressing h), an individual could switch their mobile device to 2G or 3G depending on their requirements. Switching a device to a 2G network could allow for more talk time, but also reduce standby time. Fixing a device to a 3G network could also allow for more standby time, but less talk time. Nokia has claimed that the Lumia 800 is capable of achieving 13 hours of talk time in a 2G network, but only 9,5 hours on a 3G network. In contrast, the 3G network reportedly allows for 335 hours of standby time, whereas the 2G network only provides 265 hours (Nokia, 2012).

From this discussion it is clear that individuals who predominantly make and receive calls on the device would be advised to use a 2G network. On the other hand, users who prefer to have prolonged availability would be advised to make use of a 3G network. The following is a graphical representation of Layer 1.

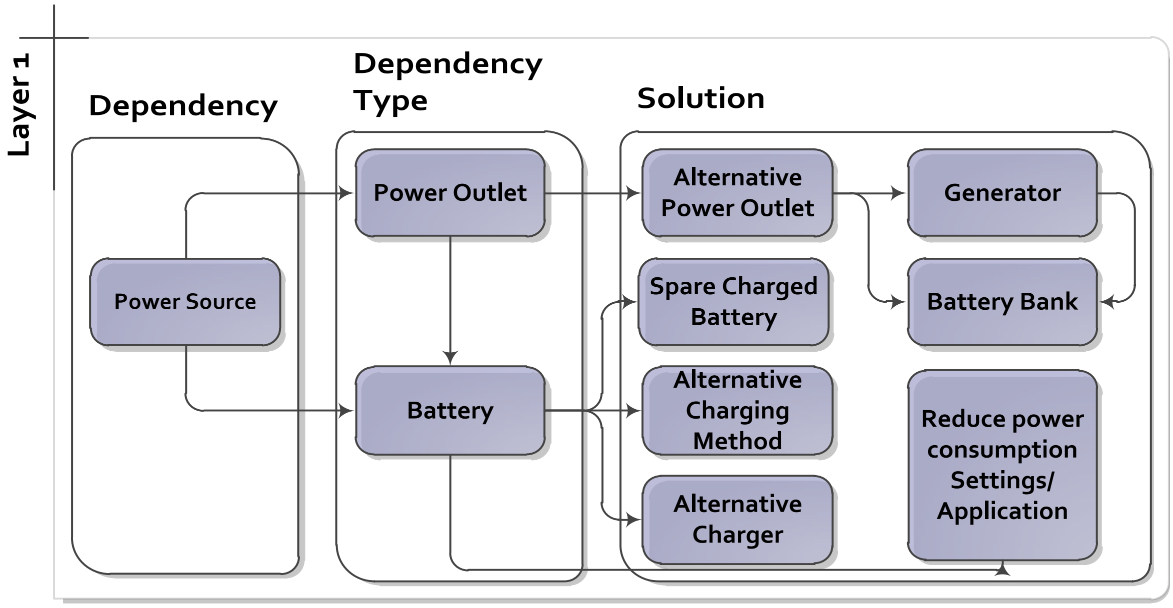

Figure 5.10: Layer 1 (power)

Layer 2 (device). Layer 2 addresses the physical devices used during the communication process. Such a device can either be a desktop device or a mobile device. For the purpose of this study, a desktop computer and a VoIP phone will be treated as desktop devices, while mobile phones, tablets, laptops and netbooks will be treated as mobile computing devices.

If a device becomes unavailable, an alternative or back-up device could be used. The back-up device can be a device that replaces the current faulty device, in which case it should be capable of performing the functions required to temporarily replace the main device.

In contrast, if a back-up device cannot be made available, an individual could make use of an alternative platform. An example of an alternative platform is to use a mobile phone to retrieve email if the desktop device that is generally used is not available. The following is a graphical representation of Layer 2.

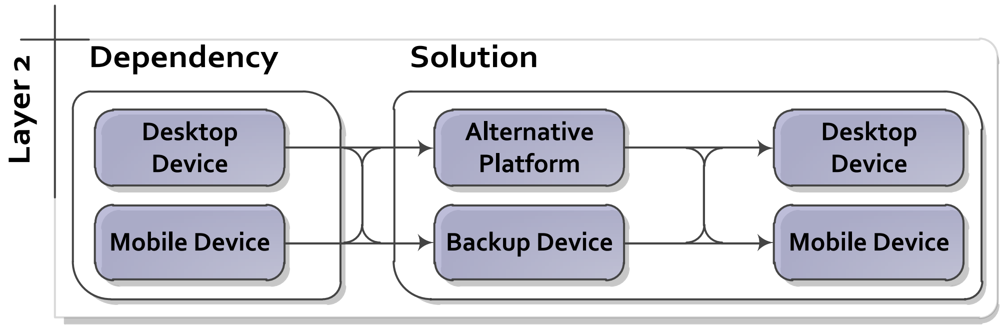

Figure 5.11: Layer 2 (device)

Layer 3 (funding). This layer addresses account funding. A service provider will provide access to its network and services if an account is funded. When an account has no funds mobile networks generally only grant access to emergency services. So, in order to access services such as Internet services, sending SMSs or making a phone call, an individual will need a sufficiently funded account. To maintain a sufficiently funded account an individual could follow various strategies.

If an individual makes use of a prepaid funding method, they should keep the account well-funded. In this case, a well-funded account could be considered an account with three times the average daily usage available. In addition to a well-funded account, an individual should have an alternative funding method, such as having additional, unused recharge vouchers available. These recharge vouchers could then be used to recharge an account in case of an emergency. Another alternative funding method is to link a bank account to the mobile phone number in use. Banks, such as FNB, allow the purchase of airtime free of mobile carrier charges. Additionally, Internet banking can be used to fund various electronic communication accounts, such as Internet service accounts and mobile network accounts. If an individual has ongoing account funding problems, an alternative billing method, such as a contract-based account, should be considered. Finally, an alternative account could be kept, such as an additional SIM card, or mobile phone and SIM card if all funds on the main SIM card have been depleted. The following is a graphical representation of the possibilities at layer 3.

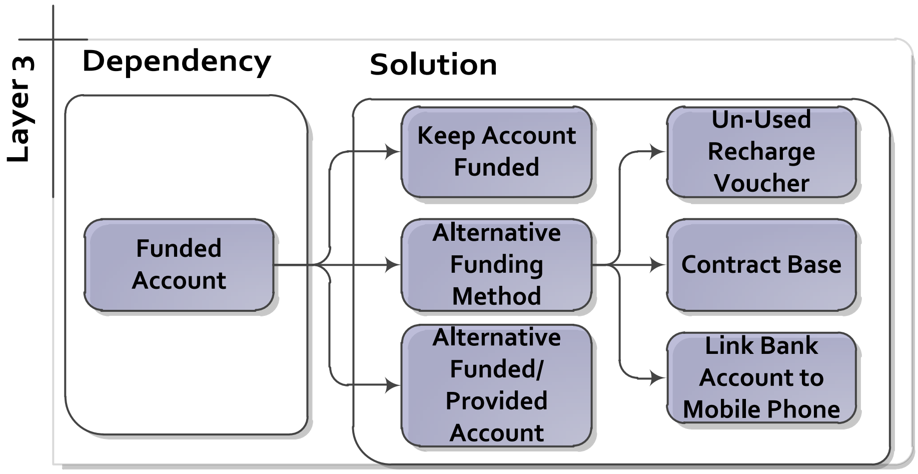

Figure 5.12: Layer 3 (Funding)

Layer 4 (network). To be able to communicate, an active account with a network provider is required. The network providers could be either of a fixed or a mobile nature. For the purpose of this research, fixed networks generally refer to fixed line networks such as plain old telephone systems (POTS). However, any wireless network fixed to a location will be considered a fixed line network. Mobile networks, on the other hand, refer solely to mobile phone networks.

In the case of fixed networks, if disruptions occur an individual could potentially make use of an alternative provider. This alternative provider could be in the form of an additional fixed line network. Furthermore, this fixed line network could be a wireless solution, as described above. Alternatively, a mobile network could be used. If the network in use requires a wireless signal, a signal booster could be used to improve connection quality. Signal boosters will be discussed later in this subsection.

In the case of mobile networks, if the service is intermittent or functioning inadequately, an individual could make use of an alternative network provider, in the form of a fixed line provider, or a mobile phone network provider. Using an alternative mobile phone network provider would require the use of an alternative SIM card. This SIM card could be accompanied by its own mobile device, such as a 3G USB modem or mobile phone. Using an alternative fixed line network requires infrastructure to be available for the chosen fixed line.

When using mobile phone networks, a wireless signal is required. Receiving a signal or a quality signal can be challenging in some geographical areas. However, there are some strategies an individual could implement to improve their personal wireless signal reception. Some of these strategies will be discussed briefly,

If the signal is intermittent or of a low quality, an alternative mobile phone network provider could potentially solve the problem, as some mobile network providers' coverage is more extensive or uses lower transmission frequencies that allow for better obstacle penetration.

As mentioned earlier, if a wireless signal is required a wireless signal booster could be used to improve the signal. Signal boosters can be bought or made. The process of making a crude manmade signal booster will briefly be explained. A simple signal booster can be made from tin foil and cardboard. The greater the dimensions of the cardboard the better the results should be, but a 40 cm by 40 cm square was used in the conducted experiment. The tin foil should cover the side of the cardboard facing the mobile device. The distance the device is held from the signal booster will differ depending on the dimensions of the booster and the device should be placed in the middle of the booster. The booster uses signal reflection to enhance the signal.

This crude signal booster operates in much the same manner as a satellite dish; therefore, any reflective material, such as metal, could be used to enhance the signal to varying degrees. A graphical representation of this crude signal booster is shown in Figure 5.13.

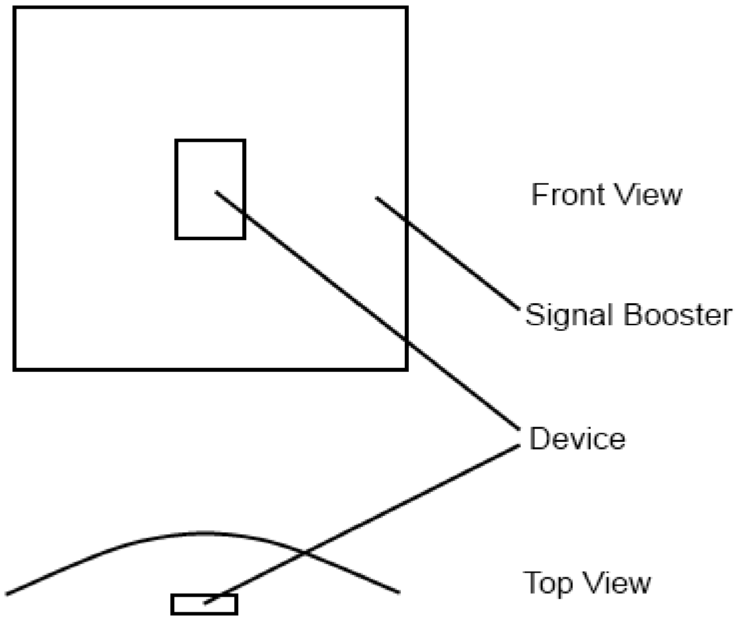

Figure 5.13: Crude signal booster

The following is a graphical representation of layer 4, as described above.

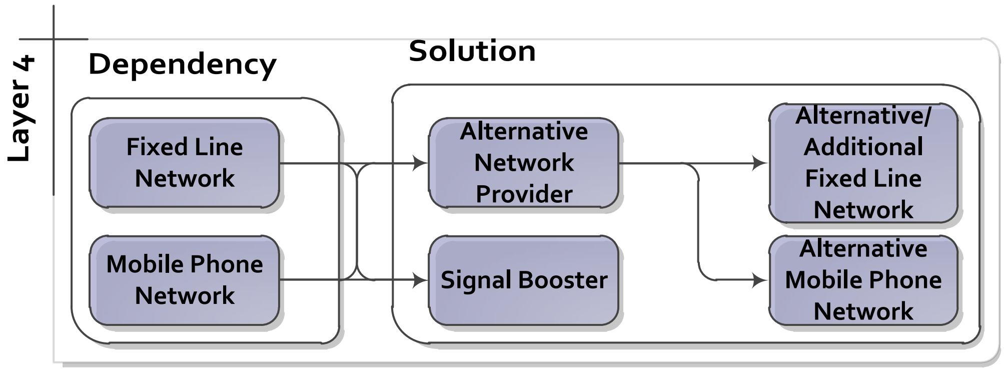

Figure 5.14: Layer 4 (network)

Layer 5 (Internet). This layer is concerned with access to the Internet as a service. Although the Internet enables many other services, a functioning Internet connection is required.

A functioning Internet connection requires an access link to the Internet, in this case, an Internet Service Provider (ISP). If a disruption occurs, maybe as a result of some incident, an alternative ISP could be used. In such a case, the alternative ISP should ideally make use of alternative infrastructure, which could be a local wireless loop provided by an ISP provider that uses alternative local fibre and makes use of redundant international fibre. The following is a graphical representation of layer 5, as described above.

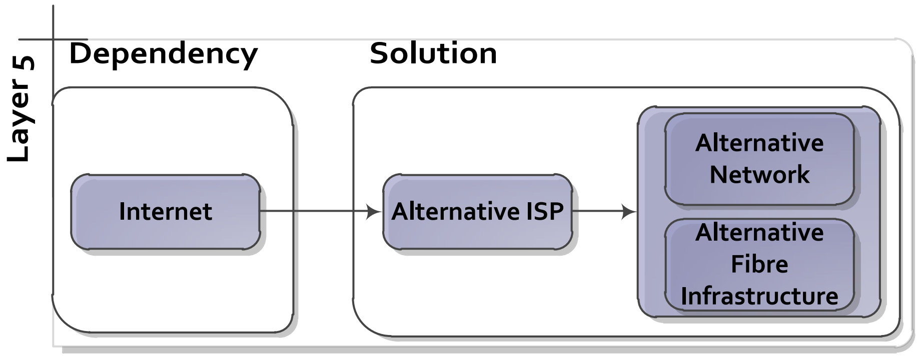

Figure 5.15: Layer 5 (Internet)

Layer 6 (Internet services). The services enabled by the Internet are located at this layer. To address potential disruptions at this level, alternative accounts or alternative clients could be used.

An example of an alternative account is where an individual signs up to an alternative provider, such as an email provider or online banking provider. In the case of an email account disruption, if the primary email account becomes unavailable, a secondary email account can then be used. However, the secondary account for online banking could be costly. Nevertheless, some banks offer 'free' accounts to certain clients, one example being a Standard Bank student account, which allows the client to perform the required function and achieve the required results in the case of a communication disruption.

The following is an account of such a disruption: On the 20th of March 2012, between 17:00 and 19:00, FNB banking services, including Internet banking, mobile phone banking, ATM and POS (Point of Sale) systems were disrupted (MyBroadband, 2012a), with mobile phone banking disruption occurring again later in March (Muller, 2012a). More recently, Absa Internet and mobile banking services were reported to be offline from 13:00 on 2 July 2012 till 00:00 the same day (Vermeulen, 2012), this incident follows those that affected Absa in May 2012 (MyBroadband, 2012b). Seen in this light, the value of having an alternative account is obvious.

There are other potential solutions at Layer 6. To further address disruptions at this layer, alternative software clients could be used. As a client could potentially become faulty or inoperable, an example of an alternative client being used is using an alternative web browser, such as Google Chrome or Mozilla Firefox. Another example of this could be to use an interoperable IM client, such as Pidgin or Trillian. The use of such a client allows multiple IM protocols to function over a single client However, some IM clients do not allow for interoperability, for example BlackBerry Messenger (BBM), a free BlackBerry IM application.

Many electronic communication individuals turn to BlackBerry Internet Services (BIS) to provide for their mobile communication needs. BIS provide unlimited Internet browsing and email access. BlackBerry is currently the biggest selling smart phone in South Africa and 98% of South African BlackBerry owners make use of BBM (Muller, 2012b). However, BIS as well as other BlackBerry communication infrastructure, is used to provide this complete mobile communication solution. Therefore, if BlackBerry services become unavailable, as they have in the past (MyBroadband, 2012c), an individual may be disconnected from such services. In this case, multiple solutions should be used to address each of the services required, such as an alternative client and alternative account.

A graphical representation of Layer 6 is provided in Figure 5.16.

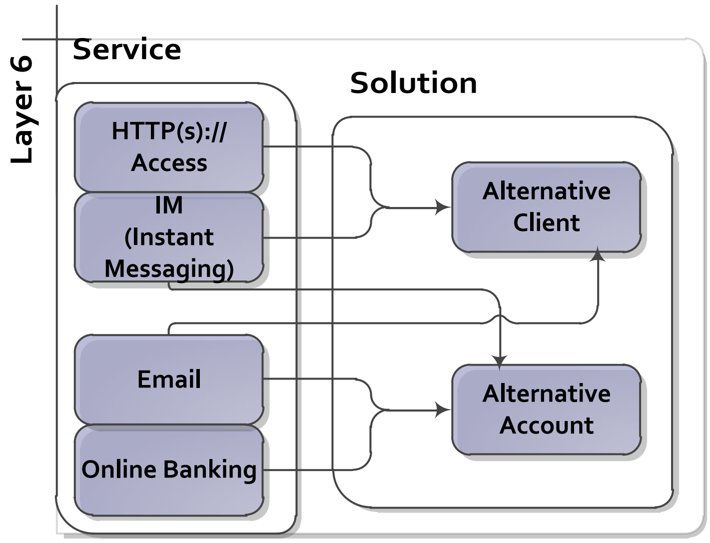

Figure 5.16: Layer 6 (Internet services)

As mentioned, the above figures serve to help an individual to create a personal ICT continuity strategy. The processes described in each layer should be used together with the corresponding figures and the services used should be tracked down to the base layer following the technologies used. If an incident occurs, the solutions provided by each layer should be applied in an attempt to extend the availability levels of the required services. However, after such a continuity strategy has been created, it should also be continually reviewed and tested.

5.6 Continual Review and Testing (CRT)

Since a continuity plan is a “living document” (Upfold & Sewry, 2005), maintaining an effective continuity plan implies that it should be revised regularly. In the case of the suggested CTHAG framework, each service required by the individual should be reassessed regularly, at least annually. Consequently, the revised plan should be tested to ensure its effectiveness. This is further supported by CobiT’s DS4.4: Maintenance of the IT Continuity Plan and DS4.5: Testing of the IT continuity plan from CobiT 4.1. DS4.4 states that the IT continuity plan should be kept up to date and should reflect business requirements, while DS4.5 states that the continuity plan should be tested regularly (IT Governance Institute, 2007).

The following is a graphical representation of the ongoing review and testing process that will form part of the CTHAG framework.

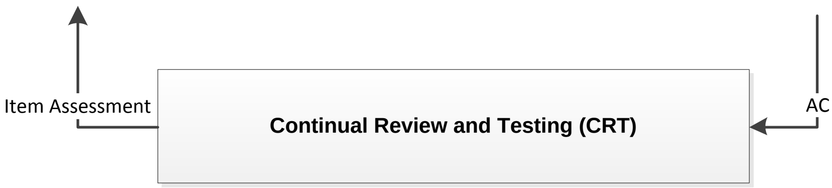

Figure 5.17: Continual review and testing process

5.7 Conclusion

As the importance of communication was established in Chapter 4, this chapter aimed to assist the individual in determining the importance of each service for that individual. Furthermore, a method to assess the risks each service faces was discussed. The dependency and risk processes together serve as input to the availability continuity process, which, in turn, and based on its input, aims to provide an individual with the guidelines for producing a continuity plan. The availability continuity process leads to the continual review and testing process. These components together form the CTHAG framework; as framework which aims to provide individuals with greater service availability for their required services. Following the creation of this framework, its effectiveness and value will be evaluated and demonstrated in the following chapter in line with Peffers et al. (2007).

Chapter 6: Evaluation and Testing

"It is only through evaluation that designers come to understand the nuances of their design and add to the body of knowledge for other future designers to learn from" (Hevner & Chatterjee, 2012).

6.1 Introduction

It is crucial to evaluate an artefact, as evaluating such artefact can provide insight on how to refine and improve it. As discussed in Chapter 2, design science was chosen as the overarching paradigm for this research. Design science is of an iterative nature through which an artefact can be refined. It is therefore important to evaluate and revise the artefact. In the case of this dissertation, the evaluation is performed by means of an Exploratory Focus Group (EFG) and two confirmatory focus groups (CFGs), in line with the recommendations of Hevner and Chatterjee (2012). The artefact developed and refined in this dissertation is the CTHAG framework, as depicted in Figure 5.1. The following diagram, Figure 6.1, depicts the various focus groups used to refine the artefact.

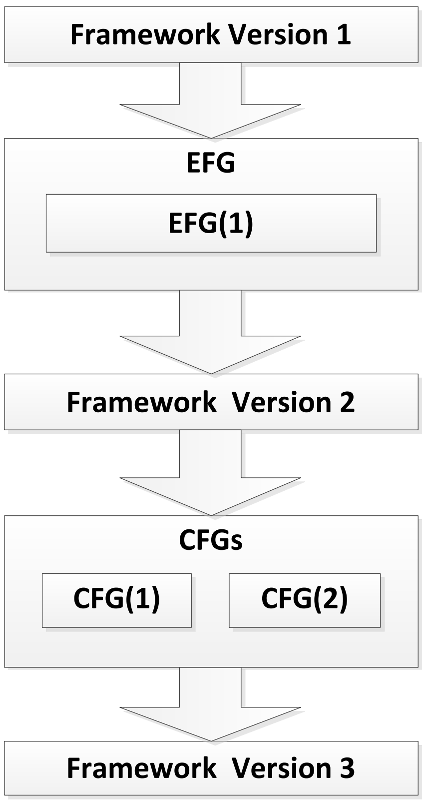

Figure 6.1: Framework refinement process

The various focus groups used and their implementation will be discussed in the following section. The remainder of the chapter will then discuss the results of the evaluation.

6.2 Methodology Implementation

As mentioned in Chapter 2, the main research paradigm chosen was design science, of which Peffers et al.'s (2007) interpretation was chosen. As mentioned in Chapter 2, there are six steps involved in Peffers et al's interpretation of design science.

In support of the design science research approach, focus groups were chosen as a supporting method and will be briefly discussed here. This chapter is primarily concerned with step 4 (Demonstration) and step 5 (Evaluation) of the underlying design science methodology of Peffers et al. as described in section 2.2.2. Step 4, demonstration, was carried out by conducting CFGs. Furthermore, an EFG identified a component of the framework that was demonstrated by means of an experiment. Thereafter, CFGs were used to evaluate the framework. The particular focus group interpretation used in this dissertation was constituted according to Hevner and Chatterjee (2012) in line with design science research. The following is a graphical representation of the focus group method and its implementation.

Step	**Focus group steps**	**Implementation**
1	Formulate research question or problem	The goal is to improve the framework and to determine the utility of the framework.
2	Identify sample frame • Number of groups • Size of groups • Source of participants	Included one EFG, two CFGs and a pilot study The EFG comprised twelve participants; CFGs comprised six participants in each of the two groups being knowledgeable senior ICT students
3	Identify moderator	The moderator was selected for his qualifications relating to communication

		networks and people skills.
Step	**Focus group steps**	**Implementation**
4	Develop and pre-test a questioning route	A script was developed to address key concerns.
5	Recruit participants	Participants were asked personally after a brief introduction to the project was presented.
6	Conduct focus group	Participants discussed the various components of the framework and came to a consensus on all questions.
7	Analyse and interpret data	The agreed upon changes, based on the various scripted questions, where used to improve the framework.
8	Report results	The results are reported by adding short quotes from the original discussion and listing the agreed responses.

Table 6.1: Focus group steps and implementation

The implementation of the methods used to evaluate the framework has been briefly discussed. The following section discusses the framework evaluation process and the results.

6.3 Framework Evaluation

The framework evaluation was performed in line with the design science focus group guidelines, as described by Hevner and Chatterjee (2012). As seen from Table 6.1, there are eight steps involved in conducting a focus group. A moderator was present and all the results were captured by an audio recording and were transcribed. The following is an account of the EFG and CFG focus group discussions.

6.3.1 Exploratory Focus Group (EFG)

As mentioned in section 6.2, this study made use of one EFG to refine the framework from version 1 to version 2. The EFG consisted of twelve members with various ICT backgrounds and qualifications. The size of the group was consistent with Hevner and Chatterjee's (2012) suggested size of four to twelve members. The EFG was conducted at the Nelson Mandela Metropolitan University in a pre-booked location. As the participants arrived they were greeted and they were invited to take a seat at the U-shaped seating arrangement. After all participants had been seated, they were formally welcomed and thanked for their participation. The focus group was called to session and the session recording commenced. The moderator provided a brief overview of the proceedings and explained the background to the field of study and the goal of the framework. The framework was then discussed and possible scenarios where it could be used were given. The EFG was conducted over 90 minutes and covered various questions during this time. The questions covered were guided by the moderator and established from the fourth step of the focus groups steps, as seen from Table 6.1. The EFG questions were ordered in three question banks, firstly, that of the framework question bank, and secondly, the guidelines question bank and, thirdly, the CFG question bank. The researcher was present to observe the proceedings and provide further detail where needed. The results of these questions were as follows:

Framework Question Bank

Q1. Do you understand how to use the framework?

A: The group all agreed that it was clear and easy to understand. "It is clear on every level", one participant remarked.

Q2. Does it have a logical flow of events?

A: The group agreed that the framework had a logical flow.

Q3. Do you agree on the usage of the various layers and their assignment?

(I.e. Missing or redundant components, unclear layers etc.)

A: The group agreed that the structure and assignment of the layers were correct. The group felt that names would identify the layer better than numbers. Furthermore, the group felt that Layer 4.5 (service layer) in Figure 5.9 needed to be labelled and make use of unique alternative shapes. In addition, Layer 3 (accounts) of Figure 5.9 was questioned. One participant felt it might be unnecessary. The group defended the layer as some users might not be aware of what funding needs to be provided to use the required functions. One example that was mentioned was that not having a data bundle does not mean you cannot access the Internet; having only an SMS bundle would only allow you to SMS and users need to be aware that the account should have a positive balance. Furthermore, one participant made the following remark "I don't think that there is anything missing or obviously missing".

Guidelines Question Bank

Q1. Are the framework implementation guidelines of the various layers and their components easily understood?

A: The group agreed that the implementation guidelines were easily understood.

Q2. Is there any identified missing or redundant information in the implementation guidelines?

A: One participant remarked that "Those are the solutions". The group discussed the concept of redundant information. The group felt that none of the information was redundant or unnecessary. The group said that the account layer could benefit from the addition of regulatory and roaming information with regard to accounts and funding. "If 'is it on?' is not too simple nothing here is too simple", another participant added to the discussion.

Q3. There are some components that have been identified for experimental testing. These are the battery temperature experiment and the crude signal booster experiment. Do you believe that this is correct and are there any other components that need experimental testing?

A: The group agreed that the study could benefit from experimental testing and proof of concept. The participants expressed some doubt over the effectiveness of the crude signal booster. However, after the theory was discussed, participants agreed that it could potentially provide value. The theory of the crude signal booster was defended by the author and some participants. Furthermore, some participants confirmed using a similar strategy with positive results. “I’ve actually created one, and it works“, one of the participants remarked. Participants mentioned that explaining the theory behind the signal booster would increase the likelihood of building one or finding an alternative to provide similar value. The participants decided that there would be no need to test the battery concept. Furthermore, it was agreed that no other components required experimental testing or proof.

Q4. Do you believe that by using the framework and its guidelines you could potentially increase your electronic communication access?

A: “I think that it is very logical and that we have all used a lot of these methods” was a comment made by one participant. Furthermore, another participant made the following comment; “I think it’s a starting point from a high level awareness point of view, it’s not detailed enough for example with regards to ISP infrastructure”. However, this comment was addressed by a participant who added that: “Detailed technological guidelines should not be added as it is a ‘snapshot’ in time”. All participants agreed that the framework could provide value. However, some participants felt that the framework would increase their electronic communication access, but, as a high level framework. The framework was branded as a high level framework as some information needs to be gathered before it can be used effectively.

CFGs Question Bank

Q1. Taking the current framework and its guidelines into account, what field tests would you recommend for the CFGs? For example, should the participants go through the entire framework and select certain components as required or only test certain sections.

> A: One participant suggested the following “What I would say is to give them tasks and create scenarios”. The group unanimously agreed on this suggestion. “The framework is meant to be used as individuals; therefore, it should be tested as it is meant to be used” another participant remarked, adding to the previous suggestion. It was suggested that the CFG should be conducted with six participants per session and be given six scenarios based on the dependencies of the participants. Each participant would follow the framework individually with no help from the other participants. This evaluation would be done with two CFGs. Furthermore, it was suggested that specific groups with specific dependencies be tested. The example of a business that is dependent on online banking should be tested. It was mentioned that the CFG participants should be given the framework and the pre-emptive solutions and reactive solutions should be discussed. However, the group felt that the individual participants would be enough to test the framework.

From this EFG, it can be seen that the participants agreed that the layout, layers and content of the framework made logical sense. The participants also felt that the framework could assist in the creation of a service continuity plan. However, some valuable feedback was collected on improving the framework, which was subsequently refined to version 2. As the results of the EFG have now been discussed, the CFGs and their results will now be discussed in more detail.

6.3.2 Confirmatory Focus Groups (CFGs)

As mentioned in section 6.2, this study made use of two CFGs in order to further refine the framework from version 2. Section 6.4.1 discussed the CFG procedure and agreed upon a process. This CFG proceeding was adopted and executed as agreed upon. The following is an account of the proceedings of the CFGs.

The focus group participants were selected on the basis of their knowledge of electronic communication networks. The participants were asked in person to participate in the CFGs and were informed of the proceedings. A recruitment email was subsequently sent by the moderator to all participants outlining the proceedings and informing the participants as to what was required from them. The email also contained the framework and examples of completed risk and dependency assessments, as well as requesting the participants to follow the framework dependency component, as described in section 5.3, to select the services on which they were most dependent. In addition, the participants were asked to follow the risk assessment component in section 5.4 to establish the risks they were most likely to encounter. The results of the dependency and risk assessment exercises were used to create a disruption scenario relevant to each participant.

As mentioned, two CFGs were conducted, each consisting of six members. The first CFG (CFG1) was given a disruption scenario and was asked to complete a task relevant to their needs. The needs of the participants in the second CFG (CFG2) were matched to the needs of the participants in CFG1. For example, CFG1 participant 1 (P1) identified voice communication as their dependency and a damaged device as their primary risk; accordingly, a matching dependency from P1 in CFG2 was assigned to the scenario. The participants were then asked to demonstrate the usage of the framework. For example, given the disruption scenario, P1 was asked to make a phone call to a specified number using the framework. After each participant had completed their scenario, they were asked to answer the following four questions.

> Q1. Did you find it easy to analyse your dependency and the risk you experienced for the services you selected? If not, state what would have made it easier?
>
> Q2. Did you achieve communication continuity by following the framework?
>
> Q3. Did you use proactive measures, reactive measures or both to achieve continuity?
>
> Q4. Do you think that your communication continuity can be best provided by using proactive measures, reactive measures or both?

The following table represents the scenarios given, the participants, the groups they represented and their feedback.

Group	Scenario	Participant	Q1	Q2	Q3	Q4
1	1	P1	Yes	Yes	Both	Both
	2	P2	Yes	Yes	Reactive	Both
	3	P3	Yes	No	None	None
	4	P4	Yes	Yes	Proactive	Both
	5	P5	Yes	Yes	Reactive	Reactive
	6	P6	Yes	Yes	Reactive	Both
2	1	P1	Yes	Yes	Reactive	Both
	2	P2	Yes	Yes	Reactive	Both
	3	P3	Yes	Yes	Reactive	Both
	4	P4	Yes	Yes	Proactive	Proactive
	5	P5	Yes	Yes	Proactive	Proactive
	6	P6	Yes	Yes	Proactive	Both

Table 6.2: CFG Results

The results in Table 6.2 will now be discussed. In question 1, all participants found it easy to use the framework's risk and dependency assessment components. However, as per question 2, not all participants perceived that by using the framework they could achieve continuity. One participant, P3, from CFG1 felt that he was not sufficiently dependent on his selected service to warrant the need for continuity, therefore he argued that he would "wait out the disruption". Nevertheless, the participant did acknowledge that continuity could be achieved had the framework been followed.

Question 3 required the participants to inform the moderator as to whether they achieved continuity by using proactive means, reactive means or both. It was concluded that the framework could be used in a proactive and reactive manner or both owing to the nature of the continuity plans.

Question 4 required the participants to inform the author of the approach they believed could best provide continuity for the services that they were dependent on. Most of the participants believed that both a proactive and a reactive approach should be used to provide service continuity. This is indeed true for both business continuity planning and this framework.

On completion of the CFGs, the framework was further refined to reflect the necessary changes, that is, from framework version 2 to version 3. Furthermore, from the results of the CFGs it can be concluded that the framework was easy to use and in most cases resulted in service continuity. As mentioned, the only case that did not result in service continuity was when one participant felt the dependency did not warrant a need for continuity planning. Therefore, it can be argued that the framework can be used effectively to provide service continuity for identified dependencies.

In the following section, the solution identified by the EFG will be evaluated.

6.4 Solution Evaluation

As mentioned in section 6.2, the component evaluation was determined with the aid of an EFG. In line with the discussion, the solution that required proof of concept was identified as the crude signal booster. The test results will now be discussed.

Signal Booster Test

The crude signal booster component of the process model was tested by means of an experiment to capture its effectiveness. The following are the circumstances under which the test was conducted and the results thereof.

The signal booster test was conducted by, firstly, constructing the device according to the guidelines discussed in subsection 5.5.2, although various other designs were also tested. In experimenting with the crude signal booster, it was set at various angles and directions to obtain the best signal. The experiment found that this booster could indeed enhance the signal received. This signal gain was measured by experimenting with three different devices and networks. Accordingly, the constant gain across this entire test, from here on referred to as the effective gain, was measured at -2db. However, the signal booster was able to gain up to a -4db gain. The effective gain was measured indoors, and reproduced at a different location. However, it should be noted that this result may vary greatly depending on the manmade and natural obstacles, such as walls, trees and mountains, as they may affect the signal. Such obstacles could also absorb the signal, in which case the signal strength would be reduced, or reflect the signal, in which case the signal would be deflected in a certain direction (Lee, Seah, Tan, & Yao, 2009). However, when the signal is reflected towards a wireless communication device, it can potentially boost the signal. This reflection is what the crude manmade device uses to achieve the signal gain.

6.5 Conclusion

The framework (CTHAG) was evaluated and tested according to design science guidelines. In the evaluation and testing the moderator found that the EFG agreed with the design and contents of the framework. Furthermore, two additional CFGs tested the framework by evaluating the electronic communication services they require. The CFG participants found that it could indeed provide service continuity and eleven of the twelve participants demonstrated the use of the framework to achieve such continuity. One experiment was conducted on the identified solution to measure its effectiveness. From this experiment it was found that the solution can in fact aid an individual in remaining connected to the services they require. Furthermore, the framework was subsequently refined from its original version in multiple iterations. In conclusion, by making use of the framework, it was found that individuals could achieve a higher level of service guarantee on the services they required.

Chapter 7: Conclusion

7.1. Introduction

This research dissertation focused on current electronic communication methods and technologies, and user dependency on these technologies. It has been debated that the electronic communication technologies used by modern-day individuals are becoming more integrated into everyday life. As a result of this integration many individuals have grown dependent on these technologies. Therefore, the aim of this research was to provide individuals with a means to *assess* their dependence on these services, to *determine* the potential risks and then *formulate* a continuity plan based on a framework which was presented as the outcome of this research.

This chapter provides a summary of each chapter; highlights important findings in each of these chapters; evaluates the research outcomes against the objectives set and then concludes with a discussion on potential future research.

7.2. Summary of Chapters

In **Chapter 1** an introduction to the research project was provided. The chapter discussed the development of communication technology and the use of electronic communication as critical infrastructure. Finally, examples of disruptions to the communication infrastructure were given along with the effects these disruptions had on the individuals who rely on them.

The methods and methodologies used to conduct this research were discussed in detail in **Chapter 2**. The chapter discussed the design science research paradigm and displayed various design science interpretations from various authors. In addition to this, the choice of Peffers et al.'s (2007) interpretation of the design science paradigm as an overarching methodology of this research project was discussed. Hevner and Chatterjee's (2012) adapted design science focus group method was also selected as a method to evaluate the framework that was developed. The interpretations and steps involved in the selected methodologies were then finally explained.

In **Chapter 3** the past, present and the possible future of electronic communications was discussed. This chapter also discussed the history of various electronic communication technologies. This was followed by a discussion of each of the electronic communication technologies that are prevalent in a modern context. A general discussion on the possible future of electronic communication was also provided.

Chapter 4 discussed how electronic communication has become vital to many modern-day individuals and could be considered by them as being critical infrastructure. To convey this, current electronic communication and its uses in modern society were discussed. This chapter also demonstrated how the users of this technology may become reliant on such technology. After users have grown reliant on these electronic communication technologies they can enable an individual to meet some his/her basic human needs, such as love and belonging, as described by Maslow. In addition to this, the factors that determine a national critical infrastructure were compared to Maslow's human needs theory. Finally, it was concluded that as individuals have grown dependent on certain electronic communication services they should ideally experience a high level of availability from them.

In **Chapter 5,** a framework was proposed that could assist an individual in achieving a higher level of electronic communication availability from the services on which they are dependent. The macro extract of the framework, the continuity framework and each of its processes were discussed. This comprises four main processes, namely, a dependency assessment, a risk assessment, an availability continuity and continual review, and testing steps. Each of these main processes is comprised of more detailed modules. It was proposed that if an individual uses the proposed framework effectively, they could achieve a greater level of service availability.

Chapter 6 evaluated and tested the various processes of the framework. Focus groups were used to evaluate the framework and experiments were used to test some of the processes identified by the author and agreed on by the EFG. The focus group method that was used was proposed by Hevner and Chatterjee (2012) as an adjusted interpretation of focus group to suit design science research. This focus group study consisted of one EFG and two CFGs. The first group agreed on the design and layout of the framework and felt that it could allow for extended electronic communication availability. The two CFGs were then given six scenarios based on the dependencies and risk relevant to them, with both groups being given the same scenarios. Based on the results obtained from the CFGs, it was clear that the framework would indeed allow for extended connectivity to the electronic communication services users depend on.

7.3. Meeting the Research Objectives

As stated in Chapter 1 (section 1.3), the primary objective of this research project is *to provide a framework that could be used to improve the accessibility of current communication technology from the perspective of an individual*. To achieve this, a number of secondary objectives were addressed in order to achieve the primary objective. The secondary objectives are as follows:

- To determine what technologies play a part in the communication technology used by an individual.
- To determine to what extent communication technology can be deemed critical to an individual.
- To determine which of the four critical infrastructure functions are affected by communication technology from the perspective of an individual.
- To recommend a framework to improve the accessibility of electronic communication technology for an individual.

The **first** objective was achieved by means of Chapters 3 and 4, using a literature review. Chapter 3 discussed the history of communication and also provided information on the current electronic communication devices and technology in use today. Chapter 4 discussed electronic communication services that modern-day individuals make use of. This achieved the first research objective.

The **second** research objective was achieved though Chapter 4. The chapter discussed the current use of electronic communication services by a modern-day individual. Furthermore, the “locked-in” habit purposed by Shove (2003) was compared to the individual’s use of electronic communication services. The services used were then compared to Maslow's hierarchy of human needs, with the second secondary objective therefore being achieved.

The **third** research objective was also achieved by means of Chapter 4. As mentioned, Chapter 4 discussed the current use of electronic communication services by a modern-day individual. The services such an individual uses were compared to Maslow's human needs hierarchy and, in turn, related to critical infrastructure functions.

The **fourth** research objective was achieved through Chapter 5. In Chapter 5, a framework was developed to improve the accessibility of current communication technology. This framework was developed by using Peffers et al.'s (2007) interpretation of design science research. Furthermore, this framework was developed using concepts from SANS 31010:2010, SANS 25777:2010, CobiT 4.1 and the National Infrastructure Protection Plan (NIPP).

By achieving these four secondary objectives, it can be argued that the main research objective was met. Therefore, it was possible to develop a framework that could improve the availability of current communication technology by an individual. Therefore the main research objective, *to provide a framework that could be used to improve the accessibility of current communication technology from the perspective of an individual*, was met through the development of the CTHAG framework in Chapter 5.

The CTHAG framework allows an individual to evaluate the dependency they experience on services and then follow recommendations to address likely risks. This will allow for a greater level of availability of the services individuals depend on. Therefore, it can be said that the main objective has been met.

7.4. Limitation of Research

This research project does not provide a comparison of the various continuation techniques proposed in the CTHAG framework. Furthermore, this research does not provide the user with implementation guidelines based on the dependency level and associated risks. The strategy used in and the extent of the continuity techniques implemented is left to the user's discretion.

7.5. Future Research

As this research project developed a framework for the improvement of electronic communication availability it does not have recommended paths for identified scenarios. A simplified flowchart could be constructed to aid users in selecting a continuity strategy appropriate to their needs. Furthermore, the framework could benefit from a detailed dependency assessment process. This process would aid the user in determining their level of dependency in a more detailed and guided approach.

7.6. Conclusion

Electronic communication technology has become pervasive in almost every facet of most modern-day individuals' lives. Although electronic communication can provide an individual with utility, the lack of this technology could affect an individual's basic human needs and required functions. Some of the basic human needs are safety and love and belonging. Furthermore, required functions could be those of economic security, morale and health and safety. Therefore, if communication technology is used to facilitate these functions and basic human needs then it should be made as available as possible.

It is for this reason that the CTHAG framework was developed. The CTHAG framework allows an individual to assess the dependency they have on a given electronic communication service. Furthermore, the individual can determine the risk the service currently faces. From this a continuity strategy can be determined. The effectiveness of the framework was evaluated by means of a focus group study. The study revealed that individuals that experienced a dependency on a service could in fact extend its availability by following the framework. Therefore, by using the CTHAG framework, a modern-day individual could achieve the level of availability required from the services they have grown dependent on.

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Appendix A

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Paper Presented and Published

Electronic Communication: Stay Connected

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Abstract. Electronic communication technology offers many services; hence providing the individual with utility. The utility obtained may enable individuals economically, from an organisational or personal point of view, or the utility may lie in safety or morale, a more personal matter. There are many reasons for using electronic communication technology; however, once it has been incorporated into individuals' lives, they may come to rely on it heavily. It is for this reason, that individuals should identify their level of dependency on electronic communication services. Then, a continuity strategy can be established to address the level of dependency. This paper seeks to provide individuals with a framework for establishing a personal ICT continuity strategy to prolong electronic communication service.

Keywords: personal ICT continuity strategy, communication technology

Introduction

The electronic communication services individuals use have become important to them. However, such services cannot operate without supporting devices and the required infrastructure. The availability of these devices and the infrastructure that underpins them should be of equal importance to the services they provide.

The South African president, Jacob Zuma, stated that infrastructure remains critical to South Africa's development goals, underlining its importance in service delivery. Among the infrastructure mentioned in this regard was communications infrastructure [1]. However, South Africa, like the other countries on the African continent, is a developing country and such infrastructure is not always available. An example of unavailable infrastructure would be where a mobile signal becomes unavailable or degraded. Furthermore, the power source a communication device relies on may become unavailable.

Against this backdrop, the objective of this paper is to provide a framework to improve communication technology availability for the individual. To achieve this objective, guidelines for information communication technology (ICT) continuity have been adopted from the SANS 25777:2010 standard. Following these guidelines, individuals could then use the framework to identify the services they require and the dependencies they experience. These dependencies and services have been arranged in logical layers, and will each be discussed in more detail below.

The rest of the paper is structured as follows: In the next section, the current electronic communication usage trends will be discussed. This will be followed by an account of the importance of communication technology to the individual. The following section contains the focus of this paper, that is, the protection of personal communication technology.

Trends in current electronic communication usage

In a modern society, electronic communication is integrated to a large extent with many aspects of an individual's daily activities. One example of such electronic communication is electronic mail, or email as it has become generally known. Currently, it is estimated that there are 3,1 billion email accounts worldwide; and an average annual growth of 7% can be expected [2]. Another popular communication method is instant messaging (IM), with 2,6 billion accounts worldwide and an expected average annual growth of 11% [2].

A second example of the critical role played by electronic communications is in modern social networking. In the past few years, social media have undergone enormous growth. Social websites like Twitter, Facebook, Google+ and LinkedIn have experienced various levels of growth. Facebook had a 37% growth in 2011 from its 585 million users at the beginning of 2011 to 800+ million users towards the end of 2011. This represents an average growth of seven users per second [3]. Other social networks, such as Twitter, had 100 million followers [4]. Furthermore, in September 2011, the social networking site Google+ entered the arena and reached 50 million users in about 88 days. This is according to Paul Allen, who is well known for his methodology used to count Google+ users [5].

Both of these services, email and social networking, are extensively utilised today by means of electronic communication. In fact, modern mobile phones have lately become the preferred platform for these services. The mobile and smartphone market is prospering. For this reason, most companies now provide a mobile implementation, or even a mobile application to access their services. First National Bank (FNB), one of the largest banking service providers in South Africa, offers Android, Apple, Blackberry and Nokia Symbian applications for accessing online banking via a smartphone [6]. Popular communication applications, such as Windows Live Messenger, Google Talk Skype and many of the social networking sites, all have mobile implementations.

Nevertheless, in South Africa, the leading social network contender remains MXit with approximately 10 million active users [7]. This mobile instant messaging (MIM) platform can attribute its success to the fact that it is capable of functioning on as many as 3 000 different mobile handsets, ranging from the most basic mobile phones to smartphones [8]. However, smartphone users' numbers are growing and they have many more social network options than MXit.

The information above demonstrates how extensively electronic communication is used today, especially when using a mobile platform. Accordingly, the question arises as to how dependent users have grown on these important electronic communications and, consequently, how important this has become to them.

The importance of communication technology to the individual

It may well be said that for something to be important to an individual, it must make a significant difference in his/her life. Furthermore, to be significant, the difference that is makes must be important and be seen by the individual as being an improvement. Therefore, something is important to an individual if it makes a significant difference to him/her and their life [9].

The world is home to seven billion people and there are currently almost six billion mobile cellular subscriptions [10]. Having access to a mobile phone has made a significant different to the way individuals communicate, as well as to how they live and act in general. Since the majority of individuals now have access to mobile phones, these phones provide a certain sense of security. This sense of security stems from being able to call for help, and of being connected, or being part of some group. Thus, the mobile phone, as a communication technology, is a fundamental agent of one of man's basic needs, namely, that of safety [11].

The individual self exists in relation to social conversations. Furthermore, it has been suggested that individuals are the sum of their social interactions [12, p58]. Therefore, if the social media are frequently used for the purpose of social interactions, it may be said that the social media shape the self which is constantly changing through these interactions. Thus, the social media become an important social tool to the individual, which assist in creating a sense of belonging, despite the fact that this may be accomplished electronically. Again, communication technology is of fundamental importance to the mobile phone.

A study by Ericson found that 40% of Android and iPhone smartphone users use their phones in bed before going to sleep at night. Furthermore, 35% of these smartphone users check their email or Facebook account in the mornings before getting out of bed [13].

It can thus be seen that electronic communication technology plays an important part in an individual’s personal life. Moreover, it also most certainly plays a major role in a professional context.

Organisations that require a high level of communication with their employees will require them to stay connected. This could be in the work environment only, where ICT continuity strategies are in place, but it could also be away from the workplace, where a personal continuity strategy needs to be in place.

It is thus clear that communication technology is becoming more and more important as well as an integral part of the individual’s everyday wellbeing; it also plays an important role in creating a sense of security and belonging and even of being in control, if seen from a business perspective. For this reason, the mobile phone has become a valued possession for most individuals; and such a possession needs to be protected for the future.

Protection of personal communication technology

To protect and ensure the continued availability of some infrastructure or service is a well-known function in the business world. SANS 25777:2010 is a South African standard that provides definitive guidelines in this regard. In accordance with the SANS 25777:2010 standard, there are four main steps required in any ICT continuity strategy. These steps are as follows:

1) understand ICT continuity requirements
2) determine an ICT continuity strategy
3) develop and implementing ICT continuity strategies
4) exercise, test, maintain, review and improve [14]

A brief description of these steps follows. Firstly, understanding ICT continuity requirements involves understanding what ICT configuration is generally required. These requirements need to be categorised according to certain priorities. Furthermore, it involves determining the gap between current ICT continuity capabilities and the continuity requirements for each critical ICT service [14].

Secondly, an ICT continuity strategy should define an approach to implementing the required resilience, protection and recovery processes. At this stage, the risk appetite, the costs and the benefits should be considered. The continuity strategy should cater for any likely risk, as well as the effects of possible disruptions [14].

Thirdly, developing and implementing ICT continuity strategies includes putting into place the chosen ICT strategies, along with the steps required to support the implementation. Such implementation may include training to ensure that skills/knowledge gaps are minimised and may also include selecting the technologies required by the chosen strategy [14].

The fourth step in the continuity plan is exercise, testing, maintaining, reviewing and improving. This step aims to ensure that the chosen strategies work as expected and when required. The recovery and resilience implementations should also be tested and documented. Furthermore, maintaining, reviewing and improving are carried out in order to deal with any changes. As the individual's requirements may change, the ICT requirements will therefore change as well. This means that the ICT continuity plan needs to be updated to match these new requirements. Furthermore, the documented tests should be reviewed and improvements implemented where required [14].

It is important to note that the ICT continuity process should be treated as an ongoing lifecycle. The individual will need to determine what ICT requirements he/she has. This is particularly important as the continuity plan has cost implications. Therefore, the continuity strategy that is implemented should reflect the requirements. Once the requirements are known, the individual can use Figure 1 to determine a continuity strategy. The details on how to develop and implement the ICT strategy will be discussed in the following section and figures. After an ICT plan has been developed, it should be carried out, tested, maintained and reviewed.

In order to meet an individual's communication requirements, the following communication technology continuity framework has been developed. Figure 1 can be used to determine an ICT continuity strategy in accordance with the four main steps of SANS 25777:2010, as described above.

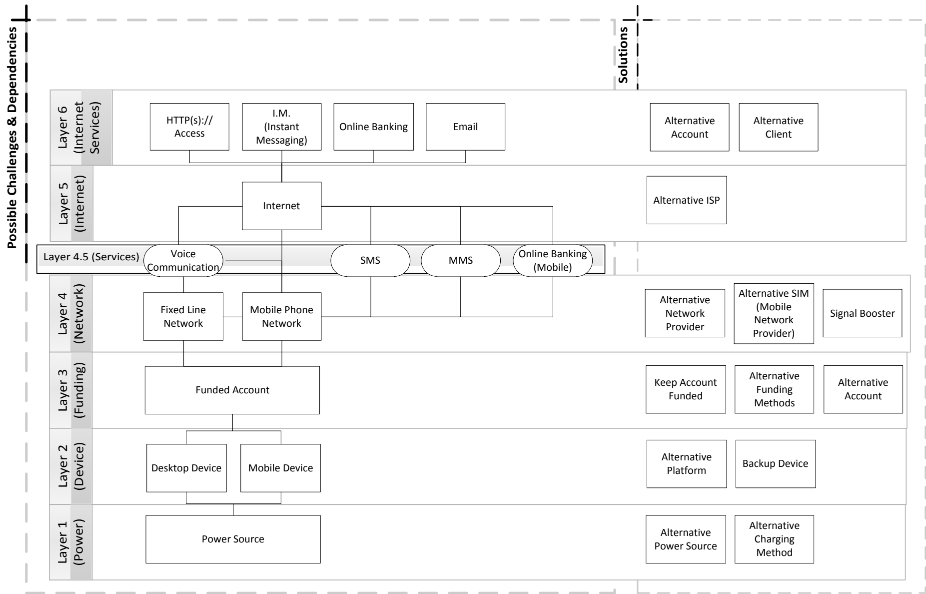

Figure 1: Continuity framework

Figure 1 represents an example of a typical continuity planning framework. The continuity framework has six layers, which are arranged in order of their dependency.

Layer 1: The base requirement for communication can be found in this layer. All devices are dependent on a power source; in turn, however, a power source may be dependent on either a power outlet or a battery. Once this dependency is identified, it becomes necessary to address the challenges one might face in this layer.

To increase power source availability, individuals might need to find an alternative power outlet. This could include a generator of some sort, such as a solar-powered generator, a wind turbine, or a fuel-powered generator. Further, these generators could be linked up to a battery bank, which could subsequently be charged in order to provide power through an inverter.

A battery is another power source and may be a device's primary power source. However, batteries have to be charged, which is done mainly through a power outlet. It is handy to keep a spare charger in case it is required. One should also have an alternative charging station. Many devices use USB chargers, which are small enough to carry around and can be used to charge by means of a PC or a laptop. A laptop is also capable of charging a device – even while it is using its own battery to power itself. There are many types of charger available today – miniature solar chargers and car chargers. Car chargers usually plug into the cigarette lighter of the car. These car outlet chargers can support USB devices and they can therefore supply power to any such device.

In addition, the operating temperature can improve battery performance. There are many different battery compositions; however, general rules apply to most compositions used in mobile electronic communication devices. Some of these rules will now be discussed. The ideal operating temperature for most battery types is at 20 °C (80 °F). Cold temperature increases the internal resistance and slows down the chemical reaction. Moreover, at certain lower temperatures, batteries will discharge at a reduced rate. Therefore, storing an unused battery at colder temperatures could allow longer battery discharge time, resulting in longer use when warmed up to 20 °C again. In contrast, when warming a battery to temperatures higher than 20 °C, the internal chemical reaction will be speeded up, and the internal resistance lowered. This effect provides improved battery performance, but shortens the service life of the battery if continued for long periods [15], [16]. It should be noted that this should only be done in emergencies, as prolonged use can shorten the lifespan of the battery and the device. Battery life can be extended by changing settings or installing certain applications on a device. For example, a battery-saver application could be installed that automatically configures a device to consume less power. Alternatively, one could change the settings on the device manually so that it consumes less power.

There are several settings that will allow lower power consumption by a device. These settings include turning off unnecessary or unneeded functions, or changing the device operation. Examples of these are the following:

- Dim the display brightness.
- Set the background image and themes to black.
- Turn the device sounds down or off.
- Turn off any vibrating function.
- Turn off the wireless.
- Turn off the Bluetooth.
- Turn off the internet synchronisation.
- Switch to 2G or 3G.

These examples will now be discussed in a little more detail. If email and other internet synchronisation services are used, such as a weather application, turning the synchronisation to manual, or setting the synchronisation time to less often would result in lower power consumption. Another setting on a mobile phone that may allow more talking time, but less standby time, is setting a device to 2G. One example of this is the Nokia Lumia 800. Nokia claims that this device is capable of achieving 13 hours of talk time on a 2G network, but only 9,5 hours on a 3G network. However, the standby time on a 3G network is considerably longer than that of 2G, with 3G achieving 335 hours and 2G only 265 hours [17].

Therefore, a mobile phone user who predominantly makes and receives mobile phone calls is advised to use a 2G network. However, a mobile phone user who prefers to have prolonged availability is advised to make use of a 3G network. The following is a graphic representation of layer 1, as described above.

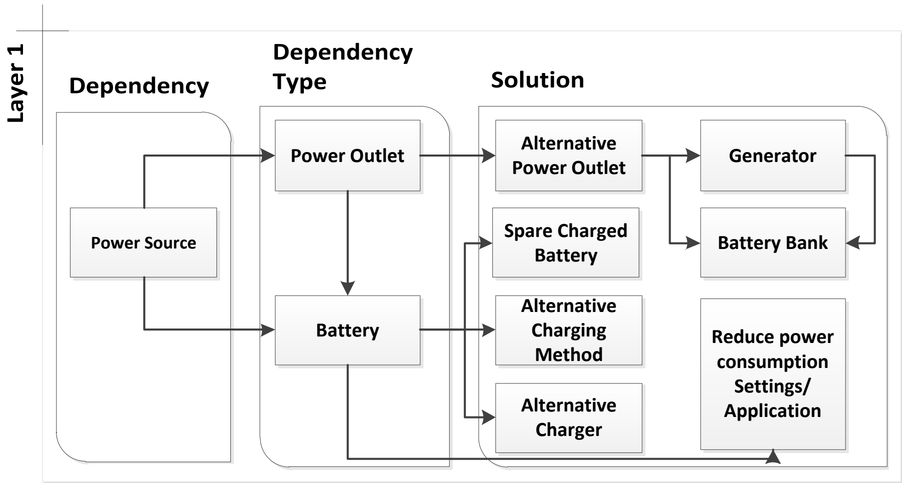

Figure 2: Layer 1

Layer 2: In this layer, the physical device used to communicate is identified. Such a device can be either a desktop device or a mobile device. In the case of both a desktop and a mobile device, if it becomes unavailable or faulty, the first option is to use a back-up or alternative device, such as another desktop or mobile device. For example, one could keep a spare mobile phone handy for when the current one fails to operate properly.

If, however, a back-up device is not available, one could make use of an alternative platform, such as another device capable of achieving the same goals. For example, if a desktop device were to fail and an individual is waiting for an important email, the email could be retrieved via a smartphone. The following is a graphic representation of layer 2, as described above.

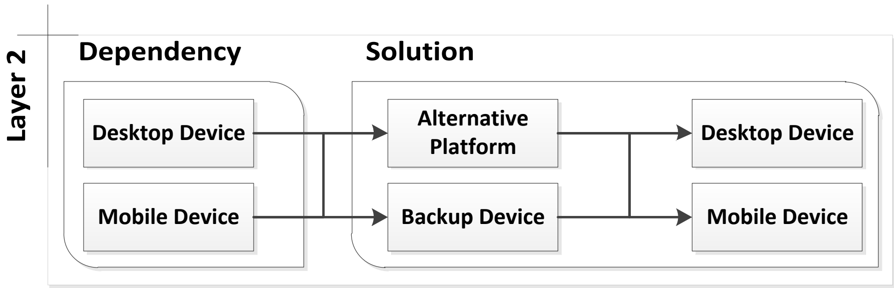

Figure 3: Layer 2

Layer 3: This layer focuses on a funded account. In this layer, the service provider will provide access to its network and services. However, such access will only be granted to a funded account. There are several steps an individual can take to avoid possible account-funding issues. These steps will now be discussed.

In the case of a prepaid funding method, an individual should keep the account well funded. Such a well-funded account should consist of at least three times the amount an individual would normally use on any given day. If an individual consistently has trouble managing a positive balance in an account, an alternative funding method should be used, such as purchasing additional, unused recharge vouchers, which could be used in an emergency. One can also link a bank account to a mobile phone. Banks such as FNB allow airtime to be purchased free of mobile network carrier charges. Another option is internet banking, which can be used to fund most communication accounts, such as an internet account or a mobile network account. Finally, another way to keep an account funded is to have an alternative back-up account. For example, have a back-up SIM card or mobile phone and SIM loaded with airtime. The following is a graphic representation of layer 3, as described above.

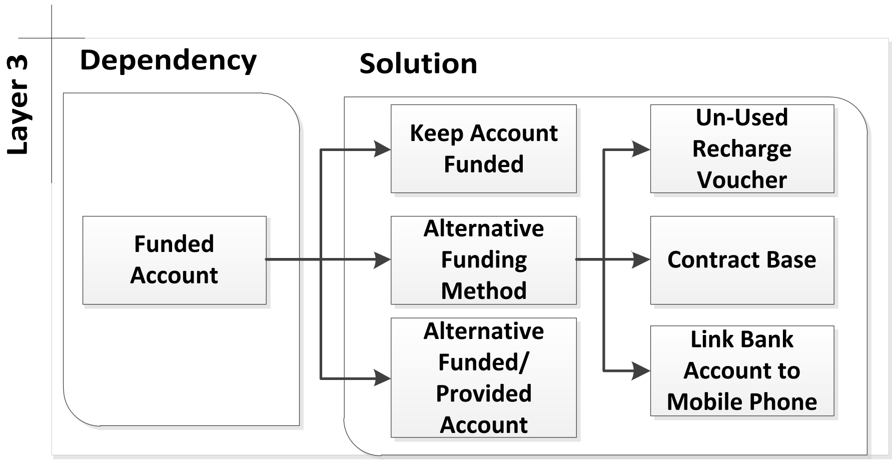

Figure 4: Layer 3

Layer 4: The network providers are located in this layer. A network provider of some sort is required in order to be able to communicate and can be either fixed-line or mobile phone network.

In the case of a fixed-line network, if a disruption occurs the individual could potentially install an additional fixed line on the premises, although this is suggested only in cases where prolonged problems with the line are being experienced. Another alternative would be to use an alternative network type; for example a fixed-line user could make use of a mobile phone network as a back-up network.

In the case of a mobile phone network, if a disruption occurs the individual could use an alternative mobile phone network provider. The use of an alternative mobile phone network could be to have an additional mobile phone with SIM, 3G USB modem with SIM or just a SIM card. Furthermore, an individual could make use of an alternative network, such as a fixed-line network.

Finally, in the case of a mobile phone network, a network signal is required. Since receiving a signal from a mobile phone network could be a challenge in some areas, an individual should take steps to enhance the current signal strength. This could be done by using an alternative network provider, as some providers have extended coverage. Alternatively, an individual could make use of a signal booster, which could be either a purchased version or a crude manmade device. A simple device can be made by wrapping a piece of cardboard with foil. The foil needs to cover the entire area of the cardboard facing the device. The dimensions of the cardboard should be larger than the device; in our experiment, a 40 x 40 centimetre signal booster was used. The results of the test were an average gain of –2db with a gain of up to –4db. Finally, to implement the booster, place a 3G USB modem or phone in the middle of the signal booster. This booster works much like as a satellite would; it uses signal reflection and concentrates that signal to enhance the signal reception of a device. For this reason, the signal booster should also face the nearest signal transmitter or mobile base station. The following is a graphic representation of a simple manmade signal booster like the one mentioned above.

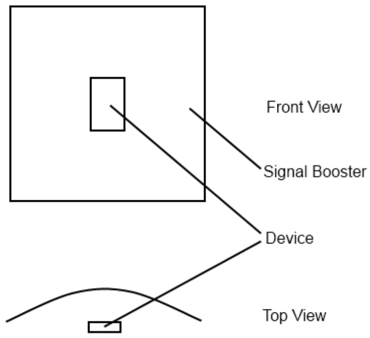

Figure 5: Signal Booster

The manmade device works by consolidating the signal, very like a satellite dish.

The following is a graphic representation of layer 4, as described above.

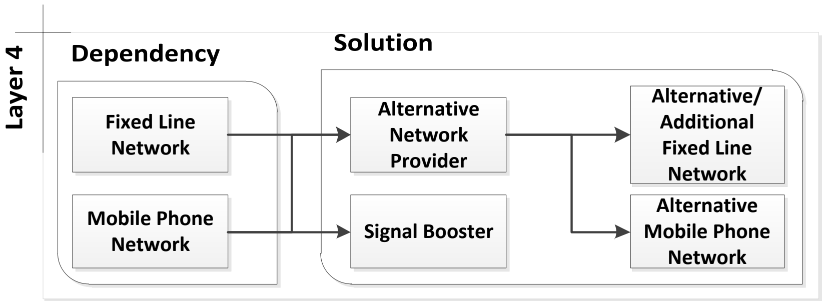

Figure 6: Layer 4

Layer 5: In this layer, the internet as a service is located. The internet allows for many services; however, in order to use these services, a functioning connection to the internet is required.

In the case of a disruption, an individual could make use of an alternative ISP (internet service provider). This alternative provider should ideally be on a different network and make use of different fibre infrastructures, local and international. The following is a graphic representation of layer 5, as described above.

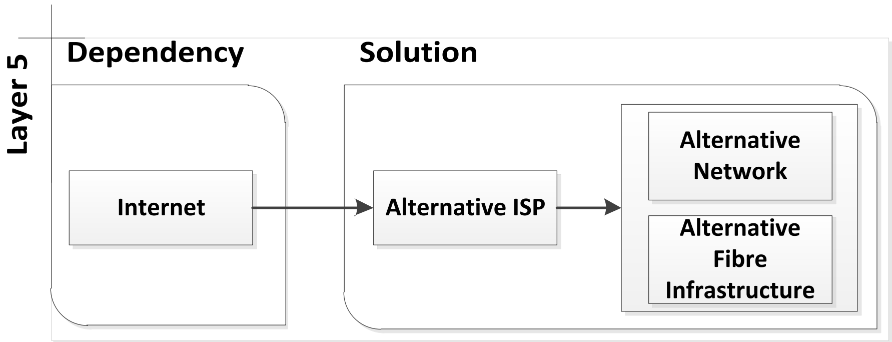

Figure 7: Layer 5

Layer 6: In this layer, the internet services an individual could use are located. To address potential disruption at this level, an individual could use alternative accounts or an alternative client.

An alternative account would be where the user signs up for an alternative account with an alternative provider. An example of this would be to have an alternative email account. Then, if the email account becomes unreachable, a secondary email could be used. In the case of online banking, an alternative bank account can be used. However, an alternative bank account can be expensive, although there are banks that offer “free” accounts in certain situations. One example of a free bank account is a student account at Standard Bank. Having an alternative bank account could help in some situations; for example when a bank has communication disruptions.

As mentioned earlier, another possible solution in layer 6 is to use an alternative client. The reason for doing this is because a client could become faulty. For example, one could use an alternative browser, such as Google Chrome or Mozilla Firefox. Another alternative client is an interoperable IM client, such as Pidgin or Trillian. The following is a graphic representation of layer 6, as described above.

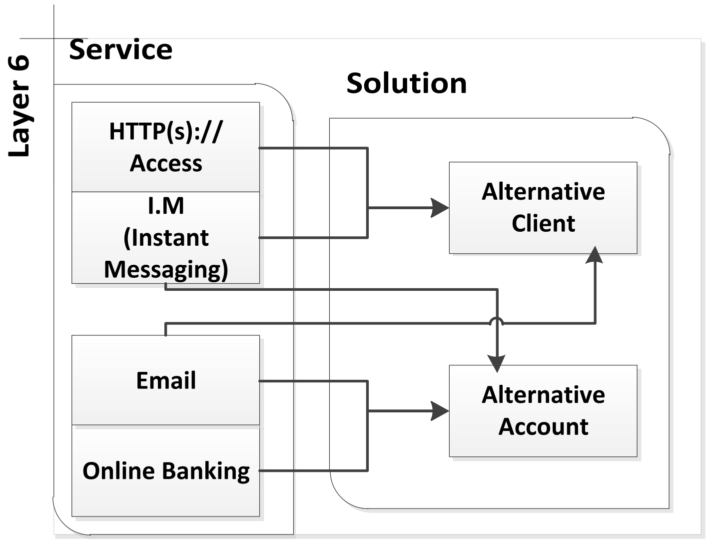

Figure 8: Layer 6

The above figures serve to help individuals create personal ICT continuity strategies. It should be noted that the details of each layer should be read in conjunction with the corresponding figure describing that layer.

Conclusion

It can be seen that communication technology, specifically the mobile phone and the internet, has become integrated and is a very important component of people's daily lives. Although this integration is generally advantageous, it could also hinder daily functioning if it becomes unavailable. For this reason, a personal communication technology continuity plan should be developed. Such a continuity plan would help to determine what is important and how services may be extended when required. To develop a continuity plan, the individual determines his/her personal communication needs – if the requirements are known the continuity framework can also be used. This framework should be used together with the corresponding layers, descriptions and figures. In applying this framework, individuals should trace the service they need down to layer 1, and then implement the suggested solutions. This would provide an ongoing communication technology experience.

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