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THE IMPACT OF EMERGING TECHNOLOGIES ON WIRELESS COMMUNICATIONS

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Abstract

This paper analyzes past and present wireless communication technologies and their subsequent impact in the United States. As wireless technology has evolved from the 1990s to 2010, so have the capabilities available to wireless users. For example, added capabilities have allowed for mobile devices to stream audio and video content over the Internet, a feat that was impracticable just years ago. The thesis also looks at emerging technologies such as mobile voice-over-internet protocol (VOIP) services and Long Term Evolution (LTE) systems and analyzes how they may affect the wireless industry within the next several years.

The comparative analysis examines different hypotheses which may have an influence on the feasibility of a wireless infrastructure in the U.S. that relies mainly on mobile VOIP technologies for placing and receiving phones calls. The analysis includes a possibility tree that examines thirty-three alternative scenarios in which U.S. wireless carriers may or may not implement emerging wireless technologies that could consequently impact mobile VOIP services. In addition, the thesis incorporates a pairwise ranking that looks at the three most impactful alternative futures of the wireless infrastructures of AT&T Mobility and Verizon Wireless to try to determine which of the scenarios has the highest likelihood of occurrence by 2013.

The paper concludes that major wireless carriers in the United States will most likely implement LTE technologies in the near future which would support a shift to mobile VOIP in the wireless industry which would have the greatest potential impact. The implications of

these emerging technologies, such as the potential change in business model for wireless carriers, are discussed at the end of the thesis. The least likely scenario is that major wireless carriers do not make any enhancements to their current infrastructure, which would result in a lower possibility of a nationwide transition to mobile VOIP.

Some implications of a transition to mobile VOIP include major wireless carriers losing revenue from voice calling plans. VOIP providers such as Skype would also see a significant increase in demand. By relying on a mobile VOIP infrastructure for placing and receiving calls, it is also possible that consumers will be spending less for mobile phone services.

Table of Contents

Abstract i

Chapter 1: Introduction 1

1.1 Objective 1

1.2 Significance 1

1.3 Research Question 2

1.4 Approach 2

Chapter 2: Four Generations of Wireless Telephony 4

2.1 First Generation (1G) 4

2.2 Second Generation (2G) 5

2.2.1 Code Division Multiple Access (CDMA) 5

2.2.2 Global System for Mobile Communications (GSM) 6

2.3 Third Generation (3G) 8

2.3.1 CDMA2000 8

2.3.2 Universal Mobile Telecommunications System (UMTS) 10

2.3.3 3G Enhancements 12

2.4 Next-Generation/Fourth Generation (4G) 15

2.4.1 Mobile WiMAX 15

2.4.2 LTE 16

Chapter 3: Methodology 18

3.1 Overview of the Method 18

3.2 The Problem 19

3.3 Possibility Tree 19

3.4 Pairwise Ranking 20

Chapter 4: Analysis 21

4.1 Wireless carriers in the U.S. are focusing less on revenue from voice services 21

4.2 Sprint Nextel and T-Mobile USA will have a limited impact as carriers for mobile VOIP in the U.S. consumer wireless market 23

4.3 Technical limitations in current 3G networks lower the feasibility of a transition to mobile VOIP as a primary wireless voice service in the U.S. 25

4.4 Possibility Tree 29

4.5 Pairwise Ranking 35

4.5.1 Description of Alternatives 36

4.5.2 Ranking of Alternatives 39

4.5.3 Pairwise Ranking Results 41

4.6 Pre-Mortem Analysis 41

4.7 Conclusion 42

Chapter 5: Implications 44

Works Cited 47

Chapter 1: Introduction

1.1 Objective

The various methods of voice communication have greatly evolved over the past 20 years. In the past, landline telephones were the main medium used for remote voice communications. Today, many individuals rely on the use of cellular phones to establish voice conversations. Many individuals also take advantage of voice-over-internet protocol (VOIP) technologies that allow them to inexpensively place telephone calls over the Internet. The objective of this thesis is to examine the feasibility of a nationwide transition to mobile VOIP due to innovations in wireless technology.

1.2 Significance

The motivation behind investigating the potential for a nationwide transition to mobile VOIP is because of the impact this type of technology could have on the telecommunications industry. The possible transition would further support the idea that mobile devices are taking over as a significant portion of computing technologies. The transition would be an example of a type of technology that was initially used on personal computers, but later also became available on mobile devices due to advances in technology. Easier access to VOIP technologies could allow for more individuals to talk with family members on the other side of world for unlimited amounts of time at little to no cost.

1.3 Research Question

The research question being addressed by this thesis is as follows:

What types of technologies will be implemented in the wireless industry by 2013 and will the technologies transform the wireless communications industry by allowing for the shift of voice communications to mobile VOIP services?

1.4 Approach

This thesis will proceed as follows: Chapter 2 will begin by examining the transformation of cellular phone technologies. The chapter will discuss how cellular technologies changed from analog communications to digital communications and how change improved the capabilities of wireless phones. Subsequently, the chapter will discuss the various improvements made to digital cellular technology up until the present.

Chapter 3 focuses on the methodology used when performing the analysis for this paper. The chapter will discuss the different types of facts and their sources that were consulted and how they impact the analysis. When making a prediction of the future state of wireless mobile communications, three alternative scenarios will be mentioned. A possibility tree and pairwise ranking will be used to analyze the three alternative scenarios to assist with the creation of a ranking that will help determine which scenarios are most likely.

Chapter 4 of the paper will consist of an analysis of recent developments in the field of wireless communications and how they will most likely support the potential for a change in how consumers communicate wirelessly. The chapter will discuss into detail how different facts support the three different theories of the future state of wireless communication in the

United States. A possibility tree and pairwise ranking will be included in chapter 4 when comparing the three future scenarios.

Chapter 5 will discuss the implications of a potential shift in how individuals use wireless technologies and services to communicate. The implications to different stakeholders such as telecommunication companies and consumers will be analyzed.

Chapter 2: Four Generations of Wireless Telephony

Wireless telephone communications have evolved greatly from the 1990s to 2010. Cellular communications have changed from being transmitted via analog signals to digital signals. As cellular technologies have improved, their capabilities have also increased. For example, cellular communications were originally used for only voice communications, but over the years technology has allowed for other usage as well, such as text messaging and access to the Internet. These changes in wireless technologies have resulted in the creation of 4 different "generations" of mobile communications. The First Generation (1G) consisted of analog phone technologies. Next, the Second Generation (2G) introduced digital technologies for voice and some limited data capabilities. Third Generation (3G) includes wireless technologies that are implemented within current wireless infrastructures that use digital technologies for voice and data capabilities. Next generation/Fourth Generation (4G) technologies include newer wireless technologies that may be implemented by 2013 in the United States which would allow for much faster data capabilities compared to previous technologies.

2.1 First Generation (1G)

First generation (1G) cellular phone technology emerged during the 1980s. 1G phones were similar in size to bricks and used analog radio signals to send and receive voice communications (Miller School of Medicine at the University of Miami). In the United States the 1G standard implemented was created by Bell Labs and called the Advanced Mobile Phone System (AMPS) (Goldsmith 554).

2.2 Second Generation (2G)

2G wireless technology networks were first implemented in the 1990s. The newer technology uses digital signals to transmit voice and data instead of analog signals (3G Americas). 2G was a significant improvement over its predecessor since digital wireless networks allowed for the use of data services such as text messaging and improved security such that it became much harder for one to eavesdrop on a cellular phone conversation (Miller School of Medicine at the University of Miami). The 2G technologies known as Global System for Mobile Communications (GSM) and Code Division Multiple Access (CDMA) were both implemented in the United States by telecommunication companies such as Cellular One (later acquired by AT&T Mobility) and Verizon Wireless.

2.2.1 Code Division Multiple Access (CDMA)

CDMA technology was first developed by the wireless telecommunications research company known as Qualcomm in the early 1990s. By 1995 CDMA was commercially introduced as CDMAone and based upon the IS-95A standard (Goldsmith 555). IS-95A was developed by the Telecommunications Industry Association/Electronic Industries Association (TIA/EIA) and specifies “the 1.25 MHz CDMA channel structure, power control, call processing, intercellular hand-offs, and registration techniques for end-to-end wireless system operation” (cdmaOne). CDMA wireless technology only makes up a small portion of the world market for cellular technologies. As of February 2010, the World Cellular Information Service (WCIS) states that CDMA technology only makes up 11.6% of cellular phone subscribers in the world (World Cellular Information Service). While CDMA isn’t extensively used worldwide, the technology has a strong presence in the United States, with large CDMA carriers such as Sprint and Verizon Wireless.

Some advantages of CDMAone over analog 1G service include improved call quality and voice network capacity (cdmaOne Advantages). Like the original GSM design, IS-95A includes the ability for users to establish circuit-switched data connections with speeds at 14.4 kbps (cdmaOne). While the CDMA circuit switched data service is faster than the similar service in GSM, the slow speed still limits the capabilities of the technology.

2.2.2 Global System for Mobile Communications (GSM)

GSM first became commercially available in the United States in 1994. The U.S. followed the GSM standard IS-54 created by TIA/EIA (Andrea Goldsmith page 555). GSM is considered the most extensively used mobile telephone technology across the globe, used by over 3.8 billion people since May 2009 (GSM: Global System for Mobile Communications). GSM phones operate in the 800, 900, 1800, and 1900 MHz bands. While originally designed for voice communications, GSM began to be used for circuit switched data connections with the capability to transport data at 9600 bit/s (European Telecommunications Standards Institute). The data speeds at 9600 bit/s were very slow, but fast enough to introduce new data services such as text messaging.

General Packet Radio Service (GPRS)

While circuit switched networking is fine for handling voice communications, it is also very inefficient when handling data connections. The GSM add-on General Packet Radio

Service (GPRS) was first launched in 2000 to help alleviate this issue. GPRS allows GSM phone users to establish packet switched data connections from their handsets (GPRS & EDGE).

Packet switched data networking is much faster compared to circuit switched networks, allowing GPRS to handle various additional data services such as Multimedia Messaging (MMS), the ability to browse the Internet, and send and receive email. However, web browsing capabilities are still limited since data transfer speeds are slow, allowing a user to transfer data at an average rate of 40 to 50 kb/s (GPRS: General Packet Radio Service). Latency rates for GPRS connections are also very poor, with an average latency of about 700 ms (Rysavy Research 44).

GPRS is considered a 2.5G technology since it is the first major step towards a 3G wireless architecture with improved data services (GPRS: General Packet Radio Service). Unlike circuit switched data services, GPRS features an always-on data connection and users can be charged only for the data used (GPRS: General Packet Radio Service). GPRS has been implemented in over 200 countries and is considered one of the most widely used wireless technologies that use packet switched data networking (GPRS: General Packet Radio Service).

Enhanced Data Rates for GSM Evolution (EDGE)

In July 2003 the GPRS improvement called Enhanced Data Rates for GSM Evolution (EDGE) first became available. EDGE is a simple upgrade for wireless carriers, only requiring updated software and added channel cards to support the increase in wireless data capabilities (EDGE: Enhanced Data Rates for GSM Evolution). EDGE data rates are a respectable improvement compared to GPRS data speeds. EDGE can hypothetically support data connections at speeds of up to 474 kbps, while typical data speeds vary between 70 to 130kbps (Q&A: EDGE). Although still slow, EDGE latency rates are a big improvement compared to GPRS, with average rates of about 300 ms (EDGE, HSPA, LTE: Broadband Innovation 44).

While some organizations such as the International Telecommunication Union (ITU) consider EDGE to be a 3G technology, other organizations such as the 3rd Generation Partnership Project (3GPP) have referred to EDGE as a 2.75G technology, believing that EDGE speeds are not fast enough to be considered 3G (GPRS & EDGE) (Q&A: EDGE).

2.3 Third Generation (3G)

In the early 2000's, 3G wireless technology became available to the general public. Mobile communication researchers developed 3G solutions for both GSM and CDMA wireless technologies. 3G technology is a significant improvement over its precursor. For example, after the implementation of 3G technology within the United States wireless carriers such as Verizon Wireless and AT&T Mobility began to offer additional services, such as mobile broadband internet plans for individuals to use on laptop computers. 3G also allowed for the introduction of new capabilities that could be extended to mobile phone users, such as the ability to quickly stream video content from web sites such as YouTube.com.

2.3.1 CDMA2000

In October 2000 a new CDMA technology referred to as CDMA2000 1X became available (CDMA2000 1X). CDMA2000 1X is based off a standard developed by the International Telecommunications Union (ITU) and is known as the International Mobile Telephone 2000 (IMT-2000) standard (Goldsmith 557).

The 3G technology operates in a pair of 1.25 MHz channels. Like CDMAone the 3G technology still uses circuit switched networking for voice communications, but CDMA2000 1X doubles the voice capability of its ancestor, allowing CDMA wireless carriers to handle more users on their network (Goldsmith 557). CDMA2000 1X uses packet switched networking for handling data connections. It is able to support up and downlink data rates of up to 153.6 kbps, with an average rate of 80-100 kbps and an average latency rate of 250 ms (CDMA2000 1X).

Soon after the release of CDMA2000 1X, a data services enhancement known as CDMA2000 1xEV-DO Release 0 (Evolution-Data Optimized) became available in 2002 (1xEV-DO Release 0). The 3G update uses a separate 1.25 MHz channel that supports data transfer rates of up to 2.4Mbps (Goldsmith 557). Actual data rates in a commercial network average about 300-700 kbps for the downlink and 70-90 kbps for uplink data rates. The latency rates are also an improvement over an original CDMA2000 1X data connection, with an average latency of 110 ms (1xEV-DO Release 0).

In October 2006 CDMA2000 1xEV-DO Revision A (EV-DO Rev. A) was launched. The updated technology improved data rates of EV-DO Rev. 0, allowing for download rates of up to 3.1 Mbps and upload rates of 1.8 Mbps. Actual rates in a commercial network vary with average downlink rates of 600 kbps – 1.4Mbps and average uplink rates of 500-800 kbps. Latency rates improved significantly with EV-DO Rev. A, allowing for average rates of below 50 ms (1xEV-DO Revision A).

2.3.2 Universal Mobile Telecommunications System (UMTS)

Universal Mobile Telecommunications System (UMTS) is an overarching term that refers to the evolution of GSM voice and data technologies that are considered to be 3G (UMTS). UMTS was first deployed in Japan by the mobile carrier NTT DoCoMo in 2001 (The Mobile Broadband Evolution: 3GPP Release 8 and Beyond HSPA+, SAE/LTE and LTE-Advanced 10). In July 2004, AT&T Wireless (now AT&T Mobility) launched 3G UMTS wireless networks across multiple cities in the United States (AT&T Wireless Delivers 3G UMTS Service in the United States). Most deployments of UMTS operate under the Frequency Division Duplex (FDD) Wideband Code Division Multiple Access (FDD/WCDMA) system which uses one frequency for transmission and another frequency for reception for wireless communications (Q&A: UMTS/WCDMA). Figure 1 shows the different components of UMTS and how it interacts with other networks.

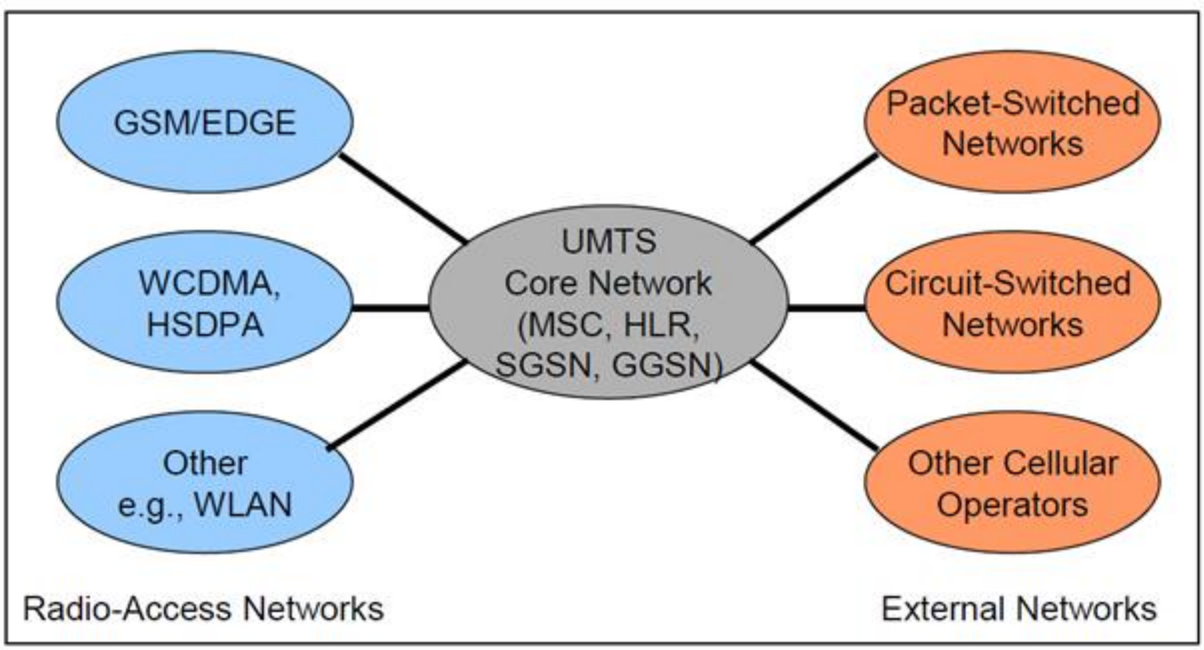

Figure 1 – UMTS Multiradio Network; Source: (EDGE, HSPA and LTE Broadband Innovation 71)

In the original release of UMTS, wireless users could expect peak upload and download rates of about 350 kbps and average speeds of 200 – 300 kbps (EDGE, HSPA and LTE Broadband Innovation 38). Latency rates of UMTS are also an improvement over EDGE, with typical rates between 100 and 200 ms (EDGE, HSPA and LTE Broadband Innovation 71).

High Speed Packet Access (HSPA)

High Speed Packet Access (HSPA) is a data upgrade for UMTS networks that have implemented both High Speed Downlink Packet Access (HSDPA) and High Speed Uplink Packet Access (HSUPA) 3G technologies. Upgrading a UMTS network to support HSPA involves a software upgrade that can lower the costs for transferring bits of data due to the improvements of wireless spectrum efficiency (UMTS Forum 16).

HSDPA first became available in December 2005 after Cingular Wireless (now AT&T Mobility) implemented the technology. HSDPA can provide theoretical data speeds of 14Mbps, but average real-life speeds range from 550 to 800 kbps (HSDPA: High Speed Downlink Packet Access; EDGE, HSPA and LTE Broadband Innovation 73). Latency rates are a slight improvement over its predecessor, with average rates of about 100 ms (HSPA). Upgrades to HSDPA are similar in nature to upgrades from GPRS to EDGE, requiring updated software and additional channel cards (HSDPA: High Speed Downlink Packet Access). HSDPA is able to provide users with faster data speeds by implementing new features such as fast scheduling, which assigns user channels based upon the best current signal condition, such that users are able to receive better data speeds when they have a better radio signal (EDGE, HSPA and LTE Broadband Innovation 74).

HSUPA first became commercially available in early 2007 (HSPA). HSUPA can provide hypothetical uplink speeds of 5.8 Mbps, while typical speeds fall between 500 kbps to 2 Mbps (Q&A: HSUPA). Latency rates are significantly improved with HSUPA, with average rates of 50 ms (HSPA). Unlike HSDPA that uses a shared channel to transfer data, HSUPA makes use of an Enhanced Dedicated Channel (E-DCH) which helps allow for faster uplink speeds (EDGE, HSPA and LTE Broadband Innovation 77).

2.3.3 3G Enhancements

HSPA+

HSPA+ is an enhancement for UMTS networks that is currently commercially available for deployment. The wireless 3G enhancement incorporates technologies such as multiple input multiple output (MIMO), high order modulation (HOM) and discontinuous transmission and reception (DTX/DRX) to help improve data transfer rates (Qualcomm Incorporated). HSPA+ also improves latency rates to below 50 ms (HSPA+: High Speed Packet Access Plus).

In early 2009, the Australian wireless carrier Telstra deployed HSPA+ wireless service with theoretical downlink transfer rates of 21 Mbps (HSPA+: High Speed Packet Access Plus). While theoretical download speeds are very high, actual downlink speeds vary between 550kbps to 8Mbps for users of Australia's wireless carrier. Uplink speeds are also low, with typical speeds between 300kbps to 3.0Mbps (BigPond Wireless Broadband). Shown in Figure 2 is a chart from Qualcomm that projects theoretical speeds for future deployments of HSPA+ technologies.

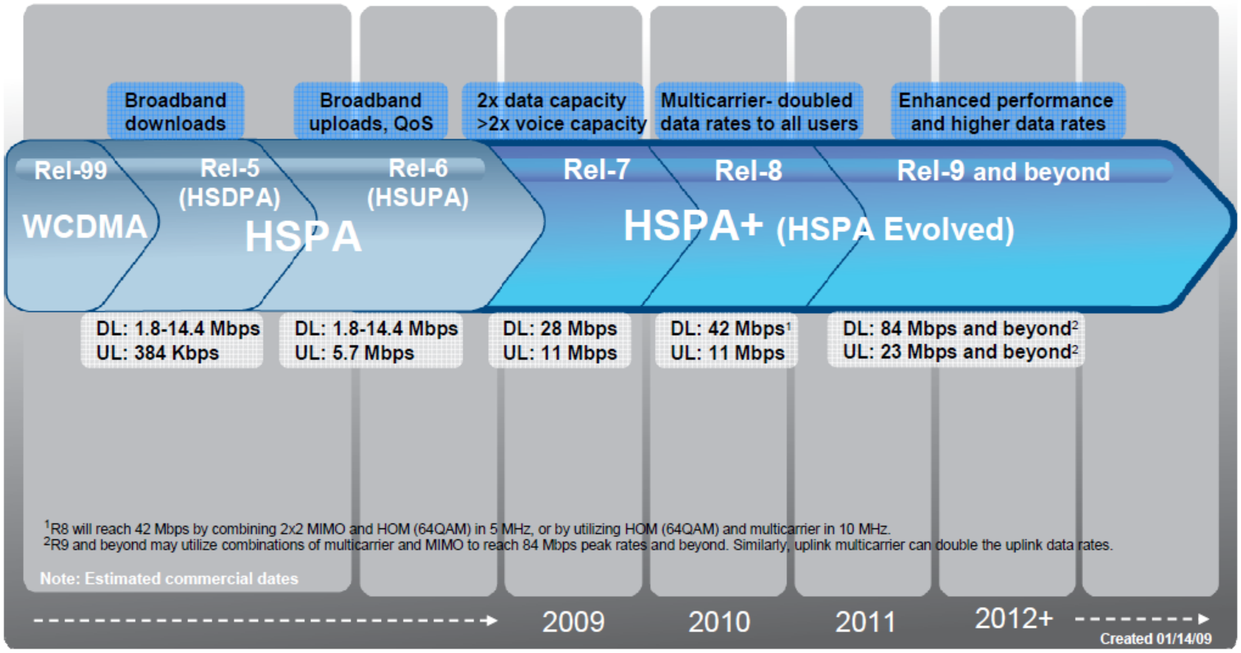

Figure 2 – Evolution of HSPA; Source: (Qualcomm Incorporated)

EV-DO Rev. B.

EV-DO Rev. B. is a 3G enhancement being developed for CDMA2000 1X networks. The enhancement will require software and/or hardware upgrades before it is implemented by CDMA wireless carriers (Multicarrier EV-DO and EV-DO Revision B). With a software upgrade, Revision B uses numerous 1.25 MHz Rev. A channels which can allow for peak download and upload rates of 9.3 Mbps and 5.4 Mbps, respectfully (Multicarrier EV-DO and EV-DO Revision B). A hardware upgrade allows carriers to make use of 5 MHz channels that can increase peak downlink rates to 14.7 Mbps (Multicarrier EV-DO and EV-DO Revision B). As with other improvements in CDMA data technologies, EV-DO Rev. B should significantly improve latency, with rates below 35 ms (Multicarrier EV-DO and EV-DO Revision B). Shown in Figure 3 is a table that shows how latency rates have improved since the emergence of CDMA2000 1X technologies.

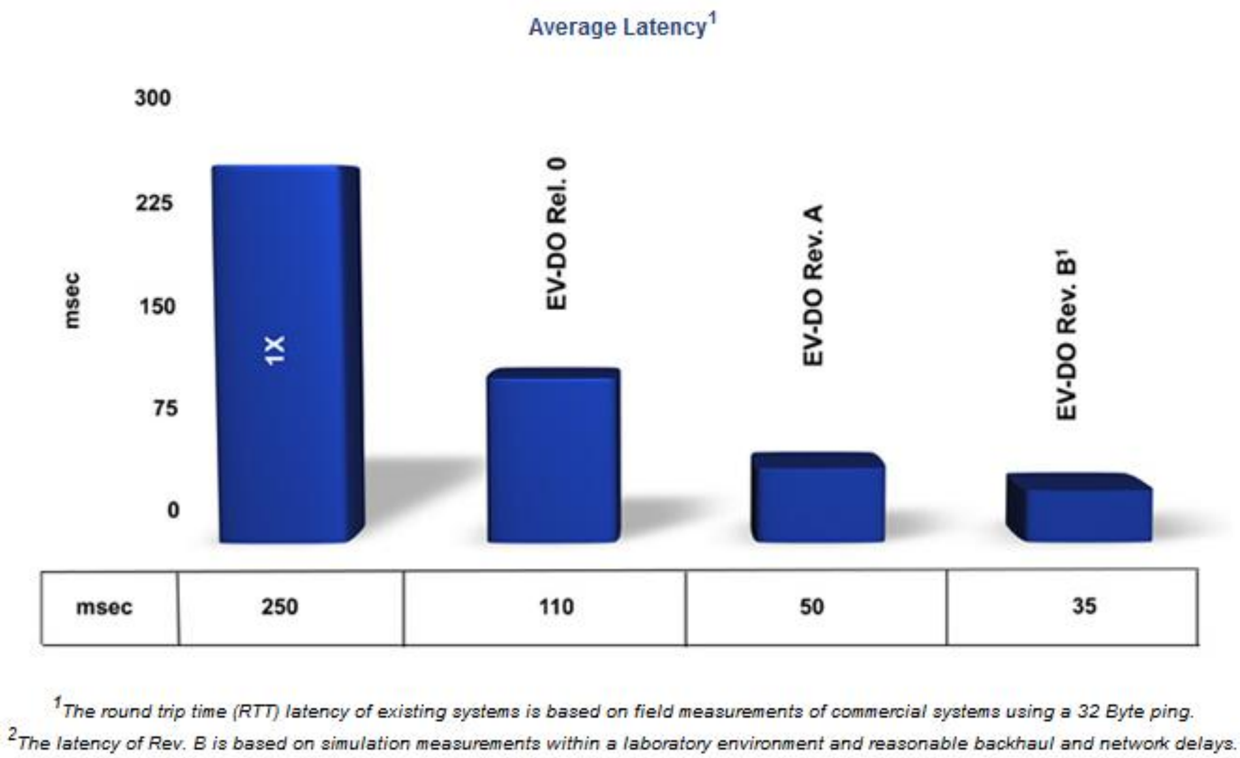

Figure 3 – Average Latency of CDMA technologies; Source: (CDMA2000 Performance)

2.4 Next-Generation/Fourth Generation (4G)

Wireless carriers such as Verizon Wireless, AT&T Mobility, and Sprint Nextel are in the process of planning and implementing next-generation wireless technologies. Verizon Wireless and AT&T Mobility are both planning on implementing LTE (Long Term Evolution) wireless technologies in the near future. Sprint Nextel is in the process of implementing the wireless technology WiMAX across the United States as well.

Sprint Nextel is one of the first major wireless carriers in the United States to begin deployment of a major next-generation wireless technology, and has repeatedly referred to their WiMAX deployment as a 4G network. Verizon Wireless' web site also refers to their future LTE implementation as a "4G network" (Verizon Wireless).

While these next generation technologies should be a significant improvement over current 3G networks, both technologies most likely will not meet the current criteria as 4G networks as specified by the ITU. For example, the ITU states that 4G networks will need to be able to provide data speeds of up to 1Gbps (Tabbane). Theoretical rates for current LTE and WiMAX technologies are unable to achieve 1Gbps, and therefore do not meet one of the ITU's requirements for a wireless network to be considered 4G. This claim is also supported since the ITU referred to LTE as a 3G technology in a presentation (Tabbane).

2.4.1 Mobile WiMAX

Mobile WiMAX is a wireless technology capable of providing a data connection to users on the go. The technology was included in the IEEE standard 802.16e towards the end of 2005 (WiMax.com Broadband Solutions, Inc.). WiMAX technology was first introduced before 2005, but earlier versions did not support mobile connectivity and was referred to as “Fixed WiMAX” (WiMax.com Broadband Solutions, Inc.).

Theoretical data speeds of mobile WiMAX are significantly faster when compared to current CDMA and GSM 3G networks. The 802.16e technology is able to achieve peak rates of up to 40Mbps and 10Mbps for downloading and uploading, respectfully (Wieland). While these rates are high, typical rates are slower. For example, Sprint Nextel states that average downlink speeds for their WiMAX network vary between 3 - 6Mbps (4G Wireless Broadband Network from Sprint).

2.4.2 LTE

Long Term Evolution (LTE) is a next-generation wireless technology developed by the 3GPP and specified in 3GPP Release 8, with the latest version of release 8 released in 2009 (LTE). LTE uses various technologies such as MIMO, Orthogonal Frequency Division Multiplexing (OFDM), and Single Carrier-Frequency Division Multiple Access (SC-FDMA) to allow for efficient use of wireless spectrum (LTE). LTE can theoretically support download speeds up to 326Mbps and upload speeds of 86.4Mbps if implemented with 20 MHz bandwidth (LTE: Long Term Evolution). The next-generation technology also supports latency rates much faster than other wireless technologies, with rates of up to 10 ms (LTE: Long Term Evolution).

LTE was first commercially released in December 2009 by the wireless carrier TeliaSonera in the cities of Stockholm and Oslo (Ricknäs, TeliaSonera Launches First Commercial LTE Services). While initial tests of the commercial service were somewhat disappointing, new tests of the LTE network have shown average download speeds of 25Mbps, with peak speeds of 45Mbps (Ricknäs, LTE Delivers Faster Speeds After New Tests, Says Analyst).

Chapter 3: Methodology

3.1 Overview of the Method

The remainder of this paper will present three different propositions that may happen within the next several years (between 2011 and 2013) which would impact how people communicate with each other using mobile devices. The analysis will focus on current and future technologies to be offered by the two largest wireless carriers in the United States: Verizon Wireless and AT&T Mobility. Since Verizon Wireless and AT&T Mobility make up the majority of the wireless market in the U.S., other wireless carriers will not be thoroughly examined in this thesis due to their limited market share of wireless customers in the United States and the limitations to their wireless infrastructures. The three different arguments will be supported by facts collected from various sources. Reputable sources were consulted when gathering supportive facts. When discussing the evolution of different wireless communication technologies over the past twenty years, information supplied by leaders within the current wireless industry were integrated into this paper. Some specific examples include information from the 3rd Generation Partnership Project (3GPP) which is made up of multiple organizations from around the globe that work together to decide upon wireless communication standards. Another example includes information taken from 3G Americas, an organization that unites mobile phone manufacturers and wireless carriers within the Americas to represent different GSM technologies (3G Americas).

3.2 The Problem

The problem the methodology tries to address is how to estimate the future of wireless communications given all the uncertainties that are present. In order to gain a better understanding of the future, the analysis includes a possibility tree which indentifies a mutually exclusive and collectively exhaustive list of possible scenarios where Verizon and AT&T implement different types of wireless technologies to their wireless infrastructures. The list of scenarios is later shortened to several alternative scenarios which are compared regarding likelihood of occurrence using pairwise ranking.

3.3 Possibility Tree

A possibility tree will be presented in the analysis that consists of a mutually exclusive and collectively exhaustive list of 33 different scenarios based upon the occurrence of 6 potential events. The 33 scenarios include potential futures where AT&T Mobility and Verizon Wireless implement different types of emerging wireless technologies such as LTE and HSPA+. The 33 scenarios are further examined by the application of a weighting system that applies a weight to each scenario based upon its potential impact to wireless consumers with regards to the scenarios' ability to provide added capabilities to wireless users that could increase the potential for a transition to mobile VOIP technologies in the United States. The weighting system is used to help determine which scenarios are the most impactful and should be included in the pairwise ranking.

3.4 Pairwise Ranking

Pairwise ranking is a method that will be used to compare the three alternative scenarios to determine which ones are most likely. The method works by comparing each scenario against another scenario and selecting the preferred scenario for each comparison. A total of three comparisons will be made in the analysis. After all of the pairwise comparisons are completed, the propositions will be ranked in a table according to the most number of counts in the matrix. The scenario with the most counts will be considered the proposition with the greatest likelihood of happening in the near future.

Shown in Figure 4 is an example of pairwise ranking that was done with 5 different items:

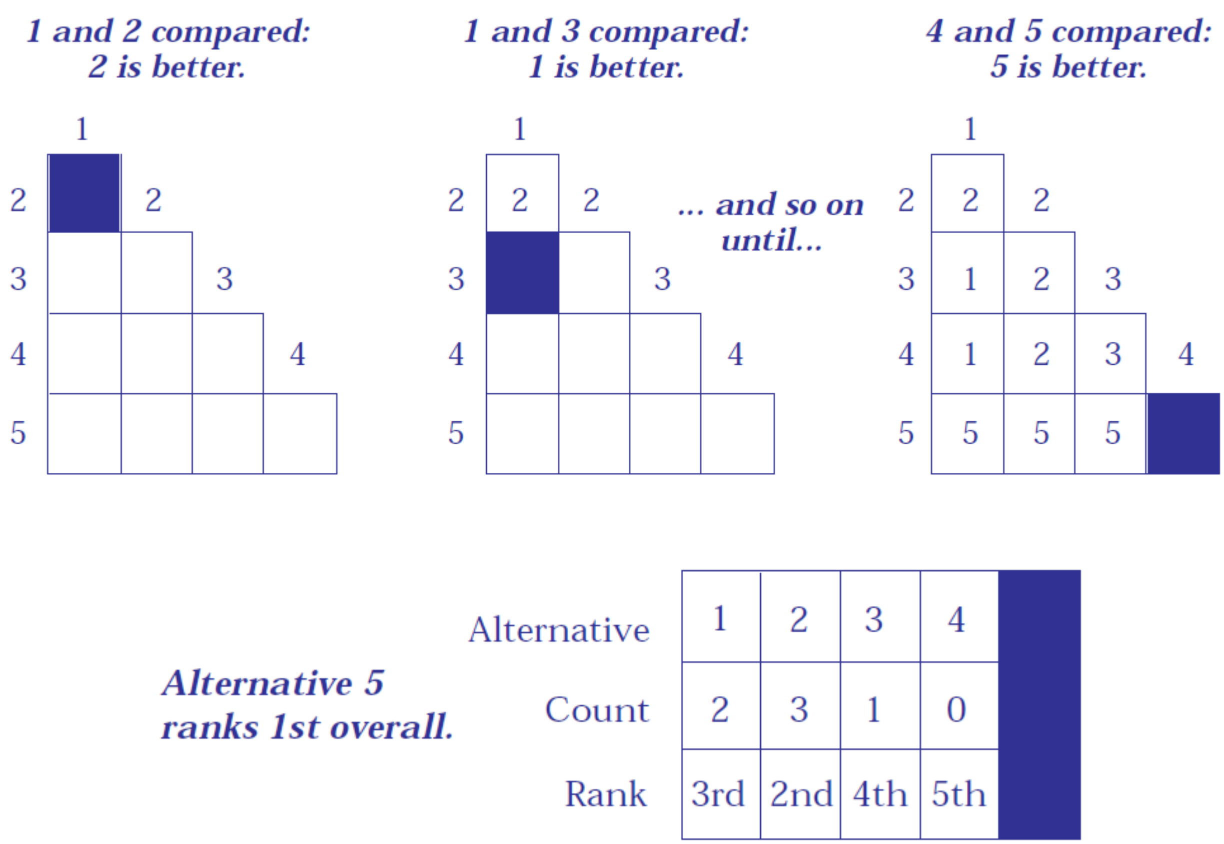

Figure 4 – Example of Pairwise Ranking; Source: (Concordia University)

Chapter 4: Analysis

Whenever considering the feasibility of a nationwide adaption to mobile VOIP, one must consider both the technical capabilities of the wireless communication technologies and the wireless carriers' ability to either allow or restrict customers from using VOIP services over their wireless data networks. The alternative scenarios will be examining the likelihood of an adaption of various types of emerging wireless technologies and their potential for supporting mobile VOIP services. The pairwise ranking will then be used to determine which of the scenarios is most likely for both their implementation of new wireless data technology and their support for mobile VOIP services.

4.1 Wireless carriers in the U.S. are focusing less on revenue from voice services

As demand for Smartphones in the United States has increased, so has the emphasis on data services offered by wireless carriers. Smartphones allow for users to treat their mobile device less as a telephone and more as a portable computer. For example, many Apple iPhone users use wireless data services for browsing the internet, email, location-based services, and streaming audio and video.

Wireless carriers have recognized this increase in the demand for data services and have taken steps to generate additional revenue. For example, Verizon Wireless recently started to require some non-Smartphone customers to pay an additional $10 a month for a data plan (Goldman).

Over the past couple years the increase in the demand of data services has also resulted in a decrease for voice services. This claim is supported by the fact that both AT&T and Verizon Wireless stated on January 15, 2010 that the pricing for their unlimited voice calling plans would be reduced by $30 a month (The Wall Street Journal).

While wireless carriers in the United States may be losing revenue in calling plan revenue, the increase in demand for data services should offset the loss. A financial services company known as Credit Suisse has stated that while Verizon Wireless may lose $540 million from a decrease in voice services, the wireless carrier should make an additional $630 million in revenue from data services (Kharif). This shift in revenue supports the idea that wireless carriers in the United States are beginning to alter their revenue model such that they are decreasingly seen as a wireless telephone service provider versus a wireless carrier offering data services. Figure 5 shows a graph that depicts the substantial increase of data traffic in UMTS networks, while voice traffic has only increased slightly from the period of January 2007 to March 2008.

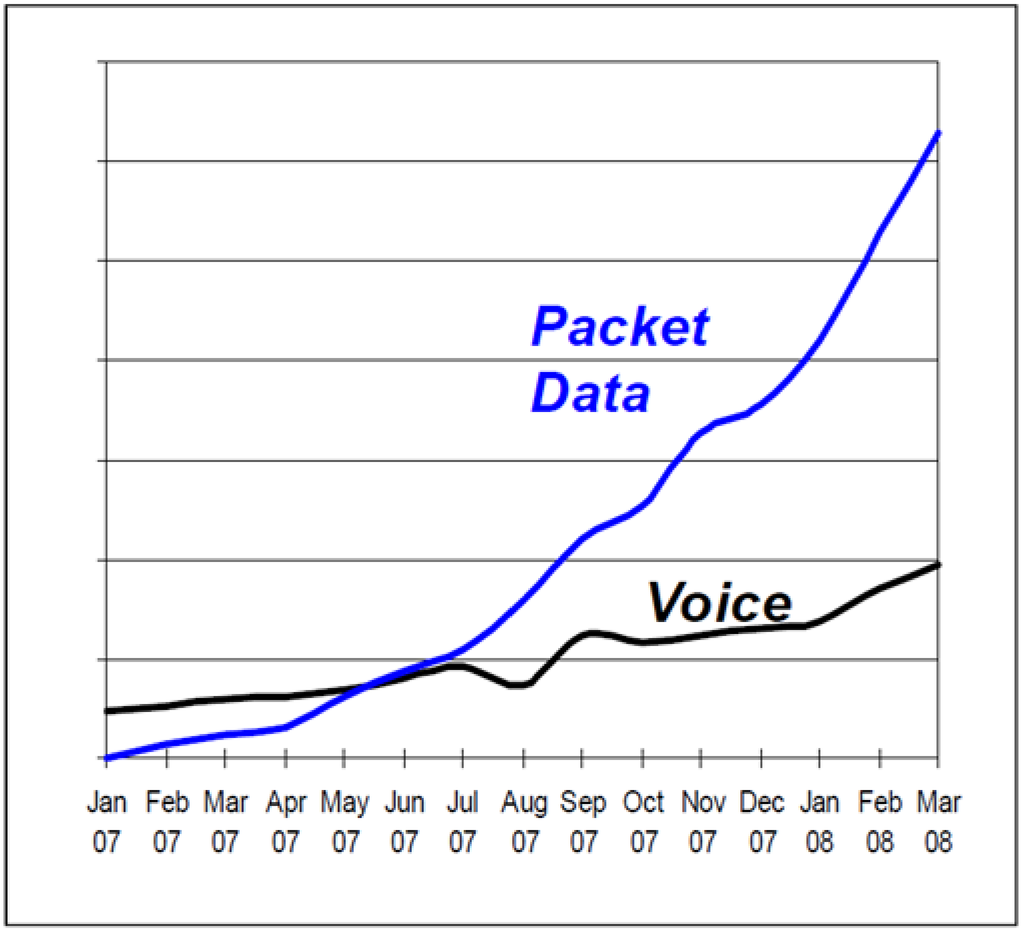

Figure 5 – UMTS/HSPA Voice and Data Traffic; Source: (EDGE, HSPA, LTE: Broadband Innovation 11)

4.2 Sprint Nextel and T-Mobile USA will have a limited impact as carriers for mobile VOIP in the U.S. consumer wireless market

Sprint Nextel is currently the 3rd largest wireless carrier in the United States; with about 48.1 million wireless customers as of the end of 2009 (Sprint Nextel Reports Fourth Quarter and Full-Year 2009 Results). While the carrier has a large number of wireless customers in North America, their number of customers is much less than Verizon Wireless and AT&T Mobility. The fact that Sprint Nextel has a limited customer base in the United States lowers the potential for them to have a significant influence on the U.S. consumer market as a whole.

As of early 2010, Sprint Nextel is one of the first wireless carriers in the United States to offer WiMAX, a 4G wireless technology, to some limited consumer markets in North America. While the capabilities of many 4G technologies support the technological feasibility of a nationwide shift to mobile VOIP, Sprint Nextel's implementation of WiMAX will most likely not affect the consumer wireless voice services market in the near future.

Sprint Nextel has been implementing their WiMAX infrastructure with the Quality of Service (QoS) method known as Best-Effort Service (BE). A best-effort QoS approach allows for improved data transfer and internet browsing by focusing on data traffic as a priority (Mobile WiMAX: The 4G Revolution Has Begun 11). While BE is sufficient for an individual browsing the web, the QoS method is not designed to handle VOIP applications, such that VOIP quality may suffer. Unlike BE, there are two QoS methods that are designed to support VOIP, Unsolicited Grant Service (UGS) and Extended real-time polling service (ErtPS). Both QoS methods support quality VOIP services by specifying maximum latency rates (Li, Qin and Low 73).

T-Mobile USA has 33.8 million customers as of the end of 2009 and is therefore considered the fourth largest wireless carrier in the United States (T-MOBILE USA 2). T-Mobile is also one of the first major carriers in the United States to begin the implementation of HSPA+ wireless technologies (T-MOBILE USA 2). HSPA+ technologies provide added technical capabilities to T-Mobile's networks, which further support the feasibility of T-Mobile being able to fully support mobile VOIP. While T-Mobile USA is making enhancements to their network in support of emerging technologies, their impact on the U.S. wireless market as a whole is limited due to their small number of customers compared to carriers such as AT&T and Verizon Wireless.

4.3 Technical limitations in current 3G networks lower the feasibility of a transition to mobile VOIP as a primary wireless voice service in the U.S.

While current 3G networks operated by AT&T Mobility and Verizon Wireless can be used to place VOIP calls, the quality of VOIP services may be inferior to calls placed via plain old telephone service (POTS). Poor quality VOIP calls over 3G are due because of several contributing factors, such as congested networks, high latency rates, and limited system resources on some mobile handsets.

AT&T Mobility's 3G network has faced many network issues due to a lack of network resources. Consumers in cities such as San Francisco and New York City have faced major issues with their AT&T 3G services due to the large number of network users (Wortham). Many AT&T network users are owners of Smartphones such as the Apple iPhone. Smartphones allow for users to take advantage of multiple data services, such as the ability to surf the web and stream audio and video content. These types of services cause additional strain to AT&T's 3G network due to the need for extensive network resources. Wireless users then notice AT&T's inability to handle the large amount of data traffic, by experiencing "dropped calls, spotty service, delayed text and voice messages and glacial download speeds" (Wortham). Gene Munster, an analyst for the banking firm Piper Jaffray, has stated that cellular phone users in some cities should not even attempt to connect to 3G networks during peak hours due to the large number of cellular users which can lead to dropped calls (Wortham).

AT&T's 3G network may continue to face network problems into the future. Apple recently announced the release of their new tablet-like device known as the Apple iPad. The device can be used in conjunction with AT&T's 3G network in order for iPad users to access the Internet. The FCC has recognized the potential for additional network strain for AT&T with the release of the Apple iPad. Phil Bellari, the Director of Scenario Planning in association with the Omnibus Broadband Initiative for the Federal Communications Commission (FCC) has stated that it is possible that AT&T's networks may not be able to handle additional data traffic due to the iPad which could lead to further network congestion problems, similar to issues consumers faced during the mid-1990's whenever dialup provider AOL allowed for unlimited Internet usage (Bellaria). Bellaria also states that wireless network congestion issues need to be mitigated or else the United States could lose competitiveness compared to other nations regarding broadband access (Bellaria).

Latency issues are another negative factor regarding the use of VOIP over 3G networks. For example, AT&T Mobility uses a HSPA network for data services. As stated in the literature review, HSDPA can have latency rates of about 100 ms. These higher latency rates can result in low quality VOIP calls. For example, I have tested AT&T Mobility's 3G network in State College, Pennsylvania to place calls using VOIP services. I have used the application known as Fring, a VOIP telephone network that allows for users to place calls over their network or use the application to place calls over Skype. Once I have the application launched and I have logged into Skype, I am able to place VOIP calls to landline and mobile phones of individuals across the United States. I am able to do this by subscribing to a subscription service known as SkypeOut that allows for users to place unlimited calls to phones within the United States for only $2.95/month, a price much cheaper compared to unlimited voice plans offered by wireless carriers in the United States. Figure 6 displays the latency rates of current wireless technologies to show the difference between past technologies and LTE.

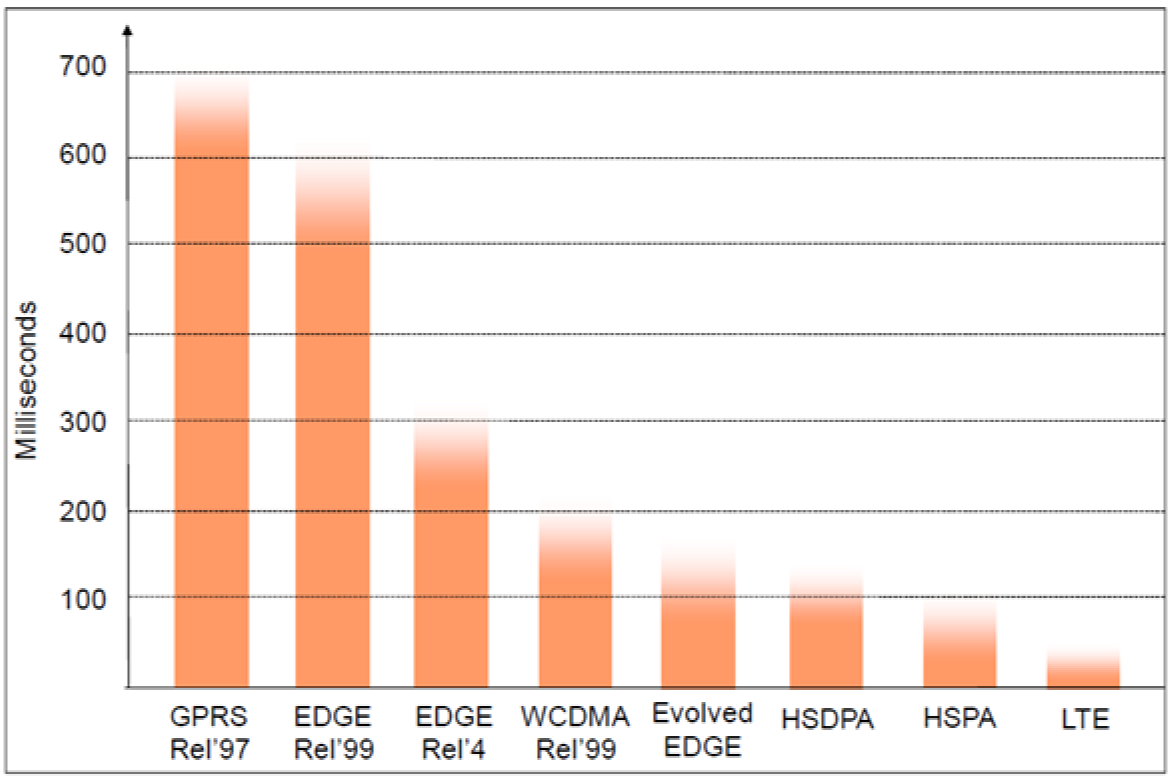

Figure 6 – Latency Rates of Wireless Technologies; Source: (EDGE, HSPA, LTE: Broadband Innovation 44)

While placing VOIP calls to landline phones using the Fring application over AT&T's 3G network in State College, I have noticed many issues that affect call quality. For example, while placing a VOIP call over 3G I have experienced frequent lag issues, resulting in a noticeable delay between myself saying something and the landline phone user hearing what I said. During VOIP calls over 3G, I have also noticed occasional distortion of the other caller's voice due to the varying quality of the 3G connection. The overall audio quality is also inferior while placing VOIP calls compared to callings placed over POTS.

4.4 Possibility Tree

The following section contains a possibility tree (Figure 7) that analyzes the possibility of 33 collectively exhaustive future scenarios regarding the implementation of new wireless technologies in the wireless infrastructures of both Verizon and AT&T. The tree includes the possibility for the implementation of next generation LTE technologies and 3G enhancement technologies such as HSPA+ and EV-DO Rev. B (Table 1) in both wireless carriers.

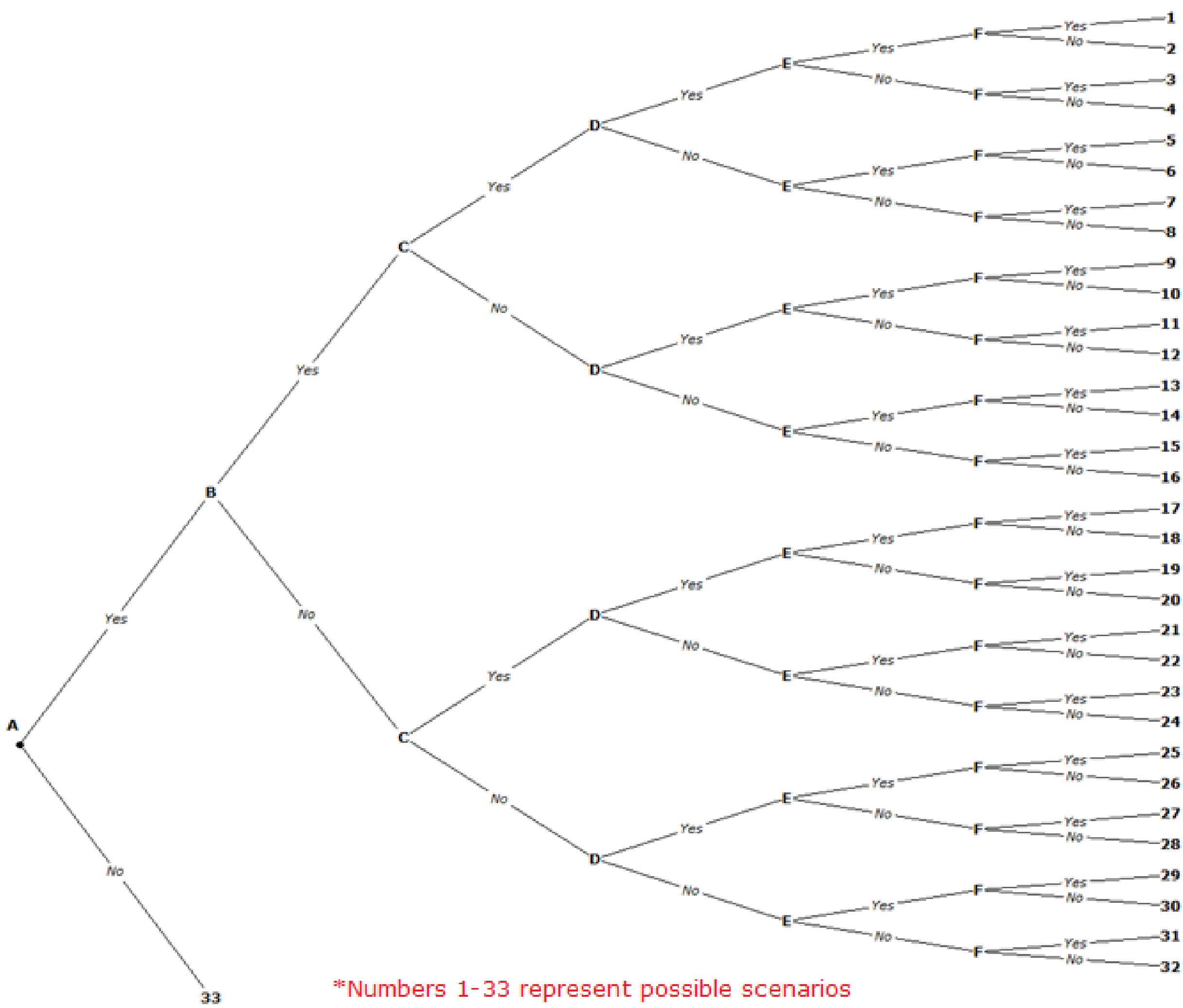

Figure 7 – Possibility Tree for Wireless Infrastructure Scenarios

Table 1 – Events represented in Possibility Tree

Letter	Event
A	Change in wireless infrastructure?
B	Verizon implements LTE
C	AT&T implements LTE
D	AT&T implements HSPA+
E	Verizon implements EV-DO Rev. B
F	AT&T implements EV-DO Rev. B

Table 2 includes a numbered listing of all of the possible scenarios considered and a brief description for each possible future.

Table 2 – Description of Alternative Scenarios

Scenario number	Description
1	In scenario 1, a change in infrastructure occurs due to the implementation of LTE by both Verizon and AT&T, EV-DO Rev. B by both Verizon and AT&T, and the implementation of HSPA+ by AT&T.
2	In scenario 2, a change in infrastructure occurs due to the implementation of LTE by both Verizon and AT&T, EV-DO Rev. B by Verizon, and the implementation of HSPA+ by AT&T.
3	In scenario 3, a change in infrastructure occurs due to the implementation of LTE by both Verizon and AT&T, EV-DO Rev. B by AT&T, and the implementation of HSPA+ by AT&T.
4	In scenario 4, a change in infrastructure occurs due to the implementation of LTE by both Verizon and AT&T, and the implementation of HSPA+ by AT&T.
5	In scenario 5, a change in infrastructure occurs due to the implementation of LTE by both Verizon and AT&T, and EV-DO Rev. B by both Verizon and AT&T.
6	In scenario 6, a change in infrastructure occurs due to the implementation of LTE by both Verizon and AT&T, and EV-DO Rev. B by Verizon.
7	In scenario 7, a change in infrastructure occurs due to the implementation of LTE by both Verizon and AT&T, and EV-DO Rev. B by AT&T.
8	In scenario 8, a change in infrastructure occurs due to the implementation of LTE by both Verizon and AT&T.

9	In scenario 9, a change in infrastructure occurs due to the implementation of LTE by Verizon, EV-DO Rev. B by both Verizon and AT&T, and the implementation of HSPA+ by AT&T.
10	In scenario 10, a change in infrastructure occurs due to the implementation of LTE by Verizon, EV-DO Rev. B by Verizon, and the implementation of HSPA+ by AT&T.
11	In scenario 11, a change in infrastructure occurs due to the implementation of LTE by Verizon, EV-DO Rev. B by AT&T, and the implementation of HSPA+ by AT&T.
12	In scenario 12, a change in infrastructure occurs due to the implementation of LTE by Verizon, and the implementation of HSPA+ by AT&T.
13	In scenario 13, a change in infrastructure occurs due to the implementation of LTE by Verizon, and EV-DO Rev. B by both Verizon and AT&T.
14	In scenario 14, a change in infrastructure occurs due to the implementation of LTE and EV-DO Rev. B by Verizon.
15	In scenario 15, a change in infrastructure occurs due to the implementation of LTE by Verizon, and EV-DO Rev. B by AT&T.
16	In scenario 16, a change in infrastructure occurs due to the implementation of LTE by Verizon.
17	In scenario 17, a change in infrastructure occurs due to the implementation of LTE by AT&T, EV-DO Rev. B by both Verizon and AT&T, and the implementation of HSPA+ by AT&T.
18	In scenario 18, a change in infrastructure occurs due to the implementation of LTE by AT&T, EV-DO Rev. B by Verizon, and the implementation of HSPA+ by AT&T.
19	In scenario 19, a change in infrastructure occurs due to the implementation of LTE by AT&T, EV-DO Rev. B by AT&T, and the implementation of HSPA+ by AT&T.
20	In scenario 20, a change in infrastructure occurs due to the implementation of LTE by AT&T and the implementation of HSPA+ by AT&T.
21	In scenario 21, a change in infrastructure occurs due to the implementation of LTE by AT&T and EV-DO Rev. B by both Verizon and AT&T.
22	In scenario 22, a change in infrastructure occurs due to the implementation of LTE by AT&T and EV-DO Rev. B by Verizon.
23	In scenario 23, a change in infrastructure occurs due to the implementation of LTE by AT&T and EV-DO Rev. B by AT&T.
24	In scenario 24, a change in infrastructure occurs due to the implementation of LTE by AT&T.
25	In scenario 25, a change in infrastructure occurs due to the implementation of EV-DO Rev. B by both Verizon and AT&T, and the implementation of HSPA+ by AT&T.
26	In scenario 26, a change in infrastructure occurs due to the implementation of EV-DO Rev. B by Verizon, and the implementation of HSPA+ by AT&T.
27	In scenario 27, a change in infrastructure occurs due to the implementation of EV-DO Rev. B by AT&T, and the implementation of HSPA+ by AT&T.
28	In scenario 28, a change in infrastructure occurs due to the implementation of HSPA+ by AT&T.

29	In scenario 29, a change in infrastructure occurs due to the implementation of EV-DO Rev. B by both Verizon and AT&T.
30	In scenario 30, a change in infrastructure occurs due to the implementation of EV-DO Rev. B by Verizon.
31	In scenario 31, a change in infrastructure occurs due to the implementation of EV-DO Rev. B by AT&T.
32	In scenario 32, a change in infrastructure occurs, but one that is not attributable to a specific technological upgrade previously considered.
33	In scenario 33, a change in wireless infrastructure does not occur.

The possible scenarios can be further analyzed by assigning weights based upon their potential impact to consumers regarding the scenarios ability to provide more wireless capabilities to consumers. By having access to additional wireless capabilities, the potential for consumers to utilize mobile VOIP technologies as their main form of voice communications increases.

When weighting the different scenarios, each scenario is assigned a weight value of Best, Middle, or Worst. In order for a scenario to have the "Best" impact to consumers, it must include the implementation of next generation LTE technologies for both Verizon and AT&T. "Best" scenarios have the greatest potential impact to consumers since they allow for the introduction of the most added wireless capabilities to most wireless consumers in the United States within the next several years.

"Middle" scenarios must include the implementation of LTE technologies by at least one major carrier and the implementation of 3G enhancement technologies in at least one of the major carriers as well. Both wireless carriers must have the implementation of either LTE technologies or 3G enhancement technologies to be considered a "Middle" scenario. "Middle" scenarios can also include situations where both wireless carriers invest in 3G enhancement technologies. “Middle” scenarios have a significant impact to consumers since they can provide users with 3G enhancement technologies and/or LTE technologies to allow for quicker access to added capabilities, similar to a “Best” scenario. However, “Middle” scenarios vary such that they don’t offer as many capabilities to as many wireless consumers in the United States, hence not making as large as an impact to consumers as a whole in the United States.

Scenarios that are assigned a weight of “Worst” include the implementation of LTE and/or 3G enhancements in only one of the wireless carriers. It is also possible that a “Worst” scenario doesn’t include any enhancements to the wireless infrastructure of the United States. If wireless technologies are only implemented in one wireless carrier, then only a portion of wireless consumers in the United States will be affected, resulting in a low impact to the U.S. consumer market as a whole. Considering these dimensions for accessing impact, the Table 3 includes a list of all of the possible scenarios considered and their assigned weight of Best, Middle, or Worst.

Table 3 – Impact of Scenarios on Consumer Capabilities

Scenario number	Postulated Impact
1	Best
2	Best
3	Best
4	Best
5	Best
6	Best
7	Best
8	Best
9	Middle
10	Middle
11	Middle
12	Middle
13	Middle
14	Worst
15	Middle
16	Worst
17	Middle
18	Middle
19	Worst
20	Worst
21	Middle
22	Middle
23	Worst
24	Worst
25	Middle
26	Middle
27	Worst
28	Worst
29	Middle
30	Worst
31	Worst
32	Worst
33	Worst

4.5 Pairwise Ranking

After sorting through the 33 scenarios, there are many instances where scenarios were discarded due to their very low likelihood of occurring. For example, one event included in the possibility tree was the implementation of EV-DO Rev. B technologies by AT&T Mobility. This specific event has an extremely low likelihood of occurring since EV-DO Rev. B is not yet commercially available as of 2010 and it would be very costly for AT&T to invest in EV-DO technology since it is used in CDMA wireless infrastructures and AT&T Mobility operates a GSM-based infrastructure. In order for AT&T to implement EV-DO they would need to implement an entirely new CDMA infrastructure. While possible, it would be extremely unlikely due to the massive time and investment on AT&T's part without adding a significant amount of wireless capabilities. It would be much more feasible for AT&T to invest in the 3G enhancement technology HSPA+ or implement an LTE infrastructure as opposed to attempting to implement EV-DO Rev. B. This reasoning allowed for the elimination of all odd-numbered scenarios between 1 and 31 from being included in the pairwise ranking.

Seventeen scenarios remained after the first round of elimination. These scenarios included the implementation of LTE technologies, 3G enhancement technologies, no additional technologies, and combinations of all three extremes. For the pairwise ranking analysis only a few scenarios could be selected due to how pairwise rankings are done, which could have resulted in an excessive number of comparisons if too many scenarios were compared. In order to allow for a more reasonable analysis, the three scenarios on different extremes of the types of technologies that could be implemented were considered for the pairwise ranking.

After the scenarios were assigned weights based upon their postulated impact to consumers, one scenario from each weight category was selected to be included in the pairwise ranking. The selection process involved identifying which of the scenarios involved the smallest investment to wireless carriers while still providing customers with the necessary capabilities for the scenario to have a best, middle, or worst impact on consumers. For example, it would be an unwise investment for a wireless carrier to implement LTE technology the same time as HSPA+ due to the added investment towards a wireless infrastructure that will soon become obsolete. It is assumed that wireless carriers would choose to make the best use of their funding in order to make the best return on investment.

One scenario identified includes the implementation of LTE technologies by AT&T and Verizon by the year 2013. Another possible scenario includes the implementation of 3G enhancement technologies by both wireless carriers. The third scenario includes the possibility of wireless carriers not making any changes to their wireless infrastructures by 2013.

4.5.1 Description of Alternatives

Alternative 1: AT&T Mobility and Verizon Wireless implement 4G wireless networks nationwide by 2013

LTE is one major technology that AT&T Mobility and Verizon Wireless are planning on implementing over the next several years as an upgrade to their current 3G wireless infrastructures. The wireless technology will allow for wireless carriers in the United States to offer customers with new capabilities compared to their current 3G networks. Some examples include much faster downlink and uplink data speeds, which could allow some LTE customers to depend on the wireless service as their main form of broadband internet access. The newer technology can also enhance how wireless customers communicate with one another. For example, faster data speeds can allow for wireless users to communicate with one another via video chat using their mobile device.

AT&T Mobility and Verizon Wireless are likely to implement LTE due to their significant investments in additional wireless spectrum. In early 2008, the FCC auctioned off the 700 MHz wireless spectrum in the United States. The spectrum was previously used by analog TV broadcasters, but was sold for $19.12 billion due to the transition of broadcast TV to digital format (Kaplan, Verizon and AT&T dominate airwaves auction). Verizon Wireless purchased about $9.63 billion of spectrum and AT&T Mobility spent about $6.64 billion on additional wireless spectrum at the auction (Kaplan, Verizon and AT&T dominate airwaves auction).

In 2007, Google made an agreement with the FCC to place a bid of at least $4.6 billion on wireless spectrum as long as the FCC required “open-access” for mobile devices and software applications on the “C block” of spectrum. The FCC complied, and Verizon Wireless purchased the “C block” at the auction for $4.74 billion (Kaplan, Verizon Wireless wins C block in airwave auction). If Verizon Wireless plans to use the “C block” for part of their LTE infrastructure, they will have to allow any device and application to access their wireless network, which helps support the feasibility of a transition to mobile VOIP if Verizon Wireless is unable to restrict how customers use their network.

Verizon Wireless is planning on initially implementing LTE technology across 25 to 30 markets in the United States by the end of 2010 (Maisto). Verizon Wireless also stated that they plan to have LTE technology implemented across the majority of the United States by 2013 (Verizon Wireless). AT&T is planning on launching commercial service beginning in 2011 (Fox Business).

Alternative 2: AT&T Mobility and Verizon Wireless only implement 3G enhancements

One possible alternative scenario is for both Verizon Wireless and AT&T to implement 3G enhancements as a cheaper option compared to the implementation of LTE. LTE will require carriers to purchase and implement new networking equipment and overhaul their entire wireless network. 3G enhancements such as HSPA+ and EV-DO Rev. B., however, only require carriers to make some software and hardware changes unto their previous investment. This could be a feasible option for AT&T since HSPA+ technology is already available and theoretical data speeds are fast. Verizon Wireless, however, is at a disadvantage, since EV-DO Rev. B. technology is not yet commercially deployed and the peak data rates are much slower compared to HSPA+. 3G enhancements help increase the likelihood of an adoption to mobile VOIP technology due to their lower latency rates and capability to support more bandwidth.

Alternative 3: AT&T Mobility and Verizon Wireless do not perform any network upgrades and keep existing 3G infrastructure

One other potential scenario is for AT&T and Verizon Wireless to just maintain their current 3G networks without making any upgrades. While this action could help initially save wireless carriers money, it would most likely have a negative impact on the likelihood for an adoption to mobile VOIP due to slow latency rates and significant network congestion issues.

4.5.2 Ranking of Alternatives

Alternative 1 vs. Alternative 2

Alternative 1 involves an adoption of next generation wireless technology that will be all packet based. The technology supports very fast data transfer rates and fast latency rates, which help support VOIP. The fact that a large part of Verizon Wireless' spectrum will have to be open to customers also supports the feasibility of mobile VOIP, since the wireless carrier will be unable to restrict access of their customers, even if it means a significant decrease in their revenue generated from voice services.

Alternative 2 is also supportive of mobile VOIP by allowing for faster data speeds and lower latency rates, but the scenario has some flaws. For example, the fact that LTE technology is currently available yet EVDO Rev. B is not hurts the likelihood of Verizon Wireless deploying the technology in the near future. In addition, while wireless carriers in the United States have begun to allow customers to use VOIP services over their 3G data networks, they are not yet required to abide by net neutrality laws and could decide to restrict access to VOIP services again if they cause a negative impact to the wireless carriers' revenue.

Winner: Alternative 1

Alternative 1 vs. Alternative 3

Alternative 1 involves an adoption of next generation wireless technology that will be all packet based. The technology supports very fast data transfer rates and fast latency rates, which help support VOIP. The fact that a large part of Verizon Wireless' spectrum will have to be open to customers also supports the feasibility of mobile VOIP, since the wireless carrier will be unable to restrict access of their customers, even if it means a significant decrease in their revenue generated from voice services.

Alternative 3 allows for the possibility of mobile VOIP, but the chances of it being adopted using the current infrastructure is unlikely. This is due to technical limitations with latency and network congestion issues. It is likely that 3G networks will continue to become congested if upgrades are not made due to the ever increasing demand for wireless data services. The fact that current laws allows don't require open access for consumers using data services of wireless carriers also negatively impacts the potential for an adoption to mobile VOIP.

Winner: Alternative 1

Alternative 2 vs. Alternative 3

Alternative 2 is also supportive of mobile VOIP by allowing for faster data speeds and lower latency rates, but the scenario has some flaws. For example, the fact that LTE technology is currently available yet EVDO Rev. B is not hurts the likelihood of Verizon Wireless deploying the technology in the near future. In addition, while wireless carriers in the United States have begun to allow customers to use VOIP services over their 3G data networks, they are not yet required to by net neutrality laws and could decide to restrict access to VOIP services again if they cause a negative impact to the wireless carriers' revenue.

Alternative 3 allows for the possibility of mobile VOIP, but the chances of it being adopted using the current infrastructure is unlikely. This is due to technical limitations with latency and network congestion issues. It is likely that 3G networks will continue to become

congested if upgrades are not made due to the ever increasing demand for wireless data services. The fact that current laws allows don't require open access for consumers using data services of wireless carriers also negatively impacts the potential for an adoption to mobile VOIP.

Winner: Alternative 2

4.5.3 Pairwise Ranking Results

After making all of the necessary comparisons for the pairwise ranking, the winner of each comparison was totaled. The final results found that Alternative 1 is ranked 1st with 2 counts, followed by Alternative 2 with 1 count, and lastly Alternative 3 with 0 counts. Table 4 shows the results of the pairwise ranking.

Table 4 – Pairwise Ranking Results

Alternative	1	2	3
Count	2	1	0
Rank	1st	2nd	3rd

4.6 Pre-Mortem Analysis

While the pairwise ranking concludes that Alternative 1 has the highest likelihood of occurring, it is possible that the prediction is incorrect. When conducting a pre-mortem analysis, it is assumed that the prediction or solution has failed in order to generate possible reasons to the failure (Klein).

When considering Alternative 1 there are several examples of situations which may lead to its failure. For example, it is possible that wireless carriers could undergo a substantial financial loss which could limit the amount of funding available to be invested in a new wireless infrastructure. One other possible example could include the successful implementation of LTE networks by both AT&T Mobility and Verizon Wireless, but also handset manufacturing issues with phone manufacturers such as Motorola and HTC. Both of these examples could cause a delay in the availability of an LTE wireless network to consumers, resulting in a nationwide implementation after the year 2013 as predicted in Alternative 1.

While unlikely, it is also possible that 3G network engineers could develop 3G enhancement solutions similar to HSPA+ and EV-DO Rev. B., but much more efficient, which could provide wireless capabilities that exceed that of an LTE infrastructure. In this situation, it would be unwise for wireless carriers to invest in the implementation of an entirely new wireless infrastructure whenever they could make improvements on their current infrastructure and generate the same results. In this situation it is likely that a variation of Alterative 2 would occur as opposed to Alternative 1.

4.7 Conclusion

The comparative analysis concludes that Verizon Wireless and AT&T Mobility implementing LTE networks for mobile communications in the United States by 2013 is the most impactful scenario that will most likely happen. LTE technologies also best support the potential for a nationwide shift towards mobile VOIP services due to the added capabilities of wireless networks such as faster bandwidth speeds and lower latency rates. The possibility tree helped generate a mutually exclusive and collectively exhaustive list of potential scenarios which were further analyzed with the use of pairwise ranking. The pairwise ranking results found Alternative 1 as the 1st ranked alternative.

Chapter 5: Implications

Different stakeholders across the United States would be affected if the wireless consumer market shifted towards mobile VOIP services for placing and receiving mobile phone calls. For example, consumers could be financially affected by a transition to mobile VOIP. Currently, wireless consumers in the United States subscribe to voice calling plans through wireless carriers for placing and receiving calls. The cost for these voice calling plans depends on the number of minutes a consumer wishes to use on a monthly basis for placing telephone calls. With the potential emergence of mobile VOIP that is able to place calls and receive calls from phones connected to the public switched telephone network (PSTN), mobile phone users could save on their monthly mobile phone costs by cancelling their voice plan with a wireless carrier and subscribing to a data only plan offered by Verizon Wireless or AT&T Wireless and VOIP service to the PSTN with a provider such as Skype for a much lower monthly cost.

Wireless carriers in the United States would also be affected if consumers switched to mobile VOIP providers for mobile voice calling. Carriers such as Verizon Wireless and AT&T could see their revenue from voice calling plans drop dramatically. In order to continue to stay profitable, wireless carriers in the United States may need to change their current business model. Instead of making money by having customers subscribe to wireless voice and data services, carriers may need to make a transition to being solely wireless data providers. Wireless carriers would most likely be able to higher their rates on data services in order to make up for lost revenue. Carriers could also justify higher prices for data plans due to the added necessity the plans would become, increasing their importance to consumers which would result in an increase of higher value.

Mobile VOIP services offered by Internet companies such as Skype to place and receive calls could see a dramatic increase in demand by mobile users. The increase in potential customers could result in a massive increase in profits for Skype and similar web-based companies. A shift toward mobile VOIP services could also allow for the emergence of new Internet companies willing to offer customers voice telephone service for low rates. By using the Internet as a medium for voice calling service, many VOIP companies could compete for customers which could result in even lower prices for consumers, unlike the current setup where wireless carriers such as Verizon and AT&T make up the majority of mobile voice services in the United States.

As mobile voice services possibly shift as an application on mobile devices, the presence of Smartphones in the wireless industry will most likely increase. The change of voice to an application would require phones to have substantial resources for running the data application. Smartphones allow for users to use multiple applications on their cellular phone at the same time. Smartphone manufacturers such as HTC, Apple, and Research in Motion (RIM) could see an increase in their production of Smartphones. A transition of all mobile phones to Smartphones would also result in an increase of mobile device application developers to keep up with the added demand.

If wireless carriers such as Verizon Wireless and AT&T Mobility upgrade their networks to LTE technology, the upgrade could result in further implications. For example, if LTE data transfer rates are fast enough for consumers, it is possible some users will disconnect home DSL or cable broadband service in lieu for the high speed internet they can access via their LTE mobile device. This could impact wireless carriers by placing a much higher demand for wireless telecommunication resources. A loss of revenue to current Internet Service Providers (ISPs) would also result if consumers cancelled broadband services.

Within the upcoming months of 2010, individuals will be able to tell how imminent the implementation of LTE technologies within the United States will be. For example, Verizon Wireless stated that they are planning to deploy LTE networks across some cities in the United States starting in 2010 (Maisto). The announcement of the beginning of city-wide deployment or the completion of LTE deployment in cities such as Seattle, Washington will help further support the claim of Alternative 1. The possible announcement of LTE phones by mobile phone manufacturers will also help backup Alternative 1.

If mobile VOIP is adopted as the standard technology for mobile voice communications, it will be interesting to see what will happen to the PSTN. For example, if by 2013 the majority of all cellular phone users use Skype for communication, what is the point for also paying for SkypeIn and SkypeOut services in order to place calls to and from the PSTN? Mobile VOIP could be the “straw that broke the camel’s back” which would result in an end to traditional landlines and VOIP as the new standard for voice communications.

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