Collaborative Innovation and User Experience Control-Strategies for Monetization of QoS of Data by Cellular Operators

by

Mohibi Hussain

B.Eng., Electronics/Telecommunications Engineering, University of Engineering & Technology, Lahore, Pakistan (2001)

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Author......

Engineering Systems Division
Aug 7, 2013

Certified by......

David D. Clark
Senior Research Scientist
Computer Science and Artificial Intelligence Laboratory
Thesis Supervisor

Accepted by......

Dava J. Newman
Professor of Aeronautics and Astronautics and Engineering Systems
Director, Technology and Policy Program

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Abstract

Monetization of Quality of Service (QoS) for Mobile Data is the prioritization and segregation of mobile data and charging based on the level of traffic prioritization. The monetization of QoS of data can be managed by traffic management and performance optimization policies. This traffic prioritization can be application specific as well as application agnostic, but essentially based on user choice and in compliance with Net Neutrality principles. The mobile operators' quest to evolve from their "dumb bit pipe" role to become more involved in shaping the user experience through collaborative innovation with application developers and content providers is the main driver behind this concept. Three case studies, have been evaluated in this thesis, namely 1) zero.facebook.com, where Facebook collaborates with mobile operators across the world to bundle a stripped down Facebook application version with a mobile connection, 2) collaboration between Google Voice and Sprint where Sprint is adding Over The Top Google Voice minutes to its mobile plans, and 3) NTT DoCoMo's i-mode, which served as a revolutionary concept in the mobile services, as a traditional mobile operator reshaped the consumer experience through customized service offerings and by getting involved in almost all sectors of the telecommunication value chain. The common parameters identified in these case studies, combined with the findings of interviews with over fifty stakeholders across the telecommunications value chain, have been brought together in the aggregated model presented in this thesis; "collaborative innovation" and "user experience control" are identified as two significant factors driving the rationale behind monetization of QoS of mobile data. The regulatory concerns, technological aspects, and future scope of this concept are also discussed in this thesis.

Thesis Supervisor: David. D. Clark
Title: Senior Research Scientist
Communications Future Program

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"Knowledge enlivens the soul"

—Ali Ibn Abu Talib (A.S)

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Since childhood, I was blessed with the unconditional love and guidance of my maternal grand parents, Saeeda Altaf and Syed Altaf Ali Shah. I am grateful for having a father who inspired me to become an engineer, my mother who has been the unwavering pillar of support, my four siblings Zahra, Zaki, Abid and Namvar who keep on making me proud with their achievements, and my two sons, Murtaza and Moataber, who make my life worth living every day.

I would like to extend my special gratitude to friends and family who helped me during the challenging time at MIT, while I was juggling my research and studies with taking care of my sons. I would specially like to thank my mother Misbah Hussain, my father S-T- Hussain, my uncle Wasim, my brother Abid, my sister Zahra, and friends like Shlomiya Bar yam, Dr. Chintan Vaishnav, Susan Perez, Sana Mujahid, Asif Khan, Sabah Chaudry, Asif Qayyum, Imran Sayeed and Fraz Tajamul for their unconditional support through my journey at MIT.

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Chapter 1

Introduction

"To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science."

— Albert Einstein

As Albert Einstein rightfully stated about the "real advance in science", I believe that the same notion applies to the strategy of business (which may be termed as the science of business management) and to the conception of new technology leading to or following the business strategy.

While working for and helping major mobile operators strategize their future for over a decade, I repeatedly encountered the same critical question; how can mobile operators maximize their profits by experimenting with innovative value-added services in order to maintain sustainable growth? Upon my arrival at MIT, I started evaluating the telecommunications value chain and started interviewing stakeholders from the telecommunications industry; the same question kept surfacing in almost every discussion.

The marvels of telecommunications industry are not just limited to the fascinating technological advancements but are also shaping the human social fabric, politics, business, and the national and global development. The telecommunications industry has been the most dynamic and volatile during the last three decades. Evolution of mobile technology has transformed the pattern of human communication across the world. The access of Internet through mobile phones has raised the usage and reach of Internet to a colossal scale.

The wireless ecosystem is more complex than the wired Internet. All of the key players in the ecosystem such as service providers or bit-pipe providers, end-user device manufacturers, back end equipment providers, content providers and application developers, as well as the end users are all interdependent. This diverse ecosystem encourages new technological and business joint ventures; collaborative innovations to enable new service offerings resulting in platform enrichment, and in turn more value to the consumers. This complexity presents new challenges, effects, and remunerations. It also demands revision of business models, identification of collaborative innovation opportunities, and strategic evolution of the value chain players.

This thesis has been conceived and presented in layers. The background layer is the analysis and study of the existing and evolving value chain of the telecommunications industry which includes device manufacturers, content providers, content aggregators, fixed line and wireless communication providers as well as the Internet layer. In the foundation layer, the thesis uses three case studies to extract lessons into collaborative innovation and user experience control. The analysis of the profitability of service providers, driven by collaborative and firm innovation and affected by perception of value by the user and perception of intrusiveness is deciphered by an aggregated model in order to look closely into the effects of these drivers on any specific collaborative innovation in general and the monetization of QoS of data by cellular operators in particular. The second layer is the analysis of a very narrowly focused idea; monetization of Quality of Service (QoS) of mobile Internet by cellular operators, and explores the regulatory barriers and technological realities and forecasts associated with this idea.

It is essential to note that the inferences from this thesis are takeaways for any player in the value chain of the telecommunications industry. The monetization of QoS of data by cellular operators is described in particular as one of the possible applications of these lessons.

This thesis explores the following four salient aspects associated with the monetization of QoS:

1) The Value Chain Evolution via collaborative Innovation & co-opetition

2) User Experience Control

3) The Regulatory Barriers

4) The Technology

1.1 Research Methodology

1.1.1 Interviews

Around 50 formal and informal interviews were conducted with various players and stakeholders across the telecommunications value chain from US & Europe, The interviewees included Chief Operating Officers, Strategy Heads, managers, research lab personnel, operational engineers and application developers from service providers, wireless and wireline telecom operators, content developers, infrastructure providers and device manufacturers. The questions were aimed to gauge the direction and trends of the telecommunications industry in general and the experimentation and innovation in the technology and services areas of the mobile operators in particular. Detailed questionnaires used in the interviews can be found in the Appendix section of the thesis.

1.1.2 Case Studies

Three case studies were used to analyze the common parameters and in particular, the "User Experience Control" and "Collaborative Innovation" as common themes.

Though individually unique and mutually disparate, the following three case studies forming the premise of this research work have been chosen in an attempt to represent the entire spectrum of the diverse issues pertinent to the question and rationale behind monetization of Quality of Service by cellular operators based on the ideas of "User Experience Control" and "Collaborative Innovation".

i. Zero.facebook.com

ii. NTT DoCoMo's i-mode

iii. Sprint-Google Voice partnership

1.1.3 Modeling

This thesis employs System Dynamics Modeling, both for individual cases as well as the aggregated model. The causal loop diagrams that have been simplified and trimmed to capture significant aspects of the three individual cases studies are presented in Chapters 2,3 and 4. The aggregated model as presented in Chapter 5 has been used to test the conclusions and endorse / dismiss the intuitions governed by the common parameters extracted from the three case studies, and to make inferences and identify policy levers.

1.2 Thesis Organization

This thesis has been organized in nine chapters. The first chapter is oriented around the introduction of the question being raised and address by this thesis. Three case studies are evaluated in this thesis in Chapters 2, 3 and 4. The second chapter is focused on the Zero.facebook.com case study and presents the causal loop diagram based on the case study. The third chapter discusses the Google Voice-Sprint case study and the causal loop diagram, which identifies the parameters salient to the case study for further utilization in the aggregated model. The fourth chapter analyzes the NTT DoCoMo i-mode case study and its represented causal loop diagram. The fifth chapter presents the aggregated model combining the overlapping and unique parameters identified in the three cases studies in prior chapters. This chapter also describes the parameters of "Collaborative Innovation" and "User Experience Control" further. The sixth chapter connects the premises of collaborative innovation and user experience control to justify the rationale behind monetization of the Quality of Service by cellular / mobile operators. The sixth chapter also briefly touches upon the difference between the concepts of Quality of Service as discussed in this thesis, and the Quality of Experience, which is further utilized in the last chapter. The seventh chapter is based on the regulatory debates around the monetization of QoS of Internet in general and mobile data in particular. The eighth chapter outlines the technological aspects of the monetization of QoS of mobile data with some focus on Long Term Evolution (LTE) of mobile technology. The final chapter sums up some of the inferences from the work presented and points towards the possible future extensions from this research. First of the two Appendices in the end contains the questionnaire utilized for the research mechanism while addressing the question presented by this thesis. The second Appendix shows causal tree connections drawn from the aggregated systems dynamics model presented in the fifth chapter.

Chapter 2

Zero.facebook.com

"Facebook is bringing the world together."

— David Kirkpatrick, 2010.

Hannu Verkasalo, SVP of the Arbitron Mobile Trends app, stated in Feb 2012 that "the growth of Facebook cannot only be explained by organic growth, but by the various partnerships and deals Facebook has with carriers and device manufacturers, which guarantees them with top position in Android and iPhone devices".

The zero.facebook.com initiative is Facebook's attempt at trying to replicate the *initial viral effect success story* of Facebook.

2.1 Social Viral Effect Success Story

The original reason for Facebook's quick success at Harvard was that it provided the students a platform to interact and connect, filling the void of being away from their families and surrounded by new people at school from diverse backgrounds. The unique attributes of this revolutionary social networking website were that one could see a stranger's name and picture, personal information such as the courses they were taking, their place of origin and above all, about their interests without getting into the social requirements of physically being present in a night club, bar, speed dating or school dating forum, or an activity club. A substantial amount of information could be acquired about a potential friend in a fast, hassle-free and convenient way through the Internet. (Kirkpatrick, 2010)

Facebook's inception at Harvard provided it the prestige associated with the historic institution. Harvard connection proved to be instrumental in gaining the attention of students at other prestigious institutions, some of which were already making use of indigenous online social networking tools, although not quite at par with Facebook. College students were now demanding Facebook, and it became a hit at other prestigious colleges too. The phenomenon started spreading to other colleges as well and demand for Facebook continued to grow. Mark Zuckerburg, founder of Facebook, was now faced with the question of allowing Facebook access to students outside the Ivy League institutions; the first critical issue faced by the novice enterprise as its association with elite colleges served as a brand recognition tool. Going against the concern of its associates regarding the potential devaluation of the Facebook brand, Zuckerberg decided to open Facebook to all college students, and subsequently to high school students. His approach worked as Facebook took off. (Kirkpatrick, 2010)

Soon after, Facebook management faced the decision of ending the exclusivity of the social network by providing access to everyone; a decision that could make or break the new enterprise due to issues of brand dilution, server space and soaring costs associated with the expansion. Existing advertising revenue was not sufficient enough to cover the substantial costs of expanding the network, so Facebook allowed access to anyone over thirteen years of age who wanted to join the hip social network. Soon after, anyone was allowed to write programs that would run on Facebook. There was no fee or permission required to write and run these applications on Facebook. Thousands of applications thus developed kept pace with the expanding network. This decision and value-addition added an extra dimension to ways in which a Facebook profile could be utilized, thus providing another vast and inexpensive gateway to business users as well, who could now use the online social networking world to advertise and expand their businesses. This flexibility and the variety of ways in which a Facebook profile could be optimized were not just limited to business users. (Kincaid, 2011)

2.2 Zero.facebook.com and Mobile Operators

Undoubtedly, Facebook is keeping its firm grasp in the developed Internet markets such as US and Europe. However, Facebook's collaborative strategy is far-sighted and equally impactful in emerging Internet markets where it collaborates with mobile operators in a quest to identify and associate a new mobile internet user's first encounter with the world of mobile data connectivity exclusively with his / her first Facebook experience.

The case study of zero.facebook.com is an example of application-specific mobile Internet traffic discrimination, and a subtle way of traffic prioritization. It represents a scenario in which Facebook, which is an Over the Top (OTT) application provider, is collaborating with existing and emerging mobile operators and facilitating them to expand their subscriber base. Primarily, this is an initiative taken by Facebook as an idea sold to mobile operators. The idea stems out of Facebook's intention to become the symbol of Internet for the new social networking application users as they join the mobile Internet experience.

Two of the significant challenges associated with the mobile Internet usage are slow data transfers and costly & complex data plans. These factors can deter the users from using the mobile Internet frequently and seamlessly. Facebook designed zero.facebook.com to help solve these two barriers with the hope that even more people will discover the mobile Internet lured by Facebook's brand appeal, recognition, and the need of association with it. With its already established worldwide popularity, Facebook desires to penetrate emerging digital markets such as Africa, and wants people to associate Facebook as the first and possibly the only application intertwined with the experience of accessing Internet from their basic mobile phones using low cost monthly plans. Zero.facebook.com is the stripped down version of the social networking application. It is WAP based, hence lightweight and doesn't consume a large amount of data bandwidth. The access to zero.facebook.com is free i.e. it does not get charged against the mobile Internet data traffic quota. The incentive for Facebook is that the user will bond with Facebook in a unique way, as they use this application and identify the Internet experience through Facebook. The incentive for the mobile operator is to get new subscriptions and introduce the mobile data services to these new users or the existing customers. In exchange, the mobile operator will charge for provision of data connectivity required for accessing and uploading pictures, and non-Facebook Internet access requirements once the user gets accustomed to the Internet accessibility through mobile.

The zero.facebook.com site is only available on the networks of 50 operators that Facebook has partnered with. People can still access Facebook from the standard mobile site m.facebook.com or Facebook mobile site for touch screen mobile devices, touch.facebook.com, under their operator's standard data charges.

Some of the operators offering ZERO.facebook.com are:

- Telstra in Australia
- Movistar in El Salvador
- SFR in France
- XL in Indonesia
- DiGi in Malaysia
- Telecom NZ in New Zealand
- SMART in the Philippines
- Vodafone in Qatar
- Digicel in Suriname
- Trinidad and Tobago
- 3 in the UK
- MTN in Cameroon and Guinea Conakry.

2.3 Causal Loop Diagram for zero.facebook.com

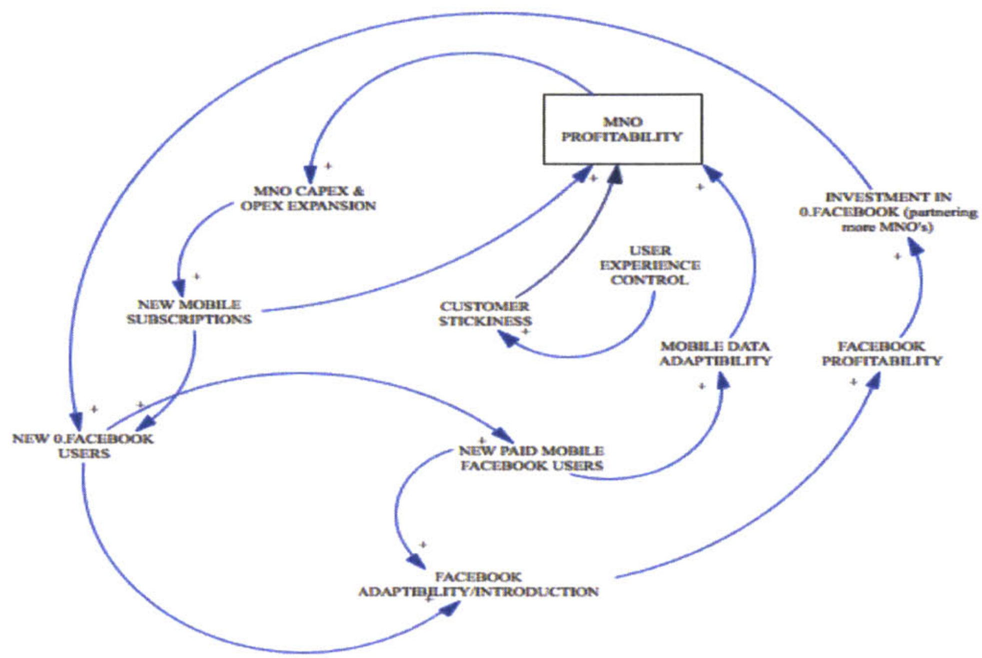


Figure 2-1: Causal loop diagram for Zero.facebook.com

This causal loop diagram primarily depicts and captures the reinforcing loops, which are benefitting both the Mobile Network Operator (MNO) and Facebook.

The arrows represent the causal relationship between two variables. The arrowhead points towards the variable affected by the cause, which is attached to the origin of the arrow. The +ve sign shows that there is a positive correlation or a reinforcing correlation between the two variables. For example, there is a positive arrow connecting the *new mobile subscriptions* to the *MNO profitability* (Mobile Network Profitability). This positive correlation implies that when the *new mobile subscriptions* increase, the *MNO profitability* increases. The reason *MNO profitability* is shown in a rectangular box is that it is considered as a stock/reservoir variable here. In terms of Systems Dynamics, when a variable is considered as a stock, there are inflows increasing its value and outflows decreasing its value. There are two primary loops in this diagram; the exterior loop representing the Facebook profitability and the interior loop representing the Mobile network operator's profitability. Facebook's profitability is dependent upon the Facebook users connected to Facebook, whereas, MNO's profitability is dependent on the number of subscribers as well as the subscribers who are paying for the content accessed through mobile data connectivity. Hence the common profit driving variable for both Facebook and MNO profitability is *New Paid Facebook Mobile Users.* This means that as the number of *New Paid Facebook Mobile Users* increases, both the Facebook and MNO profitability increases.

Here the collaborative innovation takes an interesting twist as the investment in Zero.facebook.com can be considered as two incumbents (Facebook and MNO) creating a new concept, fathering a new entrant where new mobile subscribers, *user experience control* and *customer stickiness* (further elaborated in Chapter 5) are the significant links of this causal loop diagram.

2.4 Lessons Learned from Zero.Facebook.com

2.4.1 Value for user

Collaborating with operators from around the world, Facebook developed this new mobile site with two main attributes:

2.4.1.a Application Alacrity

Zero.facebook.com includes all the key features of our standard mobile site m.facebook.com. Users can update their status, view their News Feed, like or comment on posts, send and reply to messages, or write on their friends' Wall just as they do on Facebook.com. Zero.facebook is WAP based hence lightweight and efficient. Rather than making photos viewable on zero.facebook.com, the photos are put one click away so they don't slow down the experience. Users can still view any photos on Facebook if they want but their regular mobile data fees will apply.

2.4.1.b Zero Cost

Facebook has collaborated with mobile operators to ensure that people can access 0.facebook.com without any data charges. Using zero.facebook.com is completely free. People will only pay for data charges when they view photos or when they leave zero.facebook.com to browse other mobile sites. When they click to view a photo or browse another mobile site a notification page will appear to confirm that they will be charged if they want to leave zero.facebook.com The specific terms of business agreement remain undisclosed. However it is speculated that Facebook is discreetly paying some of the mobile operators to offer zero.facebook.com with new subscriptions. Facebook management has not responded to such speculations.

2.4.2 Value Chain Evolution- Content Delivery Networks

Zero.facebook.com has presented a novel example of content delivery through mobile data. Facebook customized the application for low mobile network requirements and this can be a trendsetting example for value chain evolution where the content providers use the mobile data connectivity in untraditional ways.

The industry concedes that there is real money in mobile, but this means that bad performance is a more painful problem that hits revenue numbers and corporate profitability. At the same time, the evolution of mobile behaviors and use cases (for users, publishers, and advertisers) underscores the need for new ways to overcome weakness in wireless data network delivery to ensure that content arrival on handsets can hold users and maintain high engagement rates. Fortunately, some Content Delivery Network (CDNs) are starting to think about these business problems and have started offering mobile content acceleration platforms, laying the groundwork for a parallel CDN technology solely focused on mobile that integrates nicely within existing CDN offerings. Zero.facebook.com is an example where the user can switch from the zero.facebook.com to the m.facebook.com seamlessly with a content delivery mechanism that presents integration between the free and paid-for Internet content. Facebook managed to do this based on the historical success of the viral social effects, but for other content providers and newcomers, a lot of work is still ahead and many CDNs do not yet have a true mobile content offering in the market, let alone a mobile acceleration one. (Rayburn, 2012)

Zero.Facebook.com is one of the forerunners in this trend and is benefitting short-term as well as long-term with this strategic investment. CDN vendors that don't start addressing these developments in the market and start offering mobile delivery platforms are going to have a very hard time diversifying their business and growing their revenue over time. This is the next avenue of the content delivery business and it is developing in real-time right now. (Rayburn, 2012)

2.4.3 User Experience Control

"The Pied Piper of Hamelin led one hundred children into a cave from which they never emerged. Some 500 million people, of whom about 10 percent are thirteen to eighteen years old and another 25 percent are eighteen to twenty-five years old, are now marching to the digital pipes of Mark Zuckerberg, who is twenty-six years old. I have no idea where they are marching, and whether they will ever return."

Richard A. Posner, 2010

The number of Facebook users is astronomical. According to Facebook, 1.11 billion people are using the site each month, up from the 1.06 billion reported three months earlier, thus representing a 23 percent growth from the previous year. Facebook reports the number of monthly active users to be 665 million, up 26 percent from the previous year. Each month, 751 million people access Facebook from a mobile device, an increase of 54 percent compared to the previous year, and an increase of 10 percent from the last quarter of 2012. (Tam, 2013)

As can be inferred from the above numbers, social media, led by Facebook, has drastically affected the way we communicate. Social media sites have taken the communications technology frontier to the next level. Our personal and professional lives have been reshaped and are being transported to another new dimension inside our brains where the memory is being fundamentally altered (Nicholas Carr, 2010). In their study, Sparrow, Liu, and Wegner (2011) observed that "we are becoming symbiotic with our computer tools, growing into interconnected systems that remember less by knowing information than by knowing where the information can be found". They deem being connected to Google as essential, so that we can "know what Google knows" rather than relying on a conventional memory that is quickly dissolving.

Facebook has influenced life in the modern era in ways and levels previously unknown and unmatched. David Kirkpatrick (2010) in *The Facebook Effect,* labels Facebook "a technological powerhouse with unprecedented influence across modern life, both public and private" (p. 15). Kirkpatrick notes that in conjunction with other social media vehicles spawned in its aftermath, e.g. Twitter, Bebo, and Mixi, Facebook offers individual liberation as well as a "safety in numbers" aspect that can potentially affect social change in a variety of ways, ranging from organizing political movements and protests a la Columbia (Kirkpatrick, 2010), to connecting the separated family members and loved ones in a variety of ways; one such example being the aftermath of the Japanese earthquake and tsunami (Blackburn, 2011). **Zero.facebook.com** is spearheading the same idea of **shaping the user experience** in emerging mobile markets by associating the zero.facebook.com as the first image of Internet for a mobile user. It is interesting to note that this would not have been possible without **collaborative innovation** with the mobile operators.

Chapter 3

Google-Voice and Sprint

"*Once we rid ourselves of traditional thinking we can get on with creating the future.*"

— James Bertrand

This case study serves as an example of *collaborative innovation* and *value chain evolution* where an Over the Top application is embraced and sold by the Mobile Network operator to create a win-win situation while generating added value to attract more customers.

While Skype is one of the oldest voice chat apps, having started in 2003 and about 18 million people online at any moment in time, (Drager, 2011), Google Voice has taken up the innovative route and encroached on U.S. mobile operators' turf, even offering to port a user's carrier assigned mobile number for a $20[i] fee for use with Google Voice's service. But for one carrier, i.e. Sprint, the potential friction turned into a partnership. On March 20th 2011, Sprint and Google announced deep integration with Google Voice that allows subscribers to use their Sprint phone number as a Google Voice number to access the service's features. Features offered included transcribed visual voice mail (manage voice messages similar to e-mails), call forwarding (calls ring through on subscribers' cell phone, home phone, office phone, Gmail inbox and so on), custom voice mail greetings, and competitive international calling rates, among other additional offerings.

Vincent Paquet, senior product manager for Google Voice, described this initiative in his words as, "We always felt that the ultimate simplicity would be to just use Google Voice with your mobile phone".

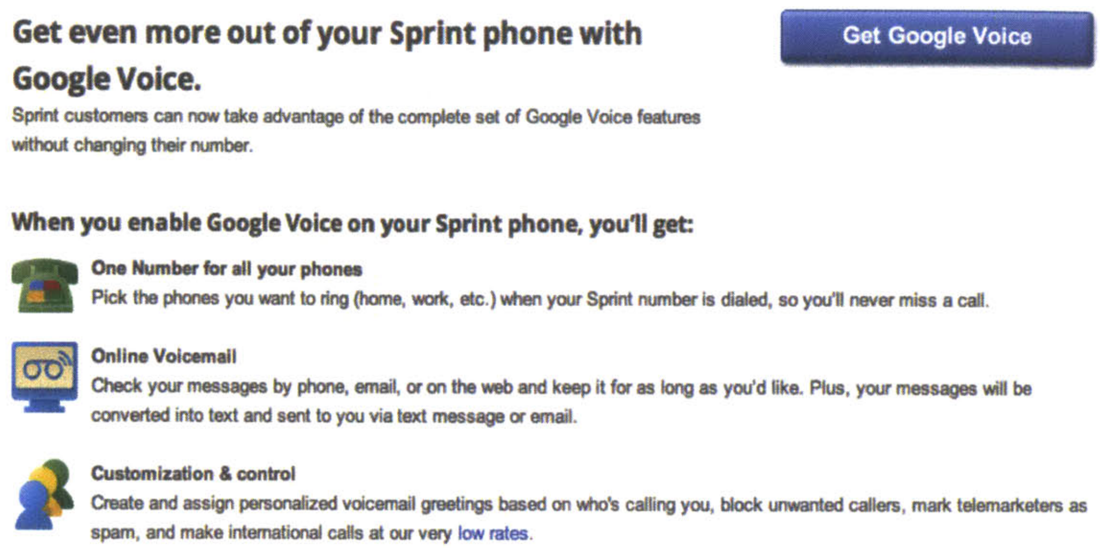


Figure 3-1: Google-Voice & Sprint advert on Google.com & Sprint.com

Anyone could sign up for the free Google Voice service before, but Sprint-Google voice agreement brought forth a few notable exclusive benefits. First, Sprint simplified getting on board with Google Voice. Previously, Google Voice users on any carrier needed to walk through a number of steps to either get a new Google Voice number, port their existing mobile number, or let Google handle just the voice mail. The results could be confusing and cumbersome, with friends often collecting multiple phone numbers for a contact, depending on several factors, including if the Google Voice user had a feature phone, or used a Google Voice mobile app or Web-optimized site from a smartphone. As a second benefit, all Google Voice calls originate from the same single number; the one first issued by Sprint. Third, if you enable Google Voice, the service replaced Sprint's voice mailbox on your phone, so dialing "1" from the handset dialed up your Google Voice message inbox. No additional setup on the Internet VoIP application would be required. Fourth, Sprint smartphones get most Google Voice features without requiring a mobile app. Mobile texting is one exception to this last point, however, Sprint's rates and plans still apply for messages sent from the phone's default texting program. Google Voice texts remain free to the United States and Canada if sent from the Web or from a Google Voice smartphone application.

Prepaid phones and Mobile Virtual Network Operators (MVNOs) that ride on Sprint's network, like Boost Mobile and Virgin Mobile, are ineligible for the Sprint/Google Voice combined package.

Similar to Zero.facebook.com, the terms of business agreement between Google Voice and Sprint remain undisclosed. The possibility of Google Voice partnering with other mobile operators is not ruled out especially in light of the integration and hand-over issues between Sprint and Google Voice. One prominent integration issue was that during international roaming the consumers get charged for Sprint cellular voice minutes instead of being charged the cheaper Over the Top Google Voice minutes.

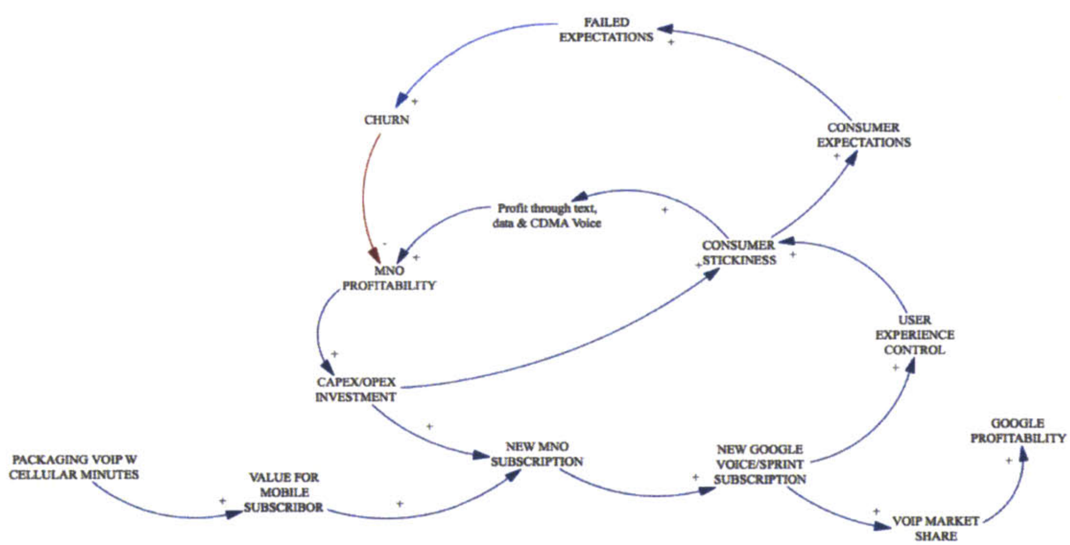


Figure 3-2: Causal loop diagram for Google-Voice and Sprint

The arrows represent the causal relationship between two variables. The arrowhead points towards the variable affected by the cause, which is attached to the origin of the arrow. The –ve polarity arrow shown with red color in the Figure 3-2 above originating from *Churn* and leading to *MNO profitability* shows the simple negative causal relationship between these two variable; as churn increases the MNO profitability decreases. *Packaging VoIP with Cellular Minutes* increases the *Value for Mobile Subscriber*, which in turn increases the *New MNO Subscription.* As the *Consumer Stickiness* increased in this case, so did the *Consumer Expectations* from the service offering. The integration failure issues gave rise to *Failed Expectations,* which increased the *Churn.*

3.1 Lessons learned from Google-Voice and Sprint case study

3.1.1 Co-opetition

This case study is an effective example of co-opetition (collaboration combined with competition, or cooperation between competitors) between a mobile service provider and an Over the Top Voice over IP (VoIP) service provider; Sprint joined hands with an apparent competitor and jumped ahead of other operators in opening a new co-opetition avenue with a traditional value chain rival Google Voice. The ease of integration and price effectiveness provided value for user and increased subscriptions for both Google-Voice and Sprint. Hence, the first lesson to be extracted out of this case study is that competitors using different technological makeups can actually act as *complimenters.* This same phenomenon is now being observed in other parts of the telecommunications value chain. With the advent of Long Term Evolution (LTE) technology for cellular operators and the question of monetization of Quality of Service of data, an integration between mobile broadband and Wi-Fi hotspot broadband networks, at interface as well as traffic management policy framework level, for offloading and seamless QoS parameter handover is highly likely in the near future.

3.1.2 Integration Failures

Integration failures represented by this case study are a good example of possible negative repercussions of collaborative ventures. Failures of technical interface integration between Google-Voice and Sprint for the international roaming mobile users, and lack of integration in the texting/SMS (Short Messaging Service) arena, proved to be the primary reasons for failed user expectations. The collaborative failure rate was enhanced which reduced the value for user and in turn reduced customer stickiness. It is also imperative to note that this setback did not affect Google-Voice revenue much because being the Over the Top platform, the users over the internet and non-Sprint subscribers could still use Google-Voice and map the Google-Voice number to other mobile carriers. Another significant factor is that Google itself has other dimensions to sustain itself and Google-Voice is still experimenting and also willing to share similar collaborations with other mobile operators. Sprint, however had a setback since they were already losing revenue on regular mobile subscriptions and voice minutes. The mobile operators are expected to provide seamless support over their network and the value added services or features that they introduce should be covered end to end to cater for special customer needs with the traditional operator services such as international roaming. This observation is endorsed by the aggregated model, presented in chapter 5 and supported by the results depicted in Figure 5-1 & Figure 5-2 (page 43- 44 of this thesis).

3.2.3 Negative Feedback from User Experience Control

The Google Voice- Sprint venture's most prominent selling point was its price sensitivity. The international roaming integration failures caused the consumers to pay more because they were forced to use the Sprint mobile minutes instead of low-priced Google-Voice minutes while travelling overseas. This reduced the *value for user* and magnified the sense of entrapment that is incorporated in the *perception of intrusiveness* parameter in the final aggregated model presented in Chapter 5. While a platform offers benefits of exclusivity, it can also backfire, if the users are unable to enjoy the benefits of other free services available in the market. A similar setback was witnessed in the case study of NTT DoCoMo i-mode, discussed in the next chapter.

Chapter 4

NTT DoCoMo i-mode

"Learning faster than your competitors is the only sustainable competitive advantage in an environment of rapid change and innovation."

— Arie de Geus, 1998.

In this case study, the years under focus are between 1999 and 2007, which were the peak years of NTT DoCoMo i-mode's success and subsequent setbacks. In 1999, the Japanese population numbered 126 million. Of this 126 million, only 12.2 percent of the population had Internet access, compared with 39 percent of the US population, 21 percent of the British population, and 23 percent of the Korean population. In a study conducted by AOL and Roper ASW, 69 percent of Japan's online population said the Internet was essential to everyday life, but 29 percent said that dial-up telephony costs were the biggest obstacle to Internet access (Mullins, 2007).

Despite the relatively low prevalence and popularity of Internet usage, the mobile handset usage and popularity was far ahead in Japan as compared to other industrially developed countries. At the end of 1999, 44.5 percent of the Japanese population had mobile phones, compared with 40 percent in the UK, and 31 percent in the USA. Dial-up telephone access was expensive in Japan and consumers were obsessed with media and information access; information ranging from daily stock exchange rates to weather updates to latest comic publications. These facts presented Japanese market as an ideal stage to sell a reasonably priced mobile data service targeted towards specified segments of users with the content and information of their choice, available on their mobile handsets 24/7 (Mullins, 2007).

i-mode is a mobile Internet service that caused a revolution in both business and private lifestyles in Japan. Despite the uniqueness of Japanese regulatory controls and the monopolistic situation NTT DoCoMo enjoyed, they improvised as an operator to jump ahead in the value chain by providing content availability and Internet experience to customers in a unique fashion.

By 1990, the Japanese mobile market had enjoyed meteoritic growth at a pace unmatched by any other country in the world. In the latter half of 1990, the Japanese mobile market was on the verge of reaching maturity, even though not complete saturation, when NTT DoCoMo developed a novel service in the form of an innovative mobile Internet platform with the aim of promoting a further evolution in mobile communications. The i-mode service was launched in 1999 attracting overwhelming support from mobile phone users. i-mode not only created new profitability in the mature mobile phone market, but also redefined mobile communications for the new age by providing users with an incomparable service.

i-mode by NTT DoCoMo Japan is a walled garden mobile Internet interface in contrast to the traditional Internet access via mobile handset. NTT DoCoMo's i-mode proved to be a revolutionary service in Japan. i-mode offered its users a wide variety of services, including web access, e-mail and the packet-switched network that delivers the data. i-mode users have access to various services such as e-mail, sports results, weather forecast, games, financial services and ticket booking through a customized interface called **i-Menu**. Content is provided by specialized services, typically from the mobile carrier, which allows them to have tighter control over billing.

Similar to zero.facebook.com that uses WAP, i-mode delivers only those services that are specifically converted for the service, or are converted through gateways. This has placed both systems at a disadvantage against handsets that use "real" browser software, which used a flat pricing structure for data. Even i-mode's creator, Takeshi Natsuno, has stated, "I believe the iPhone (a phone that uses the traditional TCP/IP model) is closer to the mobile phone of the future, compared with the latest Japanese mobile phones."

During the i-mode case study years under consideration in this thesis (1999 to 2007) i-mode had been extraordinarily successful in Japan. This was because of its outstanding convenience and its unique business model. Its reliance on this system offers an innovative approach to the mobile service value chain and to wireless service / Internet relationships.

Ingenuity is exemplified in the i-mode business model. It synchronizes all value chain aspects, ensuring that content, quality, wireless technology collectively driving the user experience control. The billing system is streamlined by bill consolidation, with DoCoMo also collecting information access fees on behalf of i-Menu-listed content providers.

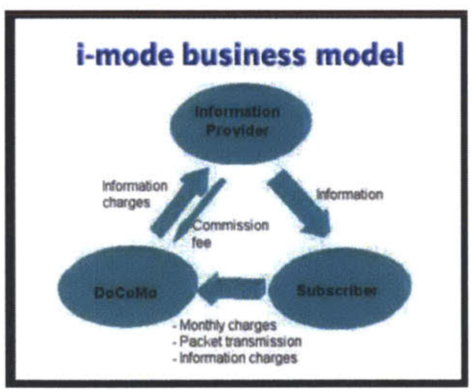


Figure 4-1: i-mode business model, Source: NTT DoCoMo website

i-mode collaborated closely with equipment manufacturers, content providers, and other platforms to ensure that wireless technology, content quality, and user experience evolve jointly. This synchronization guarantees that customers, partners and shareholders share interests with end-users, thus enabling all parties to maximize value and to continue to improve the quality of products and services connected with i-mode. i-mode's adoption of HTML subset made the creation of sites simple in addition to offering compatibility of many other standards, including GIF, Java, MIDI, Macromedia Flash, and HTTP. i-mode upholds the available quality content through the i-Menu. Fig 4-2 shows evolution of these mobile web standards. All content is continually updated, enhanced and designed to support clarity and application. i-mode used the provision of high-quality content is used as a means of attracting customers.

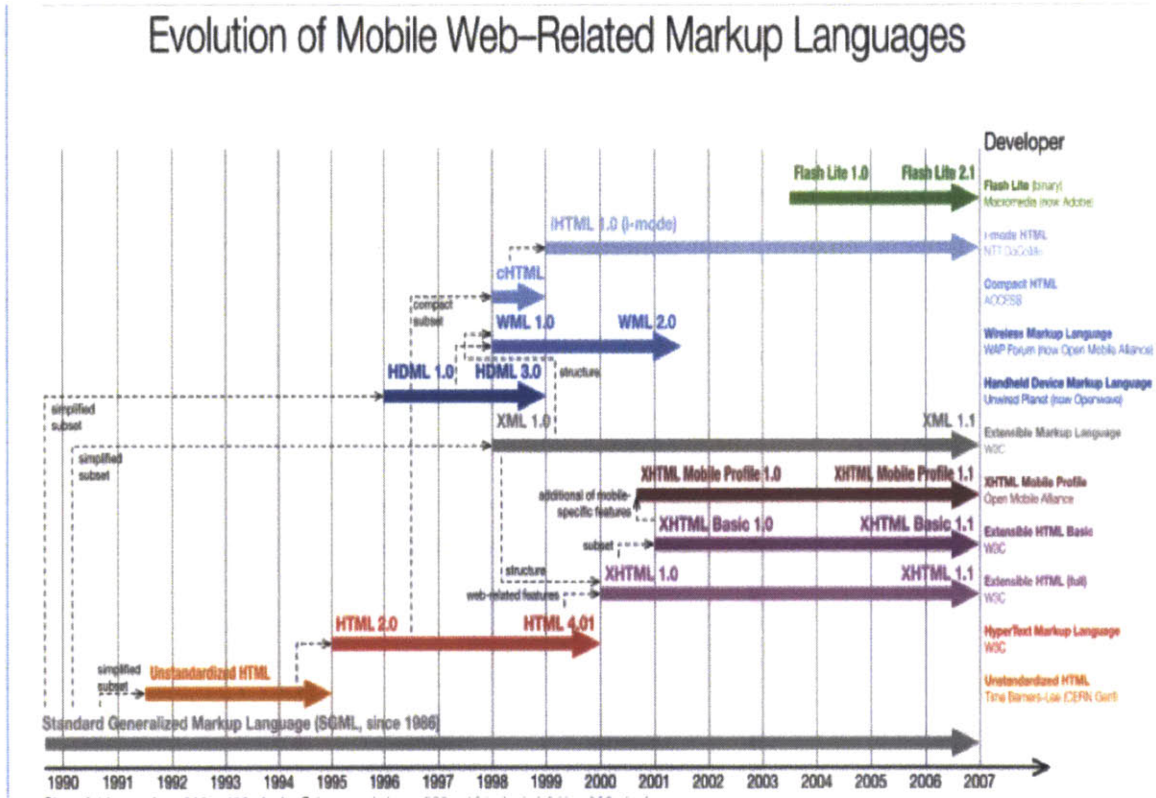


Figure 4-2: Evolution of mobile web standards -M. Stuckwisch(2007)

In contrast with the Wireless Application Protocol (WAP) standard used for zero.facebook.com, which used Wireless Markup Language (WML) on top of a protocol stack for wireless handheld devices, i-mode utilizes fixed Internet data formats such as C-HTML based on HTML, as well as DoCoMo proprietary protocols ALP (HTTP) and TLP (TCP, UDP).

i-mode phones had a special i-mode button for the user to access the start menu. There were more than 12,000 official sites and around 100,000 or more unofficial i-mode sites, which were not linked to DoCoMo's i-mode portal page and DoCoMo's billing services. NTT DoCoMo supervised the content and operations of all official i-mode sites, most of which were commercial. These official sites were accessed through DoCoMo's i-mode menu but in many cases official sites can also be accessed from mobile phones by typing the URL or through the use of QR code (a barcode).

NTT DoCoMo authorized all i-Menu content, while quality was maintained by setting high operability standards and offering quality services. Other content providers complement these services via their own sites as demand dictates. The i-mode service was thus energized by attracting more subscribers, enabling added high-quality content.

The operator NTT DoCoMo controlled the user pricing and billing by collecting monthly information charges for the i-Menu listed content providers via a consolidated bill for all mobile phone activities, thus eliminating the need for provider billing. This arrangement reduced expenses for the content partners and encourages them to generate high-quality offerings to attract new subscribers, thereby boosting their profits. Additionally, NTT DoCoMo was able to generate incremental revenue by charging a small commission for the clearinghouse billing system service. Peak profit years were between 1999 to 2006; with over 22 million subscribers within the first 2 years. The service currently boasts of more than 95,000 Internet sites providing a variety of content. By the middle of 2001, within a short span of two years, Japan's wireless phone service i-mode had signed up nearly 20 per cent of the total Japanese population, or 25 percent of the population between the ages of 15 and 64, and became the mostly widely used mobile Internet service in the world.

4.1 NTT-DoCoMo i-mode Causal Loop Diagram

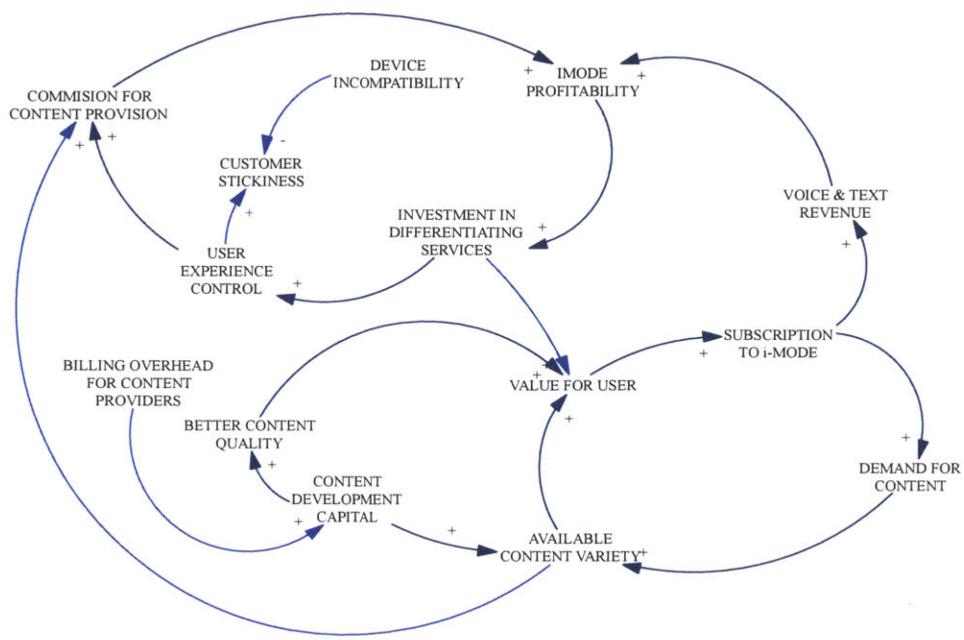


Figure 4-3: NTT DoCoMo i-mode causal loop diagram

The *Device Incompatibility* has a negative relationship with *Customer Stickiness*, whereas the *User Experience Control* is positively correlated with *Customer Stickiness. Available Content Variety* and *Better Content Quality* drive an increase in the *Value for User* which in turn increases the *Subscription to i-mode.* In this diagram the i-*mode profitability* is represented as a variable whereas the content provider is gaining the benefit of collaboration through the increase in *Content Development Capital.*

4.2 Lessons Learned from i-mode

4.2.1 Shaping User Experience Control

NTT DoCoMo's i-mode presents an ideal example of how an organization can control and shape the user experience. This case study presents a vivid and thorough example of controlling and shaping user experience by using technology and collaborative innovation. A noteworthy fact of this case study is that in addition to enjoying the traditional role of a mobile operator whose association with the end user is based on the billing relationship, NTT DoCoMo further enhanced this privilege into a consumer shaping experience mechanism by collaborating with different players in the value chain, specially the device manufacturers and the content developers. The range of this integration gave NTT DoCoMo a unique advantage and unrivaled control over shaping the user experience after determining the user's needs.

One of the primary reasons of DoCoMo's new service being an instant hit was because of its designers' intimate familiarity with the Japanese market on a segment-by-segment basis. The existing customer base and profiling advantage that NTT DoCoMo enjoyed in the Japanese market helped it in identifying the potential customers for targeted services based on the content and information salient to the respective segment of the market. DoCoMo segmented its markets behaviorally and designed offerings of different downloadable information for each segment: those interested in financial markets, comic strips, cartoons and so on.

4.2.2 Value for User

Characterized by the traditional slow transmission speed of the mobile Internet access in the late '90s, i-mode's successful strategy included creating more value for the user by charging the user not based on the time spent on the Internet (unlike the traditional wireline Internet Service Providers (ISPs). Users were charged based on the amount of information downloaded and not the connection time. Emails cost 1 yen per 20 Japanese characters (40 roman letters). Downloading still images cost 7 yen, checking share prices cost 26 yen, and transferring funds from bank accounts cost 60 yen. While some of i-mode's content providers charged a flat monthly fee, others were free of charge. In 1999, i-mode charged a basic monthly fee of 300 yen ($3.5) and a packet fee (based on the volume of data sent or received) of 0.3 yen per 128 bytes of information. i-mode also priced the mobile phone handsets reasonably in comparison to other mobile phones available in the market.

An i-mode user paid for both sent and received data. Unsolicited emails could be avoided through the email service hence making the cost fair. The basic monthly charge was typically on the order of JPY ¥200 - ¥300 for i-mode not including the data transfer charges, with additional charges on a monthly subscription basis for premium services. A variety of discount plans were also offered, for example family discount and flat packet plans for unlimited transfer of data at a fixed monthly charge (on the order of ¥4,000/month).

In addition to low price, the billing method was also convenient for users. Instead of paying i-mode for service fees and paying the content providers for subscription fees, i-mode customers received one monthly bill with all of their mobile charges. "The i-mode system has made m-commerce [mobile commerce] a reality in Japan by introducing information billing systems that attach charges directly onto telephone bills", said Natsuno.

4.2.3 Collaborative Innovation based on user needs

One target market that intrigued Takeshi Natsuno, Executive Director of NTT DoCoMo, included consumers interested in the financial markets and their own personal finances. To appeal to this group, i-mode developed relationships with the banking industry. "Of the more than 700 content partners we have, 320 are banks", said Natsuno.

Another target market comprised customers with an eye for comics. To serve this segment, i-mode contracted the publishing firm Shueisha to provide weekly comic strips for a monthly fee of 300 yen (less than $4) for the transmission of a weekly comic strip. The toy company Bandai sold charappa or cartoon characters. For less than $2 a month, subscribers received a different cartoon image on their phone every day. By February 2000, Bandai had 400,000 i-mode subscribers.

As Natsuno said, "The success of i-mode is because we adjust our site to Internet users." Furthermore, unlike a dial-up Internet connection, i-mode Web access was always on, allowing customers to use the Internet without dialing the phone. Even the phones were appealing to the Japanese market, with color screens, lightweight handsets, multi-link navigation and better graphics capabilities. The only disadvantage of the product was its transmission speed of 9.6 kilobytes per second (Mullins, 2007).

4.2.4 Win-Win arrangement with Content Providers

NTT DoCoMo's insight into the needs of its content providers was an important contributor to its early success. By taking care of the customer billing, i-mode made business easy for content providers, who were hesitant to sell online because handling the billing was a large and expensive burden. By paying NTT DoCoMo to do the billing, the content providers were able to concentrate on what they did best – providing content – and still generate earnings. In return for this, i-mode charged its content providers 9 per cent of revenue.

The company also kept a firm grip on its business, controlling all aspects of the i-mode service. Unlike some European promoters of wireless application protocol (WAP), another mobile data technology, DoCoMo knew that developing content would be crucial. DoCoMo required its content providers to create wireless content from the ground up, specifically generating content to fit the mobile phone format. DoCoMo's success lay not in its technology, which actually was not state-of-the-art, but in its ability to bring together and control all these pieces and thereby deliver content that its target customers wanted.

NTT DoCoMo created i-mode at a time when the Japanese market for mobile phones was reaching maturity and users were in need of new services. Its foresight and customer understanding led to impressive results.

The i-mode story also provides an example of the frequently raised questions of whether the technology should drive business ventures, or the consumer experience improvement and value for the end user should drive the business ventures/collaborations and this thesis argues for the latter. In i-mode's case, Internet and communications technology created the possibility of delivering information to mobile customers, any time, anywhere. Thus it is evident that once there is a valid consumer need, the business need is generated there and then, and the supporting technology can be either developed in the form of *firm innovation* or *collaborative innovation* by synergizing technological capabilities across the value chain or value network. However, it is imperative to have a clear target market, a clear customer need, and that what the opportunity offers satisfies that target market's need in a way that's faster, better, cheaper or otherwise more beneficial – generating more value for the user and hence elevating the customer stickiness and driving user experience control.

4.2.5 Global Trendsetter

A few months after DoCoMo launched i-mode in February 1999, DoCoMo's competitors launched very similar mobile data services: KDDI launched EZweb, and J-Phone launched J-Sky. Vodafone later acquired J-Phone including J-Sky, renaming the service Vodafone live!, although initially this was different from Vodafone live! in Europe and other markets. In addition, Vodafone KK was acquired by SoftBank, an operator of Yahoo! Japan in October, 2006 and changed the name to SoftBank Mobile. As of June 2006, the mobile data services KDDI, EZweb, and J-Sky, had over 80 million subscribers in Japan.

Seeing the tremendous success of i-mode in Japan, many operators in Europe, Asia and Australia sought to license the service through a partnership with DoCoMo. Takeshi Natsuno was behind the expansion of i-mode to 17 countries worldwide. Kamel Maamria who was a partner with the Boston Consulting Group and who was supporting Mr. Natsuno, is also thought to have had a major role in the expansion of the first Japanese service ever outside of Japan.

i-mode showed very fast take-up in the various countries where it was launched which led to more operators seeking to launch i-mode in their markets with the footprint reaching a total of 17 markets worldwide. i-mode was launched in the following countries:

- Australia, (Telstra)
- Belgium (Base)
- Bulgaria (Globul)
- France (Bouygues Télécom (company))
- Germany (E-Plus)
- Greece (Cosmote)
- Hong Kong (3)
- Israel (Cellcom)
- Ireland (O2)
- Italy (Wind)
- Netherlands (KPN)
- Russia (MTS)
- Romania (Cosmote Romania)
- Singapore (StarHub)
- Spain (Telefónica)
- Taiwan (Far East Tone)
- UK (O2)

4.2.6 Point of Failure

While the i-mode service was an exceptional service that positioned DoCoMo as the global leader in value add services, another key success factor for i-mode was the Japanese smartphone makers who developed state of the art handsets to support i-mode. As i-mode was exported to the rest of the world, Nokia and other major handset vendors who controlled the markets at the time, refused at first to support i-mode by developing handsets which support the i-mode service. The operators who decided to launch i-mode had to rely on Japanese vendors who had no experience in international markets. As i-mode showed success in these markets, some vendors started customizing some of their handsets to support i-mode, however, the support was only partial and came late in time. While the service was successful during the first years after launch, the lack of adequate handsets and the emergence of new handsets from new vendors, which supported new Internet services (Oomori, 2008) on one hand, and a change of leadership of i-mode in DoCoMo, lead to a number of operators to migrate or integrate i-mode into new mobile Internet services.

Chapter 5

The Aggregated Model

Based on the lessons learned from the three case studies described in the previous chapters 2,3 and 4 and the individual causal loop diagrams (Figure 3-1, Figure 4-2 & Figure 5-4), an aggregated model was developed as illustrated in Figure 5-1 and Figure 5-2 below. Figure 5-1 depicts the causal loop structures while Figure 5-2 uses shadow variables for the ease of understanding the parameter interconnections and dependencies. Following are some of the important parameters used in the aggregated model.

- **FIRM INNOVATION**

  In the aggregated model presented in this thesis, *firm innovation* can be described as the innovation that a firm develops in-house. This could be measured in the number of inventions, patents or even the new products launched by a firm. However in this model, "service features" are used as the units to measure firm innovation.

- **COLLABORATIVE INNOVATION**

  Collaborative innovation is the innovation where two or more organizations synergize their resources to either develop a new technology or launch a new service. Similar to "firm innovation", "collaborative innovation" is measured in units of service features in this thesis.

- **USER EXPERIENCE CONTROL**

"User experience control" is a parameter in this aggregated model, which describes the service provider's capability to own and shape a user's experience. Other factors such as consumer profiling and customization of service offerings based on consumer needs collectively work to enhance user experience control. Traditionally it was believed that billing Interface ownership was the primary criteria for being closely aligned and associated with the customer. However, this belief has been challenged repeatedly in the recent years. The results from the model used in this thesis also endorse the fact that billing interface ownership might delay the customer churn by some brief time period, but would not ensure customer loyalty in the long run, by itself.

- **PERCEPTION OF INTRUSIVENESS**

As obvious from the name, this parameter refers to he consumer's feeling of being intruded upon, which is not only based on the loss of privacy (a possibility in the case of consumer profiling and data mining which probes into the user's consumption of applications and choice of content etc), but also on the user's perception of confinement or entrapment because of the closeness/inflexibility of a certain platform or service and the lack of integration opportunities. One such example is the lack of compatibility of i-mode handsets with the open Internet and the unavailability of free content over the i-mode interface.

Rest of the parameters are described in the section 5.1 below:

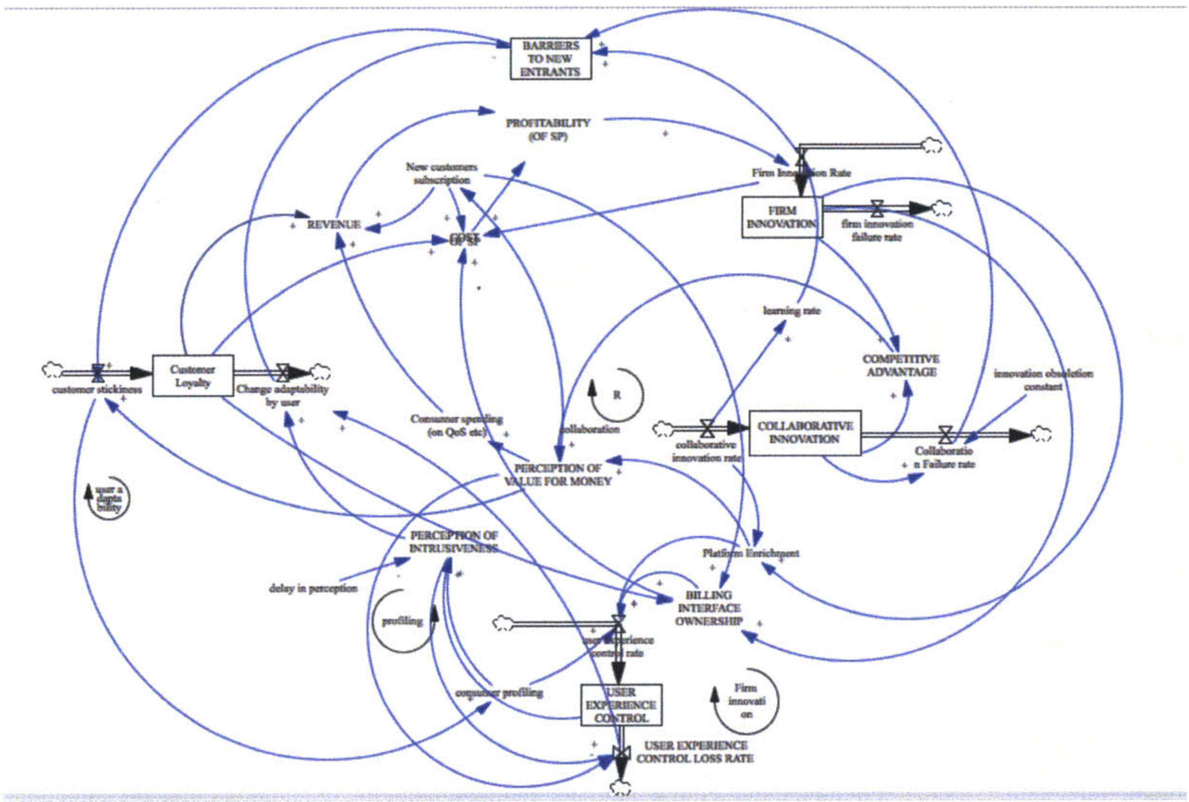


Figure 5-1: The Aggregated Model with loops

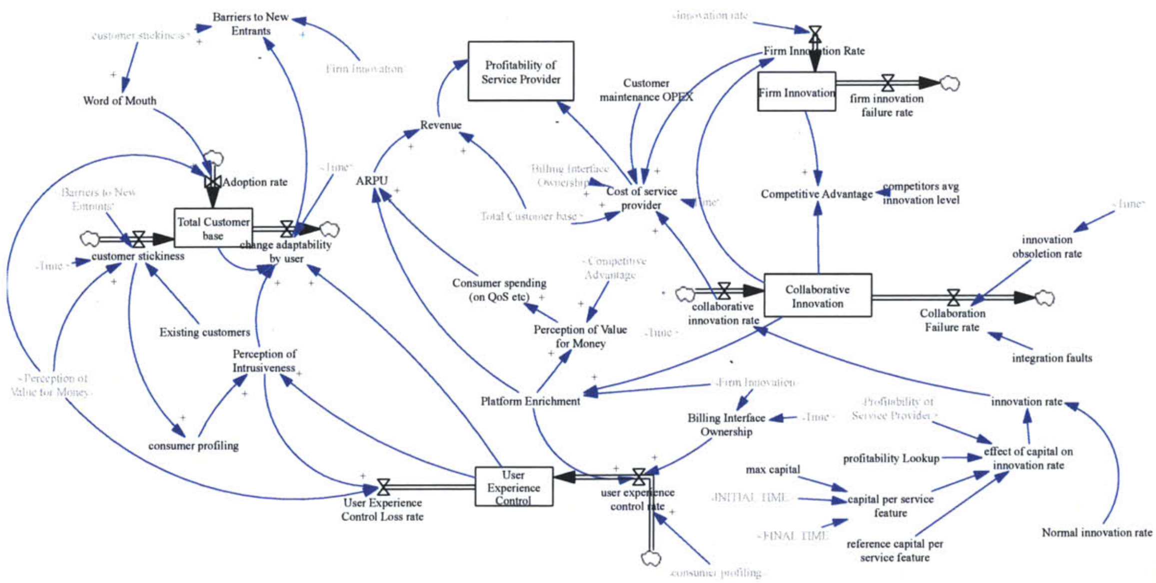


Figure 5-2: The Aggregated Model with Shadow variables to improve visibility of parameter dependence. (*Shadow* is a copy of a system dynamics variable used to reduce the complexity of the diagram and overlapping of arrows)

5.1 Parameters Evaluated In The Model

The following explains the causal dependencies. When it is said that A is a function of B , it implies that changes in A affect B.

Following is a list of the variables /parameters captured in the aggregated model presented in Figure 5-1 and Figure 5-2 above:

(01) Adoption rate is a function of: Perception of Value for Money as well as Word of Mouth.

(02) ARPU (Average Revenue per User) is a function of:
Consumer spending (on QoS etc) as well as Platform Enrichment

(03) Barriers to New Entrants is a function of:
Customer stickiness as well as change adaptability by user. This variable can be quantified with considering the other parameters e.g. the Firm innovation of one player in the value chain.

(04) Billing Interface Ownership is a function of: Firm Innovation

(05) Capital per service feature is a function of:
Maximum capital, which is governed by the profitability of the service provider

(06) Change adaptability by user is a function of:
Total Customer base, a positive causal relationship with Perception of Intrusiveness; it has a negative or balancing relationship to User Experience Control

(07) Collaboration Failure rate is a function of:
Innovation obsoletion rate as well as integration faults

(08) Collaborative Innovation is a stock or level
Collaborative innovation rate and Collaboration Failure rate

(09) Collaborative innovation rate is constant

(10) Competitive Advantage is a function of: Collaborative Innovation as well as Firm Innovation-competitors average innovation level

(11) Competitors Average innovation level is a function of:
Units: service features

(12) Consumer profiling is a function of: Customer stickiness

(13) "Consumer spending (on QoS etc)" is a function of: Perception of Value for Money

(14) Cost of Service Provider is a function of: Billing Interface Ownership, Total Customer base, Time, Firm Innovation Rate, collaborative innovation rate, Total Customer base and Customer maintenance OPEX

(15) Customer maintenance OPEX is the operational cost of maintaining one customer per month

(16) Customer stickiness is a function of: Barriers to New Entrants, Perception of Value for Money and Existing customers

(17) Effect of capital on innovation rate is a function of Profitability Lookup, capital per service feature, reference capital per service feature, and Profitability of Service Provider

(18) Existing customers is a constant, which was given values between 1000 to 20 million for different classes of service providers

(19) FINAL TIME is the final time for the simulation = 2053
Units: year

(20) Firm Innovation is a level or stock with inflow as Firm Innovation Rate and outflow as firm innovation failure rate.
Units: service features

(21) Firm innovation failure rate is a constant and varying values were utilized for test purposes depending upon the technology and its lifecycle.

(22) Firm Innovation Rate is a function of: innovation rate as well as collaborative Innovation

(23) Initial time is the initial year of stimulation = 2013

(24) Innovation obsoletion rate is the rate at which innovations or new features become obsolete with time. This obsoletion can be caused by the outgrowth or fall-out of any one of the links completing the value chain. e.g. in the case of NTT DoCoMo i-mode, the i-mode handset technology obsoletion rate was driven by the newer, faster, cheaper and more openly interfaced mobile handsets in the market.

(25) Innovation rate is a function of: Normal innovation rate and effect of capital on innovation rate

(26) Integration faults was variably tested as a constant as well as a function of collaborative innovation service features.

(27) Maximum capital was tested as a constant and as a function of profitability

(29) Perception of Intrusiveness is a function of: Consumer profiling as well as User Experience Control

(30) Perception of Value for Money is a function of: Competitive Advantage and Platform Enrichment

(31) Platform Enrichment is a function of: Collaborative Innovation as well as Firm Innovation

(33) Profitability of Service Provider is Level or stock determined by Revenue-Cost of Service Provider.

(38) Total Customer base is a stock, with inflows being Adoption rate as well as customer stickiness with customer stickiness also being a function of existing customer base and outflow as change adaptability by user.

(39) User Experience Control is a level/stock with the User Experience Control rate as an inflow, and User Experience Control Loss rate as an outflow.

(40) User Experience Control Loss rate is a function of: Perception of Intrusiveness-Perception of Value for Money.

(41) User Experience Control rate is a function of: Billing Interface Ownership, Consumer Profiling and Platform Enrichment.

(42) Word of Mouth is a function of: customer stickiness

Specific equations for the parameters used in the aggregated model can be found in Appendix C of this thesis

5.2 Intuitions endorsed by the model

5.2.1 Collaborative Innovation

"When all think alike, then no one is thinking."

— Walter Lippman

As Christensen, in his book "The Innovator's Prescription" writes "When disruptive innovators attempt to commercialize their innovations within the established value network in their industry—essentially trying to cram it into the back plane of competition—that system will either reject it (as it did with Sony's transistorized products) or co-opt the potential disruption, forcing it to conform to the existing value network in order to survive".

Christensen further says in his book "Creating an appropriate business model is essential to making disruptive innovations successful. And creating an appropriate value network is critical to making disruptive business models successful."

As discussed earlier in Chapter 1 of this thesis, while presenting the evolution of mobile value networks, it is imperative to develop the straightforward value chain into a value network in order to break the norms and collaborate for a service which amalgamates two different dimensions of the existing value chain e.g. content developer and mobile operator or device manufacture and infrastructure provider.

Following are some of the intuitions endorsed by the aggregated model:

- For a value chain player with an existing loyal customer base, the collaborative innovation failure rate affected the profitability only where the platform enrichment offered via firm innovation was not sustainable. This is aligned with the observations in the Google-Voice and Sprint case study where International Roaming integration failure was a major cause of customer churn. The NTT DoCoMo' s integration failures with newer models of handsets proved to be a point of failure in the integrated value chain that NTT DoCoMo had extended for the i-mode platform.

- Depending on the initial customer base and the resulting impact of firm innovation failure or success rates on consumer stickiness, the collaborative innovation can aggravate or alleviate barriers for new entrants. Figure 5-3 and Figure 5-4 show the impact of firm innovation and collaborative innovation on barriers to new entrants. In Scenario 1, the collaborative innovation increases firm innovation. In Scenario 2, the collaborative innovation increases similar to Scenario 1, but firm innovation keeps declining with time. As depicted in the Scenario 1 and Scenario 2 in Figure 5-3 and Figure 5-4 respectively, the barriers to new entrants are amplified if the firm innovation increases at some rate over the years (collaborative innovation also adds to firm innovation by increasing the knowledge base of an organization). However, if the collaborative innovation fails to impact firm innovation as depicted in Scenario 2, and the firm innovation fails to grow independently as well, then the barriers to new entrants are reduced.

- Billing Interface ownership can only have a delay in consumer adaptability to change. In the long run, it is the perception of value for money, which ensures consumer loyalty.

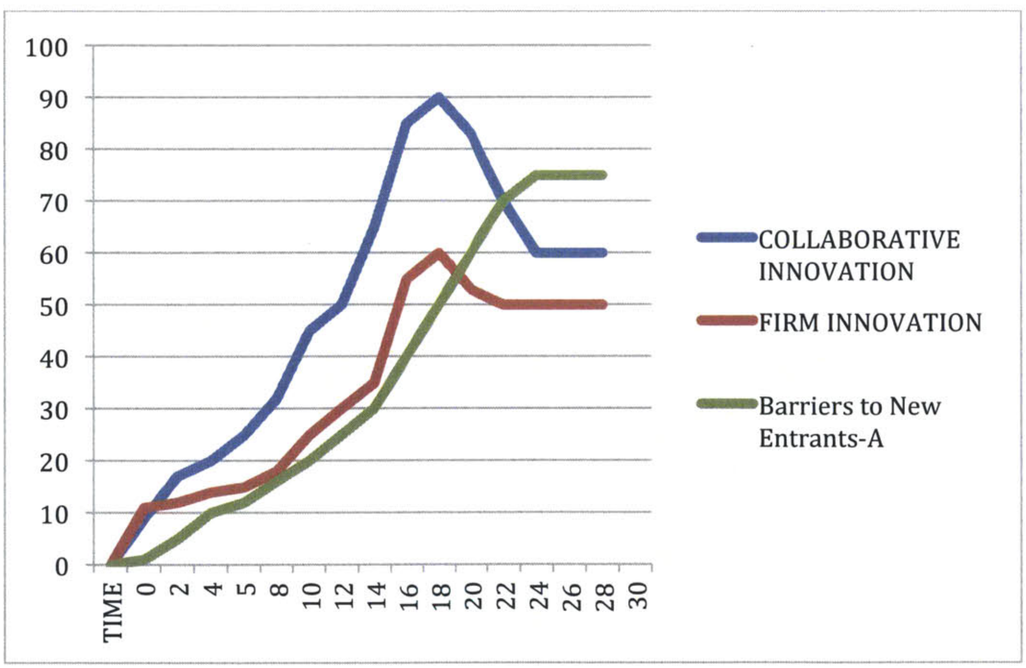


Figure 5-3: Scenario 1 -Barriers to new entrants- via consumer stickiness

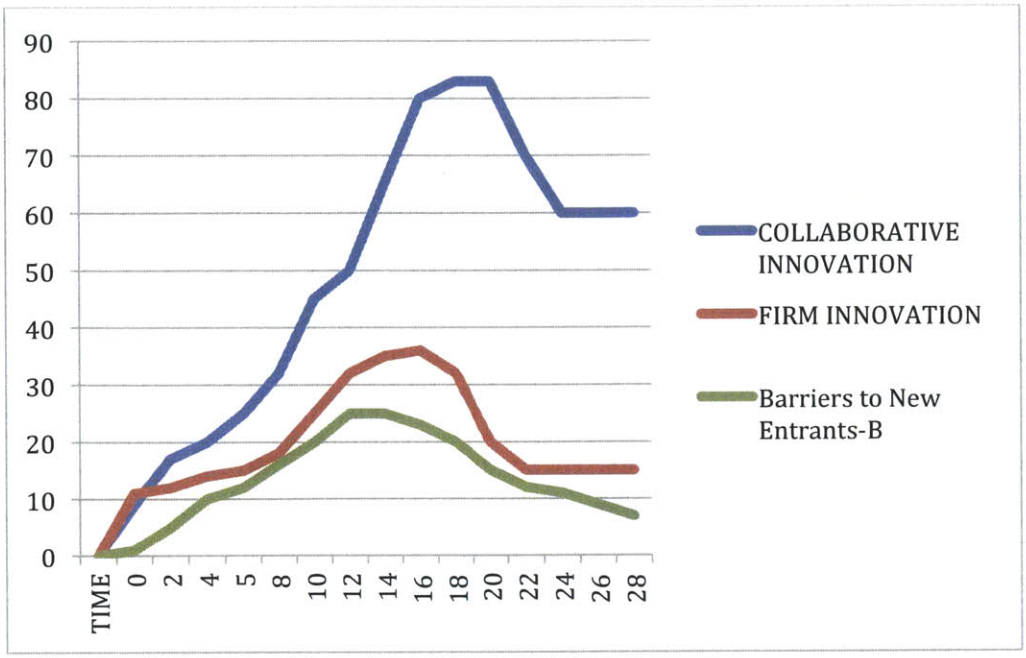


Figure 5-4: Scenario 2- Barriers to new entrants- via consumer stickiness

5.2.2 User Experience Control

According to Eyre (2008) "mobile is not just portable online, it is the first truly spontaneous medium, enabling interactions of an entirely different kind to the computer". He argued that combining social network type of information with GPS(Global Positioning System) will enable mobile and social contacts to become more real than virtual. He also stated that popular, location based and personalized new content makes way for new advertising opportunities.

The use of location based services for targeted advertisements and mobile marketing is an existing example of User Experience Control. Mobile phones personify personal experience and the mobile operators must align themselves closely to the mobile user's needs in order to keep their customers satisfied. Previously, it was believed that the service provider who provides the customer with the monthly bill statement and holds the address and credit card/other payment details of the consumer has a closer relationship to the customer. However, as the mobile and internet industries have become more competitive, customers expect more value for their money since they have more choice and they are not as bound to their monthly billed mobile connection as they used to be with a wireline home telephone because of the physical copper connection restraints. Mobile technology itself is more personalized, as the handset is smaller and mobile and usually a user's very personal and handy tool for communicating with the rest of the world. The plethora of applications available for all practical purposes, ranging from tracking the public transport, to checking the local and international news to streaming content and taking, storing and exchanging photographs, have made the mobile experience more personal than it ever was. These applications range from necessity-based such as Global Positioning System (GPS) tracking to entertainment-based such as streaming video content, and play a vital role in shaping a consumer's experience and represented by the user experience control variable.

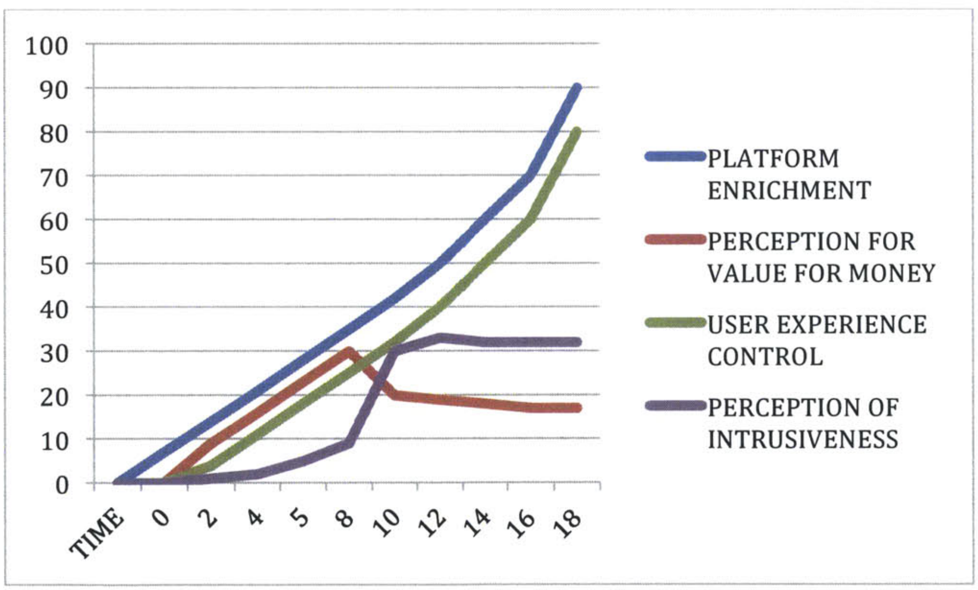


Figure 5-5: Graphical representation of Platform Enrichment, Perception of Value for Money, User Experience Control, Perception of Intrusiveness over a period of 20 years

- As depicted in Figure 5-5, there is a threshold point of perception of intrusiveness, which closely follows the increase in user experience control. Beyond this threshold point, the perception of value for the user starts declining despite the constant rise in platform enrichment.

- Not just the firm innovation, but the collaborative innovation can also cease to reap its benefits if the user's "perception of intrusiveness" as well as "entrapment" which originates from lack of openness of the platform rises with time. This phenomenon was also witnessed in case of Google-Voice and Sprint where the traditional benefits of Over the Top voice connectivity's price sensitivity could no longer be enjoyed by users since they were restricted to the use of Sprint mobile connectivity minutes instead of the cheaper Google-Voice VoIP (Voice Over IP) minutes while travelling abroad and while being connected via international roaming. Similarly, the lack of "openness" and integration with newer handsets and the lack of free access to Internet content became a major cause of demise in NTT DoCoMo i-mode's value for end user.

- Another important observation resulting from the evaluation of the aggregated model is the possibility of using this model for two or more players of the telecommunications value chain simultaneously. In this thesis, the model operates for one value chain player. Further work can be done to amalgamate the layers representing different players in the value chain to gauge their actual individual share in the available consumer surplus (the maximum amount of money a consumer or set of consumers are willing to spend on a certain service).

Chapter 6

Rationale Behind Monetization of QoS

"*The pipe cannot be just dumb in times of capacity constraints. The smart pipe is the future…with different levels of service connectivity and the ability to manage traffic.*"

— Rene Obermann, CEO Deutsche Telekom,
Mobile World Congress, Barcelona, 2012.

Sharing the same stage with Obermann, the fellow keynote speaker Ben Verwaayen, CEO of Alcatel Lucent, was a little more forthright when he declared, "I am stunned by the fact that we have to stay non-discriminatory in this industry; it's ridiculous." He added, "This market will have to develop a form of choice for the consumer on quality. Without it, this market can simply not do all the things we need it to."

In the previous chapters, the three case studies presented examples of telecom operators collaborating with other players in the value chain through more of business cooperation and less of technical joint ventures to generate revenue. The monetization of QoS of data is a technical capability, which can be used by the mobile operators to enhance revenue as well as play a more important role in shaping user experience control and evolution from a value chain into a value network (further explained in section 6.3 pg 59 of this chapter)

For the last decade, and particularly over the last few years, the communications ecosystem has evolved quite rapidly. Most of the interviews with stakeholders in the telecommunications industry resonated with the common perception from the network operators, both fixed and wireless, that *over the top* service providers have been claiming the lion's share of profitability while network providers, have been haunted by the ever-increasing fear of being reduced to dumb pipes. While often viewed as a threat, this set of circumstances can be viewed as an opportunity for cooperative innovation where network operators provide QoS for mobile data services, with the user controlling which applications will get priority.

6.1 Mobile Data: Imbalance in demand and capacity

The concept of mobility has transformed the telecommunications industry within the last decade. It has changed the social fabric of human civilization and opened new avenues of business and technology. Close to 83 percent of the world's population now enjoys access to a mobile phone. In 97 countries around the world, there are now more mobile devices than people (ITU, 2010). The drastic improvements in mobile handsets including smartphones such as iPhones, Android-based smartphones, and tablets, and the plethora of content and application availability have further increased the demand and usage of mobile Internet data. Courtesy of the attractive social networking sites, gaming websites, video streaming and ground-breaking usage of Internet for business promotion and business management, the mobile networks have seen an overwhelming demand of data connectivity specially in the last couple of years. A market research by the Cisco® Internet Business Solutions Group (IBSG) revealed that more than three-quarters of Americans were watching videos, updating their social networks, and participating in video conferences on their mobile phones by late 2012 (Cisco IBSG,2011). Mobile data connectivity ensures that people are connected to their email, their favorite applications and social networking sites anywhere, anytime.

The obvious result of this demand of mobile connectivity is an astounding growth in mobile network traffic. Cisco's Visual Networking Index (VNI) predicted that global mobile data traffic will increase 26-fold between 2010 and 2015, reaching 6.3 exa bytes per month by 2015. Global mobile traffic will continue to explode, growing at a rate three times faster than that of fixed IP traffic over this same period. (Cisco VNI, 2011)

The fierce competition, price wars, lost revenue in voice minutes, and the fast and furious innovations in mobile handheld smart devices forced the mobile operators to compete by promoting subsidized data usage offerings bundled with these data-hungry devices. A very relevant example is the iPhone promotional offerings by AT&T and many other carriers, specifically in the US, and generally around the world. The evolution of the telecommunications ecosystem compelled mobile operators to support data-hungry applications such as mobile TV, video, and social networking. Considering the overwhelming demands of mobile data connectivity and its crippling effects on the Internet bandwidth supported by most mobile operators, the operators are now struggling to hold their ground by striving for sanity between demands and revenues. The unlimited (consume all you want) data plans have been very taxing for mobile operators and cannot be sustained; hence more operators are now inclined towards tiered price plans, imposing data caps on heavy users and implementing sophisticated traffic management to control individual users and applications. Many mobile operators are aggressively acquiring new spectrum and rolling out long-term evolution (LTE) networks in an attempt to increase capacity and improve the underlying transport economics. Other carriers are searching for new sources of revenue, such as advertising and data insight, or trying to manage capital and operational expenses by outsourcing network build and operations, or other new business models. (Taylor, 2011)

For the last few years, there has been a lot of hype surrounding the Long Term Evolution (LTE) technology in the mobile operators for increase in capacity after the transformation from circuit switched to packet switched networks. According to Wireless Intelligence's 2012 report, 500 million LTE connections are predicted globally through over 200 live LTE networks across more than 70 countries. However, LTE alone cannot solve all the capacity restraints faced by mobile operators.(Wireless Intelligence's 2012 report)

Alongside the bandwidth requirements of new age Internet applications, customer demands of mobile data and expectations out of their mobile data experience continue to rise. End users increasingly expect a highly available, reliable, and fast mobile data network providing an experience at par with the wireline broadband Internet access.

The concept of improving Quality of Service was originally introduced in the manufacturing as well as service industries mostly as a financially viable investment with the expectation of resulting returns (Zahorik & Keiningham, 1995). The benefits of quality improvements come in two forms. One effect is the improved ability of the firm to attract new customers due to word of mouth, as well as the firm's ability to advertise the quality of its offerings. The second desired effect is customer retention, which also increases the word of mouth and reinforces the loop governed by word of mouth. This observation is also depicted in the aggregated systems dynamics model presented in Chapter 5 of this thesis.

However, the term *Quality of Service* is not confined to its traditional business language (Zahorik & Keiningham, 1995) meaning in this thesis. The term *Quality of Service* is taken from language of telecommunications and the Internet, which actually implies the quality of delivery of data packets (measured through delay, noise, packet loss and similar parameters) backed by the performance of the network and application layer to deliver traffic across the Internet to the end user. This traffic is delivered with a pre-defined level of service that corresponds to certain criteria to counter factors impairing the quality of Internet traffic (including but not limited to voice, video, and data), such as packet delay and packet loss etc.

6.2 Quality of Service and Quality of User Experience

There has been a long history of concerns associated with traffic engineering and how Internet routing is being managed. Its been over a decade since Border Gateway Protocol (BGP) and Multiprotocol Label Switching (MPLS) were introduced to find efficient and customized ways of Internet routing. Quality of Service for the Internet is not a new subject either. It has long been described by the phenomena such as resource allocation and performance optimization. Traffic engineering mechanisms such as *differentiated services*, and *integrated services* employing RSVP (the resource reservation protocol), are some of the widely known technologies to improve network performance through resource allocation and performance assurance.

Quality of User Experience (QoE) is another term frequently used in the telecommunications industry and has been mostly used to evaluate the experience of a consumer. QoE includes QoS as well as the wider scope of the customer experience while using an application. QoE is not limited to QoS but also includes social attributes such as customer's satisfaction level or perception of value. A term called *User Experience Control* is used in this thesis as well as in the aggregated systems dynamics model presented earlier in this thesis. However, this term is used in the context of a service provider's attempt at shaping the user's experience to ensure a strong relationship with the customer ensuring customer stickiness, and hence customer loyalty.

Quality of Service for mobile data is specifically described as the availability, reliability, speed, and throughput available for Internet traffic of any kind on the mobile data connection. Since this thesis also tackles the application specific monetization of the Quality of Service of mobile data connectivity, the criteria of availability, reliability, speed, and throughput are applied to application specific data while considering the monetization of QoS.

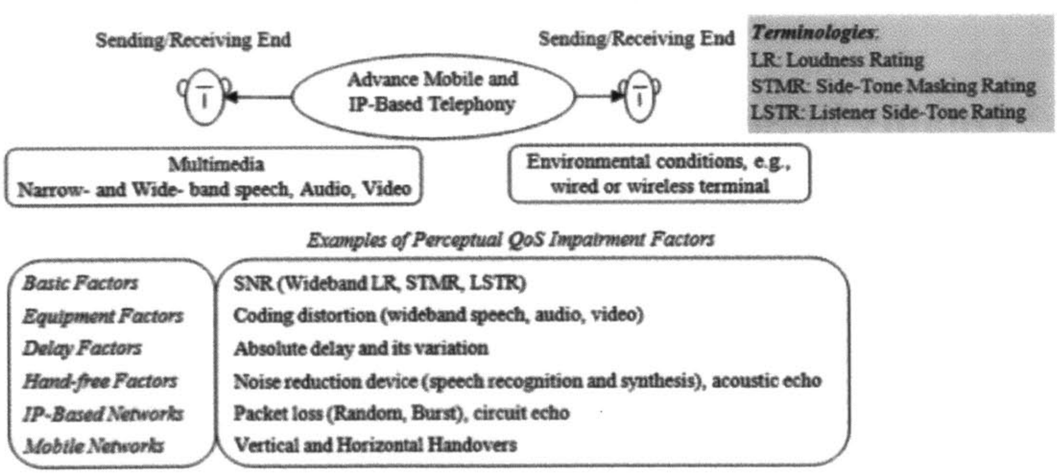


Figure 6-1: QoS factors affecting the perceived quality of advanced mobile and IP-based communication (Brooks & Hestnes, 2010)

6.3 Value Networks and Temporariness of Advantage

In his book "Clock Speed", Professor Charles H. Fine talks about the "temporary nature of advantage", and also states, "The faster an industry evolves — that is, the faster its clock-speed – the more temporary a company's advantage. The key is to choose the right advantage — again and again." This statement holds true especially for the "info-tainment" industry, which has evolved as a result of amalgamation of the multimedia, information, communications, and electronics (MICE) industries. Analogous to the fiber-optic communications systems to transmit information and entertainment at the speed of light, this industry can be considered running at a speed of light (Fine & Kimerling, 1997)

The concept of a value network is particularly relevant to network industries such as mobile communications and Internet, as well as their amalgamation in the form of "mobile Internet". Whereas value chains are known to link multiple functions, both intra-firm and inter-firm level (Porter, 1980, 1985), value networks connect multiple buyers and sellers at a single node (Normann & Ramirez, 1994; Weiner et al., 1997). Any node of a value network can be connected to one or many value chains as well as value networks. The linkage between mobile technology and the Internet itself presents a value network in addition to being a segment of the traditional telecommunications industry value chain. The firms owning the interface with the customer (e.g. mobile and fixed line operators) must often interact with a broad range of buyers, sellers, and providers of complementary products through multiple platforms (Evans, Hagiu, & Schmalensee, 2006). Amazon.com due to its large alliance program (Afuah & Tucci, 2002), and many other Internet sites including portals, search engines, auctions, employment sites, online traders, real-estate sites, and even offer such multiple platforms (Evans et al., 2006) and can be considered value networks. The idea of *layered platforms* to implement desired functionality and the concept of *interconnection* between providers at different platform layers (Claffy & Clark, 2013) can further help to understand this notion of value networks.

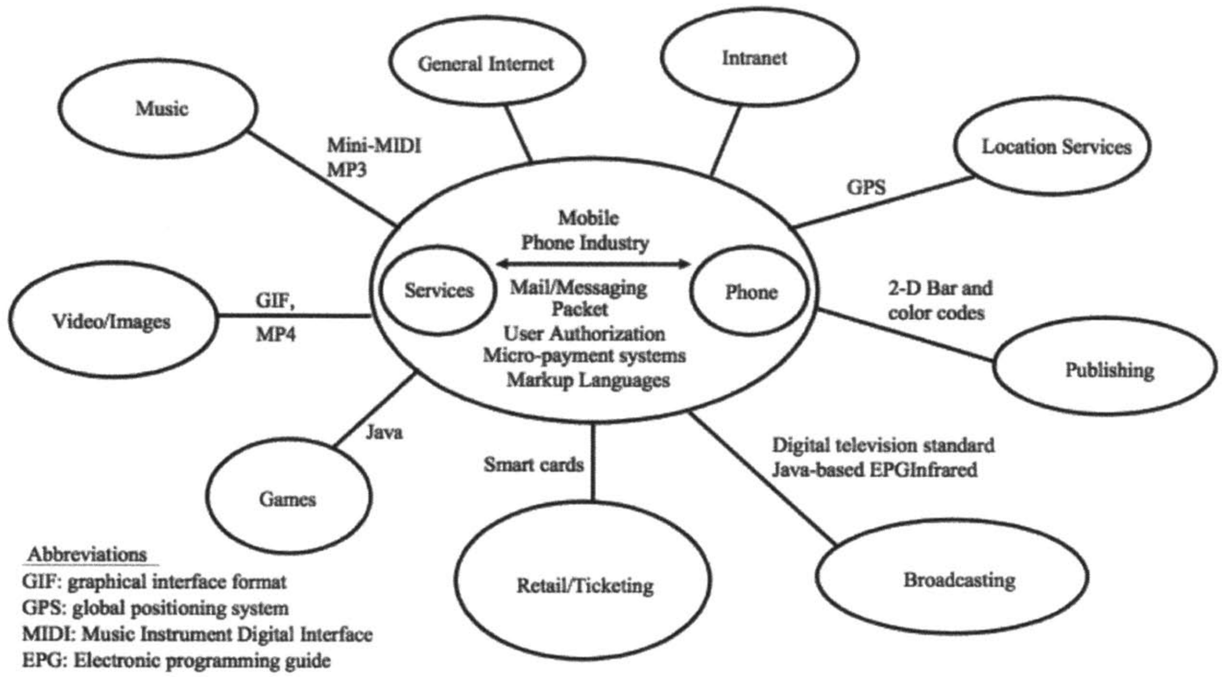


Figure 6-2: The emerging value network of the Mobile industry (Funk, 2009)

The above Figure 6-2 shows the expansion and evolution of the mobile industry with not just the value chain transforming into a value network, but with an inevitable overlap of the mobile telecommunications with other industries. We have already witnessed the Mobile Wallet such as Easypaisa*, Mobile Health such as mHealth **, and Mobile phone home surveillance and security services offered by different mobile operators in the world.

*Easypaisa Mobile Accounts are actual bank accounts and work just like a normal bank account. This service is available only for Telenor subscribers in certain countries. Using Easypaisa Mobile Account Telenor subscribers can pay bills, transfer money and use many more services from their own mobile phones, anytime, anywhere.

**mobile-health (mHealth) is the use of mobile computing and communication technologies in health care and public health. mHealth has applications such as facilitating data collection and to encourage health-care consumers to adopt healthy lifestyles or to self-manage chronic conditions. It can also be used to improve health-care service delivery processes by targeting health-care providers or communication between these providers and their patients. So, for example, mobile technologies can be used to provide clinical management support in settings where there are no specialist clinicians, and they can be used to send patients test results and timely reminders of appointments.

As illustrated in Figure 6-2, music, animation, video, and game firms are rapidly evolving as significant overlapping parts of the mobile phone industry in most countries. Particularly in Japan, the number and diversity of firms are even larger and include publishers, retail outlets, restaurants, transportation and travel-related companies, broadcasters, other general Internet sites, and enterprises that use the Internet to manage internal operations (Funk,2007). The case study of NTT DoCoMo i-mode discussed in Chapter 4 of this thesis further provides evidence and insight into this industrial overlap. The constant zest on the part of mobile operators to enhance their role further from being the commodity provider / dumb bit pipe carriers to value added service providers for the users, has been a compelling reason behind launch of these cross industrial value-added services.

6.4 Value for the mobile Internet user

As discussed in the initial sections of this chapter, the mismatch in demand and capacity, and the intention to provide user with a better experience, and the desire of network providers to become more evolved players in the telecommunications value chain are some of the compelling rationales justifying the monetization of QoS by cellular operators.

However, the most significant rationale behind monetization of QoS of data is the value proposition it holds for the mobile user. According to a consumer survey conducted by Comptel Corporation in 2012, it was discovered that two-thirds of consumers felt neglected by their mobile operators, and that almost half were likely to churn within the next two years as a result. The survey also revealed how consumers in United Kingdom, France, Germany, and the United States would be more loyal and willing to spend more if operators engaged with them more. The case studies presented in the earlier chapters of this thesis, back up the concepts of *collaborative innovation* and *user experience control.* Above all, the most significant aspect of these two phenomena is the value perceived by the end user. Eventually, a technical and/or business venture, whether driven by firm or collaborative innovation, only makes sense if it provides any prospective value to the end user.

The following Figure 6-3 shows Location of Mobile Data Usage (Percentage of Time Spent in Activity).

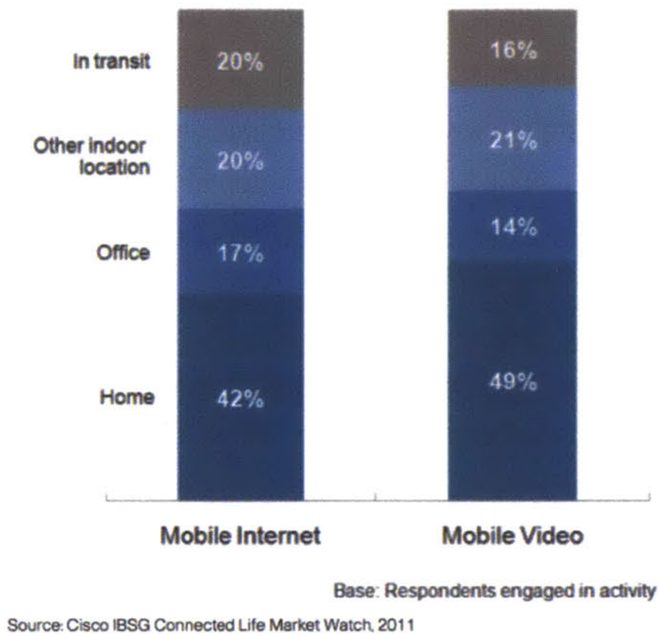


Figure 6-3: Location based usage of mobile Internet and mobile video (Source Cisco IBSG, 2011)

It is interesting to note that most of the mobile Internet users, specially the smart phone users, use stationary wi-fi, or home, office wireless, or wired Internet connectivity for most percentage of their mobile Internet usage (Schofield, 2013). While being totally mobile, the speed and availability of their stationary wi-fi connectivity cannot be matched due to the very nature of mobile connectivity. Even the latest LTE connectivity cannot match the wired on wireless home and office Internet speeds and throughputs, especially in areas with congestion and low coverage. With the ever-increasing variety to choose from, every user has individual preferences of application usage. For example, while away from home and not connected to home wifi or any public wifi hot spot, some users may consider location based public transport alert services as being the only critical ones, while others might prefer their stock exchange application to be delivered at any cost.

Despite vast applications of a mobile Internet, and the promise of alacrity and availability foreseen with the advent of LTE, the cellular data bandwidth is usually always limited by some constraint of bandwidth as described by the Shannon-Hartley Theorem. Considering this fact and the temporariness of advantage as mentioned before (Fine, 1998)implies that the mobile operators are in dire need of utilizing their data capacity in a more efficient way. This required efficiency can be attained using resource allocation and performance optimization. Mobile operators are currently using different makeshift as well as policy-oriented techniques to reduce noise, delay, and jitter in their communication interfaces. Even in the absence of a widely accepted concept of monetization of Quality of Service in the context of mobile data connectivity, the network management, resource allocation, and performance optimization have been carried out from the User Equipment (UE) to Mobile Base Stations to the core circuit switched networks.

These in-house and undeclared policies of managing the Quality of Service, which are developed and implemented by mobile operators independently and in isolation, present a huge challenge of lack of visibility and uniform standards, as well as regulatory fairness and compliance. One of the major reasons is that FCC allows the *reasonable* discrimination of traffic for *network management purposes* and it is understandable that the definition of *reasonable* usually translates into *economically efficient* for most mobile operators. Academics can assist this process by conducting further research on the mobile Internet QoS management, considering the structure of the industry, the potential revenue streams, and the processes of standard setting (Funk, 2009).

By making the monetization of Quality of Service transparent, fair, and policy oriented, users, mobile operators, end users, and regulatory bodies will benefit from enhanced visibility into the currently grey dimensions of optimum network and resource management. This transparency will also facilitate the efficient involvement of policy makers in the process of monetization, both from the economic and regulatory perspectives. Economists have acknowledged the fact that economic growth of an industry is vastly dependent on the involvement of policy makers to formulate the right set of policies and rules.

Chapter 7

Regulatory Policy

The stakeholders interviewed for this thesis were 50% from the USA, 40% from Europe and 10% from Middle East and Asia. However, the regulatory constraints addressed in this thesis are from the US centric point of view for the ease of understanding. Since the regulation of mobile Internet is still in a nascent stage in the US as well as other parts of the world, some significant inferences can be drawn and applied to other countries based on their legislation governing the mobile Internet regulation.

"The "Open Internet" is the Internet as we know it. It's open because it uses free, publicly available standards that anyone can access and build to, and it treats all traffic that flows across the network in roughly the same way. The principle of the Open Internet is sometimes referred to as "net neutrality." Under this principle, consumers can make their own choices about what applications and services to use and are free to decide what lawful content they want to access, create, or share with others. This openness promotes competition and enables investment and innovation."

Source: www.FCC.gov (2013)

On the FCC website, under the section of The Open Internet rules, it is further described that one of the significant purposes of the Internet openness is the facilitation it provides to innovators, application developers and service providers, to introduce novel technologies and services which can bring drastic improvements to communications as well as business.

The FCC rules may be general in nature but do specify the fact clearly that the

Internet content or applications are not regulated, which implies that the FCC promotes an environment of open and free competition, cooperation as well as co-opetition in the Internet world. Another clearly defined objective is that neither the government, nor the private companies should be given the leverage to deter innovation or its access to the common Internet user.

7.1 Open Internet Rules

"The FCC has adopted three basic open Internet rules: (*www.FCC.gov ,2013)*

7.1.a. Transparency

Broadband providers must disclose information regarding their network management practices, performance, and the commercial terms of their broadband services.

7.1.b. No Blocking

Fixed broadband providers (such as DSL, cable modem, or fixed wireless providers) may not block lawful content, applications, services, or non-harmful devices. Mobile broadband providers may not block lawful websites, or applications that compete with their voice or video telephony services.

7.1.c. No Unreasonable Discrimination

Fixed broadband providers may not unreasonably discriminate in transmitting lawful network traffic over a consumer's broadband Internet access service. Unreasonable discrimination of network traffic could take the form of particular services or websites appearing slower or degraded in quality."

FCC further recognizes, in the Open Internet Report and Order that "an open, robust, and well-functioning Internet requires that broadband providers have the flexibility to manage their networks, including but not limited to efforts to block spam and ensure that heavy users don't crowd out other users. For this reason, the no blocking and no discrimination rules are subject to reasonable network management."

The Open Internet R&O by the FCC, has described industry-wide rules to protect openness for consumers and innovators alike. The Open Internet R&O also recognizes that mobile broadband presents "special considerations", including the fact that it is rapidly evolving and has differences from fixed broadband in market structure and technological constraints. In the advent of 4G technologies, the Commission wants to ensure the openness for mobile broadband, requiring providers to comply with the transparency rule, and prohibiting them from blocking websites or from blocking applications that compete with the provider's voice or video telephony services. (*www.FCC.gov ,2013)*

Under the section of industry laws and rules of the FCC website, the Competition section says,

"The competitive framework for communications services should foster innovation and offer consumers reliable, meaningful selections in affordable services. The FCC pursues removing regulatory, economic and operational barriers throughout the telecommunications sector." (*www.FCC.gov ,2013)*

The FCC's non-discrimination rule has a broad general objective and it explicitly aims to ban discrimination, which is "unreasonable", and it also provides a cushion in the terminology of "exception" for network management purposes. These rules give the cellular network providers a lot of room and flexibility to formulate the so-called *reasonable* discrimination based on the legitimate premise of being *justified under network management requirements*.

In the USCA Case #11-1355 Document #1415568 Filed: 01/16/2013 Page 31 of 122 where Verizon and MetroPCS (hereafter "Verizon") demanded that the Open Internet Rules be vacated, the FCC's responses were as follows:

"Broadband providers "shall not *unreasonably* discriminate in transmitting lawful network traffic" to their customers. *Order* ¶68 (JA 40) (emphasis added); 47 C.F.R. § 8.7. Network practices are reasonable if they are "tailored to achieving a legitimate network management purpose," *Order* ¶82 (JA 48), such as "ensuring network security and integrity," contending with "traffic that is unwanted by end users" (by implementing parental controls), or "reducing or mitigating the effects of congestion on the network." *Ibid.* While describing the mobile broadband rules the comments from FCC were: "The Commission applied even lighter rules to mobile broadband service (*e.g.*, via cellular networks). Mobile broadband is less mature and more rapidly evolving than fixed service; consumers have more choices for mobile broadband; and providers face "operational constraints" that fixed broadband networks do not. *Order* ¶¶94-95 (JA 52-53). The Commission applied to mobile providers the same transparency rule that applies to fixed service providers. *Order* ¶98 (JA 55). The Commission prohibited mobile Internet access providers from blocking customer access to lawful websites or applications that compete with the service providers' own voice or video telephony services. The Commission declined, however, to apply to mobile service the rule forbidding unreasonable discrimination, deciding instead to rely on the anti-blocking rule while continuing to "monitor the development of the mobile broadband marketplace." *Order* ¶104 (JA 58).

FCC's responses from this case clearly show that FCC has given the mobile operators substantial leverage to cater for the genuine technical constraints of network management. To ensure that the innovation and development in the mobile broadband industry is not impaired by regulatory restrictions at this stage, FCC has refrained from applying stringent rules and has allowed the exceptional flexibility of reasonable traffic discrimination for efficient network management.

Future relationship between Internet service providers and content providers has been a very controversial aspect of the net neutrality debate (Kramer & Wiewiorra, 2012). Advocates of network neutrality argue that abiding by the stringent network neutrality rule prohibiting any kind of traffic discrimination is the only way to ensure a fair competition between content providers. (Lessing, 2001) (Van Schewick, 2006) (Wu T. , 2003) (Sydell,2006) (Economides & Himmelberg, 1995). The advocates of network neutrality further believe that it will also compel network operators to enhance their network capacity to reduce congestion challenges presented by the best-effort internet trafficking scheme. (Lessing, 2001)

On the contrary, opponents of network neutrality regime argue that QoS based Internet traffic discrimination will encourage more content variety as well as broadband investment (Yoo,2005) Regulatory authorities should use academic and industrial research on the mobile Internet QoS management, considering the structure of the industry, the potential revenue streams, and the processes of standard setting to formulate relevant regulatory frameworks. (Funk, 2009). Lahiri, Dewan & Freimer (2013) compare the two pricing schemes, namely 1) *service pricing* which involves pricing different services differently, and 2) *traffic pricing* which involves pricing the traffic (i.e.,bytes) transmitted and argue against the general notion that discriminatory prices across services increase profit for the operator at the cost of consumer benefit. This thesis concurs that service based/ application specific pricing is beneficial to the consumer as long as it is available for all applications and content types and the user, rather than the network operator or the content provider has the choice to discriminate between the applications' varying QoS levels.

By making the monetization of Quality of Service transparent, fair and policy oriented, users, mobile operators and the regulatory bodies will benefit from enhanced visibility into the currently grey world of optimum network and resource management. FCC acknowledges the challenges and requirements of efficient network management to meet the mobile data demands and that the mobile operators are bound to manage their traffic by optimizing resource utilization.

This thesis argues that a wide variety of traffic discrimination mechanisms are already in practice, such as the consumer packages with data caps based on price, the unavoidable peak hour congestions and performance compromises due to bandwidth sharing amongst users, resulting in unfair committed interface rate (CIR) due to the best effort delivery framework. Once the monetization of Quality of Service is identified as a legitimate practice within the confines of regulatory policy frameworks, it will make the traffic management and resource optimization transparent. This transparency will also facilitate the efficient involvement of policy makers in the process of monetization both from the economic and regulatory perspectives. Economists have acknowledged the fact that economic growth of an industry is vastly dependent on the involvement of policy makers to formulate the right set of policies and rules. The isolated network management policies of managing the Quality of Service, which are currently developed and implemented by mobile operators independently, represent lack of visibility, uniform standards, regulatory fairness and hence present huge challenges to end user interests. One of the major reasons behind this state of affairs is that even through the *Net Neutrality* principles apparently forbid discrimination within the Internet traffic, FCC allows the *reasonable* discrimination of traffic for network management purposes and it is understandable that the definition of *reasonable* usually translates into economically efficient for most mobile operators.

Barbara Van Schewick (2012) clearly articulates the same question in her paper as how to best separate socially beneficial and socially harmful discrimination in a way that

(1) Realizes the goals of network neutrality regulation, but
(2) Does not constrain the evolution of the network more than necessary
(3) Makes sense from a policy perspective and is technically sound. **(Schewick, 2012)**

She further proposes the rule to ban application specific discrimination and to allow application agnostic discrimination. However, this thesis argues that the application-agnostic discrimination based on user subscription and usage-time has already been practiced in the form of time-bound bandwidth availability due to congestion in peak hours, disparity in application structure and consumption combined with the data usage caps on mobile Internet users. This application agnostic discrimination, combined with the factors just discussed, leads to an unaccounted form of application-specific discrimination. The application-specific discrimination over the Internet implicitly happens or is orchestrated because of the significant differences in the nature, platform, overhead and development structure of the different applications. The existence and reality of these differences in the speed and availability of these variegated applications implies that even application-agnostic but network location-specific, or time-specific or user-specific discriminations results in "unreasonable" discrimination as a result of the so-called "reasonable network management requirements"

Even though Barbara Van Schewick (2012) is in favor of only application-agnostic Quality of Service (QoS) Discrimination, she argues that forms of QoS should be allowed if they meet the following conditions:

(1) The different classes of service are made available equally to all applications and classes of applications;

(2) The user is able to choose whether and when to use which class of service

(3) The network provider charges only its own Internet service customers for the use of the different classes of service. (This restriction would not constrain interconnection agreements in any way. Thus, payments among interconnecting networks would remain possible.) Schewick (2012).

An application-specific monetization of Quality of Service can be designed and regulated based on these three pre-requisites described above where instead of the service provider, the user should be in charge of the choice of applications/content to be connected as top priority and the applications/content delivered via the best effort. The consideration, however, remains that the service provider should ensure such a transparent and fair provision of choice to the consumer using some of the existing and forthcoming technological capabilities discussed in the next chapter i.e. Chapter 8 of this thesis.

7.2 Regulatory Frameworks for Monetization of QoS

The three case studies presented in Chapters 2,3 and 4 of this thesis present diverse examples of collaborative innovation and user experience control leading to different regulatory concerns. Focusing on the specific question of Monetization of QoS of mobile data, it is imperative to consider at least two different regulatory frameworks as argued by Barbara Van Schewick (2012), who exposes the deep disconnect between those who, like most network neutrality proponents and the current FCC, base calls for network neutrality regulation on a ***broad theoretical framework*** that considers a broad range of economic and non-economic harms", and those who evaluate calls for network neutrality regulation based on an ***antitrust framework***. Van Schewick (2012) argues that these two frameworks really lead to very different results regarding which forms of differential treatment proponents of each framework are concerned about. In the context of the broad theoretical framework that the FCC explicitly adopts in its order while catering to broad general rules of Net Neutrality to be adapted by the telecommunications industry, the FCC's rules make perfect sense. At the same time, network neutrality proponents who are not aware of the implications of the different frameworks don't necessarily realize that antitrust-based approaches or approaches that use terms that have well-defined meanings in antitrust law may reach correct results in the context of an antitrust framework, but do not capture many instances of discrimination that network neutrality proponents are concerned about. Thus, adopting such rules would make it impossible to successfully bring complaints against discriminatory conduct that violates the values that network neutrality rules are designed to protect. Following two sections view the question of monetization of QoS of mobile data from these two different lenses of 1) Theoretical/ Open Market and 2) Antitrust regulatory frameworks.

7.2.1 Theoretical/Open Market Regulatory Framework

Extending the concept proposed by Barbara Schewick (2012), and framing it to the application specific QoS discrimination, the first kind of regulatory framework needed would be theoretical or open Market framework. Such framework would cater to general transparency and accountability principles applicable to the reasonable data traffic discrimination allowed for network management. This regulatory framework should reinforce the key architectural principles on which the Internet was based without stifling the original architecture of the Internet itself. This kind of framework should serve to balance the public interest in network neutrality, the benefits that public can reap through transparent forms of application-specific traffic discrimination, with the legitimate interests of network providers. It should serve to prevent network providers from interfering with user choice or distorting competition among applications or classes of applications, while providing them broad flexibility to differentiate and price their Internet service offerings and manage their network in efficient and profitable ways. This framework should enable mobile network providers to offer user-controlled Quality of Service and provide equal opportunity to all application developers/content providers to collaborate for the better performance of the network and better quality of the applications.

As discussed in Chapter 6 while describing the rationale behind monetization of Quality of Service of Internet data, it is imperative to note that the numerous interviews with stakeholders from the mobile service providers across US and Europe endorse the fact that there is a unanimous agreement on the dire need of this allowance in order for mobile networks to work efficiently and cater for the users' mobile data requirements. It is advisable for regulatory bodies to understand this technical and business need as most of the backbone mobile infrastructure providers such as Ericsson and Alcatel are already advertising the intelligent and efficient management of data traffic to the mobile operators around the world. With the advent of Long Term Evolution (LTE) technology, and driven by the technical and business needs, most of the mobile operators across US and Europe have already developed in-house capabilities to discriminate traffic based on application specific segregation. However, these operators refrain to discuss the current and future execution plans due to the expected regulatory concerns. In order to come up with the realistic regulatory policies that address the current technological and business needs of these mobile operators, the regulatory authorities should consider the theoretical aspects of the regulatory framework as well as the antitrust aspects of the regulatory framework

7.2.2 Antitrust Regulatory Framework

As depicted in the case study of Zero.facebook.com's alliance with mobile operators, which involved business terms that have not been made public, the anti-trust aspect of regulation for the protection of the consumer's interests and healthy competition in the market seems very relevant. A similar scenario is observed in Google-Voice and Sprint case study where collaboration between two apparently competing players can pose a threat to open competition and impede possibility of further collaboration in the value chain. Such collaborative initiatives or strategic business alliances can be a source of concern for the regulatory authorities. Following are some of the recommendations for the policy makers to identify anti-trust concerns from the inception of a strategic alliance and also define parameters to apply rules and regulations which can foster business and technology collaborations and preserve healthy competition in the market.

1. The contractual terms of collaborative ventures should not be fostering long-term exclusivity in order to eliminate anti-trust concerns. In most cases, the value chain player with higher stakes desperate to retain their market share (such as mobile operator) is coerced to form exclusivity agreements with a player from another part of the value chain (such as over the top player) to carry a particular application and exclude others. This is against the FCC's *no blocking* rule. Such agreement is detrimental to user interests and the *Net Neutrality* principles and should be forbidden. In case of a bit pipe provider, the carrier is not allowed to block any open

internet traffic and it should be ensured that all over the top players are provided equal opportunity to make use of the network operator's internet transportation resources.

2. It is imperative to ensure that the technical specifications of certain collaborative integrations should be standardized and announced publically so that the platform is open and accessible for competitors to devise similar collaborative integrations to ensure user's openness of choice. This regulatory assurance will also eliminate the *perception of entrapment* as discussed in the Chapter 5 of this thesis. The closeness of platform and perception of entrapment proves to be detrimental to growth of the collaborative venture and can prove to be detrimental for one or both of the players as learned from the Google-Voice and Sprint as well as NTT DoCoMo i-mode's case studies.

3. Any form of application specific discrimination of Quality of Service should only be allowed if the user has been provided the interface, the ability to choose and control enabled by technology to select any application at any given time to be elevated above the best effort service level. Any QoS monetization mechanism where such a choice is not facilitated for the user should be considered a violation of Net Neutrality principles. The strategy to give the user the choice and control is coherent with the lessons learnt in the three case studies presented in this thesis. The regulatory framework's objective is to encourage consumer protection and progress in a business by creating an environment governed by rules of healthy competition and innovation. The lessons learnt from the three case studies consist of promoting collaborative innovation and user experience control only to the extent that they increase the value for the user and not beyond the threshold where the perception of intrusiveness results in reduction of value for end user.

Chapter 8

Technology Aspects of Monetization of QoS

"The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it."

—M. Weiser, The Computer for the 21st Century, 1991, p.4.

This chapter gives a technical perspective of what Internet QoS and mobile Internet QoS mean and the technology currently available and being orchestrated to monetize mobile Internet QoS. This chapter is a brief overview of diverse technical methods available and being developed to manage mobile Internet QoS and may not be considered comprehensive and definitive since new technology is being rapidly developed to facilitate this idea.

As discussed in the previous chapter while tackling the regulatory constraints, the Internet's openness is no doubt its most precious attribute, which also enables its scalability and extensibility. The following figure illustrates the remarkable openness of the internet, which allows the freedom to employ any network technology, any type of middleware software and any type of application and service across the same network.

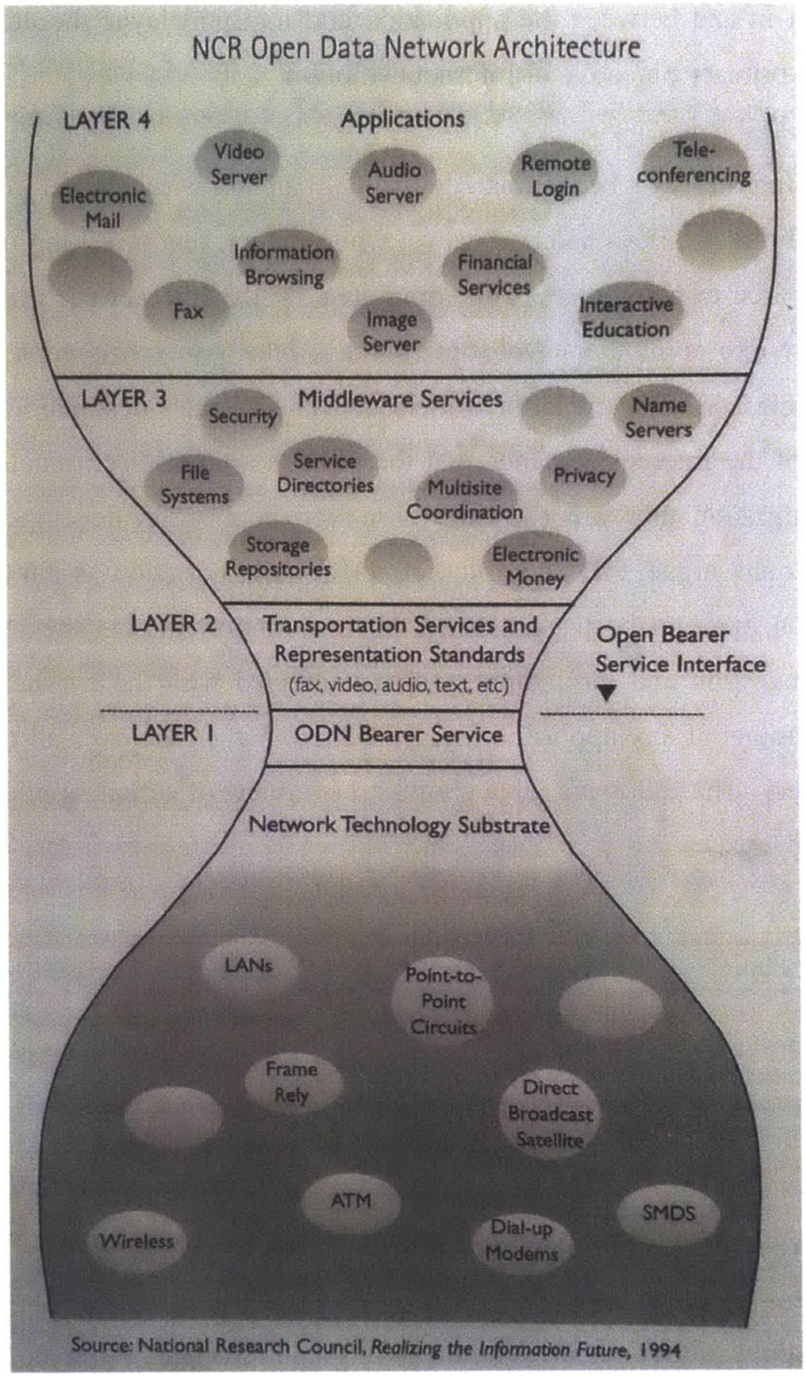


Figure 8-1: National Research Council, Realizing the Information Future, 1994

The National Research Council described this concept as an "open data network architecture", as long as the users, application developers and service providers all rely on the "bearer service" of the Internet Protocol- which allows it to transport any load. As long as the openness of the Internet platform is maintained, the innovations and advancement in and between the application and transport layer should only serve and not deter the primary objective of Internet evolution.

The Internet can be compared to an urban infrastructure of roads, highways, tunnels and bridges, alleys and walkways, while the packets travelling over the Internet can be compared to commuters. The commuters on the Internet use different modes of transport just like commuters who opt to walk, bike, use sports cars, high efficiency electric vehicles, SUV's, trucks or trailers and choose their destination. The size and complexity of the Internet demands that the packets are not discriminated based on the type of information they are carrying. However, application developers and network engineers would argue that the Internet traffic transportation is far from fair. The discrimination may not be packet based, but it definitely is dependent on the network capacity, congestion and throughput, which combined with the overhead requirements and specifications of any application, plays a great part in the over all efficiency of the packet delivery. The following table shows an overview of certain applications and their QoS requirements.

Application	*Reliability*	*Delay*	*Jitter*	*Bandwidth*
E-Mail	High	Low	Low	Low
File Transfer Protocol (FTP)	High	Low	Low	Medium
Web access	High	Medium	Low	Medium
Remote log-in	High	Medium	Medium	Low
Streaming audio	Low	Low	High	Medium
Streaming video	Low	Low	High	High
VoIP	Medium	High	High	Low
Videoconferencing	Low	High	High	High
Mobile TV	High	High	High	High

Table 8-1: Applications and corresponding QoS requirements. (Source: Nokia Siemens Network 2008: *Quality of Service requirements in tomorrow's connected world*)

8.1 Internet QoS Today

The Internet traditionally relies on the TCP protocol in the hosts to detect congestion in the network and reduce the transmission rates accordingly. TCP uses a window-based scheme for congestion-control and the window size corresponds to the amount of data being transferred between the sender and the receiver. In case of the detection of a packet loss by the TCP source, it slows down the transmission rate by slicing the window size to half and then increasing it if and when more bandwidth becomes available. TCP-based resource allocation requires all applications to use same congestion control method. However, modification in the TCP stack can enable stealing into more than a fair share of bandwidth. Also, the *best effort* service where all packets are treated equally, is simply not adequate for many new delay sensitive applications. (Wang, 2001)

8.2 Resource Assurance & Performance Optimization

Over the last decade, the Internet community came up with solutions namely Integrated Services and Differentiated Services as frameworks to support QoS over the Internet. While Integrated Services provided *resource assurance* through resource reservation for individual application flows, the Differentiated Services amalgamated edge policing, provision and traffic prioritization. (Wang, 2001)

Resource assurance is the first and performance optimization is the second most significant building block for supporting QoS over the Internet as it ensures the optimum and cost-effective resource utilization. Multiprotocol Label Switching (MPLS) provides the *explicit routing* capability to gain the necessary control over traffic paths to maximize resource utilization in the network by setting up virtual circuits in over the IP networks. Traffic engineering is employed for advanced route selection techniques, also referred to as constraint-based routing. (Wang, 2001)

8.3 Mobile Internet QoS

8.3.1 Technology Evolution of Mobile Standards

The 3rd Generation Partnership Project (3GPP) unites six telecommunications standard development organizations (ARIB, ATIS, CCSA, ETSI, TTA, TTC), known as "Organizational Partners" and provides their members with a stable environment to produce the highly successful Reports and Specifications that define 3GPP technologies. The 3GPP technologies from these groups are constantly evolving through Generations of commercial cellular / mobile systems (see Table 8-2 below). Since the completion of the first Long Term Evolution (LTE) and the Evolved Packet Core specifications, 3GPP has become the focal point for mobile systems beyond 3G.

The Generations of 3GPP Systems

Generation	GSM & 3GPP Major Milestones
1G	Analogue technology, from the 1980s on-wards. Various technologies were deployed, Nationally or Regionally, including: NMT (Nordic Mobile Telephone), AMPS (Advanced Mobile Phone System), TACS (Total Access Communications System), A-Netz to E-Netz, Radiocom 2000, RTMI (Radio Telefono Mobile Integrato), JTACS (Japan Total Access Communications System) and TZ-80n (Source:wikipedia▲)
2G	First digital systems, deployed in the 1990s introducing voice, SMS and data services. The Primary 2G technologies are: GSM/GPRS, CDMAOne, PDC, iDEN, IS-136 or D-AMPS. GSM/GPRS accounts for over 80% of all 2G subscribers (Source:wikipedia▲)
3G	Allowed a global vision for the evolution of 2G networks, with technologies that are enhancing theIMT-2000 family of systems. Primary technologies are EDGE (Enhanced Data for GSM), CDMA2000 1X/EVDO, UMTS-HSPA+
Moving beyond 3G	LTE and LTE-Advanced have crossed the "generational boundary" offering the next generation(s) of capabilities. With their capacity for high speed data, significant spectral efficiencies and adoption of advanced radio techniques, their emergence is becoming the basis for all future mobile systems. It should be noted that LTE-Advanced has qualified as an ITU-R IMT-Advanced radio interface

Table 8-2: The Generations of 3GPP Systems (Source: www.3gpp.org)

Although these Generations have become an adequate descriptor for the type of network under discussion, real progress on 3GPP standards is measured by the milestones achieved in particular Releases as depicted in the table below. New features are 'functionality frozen' and are ready for implementation when a Release is completed. 3GPP works on a number of Releases in parallel, starting future work well in advance of the completion of the current Release. Although this adds some complexity to the work of the groups, such a way of working ensures that progress is continuous & stable.

Table 8-3 below shows a brief description of various 3GPP Releases prior to and including the latest technology named LTE (Long Term Evolution).

Rel-99	Rel-5 (HSDPA)	Rel-6 (HSUPA)	Rel-7	Rel-8	Rel-9	Rel-10
WCDMA	HSPA		(HSPA+)	LTE		LTE Advanced
New Radio Interface (UTRA) FDD & TDD at 3.84 Mcps GSM/GPRS Internetworking DL: 384 kbps peak UL: 384 kbps peak	DL: 1.8-14.4 Mbps peak UL: 384 kbps peak	Real-time services (VoIP) Multicast (MBMS) DL:1.8-14.4 Mbps peak UL: 5.72 Mbps peak	Docus on decreasing latency Improements to QoS and real-time applications such as VoIP HSPA+ Edge Evolution	First LTE release All IP network (SAE) OFDMA, MIMO based radio interface	SAE Enhancements WiMAX and LTE/UMTS Interoperability	LTE Advanced fulfilling IMT Advanced 4G requirements Backwards compatible with release 8 (LTE)

Table 8-3: 3GPP Release-99 to Release-10

Release 99 – Specified the first UMTS 3G networks, incorporating CDMA air interface.- March 2000

Release 5 – Introduced mainly IMS, HSDPA (allowing broadband services on the Downlink), and other minor enhancements.- June 2002

Release 6 – Added HSUPA (enables broadband uploads and services), MBMS, and enhancements to IMS –Dec 2004

Release 7 – Introduced, among other features, enhancements to High-Speed Packet Access (HSPA+), QoS, and improvements to real-time applications like VoIP. –Sept 2005

Release 8 – Introduced E-UTRA (also called LTE, based on OFDMA), All-IP Network (also called SAE), MIMO based network- March 2008

Release 9 – SAE enhancements, WiMAX and LTE/UMTS Interoperability- Dec 2008

Release 10 – LTE Advanced fulfilling IMT Advanced 4G requirements.- March 2012

Release 11- E-UTRAN (Evolved Universal Terrestrial Access Network)- Stage 1 freeze Sept 2011

Release 12- LTE with high spectral efficiency, high peak data rates, short round trip time and frequency flexibility- Stage 1 freeze March 2012

8.3.2. Long Term Evolution (LTE)

Long Term Evolution (LTE) is the latest mobile standard in which voice in addition to data to be transferred through packet switched networks. This is a huge contrast to the previous cellular systems, such as 3G, where voice traffic was transferred through circuit-switched networks. LTE (Long Term Evolution) or the E-UTRAN (Evolved Universal Terrestrial Access Network) is the access part of the Evolved Packet System (EPS). The main requirements for the new access network are high spectral efficiency, high peak data rates, short round trip time and frequency flexibility.(Nohrborg,2013)

Following are some of the key drivers behind the development and launch of LTE:

a. User demand for higher data rates and quality of service
b. Continued demand for cost reduction (CAPEX and OPEX)
c. Low complexity by avoiding unnecessary fragmentation of technologies for paired and unpaired band operation

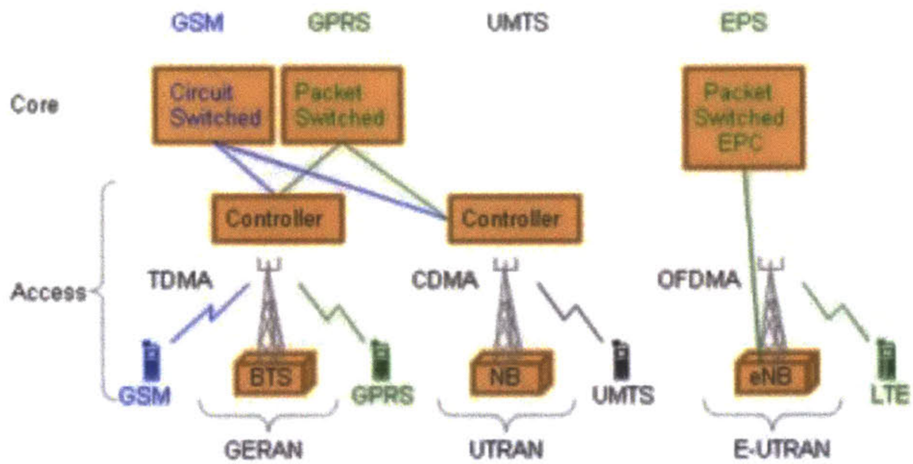


Figure 8-2: Evolution from GSM to LTE (Source: www.3gpp.org)

The GSM Mobile Standard was based on circuit switched technology, built to carry real time services; GSM could support the possibility of data services only through a circuit switched modem connection, with very low data rates. GPRS was the first leap towards IP based packet switched technology, with TDMA (Time Division Multiple Access) employed as air interface and access mechanism, which is similar to GSM.

With the objective of achieving higher data rates and data volume, 3GPP developed **Universal Mobile Telecommunications System** (**UMTS**), which is a Third generation (3G) mobile cellular system for networks based on the GSM standard. UMTS was developed with a new access network, based on CDMA (Code Division Multiple Access). The access network in UMTS operates like a circuit switched connection for real time services and a packet switched connection for data services (in black in fig. 8-2 above). In UMTS, an IP address is allocated to the UE (User Equipment) when a data service is established and released when the service is released. So the initial data connectivity services still rely upon the circuit switched core.

The Evolved Packet System (EPS) is purely IP based. Both real time and data services are carried over IP. As soon as the UE /mobile device is switched on, an IP address is allocated and that IP address is released when that device is switched off. LTE is based on OFDMA (Orthogonal Frequency Division Multiple Access) to be able to reach even higher data rates and data volumes. High order modulation (up to 64QAM), large bandwidth (up to 20 MHz) and MIMO (Multiple-Input/Multiple-Output) transmission in the downlink (up to 4x4) is also a part of the solution. The maximum theoretical data rate is 170 Mbps in uplink and with MIMO the rate can be as high as 300 Mbps in the downlink.

The **Evolved Packet Core (EPC)** is compatible with non-3GPP access technologies such as WiMAX and WiFi which can be further categorized as Trusted and Non-Trusted access networks. This categorization is based on the business relation/agreement between these networks and not on the technical grounds.

The LTE access network is simply a network of base stations, Evolved NodeB (eNB), generating a flat architecture. There is no centralized intelligent controller, and the eNBs are normally inter-connected by the X2-interface and towards the core network by the S1-interface. The reason for distributing the intelligence amongst the base-stations in LTE is to speed up the connection set-up and reduce the time required for a handover. For an end-user the connection set-up time for a real time data session is in many cases crucial, especially in on-line gaming. The time for a handover is essential for real-time services where end-users tend to end calls if the handover takes too long.

Beyond 3G wireless systems will support real-time (inelastic bandwidth demands), and non real-time (elastic bandwidth demands) traffic over a common packet-switched radio channel using QoS mechanisms to differentiate the traffic. A key challenge in accurately modeling user and system performance is to be able to simultaneously account for the impacts of mixed traffic types, QoS mechanism and varying radio channel. Over the last few years, researchers and engineers, have come up with numerous strategies, including traffic routing design and programming for the purpose of extending and combining a number of techniques into a single approximate analytic methodology for providing fast and accurate performance analysis of multiple inelastic and elastic traffic classes, subject to pre-emptive priority for the inelastic traffic.

Beyond 3G wireless broadband systems namely LTE and LTE-Advanced support a diverse range of real-time and non real-time services using only packet switching techniques, without the conventional dedicated channels of 3G and 2G systems. They will therefore use Quality of Service (QoS) schemes based on preemptive priority (3GPP TS 23.107 V6.4.0 & Alasti, Neekzad, Hui & Vanithamy, 2010) to ensure that the real-time or rate-"inelastic" traffic (e.g. voice over IP and video) has sufficiently high bandwidth and low delay for acceptable user quality. At the same time the systems should maximize the aggregate throughput (i.e. system efficiency) while also delivering practically usable performance for the non real-time or rate-"elastic" traffic types (e.g. web surfing, e-mail or file downloads). Beyond 3G wireless systems use "adaptive modulation and coding" (AMC) to maximize the data rate of each "call", depending on the "signal to interference and noise ratio"(SINR) experienced. Thus these systems exhibit variable capacity on the air interface. For the inelastic traffic this means that the radio resources (e.g. resource blocks in LTE) allocated to each connected session will vary depending on the SINR. On the other hand, the resources allocated to elastic calls are subject to variations in traffic patterns of the higher priority inelastic traffic, as well as the variable capacity radio channel. Hence the connected session could be (i) a real-time inelastic user session whose duration is driven only by holding time e.g. a voice call, and (ii) a non real- time elastic user session whose duration is driven by the combination of session volume in bytes and the available capacity, e.g. data transfer. A key issue in the design of these next generation wireless systems is how to evaluate the user and system performance for realistic user traffic comprising both inelastic and elastic calls at a range of loads. There have been a lot of work done in this field in terms of modeling and testing policies and mechanisms to distinguish elastic and inelastic data /type of traffic and then apply automatic rules to manage traffic optimization to ensure resource segregation and performance optimization based on alleviating the inelastic and elastic traffic from affecting the other. The same techniques can be applied to application-specific traffic optimizations based on similar schemes conceptualized from user-requested requirements whereas the access interface enables the orchestration of this choice to be user-controlled and hence fair and transparent. A few of such mechanisms are described in the sections below.

8.3.3 Cognitive Radio Admission Control Scheme

In order to provide QoS requirements in high speed future communication networks, such as LTE, the operator has to provide a Radio Admission Control algorithm which will guarantee the QoS of different service types (e.g. voice, data, video, ftp) while maximizing radio resource utilization. One such scheme is the Cognitive Radio Admission Control Scheme based on a Multilayer Feed-forward Neural Network. According to this scheme, the eNodeB performs Radio Admission Control using a cognitive engine that learns from the past experience how the admission of a new session would affect the QoS of all sessions in the future. (Bojovic, Baldo & Dini, 2011)

8.3.4 Network and Device aware Quality of Service

No matter what the service is, users will always expect powerful, sound and stable functions. For multimedia videos, stability is of the greatest importance. Users expect to watch videos smoothly and at a certain level of quality, no matter what changes occur in the network environment. However, the existing video platforms often provide inconsistent playback, resulting from the fluctuation of network on-line quality, especially with mobile devices, which have limited bandwidth and terminal unit hardware resources. As the number of network users is rapidly increasing, bandwidth insufficiency will occur and then network multimedia services will be affected significantly. In contrast to general services that have a high acceptance rate for packet loss, multimedia packets emphasize the correctness, sequence order and real-time nature of packets. When a multimedia video service standard is applied, the service quality declines greatly while trying to meet the demands of video transmission. Users often view live videos that freeze, have intermittent sound, or even fail to operate. Therefore, how to execute smooth playback with limited bandwidth and the different hardware specifications of mobile streaming is an interesting challenge. (Wang, Lai, Chao & Nan, 2011)

8.3.5 Interactive Mobile Multimedia Services

H.264/SVC is an extended coding and decoding architecture based on H.264/AVC. The benefit of H.264/SVC is that it can adjust the image quality dynamically, according to the bandwidth of the receiving end. The draft was proposed in April of 2004 and was decided on in November of 2007. SVC puts forward a brand-new layered architecture. This hierarchical structure can realize the scalability of temporal, spatial and quality dimensions. The spirit of SVC is that the receiving end is sure to receive image packets of the lowest quality for decoding. The image layer with the lowest quality is called the base layer. The base layer of SVC is completely compatible with H.264/AVC, and when there is enough bandwidth to receive image packets with higher quality, the decoder will carry out reference decoding according to the received packets, which is to say, high quality image packets cannot resolve images independently; the image packet of the base layer must be consulted for decoding. In terms of the scalability of the three dimensions, SVC uses the hierarchical B-picture method to realize temporal scalability, down/up sampling filters and inter-layer prediction to realize spatial scalability, and Signal-to-Noise Ratio (SNR) scalability and a Metal Gear Solid (MGS) Codec to realize quality scalability. The scalability of hierarchies in the video can be determined during the course of coding. (Wang, Lai, Chao & Nan, 2011)

In addition, interactive mobile multimedia services communicate and coordinate the mobile device with the server-side to select the multimedia file applicable to the device environment (bandwidth, resolution and arithmetic capability) (Psannis, Ishibashi, Hadjinicolaou, 2007), (Saranya & Vijayalakshmi, 2011) so as to realize an optimal multimedia streaming service. This previous study proposed an interactive mobile multimedia service over cloud computing, which was introduced in (Lai & Vasilakos, 2010), (Chang & Huang, 2012) In the previous service, the mobile device side exchanges information with the cloud environment, so as to determine an optimum multimedia video. Scholars have done numerous researches toward conventional platform, which is the Content Data Network (CDN) to store different movie formats in a multimedia server, to choose the right video stream according to the current network situation or the hardware calculation capabilities. To solve this problem, many researches have attempted dynamic encoding to transfer media content, but still cannot offer the best video quality.

This is due to the time consuming fact that traditional encoding requires re-coding of the entire multimedia content. (Lai, Wang, Chao & Nan, 2011)

8.4 Bearers & QoS – EPS QoS Parameters

8.4.1 Default & Dedicated Bearer

One EPS bearer is established when the UE connects to a Public Data Network (PDN) and it remains established throughout PDN lifetime. This is default bearer. Any additional EPS bearer for the same PDN is referred to as a dedicated bearer.

8.4.2 GBR Vs. Non-GBR

An EPS bearer is referred to a GBR if it offers a Guaranteed Bit Rate, else it would be a Non-GBR bearer. Each bearer has an associated QoS parameter. Default EPS bearer is always non-GBR, where as dedicated can be either.

Following table shows the Quality Control Indicator levels in LTE where GBR stands for Guaranteed Bit Rate and Non-GBR stands for Non-Guaranteed Bit Rate.

> Since Bearers are established in LTE as discussed above, the priority levels with corresponding packet delay and packet error loss rates are depicted in the table. QoS can be enforced and controlled per EPS bearer or a set of aggregated EPS Bearers.

8.4.3 QCI – QoS Class Identifier

QCI is used as a reference to access specific parameters that control how bearer level packets are forwarded.

Bearers & QoS: EPS QoS: QCI Service Characteristics

QCI	Resource Type	Priority	Packet Delay	Packet Error Loss rate	Example Services
1	GBR	2	100	10^{-2}	Conversational Voice
2		4	150	10^{-3}	Conversational Video (Live Streaming)
3		5	300	10^{-6}	Non-Conversational Video
4		3	50	10^{-3}	Real Time Gaming
5		1	100	10^{-6}	IMS Signaling
6	Non-GBR	7	100	10^{-3}	Voice, Video Live Streaming
7		6	300	10^{-6}	Video (Buffered Streaming)
8		8	300	10^{-6}	TCP (Email, Chat, ftp)
9		9	300	10^{-6}	File Sharing

Table 8-4: Bearers & QoS: QCI Service Characteristics

8.4.4 PCRF (Policy & Charging Rules Functions)

- Policy & Charging Rules Functions (PCRF) encompasses business and technological rules that govern which network services a subscriber can access at what bandwidth level, when and for how long.

- It aggregates information in real time to support creation of rules and automatically making intelligent policy decisions for active subscribers.

8.5 Network Application Plug-Ins (APIs)

Open operator APIs is the terminology that describes exposure of the operator's internal assets to third parties across well-defined open interfaces. . Such APIs can serve the vastly diverse purposes ranging from enhanced network QoS delivery for video content through subscriber's data management assets for profiling and advertising. The objective is to provide the content and application developers with an opportunity to offer a better service than would be possible in the regular over the top environment and with no access to the operator's internal assets. The following figure shows some developer programs that make use of, and encourage development, to open APIs.

COMPANY	PROGRAM	COMMENTARY
Orange	Partner	Well-established developer program, with over 30 APIs published; includes Orange Application Shop
Swisscom	Open APIs	Small-scale program for voice call management apps, such as click to call
Telecom Italia	Next Open Innovation	Includes Telecom API and Device SDK programs; primarily a test lab with limited base of users
Telefónica	WIMS	An open API program focused on IMS using REST principles
Vodafone	Betavine; Vodafone 360	Betavine is a small-scale development program that includes a few open APIs; Vodafone 360 offers APIs based on JIL, linked to OneAPI

Table 8-5: Examples of APIs Operator/Developer Programs (Source: Brown, 2012)

In contrast to the profitability witnessed in a closely integrated collaborative initiative taken by NTT DoCoMo while completely tying the content providers to its proprietary platform, here the revenue sharing terms are not as immediately promising. While there are not many API-oriented services generating substantial revenues today; there is a certainly a long-term strategic promise of value associated with these initiatives. At the very least, such services help operators form closer ties with the third party content providers, and help the operators attain a better position in the evolution of the telecommunications value chain where their status could be elevated from being the silent by-standers who (without such Network API's) have no linkage with the content developers and hence no standing ground to progress towards a fairer share in the future telecommunications value chain.

It is imperative to note that this thesis presents a brief overview of the various current and future technical approaches to manage mobile Internet QoS. Additionally, new technological solutions are being rapidly developed to facilitate management and monetization of QoS.

Chapter 9

Future Work

9.1 Collaborative Innovation & User Experience Control

"Innovation— any new idea—by definition will not be accepted at first. It takes repeated attempts, endless demonstrations, monotonous rehearsals before innovation can be accepted and internalized by an organization. This requires courageous patience."

— Warren Bennis

This notion about reiterative improvements holds even stronger in the case of collaborative innovation, as the two or more firms collaborating have to break internal inertia as well as the combined inertia of the collaborative venture, iteratively, till the collaboration failure rate is reduced to a minimum (refer to Figure 5-3 & Figure 5-4, Chapter 5). The collaborative innovation ventures and strategic business alliances as depicted from the zero.facebook.com, NTT DoCoMo and Google Voice-Sprint case studies will be replicated more in the near future marking the transformation of the telecommunications ecosystem and the evolution of the traditional value chain into a vlue network as explained in Chapter 1 and Chapter 5 of this thesis.

One such example was very recently reported by the Wall Street Journal on June 26, 2013 from New Delhi, India, that Google Inc. and Bharti Airtel Ltd. have announced the joint venture launch of the "Free zone," or free Internet, for first time mobile Internet users in India, which happens to be the world's second largest telecom market, (Krishna, 2012). This venture is also targeted for a price-sensitive customer base by offering a low cost value service feature for the consumers. Voice connectivity has become a commodity in emerging and competitive mobile markets of Africa and South Asia, where mobile Internet services are generating the most revenue as the tariffs for voice calls are amongst the lowest in the world due to the fierce competition and price wars between incumbent and entrant mobile operators amidst their efforts to claim the available market share. The free Internet zones will enable Airtel mobile customers access to mobile web search and will feature phone-friendly versions of Google's email and Google+ social networking services. This is a very recent example of the subtle application of Quality of Service discrimination, on the same lines as was witnessed in the case of zero.facebook.com.

"Free Zone aims to put the web in the hands of more people and empower first time Internet users with several useful services of the Internet," the two companies said in a statement. "The first page of a website linked from search results is provided at no data cost." (Krishna, 2012).

Aligned with the common theme of the three case studies evaluated in this thesis, this recent example of the Free Zone collaborative venture not only represents an example of the mobile operators getting into the content side of the Internet, but also shows the inevitable application-specific discrimination in a subtle way. It is noteworthy that, similar to the zero.facebook.com case, the viewers will be getting a flavor of Google email, Google + for social networking and some searching and surfing for free, in certain Free zones offered by a telecom operator. This is also a salient example of shaping consumer experience. The developed and saturated markets such as US and Europe should foresee the monetization of QoS of mobile data as an inevitable transition or at least an incubatory step which will lead to the evolution of the telecommunications value chain where the mobile operators will be involved in the user's Over the Top experience of content and applications in a more meaningful way. With the right regulatory policies in place, this involvement can be made fair, transparent and beneficial for the user as well as for the service provider.

From the three cases studies, the themes of collaborative innovation and user experience control were extrapolated and explored in the aggregated model of this thesis. However, it is important to understand that some times the collaborative venture has little to do with innovation in technology and more to do with bundling of two or more services to shape the user experience. This was observed in the three case studies and is analogous to the example of popcorn and movies. The two products are developed independently. However, their businesses are complimenting each other. When more people go to the movies and buy expensive popcorn at the movie theatre, the popcorn sales increase. However, it is still essential to make good movies and market them well for more people to be willing to go to the movie theatre. Similarly, the popcorn quality has to be maintained at a certain level for people to keep associating a good movie experience with popcorn consumption.

9.2 LTE & Small Cell Mobile Technology

While the Release 8 of LTE as described in Chapter 8, has enabled the packet-based transportation for voice and data alike, the future development in mobile technology governed by 3GPP is being orchestrated based on the data traffic needs and management.

The enhancements for small cells have now been specifically prioritized as a key component of Release 12 of the 3GPP standard. The mobile operators are considering numerous ways to increase capacity to meet the data explosion; with more spectrum, interworking with other access technologies, or through the use of new antenna technologies. All have a role to play, but Matthew Baker identified as 'vital' the role of small cells (Baker, 2013)

Addressing the Small Cells World Summit, in London on June 25th 2013, Baker said "Small cells using 3GPP radio access technologies will enhance capacity and per-user throughput, as well as reducing costs and uniquely offering tight cooperation with the macro coverage layer. Further optimization is coming, especially aimed at dense deployments with large numbers of small cells in hot-zones." The maximum potential benefits of the Small Cells enhancement in the mobile technology can only be reaped with the monetization of Quality of Service of mobile data.

9.3 QoE Management Framework

In Chapter 6, section 6.2 of this thesis, some differentiation was established between Quality of Service (QoS) management and Quality of Experience (QoE) management. The next evolutionary step from the monetization of QoS for mobile data is the management of Quality of Experience. Most of the mobile operators are already conducting quality and connectivity surveys and data mining analysis to measure Quality of experience for voice services mainly. This concept should be further applied to Voice, Video and Data, once the mobile operator has the required insight and QoS visibility into the user's data connectivity experience.

To correctly measure the "user experience" of service quality, appropriate QoE metrics should be defined. The measurement metrics should include factors that indicate quality levels. QoS metrics indicate the availability, reliability and quality, each for reflections among service accessibility and latency on network traffics. The quality of service can be measured with the video resolution, application response time as well as user feedback and rating measures currently utilized by the content evaluation processes in place. The QoE metrics would essentially also include objective QoS parameters such as bandwidth, delay, loss or jitter, and human factors such as emotions and experience (ITU-T, 2008). For specific service areas such as video streaming, services may include application level QoE metrics such as frame rate, resolution (ITU-T, 2008), re-buffering events (Huysegems, Vleeschauwer & Schepper, 2012), interactive delay (Yuan, Zimu & Baochun, 2011) and interruption (Gheibi, Medrad & Ozdaglar, 2011)

Each service is different from each other, and different characteristics may require different metrics for QoE measurement. For example, a service, which requires data to be downloaded, such as FTP, may regard the bandwidth as the most important measurement metric. A video service such as IPTV may need complex quality metrics for file transfer, and may include jitter as a key QoE metric. For the above reason, it is difficult to choose an optimum set of metrics that is suitable for all services. We may first consider all possible QoE metrics before QoE measurement, and may remove unimportant factors after evaluating their influence on a specific service. While broadening the QoS measurement and monetization by including the social elements of the experience and encompassing the evaluation and management of Quality of Experience, QoE management frameworks can be developed to amalgamate the additional experience elements and correlated the Quality of Service with the other parameters affecting the user experience.

9.4 The Aggregated Model

The aggregated model presented in the Figure 5-1 and Figure 5-2 (Chapter 5) is considered in this thesis for one value chain player at a time. For future work and further extrapolations, sensitivity analyses and testing policy levers such as regulatory techniques and service feature life cycles, it is noteworthy, that the aggregated model can be used simultaneously for two or more different players of the telecommunications value chain. The model presented here can be further utilized by considering it in the form of super imposed layers when being employed to analyze the parameters for more than one value chain player simultaneously. For example, the collaborative failure rate of two value chain players can be analyzed for the third player's measurement of *barriers to new entrants* and the expected consumer surplus share can be evaluated as a sum of expected revenue for two service providers operating in collaboration or *coopetition.*

9.5 The Regulatory Policy Recommendations

The regulatory concerns and the debate around application-agnostic and application-specific Quality of Service management for mobile data has been discussed in the 7th

Chapter of this thesis in detail. However, to conclude, it is strongly recommended for regulatory authorities and policy makers in the US in particular, and Europe and the rest of the world in general to acknowledge the monetization of QoS of mobile internet as an existing technical capability which is constantly being enhanced with upcoming mobile advancements such as Long Term Evolution (LTE) and others discussed in Chapter 8, and an impending business reality which has been considered seriously by mobile operators and content providers for quite some time now. In the interest of innovation, generating better value for the end user and efficient network resource management, the regulatory authorities should play an effective part by acknowledging this phenomenon and developing policies to ensure better visibility, transparency and accountability within this realm.

APPENDIX A

Questionnaire for interviews with stakeholders across the telecommunications industry

1. What is the next 3-5 year product strategy?

- Voice becoming commodity?
- 'All you can eat data' bundles sustainable?
- Premium charges by service based traffic segregation a possibility?
- What are the new generation services currently being focused for leveraging existing investments in the network infrastructure?
- Cloud based services a major focus for CSPs? If so what are some of major corporate, consumer services being offered now? In near future?
- Any plans to move towards carrier services?
- If mobility not a core service, are there plans to add mobility? Own network or MVNO?
- If fixed line not a core service, are there any plans to add fixed? Cable / Copper / Fiber? Own network or partnership with an existing fixed player?
- Is convergence (fixed / mobile) a key for survival?
- What is the main hurdle in offering new services to customers?

2. What is the main revenue driver?

- What is the main revenue driver in the Internet / Voice / Video bundles?
- What percentage of revenue can be attributed to Voice? Data? TV/Video? What's the trend in 3-5 years?
- How's interconnect revenue distribution changing?
- Is consolidation the way forward to achieve economies of scale? Have reached the point in telecom spiral where consolidation is inevitable for cost control and revenue sustainability?

3. What is the investment strategy for the next 3-5 years?

- o Key investment focus on network, user experience, service offering flexibility?
- o Investment in 4G (LTE…) essential for survival for wireless operators?
- o Investment in spectrum is on the up?
- o Acquisition part of the next 3-5 year strategy? If so for customer base? economies of scale? Spectrum?

4. Where is your customer intake?

- o Main hook for new customers?
- o Main hook for existing customers to stay?
- o What is the net additions now? Target for next 3-5 years?

5. Where do you see main customer Churn?

- o Current Churn?
- o Main reasons for Churn?
- o Main customer segment Churning?
- o Key strategy for controlling Churn? Price? Service? Technology?

6. What would be the evolving market competition like in the next 3-5 years?

- o How's the competition is changing with advent of outside players?
- o What is the key strategy to counter that? Offer similar services? Cloud based services? Service based traffic charging?
- o What's the emerging role for device manufacturers?

7. How's online video changing the face of TV/Video services?

- o Are the subscriptions to TV bundles going down with online (mostly free) TV services?
- o Cable / Satellite TV is a major revenue pipe? What's future of Cable?
- o Cable survival based on TV or Internet?

8. How are you planning to cope with increasing demand for data pipes?

- Demand for ubiquitous connectivity?
- Core, transmission and access network capacity?
- 4G spectrum acquisition and network upgrade have a business case? Or survival case?

9. How's commercial TV services changing in next 3-5 years?

- On demand on the rise?
- IPTV becoming mainstream? What's the impact?

10. How's broadband services changing in next 3-5 years?

- Broadband still being offered as commodity fixed cost bundles? What's the future?
- Consumers willing to pay for premium speed? Access?

11. Is content the main revenue driver in near future?

- What is the current revenue share for content based services? On the rise?
- CSP's share in the content revenue?

12. Who do you see as the key competition in 5-7 years (Netflix, Google, Telco's)

- Google / Skype encroaching on the CSP revenue? Future trend?
- CSP becoming dumb pipe providers?

13. How do you see the regulatory environment playing a key role in coming years?

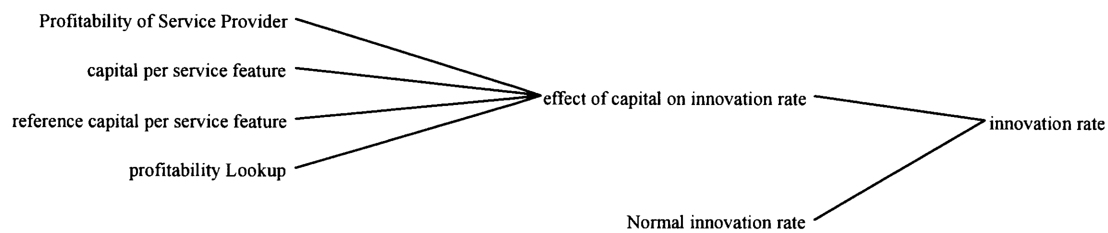
- What is the key regulation shift foreseeable?
- CSP should be allowed to charge premium for certain traffic type (VoIP traffic)?

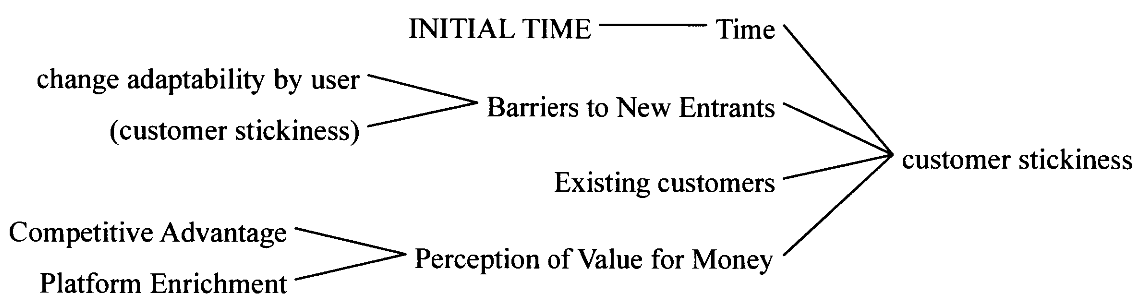
14. How does US market in triple play differ from other developed markets such as Europe?

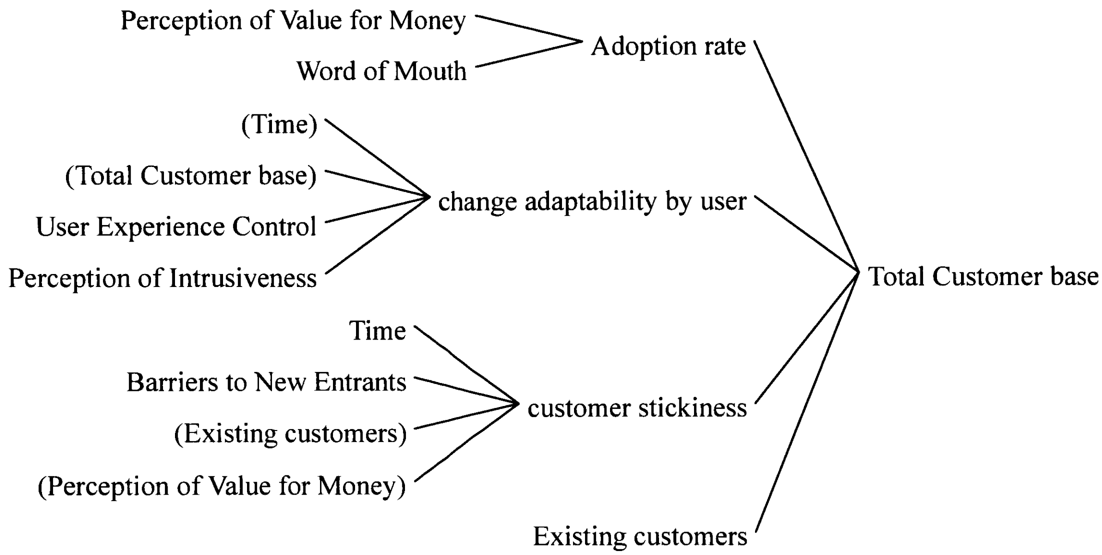
- In terms of service offerings?
- Regulatory framework?
- Customer trend?
- Investment strategy?

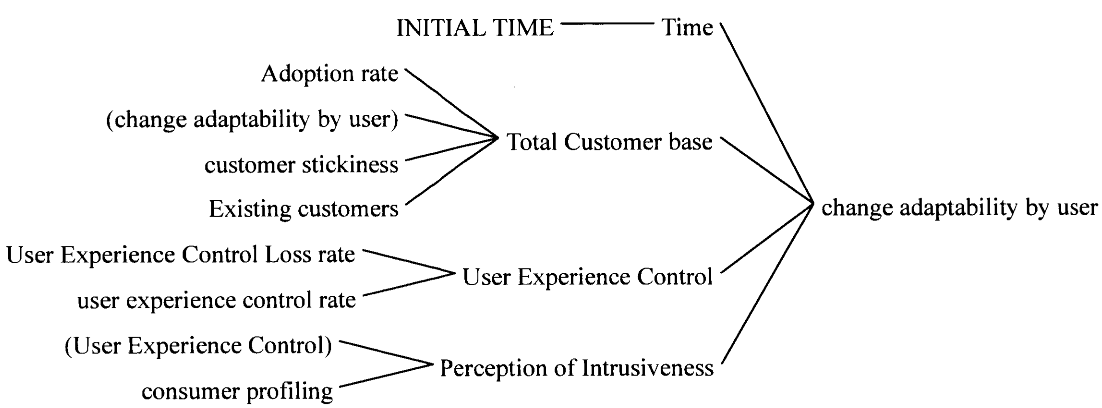
APPENDIX B

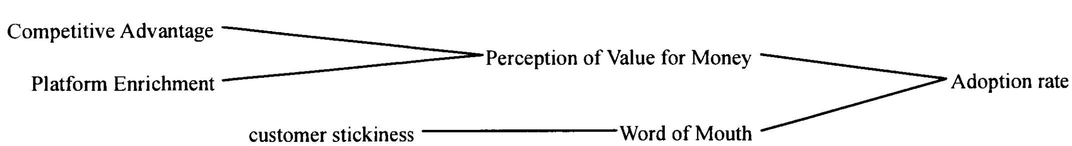
Causal Trees for Some Parameters in the Aggregated Model

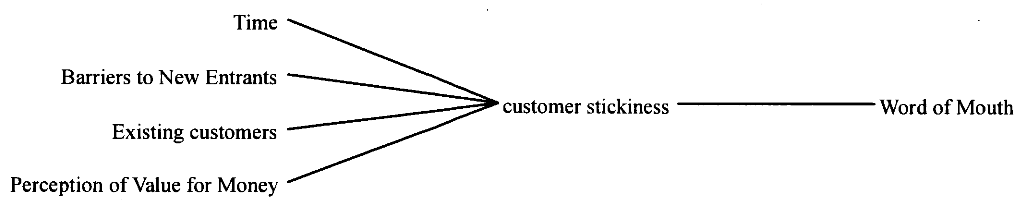


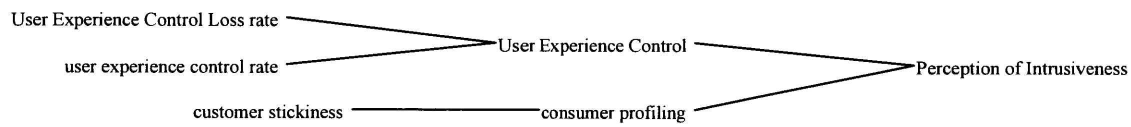


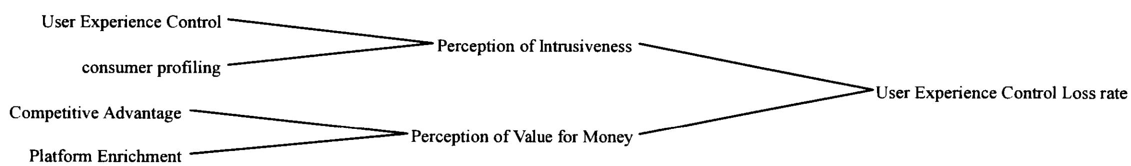

Perception of Value for Money
Word of Mouth
Adoption rate
(Time)
(Total Customer base)
User Experience Control
Perception of Intrusiveness
change adaptability by user
Total Customer base
Time
Barriers to New Entrants
(Existing customers)
(Perception of Value for Money)
customer stickiness
Existing customers

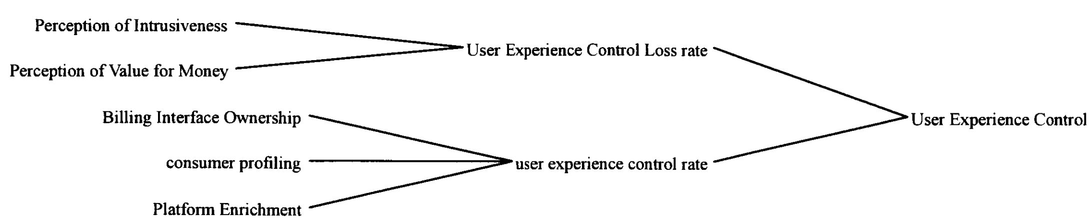

INITIAL TIME
Time
Adoption rate
(change adaptability by user)
customer stickiness
Existing customers
Total Customer base
User Experience Control Loss rate
user experience control rate
User Experience Control
(User Experience Control)
consumer profiling
Perception of Intrusiveness
change adaptability by user

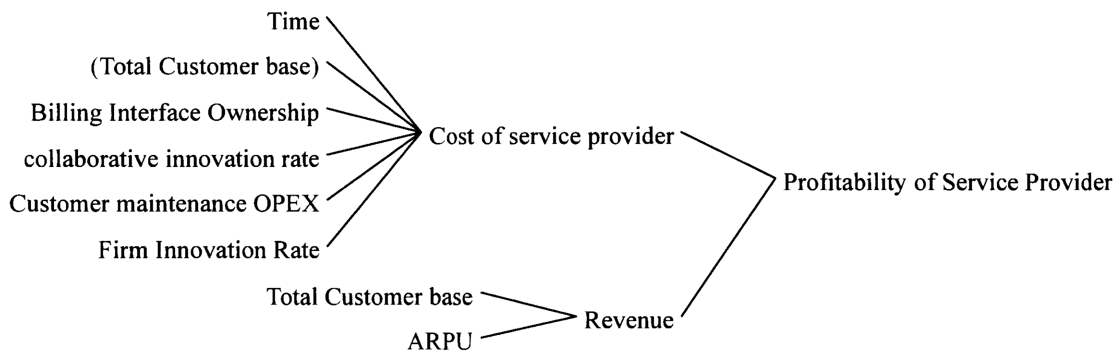

Competitive Advantage
Platform Enrichment
Perception of Value for Money
customer stickiness
Word of Mouth
Adoption rate


Time
Barriers to New Entrants
Existing customers
Perception of Value for Money
customer stickiness
Word of Mouth

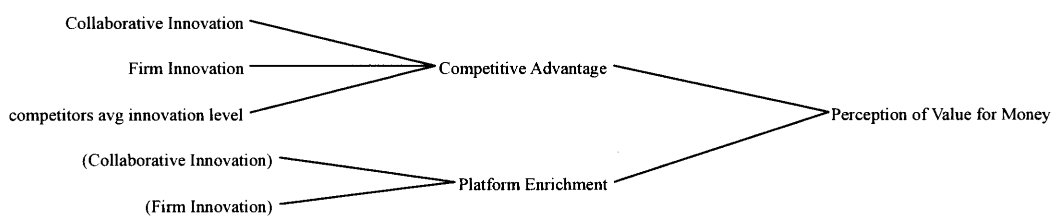

User Experience Control Loss rate
user experience control rate
customer stickiness
User Experience Control
consumer profiling
Perception of Intrusiveness


User Experience Control
consumer profiling
Competitive Advantage
Platform Enrichment
Perception of Intrusiveness
Perception of Value for Money
User Experience Control Loss rate

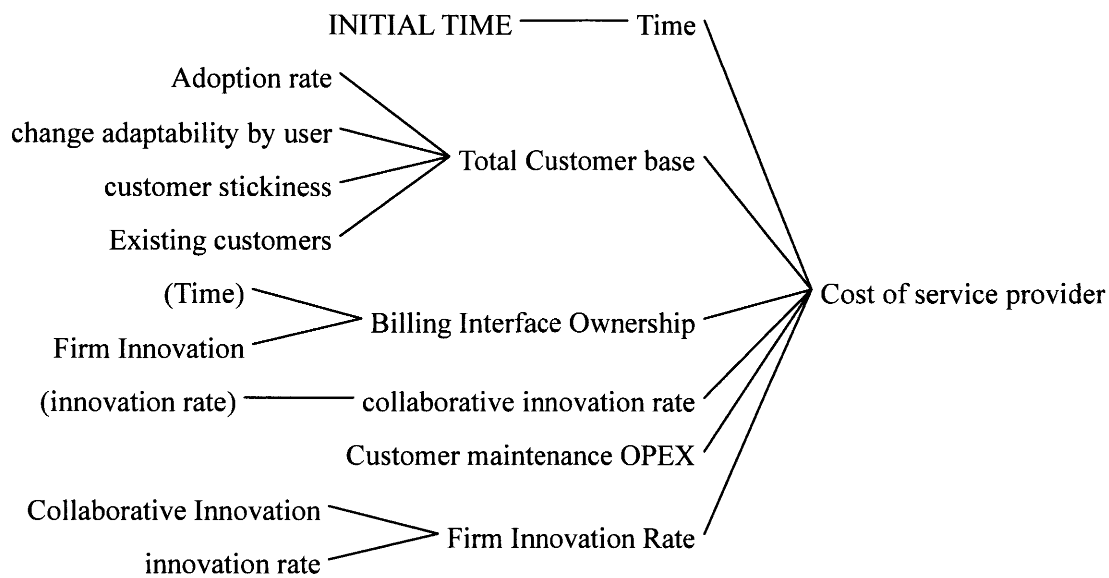

Perception of Intrusiveness
Perception of Value for Money
Billing Interface Ownership
consumer profiling
Platform Enrichment
User Experience Control Loss rate
user experience control rate
User Experience Control



Time
(Total Customer base)
Billing Interface Ownership
collaborative innovation rate
Customer maintenance OPEX
Firm Innovation Rate
Cost of service provider
Profitability of Service Provider
Total Customer base
ARPU
Revenue



Collaborative Innovation
Firm Innovation
competitors avg innovation level
Competitive Advantage
Perception of Value for Money
(Collaborative Innovation)
(Firm Innovation)
Platform Enrichment


INITIAL TIME
Time
Adoption rate
change adaptability by user
customer stickiness
Existing customers
Total Customer base
(Time)
Firm Innovation
Billing Interface Ownership
(innovation rate)
collaborative innovation rate
Customer maintenance OPEX
Collaborative Innovation
innovation rate
Firm Innovation Rate
Cost of service provider

APPENDIX C

Equations for basic run stimulation of the aggregated model

1. Adoption rate=Perception of Value for Money+Word of Mouth

   Units: cust/year

2. ARPU=

   "Consumer spending (on QoS etc)"+Platform Enrichment

Units: $/year

3. Barriers to New Entrants= INTEG (customer stickiness-change adaptability by user,0)

   Units: dmnl [0,10]

4. Billing Interface Ownership=

   Firm Innovation/Time

   Units: dmnl/year

5. capital per service feature=

   RAMP(max capital/(FINAL TIME-INITIAL TIME), INITIAL TIME, FINAL TIME)

   Units: $/service feature

6. change adaptability by user=

   (Perception of Intrusiveness-User Experience Control)* Total Customer base *Time

   Units: cust/year

7. Collaboration Failure rate=

   innovation obsoletion rate + integration faults

Units: dmnl/Month [0,10]

8. Collaborative Innovation= INTEG (collaborative innovation rate-Collaboration Failure rate,0)

   Units: service features [0,100]

9. Collaborative innovation rate=100 * innovation rate

   Units: service features/year

10. Competitive Advantage=

    Collaborative Innovation Firm Innovation-competitors average innovation level

    Units: service features [0,100]

11. Competitors average innovation level= constant value of 50 inferred from market data on service features of mobile service features including package plans etc

    Units: service features

12. consumer profiling=0.8*customer stickiness (various fractions of customer stickiness were tried)

    Units: dmnl [0,10]

13. Consumer spending (on QoS etc)= Perception of Value for Money

    Units: $/Month [0,10]

14. Cost of service provider=

    (Billing Interface Ownership * Total Customer base)/Time + Firm Innovation Rate

    + 0.5* collaborative innovation rate+(Total Customer base

    *Customer maintenance OPEX)

    Units: $/year

15. Customer maintenance OPEX= MAX[OPEX, BILLING INT OWNERSHIP+OPEX] is the operational cost of maintaining one customer per year

    Units: $/year

16. Customer stickiness=

    (Barriers to New Entrants+Perception of Value for Money)*Existing customers *Time

    Units: cust/Month [0,10]

17. Effect of capital on innovation rate=

    Profitability Lookup (capital per service feature/reference capital per service feature)*0.1*Profitability of Service Provider

    Units: dmnl

18. Existing customers=

    1e+06

    Units: customers

19. FINAL TIME = 2053

    Units: year

20. The final time for the simulation.

    Firm Innovation= INTEG (Firm Innovation Rate-firm innovation failure rate,1)

    Units: service features

21. Firm innovation failure rate= constant values tested ranging 0 to 10

    Units: service features/year [0,10]

22. Firm Innovation Rate= ACTIVE INITIAL (

    RAMP(2,0,(3*innovation rate + 0.3*Collaborative Innovation)), 10)

Units: service features/year [0,50,1]

23. INITIAL TIME = 2013

    Units: year

    The initial time for the simulation.

24. Innovation obsoletion rate=RAMP (1,0,0.1)*Time

    Units: service features/year

25. Innovation rate=

    Normal innovation rate*effect of capital on innovation rate

    Units: service features/$/year

26. Integration faults=

    1 to 30

    Units: service features/year

27. Max capital= fraction of profitability

    Units: $/service feature

28. Normal innovation rate

    Units: service features/year

29. Perception of Intrusiveness=

    0.5*consumer profiling + 0.5*User Experience Control

    Units: dmnl

30. Perception of Value for Money=

    Competitive Advantage*Platform Enrichment

    Units: $/service feature [0,100]

31. Platform Enrichment=

Collaborative Innovation + Firm Innovation

Units: service features [0,10]

32. Profitability Lookup(

[(0,0)-(30,100)],(0.794297,4.7619),(6.17108,19.5238),(12.4644,30),(16.2525,35.2381),(19.8574,47.1429),(24.1955,62.381),(27.2505,62.381),(29.6334,63.8095))

Units: dmnl

33. Profitability of Service Provider= INTEG (

Revenue-Cost of service provider,0)

Units: $ [0,10]

34. Reference capital per service feature= various constant values tested

Units: $/service feature

35. Revenue=

ARPU*Total Customer base

Units: $/year

36. Total Customer base= INTEG (

Adoption rate + customer stickiness*Total Customer base-change adaptability by user*Total Customer base, Existing customers)

Units: customers

37. User Experience Control= INTEG (user experience control rate-User Experience Control Loss rate, 1)

Units: dmnl

38. User Experience Control Loss rate=

    Perception of Intrusiveness-Perception of Value for Money

    Units: dmnl/Month

39. User experience control rate=

    Billing Interface Ownership+ consumer profiling +Platform Enrichment

    Units: dmnl/Month

40. Word of Mouth=

    0.5 * customer stickiness

    Units: cust/Month

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