Understanding Platform Business Models in the Telecommunication Industry

by

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1.1 ABSTRACT

Telecommunication (telecom) companies face increasingly tough times as digitization reshapes the industrial landscape. In 2012, telecom companies acknowledged that over-the-top (OTT) communication services have become the greatest threat to their revenues. OTT communication services use the internet to deliver an array of services such as voice, video calls, and messaging. Some of the most popular OTT companies are Skype, WhatsApp, WeChat, Google Hangouts, Viber, Line, etc.

The continued business disruption is driving telecom companies to investigate platform-based business models as key ingredients to survival. Platform business models are the core of some of the most powerful and fastest-growing companies such as Alibaba, Uber, Airbnb, Facebook, etc. Platform businesses bring together producers and users in efficient exchanges of value. These models are known for leveraging network effects, which means the more participants on the platform, the greater the value produced.

With the appearance of the 5th generation (5G) of mobile network connectivity, telecom companies need to know how they can protect themselves from being delegated by disruptors as commodity connectivity providers. In this thesis, we explored the areas where 5G can have an impact in the next five years. We used a technique developed by Professor Marshall Van Alstyne. The technique consists of plotting an interaction's perceived value versus interaction volume then selecting the area with the highest interaction of perceived value and volume. Results showed that immersive media has these characteristics.

After we identified the area, we selected a platform using the concept evaluation methodology. The most feasible multi-sided platform (MSP) for the telecom industry in the next five years is a 360° HD video platform with live and recorded long-tail content (large number of unique items with relatively small quantities). The MSP consists of four sides: users, content developers, advertisers, and software developers. Platform launch, monetization, openness and network effects strategies are proposed. Moreover, a financial analysis was performed. Results show the proposed MSP is a feasible option. Finally, a stakeholder analysis compares an existing digital platform versus our proposed platform. Results show similar behavior.

Thesis Supervisor: Professor Marshall Van Alstyne
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Finally, to my son, whom I look forward to meeting soon.

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Table of Contents

List of Figures

List of Tables

Acronyms

1G	1st generation mobile network
2G	2nd generation mobile network
3G	3rd generation mobile network
4G	4th generation mobile network
5G	5th generation
ACSI	American Customer Satisfaction Index
AR	Augmented Reality
ARIES	Antenna Radio Integration for Efficiency in Spectrum
AT&T	American Telephone and Telegraph
B2B	Business to Business
B2C	Business to Customers
CLD	Causal Loop Diagram
CNN	Cable News Network
CRM	Customer Relationship Management
CTA	Consumer Technology Association
CTIA	Cellular Telecommunications Industry Association
CWA	Communication Workers of America
DIY	Do It Yourself
DSM	Design Structure Matrix
DVD	Digital Video Disc
EBITDA	Earnings Before Interest, Tax, Depreciation and Amortization
EY	Ernst & Young
FCC	Federal Communications Commission
GB	Gigabyte
GSMA	GSM Association
HD	High Definition
HTC	High Tech Computer Corporation
HUD	Head-Up Display
ICT	Information and Communication Technology
IDE	Initiative on the Digital Economy
IoT	Internet of Things
IPTV	Internet Protocol Television
ISP	Internet Service Provider
IT	Information Technology
JAVA	Type of programing language
LG	Lucky Goldstar
LNP	Local Number Portability
LTE	Long-Term Evolution
M&A	Mergers and Acquisition
MATLAB	Matrix Laboratory Programming Language.
MAU	Monthly Active Users
MB	Megabyte
MIMO	Multiple Input, Multiple Output
MIT	Massachusetts Institute of Technology
MLS	Major League Soccer
MSP	Multi-Sided platform
NBA	National Basketball Association
NCTA	National Cable and Telecommunication Association

NES	Nintendo Entertainment System
NFL	National Football League
NPV	Net Present Value
NTT	Nippon Telegraph and Telephone
OECD	Organization for Economic Co-operation and Development
OTT	Over the Top
PS	PlayStation
Q3	3rd quarter
QIVICON	Smart Home Platform
R&D	Research and Development
ROIC	Return on Invested Capital
SDM	System Design and Management
SIM	Subscriber Identification Modules
SMS	Short Message Service
TV	Television
UAV	Unmanned Aerial Vehicle
UPS	United Parcel Service
US	United States
USA	United States of America
VR	Virtual Reality
WFVO	Weighted Value Flow Occurrence
WLNP	Wireless Local Number Portability
WSO	Weighted Stakeholder Occurrence

Nomenclature

Variable	Description	Units
Ads	Ads per hour	[ads/hour]
CD	Cost of data	[millions of dollars/year]
CPGB	Cost per GB	[$/GB]
CPM	Average cost per thousand	[$/1000 ads]
CPU	Cost per user	[$/user]
DU	Data usage for Ultra HD video	[GB/hour]
GBY	Number of GB per year	[millions of GB/year]
HV	Hours of video per year	[millions of hours/year]
IA	% of initial adopters	[%]
MAU	Monthly active users	[millions of users]
R	Revenue	[millions of dollars]
Split	Revenue the telecom keeps from ads	[%]
t	hours spent per week	[hours/(week*user)]
TCP	total cost for running the platform	[millions of $]
U	5G users	[millions of users]

1 Introduction

1.1 The telecommunication industry

Telecommunication, or telecom, companies, also known as telcos, provide fixed and mobile voice, text, and data transmission to consumers, small businesses, enterprises, and government entities. Perhaps the history of telecommunication began with the use of smoke signals and drums in Africa, the Americas, and parts of Asia.[1] However, it was not until the 1830's that electrical (wired) telecommunications systems appeared.[2] But it was in 1983, when Motorola released its first commercial mobile phone, the Motorola DynaTAC 8000X,[3] that telecommunication companies had to provide wireless communication.

At the end of 2006, Nokia, Motorola, Samsung, Sony Ericsson, and LG dominated the mobile phone market, with 84% of market share (see Figure 1).[4] These companies had classic strategic advantages that should have protected them from disruption: strong product differentiation, trusted brands, leading operating systems, excellent logistics, protective regulation, huge R&D budgets, and massive scale.[5]

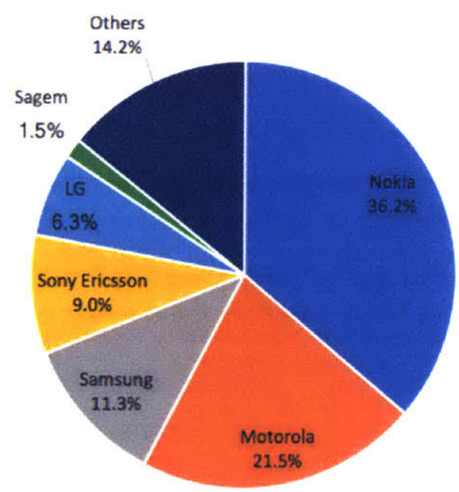

Figure 1 - Worldwide mobile market share in 4Q06

However, in January 2007, Apple introduced its *iPhone*. The iPhone was more than a product. It was a *two-sided platform* with which Apple could connect app developers on one side and app users on the other, generating value for both groups. An important feature of most two-sided platforms is that the value to customers on one side of a platform typically increases with the number of participating customers on the other side. This is known as the "cross-side network effect."[6] Today, there are more than 700 million iPhones in use worldwide.[7] The company's app store offers 2.2 million apps[8] and generated

$20 billion in 2016 alone for app developers.[9] Today, Apple is a major player, with 17.9% of the market share, followed by Samsung, with 17.8% (see Figure 2).[10]

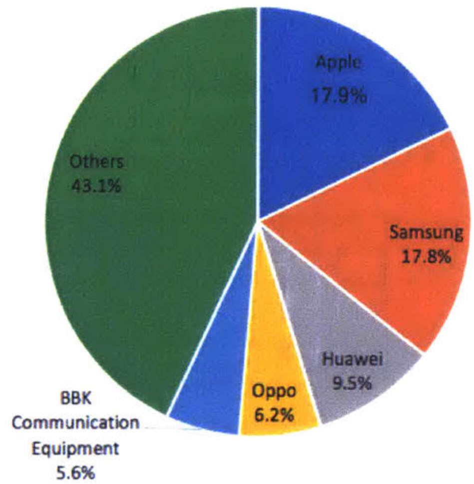

Figure 2 - Worldwide smartphone market share in 4Q16

Due to these new ways of running business, new companies have emerged and new services have been created. Among these new companies are the over-the-top (OTT) communication services. OTT communication services use the internet to deliver an array of communication services such as voice, video calls, and messaging. Some of the most popular OTT players now are: WhatsApp, Facebook messenger, QQ mobile, WeChat, Skype, Snapchat, Viber, and LINE.[11]

The new OTT communication services endangered the telecom companies in terms of market share and profits. In June 2012, a report released by Mobile Squared captured the concern of telecom companies from 68 countries. Seventy-nine percent of operators believed that OTT clients on smartphones were a threat to traditional short service message (SMS) and voice-based services.[12] In the past five years, the telecom business has entered a period of slow decline, with revenue growth down from 4.5% to 4%, Earnings Before Interest, Tax, Depreciation and Amortization (EBITDA) margins down from 25% to 17%, and cash-flow margins down from 15.6% to 8%.[13] Competitive boundaries are shifting as core voice and messaging businesses continue to shrink, partly under regulatory pressures, but also because OTT is opening up new communications channels.

On the other hand, mobile data traffic continues to grow. Data traffic grew around 10% quarter-on-quarter and 50% year-on-year from Q3 2011 and Q3 2016.[14] The growth in data traffic is being driven both by increased smartphone subscriptions and by a continued increase in average data volume per subscription, fueled primarily by an increase in video content viewing. Wireless networks have evolved over the past 30 years to support the growing demand of connected devices, from 1G to LTE Advanced. Mobile internet speed has increased from 0.3 Mbps with 2G up to 300 Mbps with LTE Advanced in 24 years. Fifth-generation mobile networks (5G), or 5th-generation wireless systems, are the proposed next telecommunication standard beyond the current 4G/LTE-Advanced standards. So far, the telecom industry has not finalized 5G standards, but 5G could reach up to 10Gbps of internet speed.[15]

With 5G, new capabilities will be enabled, including: precise remote control, near-instantaneous communication, greater efficiency, seamless connectivity, and agile networks.[16] These capabilities will help industries create new products and services to grow their markets, increase productivity and efficiency to reduce costs, and increase safety and security to reduce risk.

1.2 Problem statement

Telecommunication companies face increasingly tough times as digitization reshapes the industry landscape. The continued business disruption is driving telecom companies to investigate platform-based business models as a key element to survival. With the appearance of 5G mobile network connectivity, telecom companies need to learn how to protect themselves from being delegated as commodity connectivity providers by disruptors. Telecom companies could play a big role in several areas in the next five years. Taking all this into consideration, this thesis explores these areas to determine where the telecom companies should start and how the industry and its constituent stakeholder firms may take advantage of platform business models over the course of the next five years.

1.3 Literature review

Several proposals have been published on the ways telecom companies could enhance their long-term competitiveness. In January 2014, Shingo Kawai and Prof. Michael Cusumano from MIT studied this issue.[17] They focused on three strategic options that enable large high-tech companies to continue to make profits: 1) internal R&D, 2) growth and diversification, and 3) M&A. They proposed these techniques for Nippon Telegraph and Telephone (NTT), a major telecommunications carrier in Japan.

In October 2016, Paul-Louis Caylar and Alexandre Ménard from McKinsey[13] identified five ways to come out on top in the digital revolution: 1) reinvent the core, 2) pursue adjacencies, 3) build talent and capabilities, 4) revamp IT, and 5) start with the customer and work back from there.

Most recently, in January 2017, Jürgen Meffert and Niko Mohr, also from McKinsey, advised considering two strategic moves and, if appropriate, taking immediate action: 1) make the core business "super slim," cost-efficient, and more agile and 2) identify new growth areas in the space that combines the great potential of digitization and telcos' existing core competencies.

On the other hand, platform business models are not new for the telecom industry. In February 22, 1999, the *i-mode* was launched by NTT DoCoMo in Japan. This i-mode was the world's first smart phone for Web browsing. The i-mode wireless data service offered color and video over a variety of handsets. Its mobile computing service enabled users to do telephone banking, make airline reservations, conduct stock transactions, send and receive e-mail, play games, access weather reports, and have access to the internet. It offered a wide array of websites from internationally known companies such as CNN to very local information sites.[18] In Japan, the number of i-mode users was close to a sensational 13 million in 2001. This means that 10% of Japan's total population was using i- mode less than two years after its launching.

The success of i-mode derives from its creation of a market for content that successfully facilitated the connection of content providers to consumers. Taking a 9% cut of sales (making Apple and Google's 30% seem excessive), DoCoMo facilitated the purchase of ringtones, wallpapers, games, news, and other informational commodities on a subscription basis, billing consumers for their purchases and profiting heavily from the data traffic generated using i-mode. The more people used i-mode, the more content providers would try to offer their services and products; the more products and services available, the greater the reason to choose i-mode. In the middle—as a mediator benefiting from data traffic—stood DoCoMo.[19]

Similarly, in October 2002, Vodafone, the British multinational telecommunications company, launched the *Vodafone Live!* platform.[20] The Vodafone Live! model is a prime example of the resulting closed platform, which involved a mobile portal, a micropayment system and revenue sharing model, a distinction between "official" and "non-official" content providers, and a number of dedicated handsets. However, the fragmentation of most mobile markets, the inability or unwillingness to conclude cross-operator arrangements to benefit content providers and application developers, the laborious nature of concluding contracts, and revenue sharing models that were deemed not attractive enough all conspired to limit the success of these (semi) closed platforms.[21]

Later, in September 2009, Telefónica, a Spanish multinational broadband and telecommunications provider, launched *Telefónica Aplicateca*, an online platform for the provision and management of business applications and services facilitated through cloud computing to small- and medium-sized companies in Spain. Aplicateca enjoyed rapid growth in users and constantly expanded its cloud service portfolio. In 2014, it offered over 55 applications from multiple service vendors in a wide range of areas, including e-commerce, marketing, customer relationship management (CRM), accounting, and office administration among others.[22]

Similarly, in July 2012, Deutsche Telekom put into service its platform for cloud service applications, the *Telekom Cloud Business Marketplace*, in Germany. In 2014, the Telekom Cloud Business Marketplace's portfolio included over 45 applications from more than 20 different service vendors.

Regarding the smart home service platforms, in April 2013, AT&T launched *AT&T Digital Life*, a wireless home management platform for home security and automation services including video monitoring and locking systems. In October 2013, Deutsche Telekom launched QIVICON, a smart home services platform that offers services for home automation such as smoke detection and automated light and heat control.

Although platform business models are not new for the telecom industry, none have enjoyed huge growth and profitability as compared to Google, Facebook, Apple, and others. Our approach in this thesis will be to explore platform business models in areas where 5G connectivity may have a significant impact and also to determine in which area the focus should be based on the value and volume of interactions in the platform.

1.4 Overview

Chapter 1 introduces the position of the telecom companies today versus the OTT communication providers and generates a problem statement. We review the literature on what others have suggested to the telecom companies to address the competitiveness issue in the digital revolution. Finally, the chapter also reviews previous platform business models in the telecom industry.

In chapter 2, our research shows that telecom companies are in a very tough position. From the investors' standpoint, the telecom industry is not a very attractive industry since the ROIC (7%) is below the U.S. industry average (14.9%). Telecom companies could be easily disrupted since the threat of new entrants is high, customer power is high, supplier power is moderate, the threat of substitutes is high, and rivalry is high. In addition, the stakeholder analysis shows the customer's top stakeholder is the content provider, not the telecom industry. Strategies such as bundling services, home internet, and mobile plans together increase the stickiness of the telecom companies. However, they are still not as important as the content providers. If this scenario persists, telecom companies could become a commodity due to the disruption caused by OTT providers and content providers.

Chapter 3 identifies eight industries where 5G connectivity can have a big impact. However, the sponsor for this project, Huawei Technologies, narrowed it down to the following areas: immersive media, drones, agriculture, connected automobiles, smart homes, smart cities, and wearables. To select the most feasible area for platform business models, we use a technique proposed by Prof. Marshall Van Alstyne. The technique consists of plotting an *interaction's perceived value* versus *interaction volume*. Since the platform does not exist yet, we make some educated assumptions and use forecasts published in the literature to determine the interaction value and volume.

In chapter 4, we select the most feasible platform opportunity in the immersive media field for the telecom companies using the concept evaluation methodology. We analyze the constraints and opportunities in the next five years; in addition, we explore the existing offer. We conclude that 360° HD platforms with live and recorded long-tail content is the best solution for the telecom industry's needs.

In chapter 5, we propose how telecom companies can transform a product or service into a platform. The product in this case is 5G connectivity. A 360° HD video multi-sided platform is proposed, where there are users, content developers, advertisers, and software developers. The core interaction for the platform is defined in detail as well as network effects, launch strategies, monetization, and openness. Finally, a stakeholder analysis is performed to find out the position of the telecom companies with respect to the customers.

2 The Telecom Industry Today

2.1 Introduction

The telecommunication market size worldwide was $1.6 trillion in 2015, with North America having the largest market size, with $435 billion (see Figure 3).[23] The largest telecom company in the world was China Mobile Ltd, with a market value of $280 billion in 2016.[24]

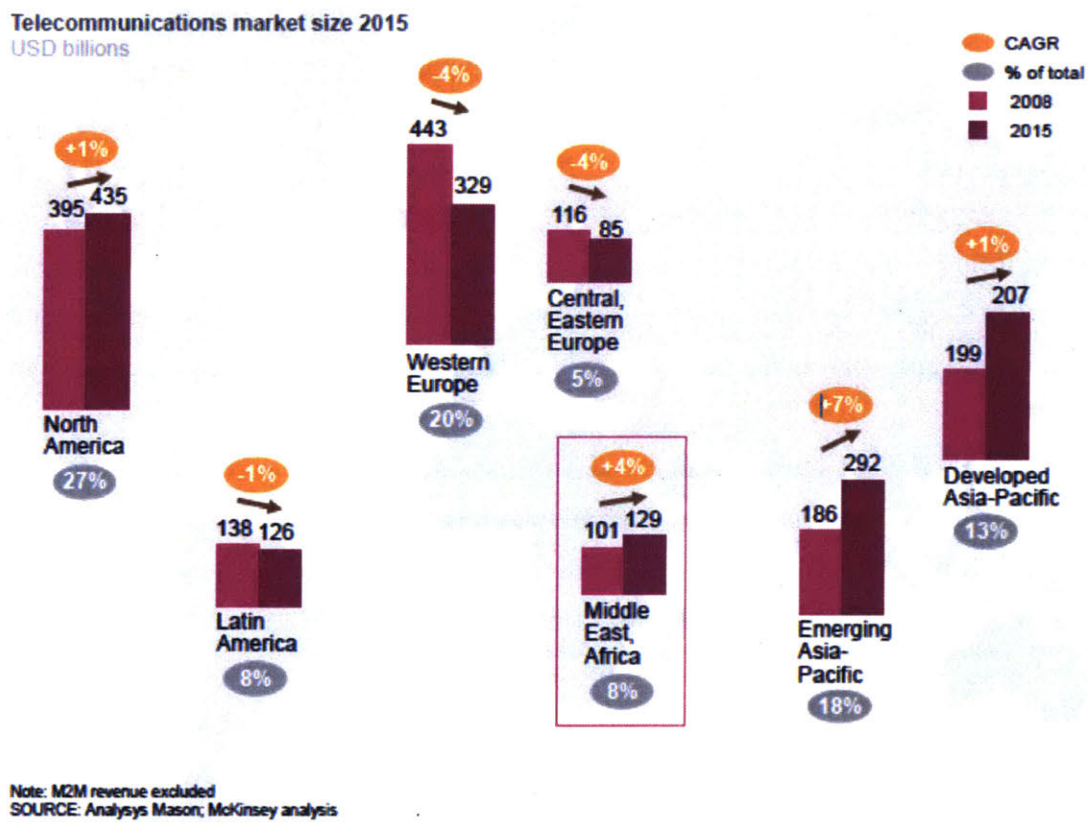

Figure 3 - Telecommunications market size in 2015

(Source: McKinsey & Company report)[23]

In the past five years, the telecom business has entered a period of slow decline, with revenue growth down from 4.5% to 4%, EBITDA margins down from 25% to 17%, and cash-flow margins down from 15.6% to 8%.[13] Competitive boundaries are shifting as core voice and messaging businesses continue to shrink, partly due to regulatory pressures but also because OTT is opening up new communication channels. Among U.S. telecom companies, for instance, landline and mobile voice now account for less than a third of total access, down from 55% in 2010, while data revenue rose from 25% of total revenues in 2010 to 65% today.

Monthly data traffic per smartphone continues to increase in all regions; however, there are large differences in data consumption patterns between networks, markets, and subscriber segments. North America had the highest usage, with 5.1 GB per month per active smartphone at the end of 2016. Total global mobile data traffic increased 50% between Q3 2015 and Q3 2016 and is expected to see a 10-fold increase by 2022 (see Figure 4).[14]

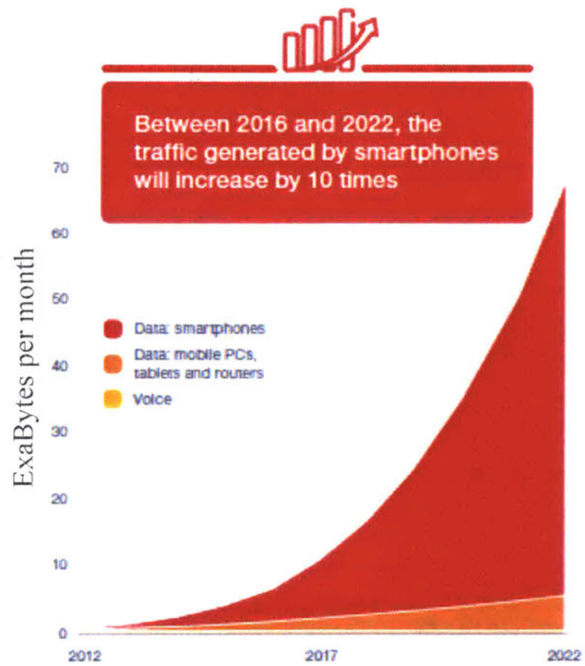

Figure 4 - Global mobile traffic

(Source: Ericsson Mobility Report 2016)[14]

The growth in data traffic is being driven both by increased smartphone subscriptions and by a continued increase in average data volume per subscription, fueled primarily by more viewing of video content. Ericsson forecasts that 75% of the total mobile traffic by 2022 is going to be video.

2.2 Five Competitive Forces Framework

In this section, we will apply the five competitive forces (rivals, customers, suppliers, potential entrants, and substitute products) framework developed by Michael Porter to understand telecom industry competition and profitability. This framework fits well with the way telecom companies are structured today, since they follow the conventional "pipeline" business model. Pipeline businesses create value by controlling a linear series of activities—the classic value-chain model. Inputs at one end of the chain (say, materials from suppliers) undergo a series of steps that transform them into an output that's worth more: the finished product.

The five competitive forces framework points out that return on invested capital (ROIC) is the appropriate measure of profitability for strategy formulation. If the forces are strong, the ROIC is going to be low, which is the case for the airline industry, for example. Currently, the telecom industry has an average ROIC of 7%.[25] The analysis of the five forces shown in Figure 5 explains why the telecom ROIC is below the average industry ROIC in the U.S, 14.9%.[26] The threat of new entrants is high, customer power is high, supplier power is moderate, threat of substitutes is high, and rivalry is high. Our results correlate with a similar analysis performed on the telecom industry in 2013.[27]

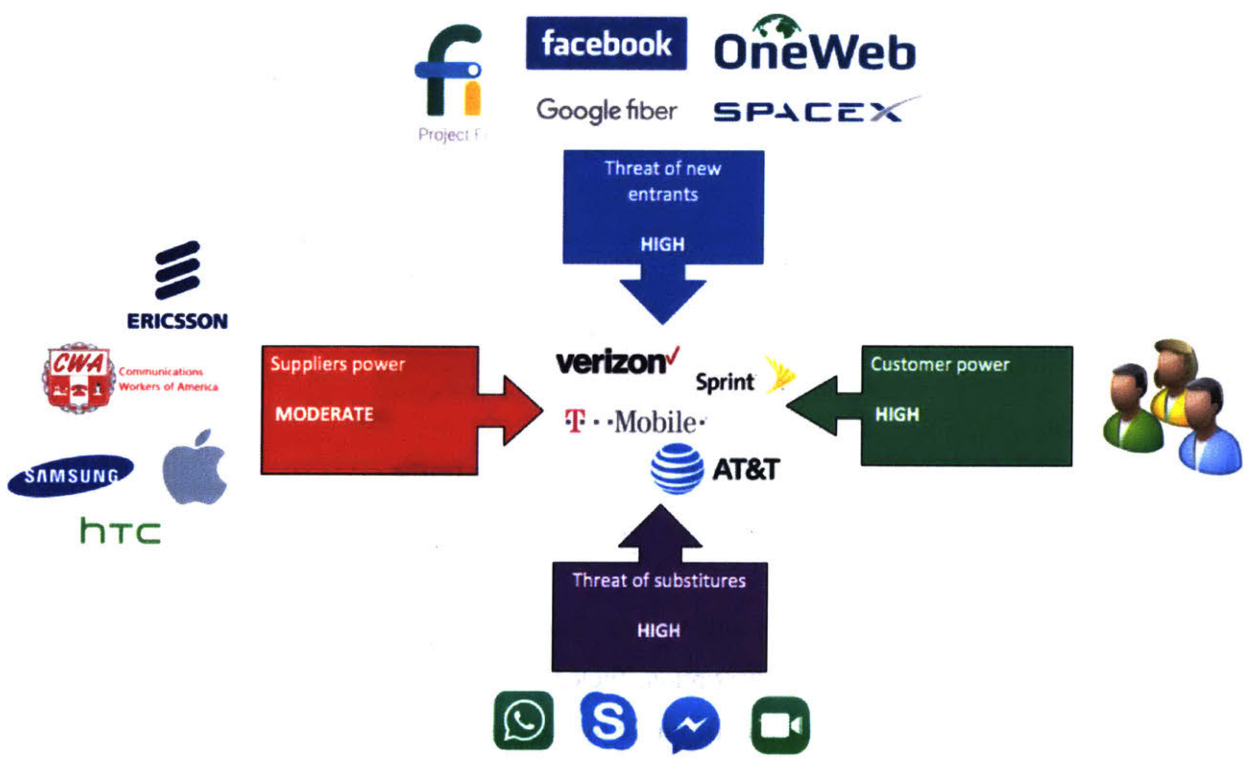

Figure 5 - Five competitive forces analysis on the telecom industry

2.2.1 Suppliers Power – Moderate

Suppliers for the telecom industry include telecommunication equipment, smartphones, utility companies, labor, etc. Telecom equipment consists of public switching equipment, transmission equipment, and customer premises equipment. Vendors in this area include companies such as Huawei, Cisco, Nokia, and Ericsson among others. These companies provide equipment with high fixed cost. Large-volume buyers, such as the telecom companies, are particularly powerful in industries with high fixed cost. Therefore, the bargaining power of telecom equipment suppliers is low.

In the U.S, there is a union called the Communication Workers of America (CWA), which represents 300,000 members who work in telephone and cable TV services, including wireline, wireless, broadband, data and IP services, and electronic security systems and services.[28] Unions usually create power against the employers. Therefore, the bargaining power of employees is high.

In addition, there are several smartphone providers, such as Samsung, LG, Apple, Google, Huawei, etc. Nowadays, smartphones work with standardized subscriber identification modules (SIM), making it easy for a customer to switch among phones at basically no cost. Therefore, the bargaining power of smartphone companies is low. Finally, if we combine the bargaining power of all these suppliers, we conclude that their power is moderate.

2.2.2 Power of Buyers – High

As the number of choices increases, so does the bargaining power of buyers. This has held true particularly after the Telecommunication Act of 1996 created local number portability (LNP). LNP is a system that enables users to keep their phone numbers when switching from one communication service provider to another. Later, in 2004, wireless local number portability (WLNP) was created, allowing cellphone users to keep their numbers so that the switching cost is almost negligible for all phones. It could be argued that switching costs are high because telecom companies currently demand a two-year contract from customers signing for service. However, in the U.S, this contract is only signed when the user agrees to buy a smartphone with an installment plan (24 months with 0% APR).

2.2.3 Rivalry - High

After the deregulation of the telecom industry, rivalry in the U.S. has become intense. Currently there are four main players: Verizon, AT&T, Sprint, and T-Mobile. At the end of 2016, these four companies controlled 98% of the U.S. market.[29]

2.2.4 New Entrants – High

Due to the complex infrastructure needed, a high fixed cost is required to enter the telecom industry. Still, companies such as Facebook, Google, and Space X have threatened to enter this market. In 2010, Google introduced Google Fiber, a high-speed broadband internet and IPTV for home use. But last year, Google pulled back because of the high cost.[30]

In April 2015, Google released their Project Fi in the U.S. Google partnered with Sprint, T-Mobile and U.S. Cellular to provide phone, messaging, and data services using both Wi-Fi and cellular networks. This project is still alive as of April 2017.

Another player, Facebook, has its Connectivity Lab, where they are developing ways to make affordable internet access possible in communities around the world. To do so, they are exploring a variety of technologies including high-altitude long-endurance planes, satellites, and lasers.[31]

In July 2015, Facebook announced its Connectivity Lab was working on an unmanned aerial vehicle (UAV) called *Aquila* to deliver internet to remote or low-population-density areas. Soaring above 60,000 feet, the Aquila unmanned aircraft is taking a different approach to connecting the world. Its tailless design and enormous wingspan allow it to float almost effortlessly, while its solar cells and super-efficient motors let it stay airborne for months, thus delivering internet to some of the most remote areas on earth. As of April 2017, this project is still ongoing. The latest results were announced in the 2017 F8 developer summit.[32]

In October 2015, Facebook announced its first project to deliver internet from space to large parts of Sub-Saharan Africa. To do this, they partnered with Eutelsat to launch a new satellite, called AMOS-6, into orbit.[33]

In April 2016, Facebook announced new terrestrial connectivity systems—Terragraph and Project ARIES (Antenna Radio Integration for Efficiency in Spectrum).[34] Terragraph is a 60 GHz, multi-node wireless system focused on bringing high-speed internet connectivity to dense urban areas. Project ARIES is a proof-of-concept effort to build a test platform for incredibly efficient usage of spectrum and energy. This would help to harness the incredible gains in providing communications to rural communities from city centers.

Another new entrant is OneWeb. OneWeb is an internet satellite company that aims to provide affordable global internet access using a constellation of 648 satellites. The company is expected to launch 10 production satellites in early 2018. Six months later, they will begin the full launch campaign and start providing low-latency broadband access as early as 2019. OneWeb proposes 100x capacity growth from their first-generation system, including Gigabit per second speeds, lower latencies, and affordable self-installed terminals.[35]

Finally, in November 2016, Space X outlined plans to put 4,425 super-fast internet satellites into space in a Federal Communications Commission (FCC) filing. But the company gave very little detail on the timeline. In May 2017, SpaceX said the company would start testing the satellites themselves later that year, launch one prototype before the end of the 2017, and launch another during the "early months" of 2018. Following that, SpaceX will begin its satellite launch campaign in 2019.[36]

2.2.5 Threat of Substitutes - High

OTT communication services are currently the greatest threat to telecom companies. OTT communication services use the internet to deliver an array of communication services such as voice, video calls, and messaging. In addition to their communication services, they offer some other services such as file sharing, payments, shared location, etc. Companies such as Skype, Viber, WeChat, Facebook Messenger, WhatsApp, etc., currently offer more convenient service and greater value than telecom companies do. They charge no international fees for sending a message, a picture, or a file to someone in another country. According to Mobile Square, the next 2 or 3 billion internet users will realistically use OTT as their primary form of communication.[37]

In summary, from an investor's perspective, the telecom industry is not an attractive industry; the ROIC is below U.S. industry average. And, according to a 2015 cross-industry survey of senior industry leaders, the telecom industry comes second in the ranks of sectors expecting moderate to massive digital disruption in the short term.[38]

2.3 Stakeholder Analysis

In 2011, Prof. Bruce Cameron from MIT and his colleagues developed a methodology that can be used to prioritize the outputs of a firm relative to its needs and strategic environment. This methodology enables managers to perform an analysis of the firm's stakeholders to determine the relative priority of stakeholder needs according to the stakeholders' importance to the firm prior to the translation of needs into requirements.[39]

The technique consists of three steps. In the first step, a user asks, "Who potentially satisfies the needs of each of the stakeholders?" In the second, a user asks, "What are the outputs of the project, and to whom are they provided?" Finally, a user pairs all stakeholders and asks whether there are relevant transactions that play out between them.[40]

In our project, this methodology can be used to:

- identify players in the ecosystem,
- find out what outputs (or outflows) are the most important, and
- find out who is the most important stakeholder.

In 2009, A.S. Arvind and Prof. Edward Crawley from MIT performed a very detailed stakeholder analysis of the telecom industry.[41] This provided a useful starting point for the analysis. However, at that time, the threats from OTT communication services was very small.

Our stakeholder map consists of 13 stakeholders, which are described below. For simplicity, we focused our stakeholder analysis in the U.S. telecom industry and restricted our analysis to voice, text, and internet service provided to individuals. Therefore, cloud services and any other services to individuals not mentioned before, as well as all services to industry, are not considered here.

Description of stakeholders

1. **Telecom companies**. Companies such as Verizon, AT&T, Sprint, T-Mobile, etc.
2. **Backhaul**. In a hierarchical telecommunications network, the backhaul portion of the network comprises the intermediate links between the core network, or backbone network, and the small subnetworks at the "edge" of the entire hierarchical network. Therefore, backhaul gives *connection* to the telecom companies and they give back *revenue*.
3. **Suppliers**. These include telecommunication equipment suppliers such as Huawei, Ericsson, etc., and hardware (smartphone) suppliers such as Apple, Samsung, LG, Google, etc. These companies give *parts* and *technology* to telecom companies, and telecom companies give back *revenue*.

4. **Local communities**. That is, the cities where the telecom companies are located. Local communities provide *workforce* to telecom companies, and the companies give back *employment*.
5. **OTT communication**. Companies such as Skype, WhatsApp, Viber, Facebook Messenger, etc., that use internet to provide messaging, voice calls, and video calls.
6. **Utility companies**. Companies that provide electricity and gas for heating. These companies are necessary to keep the telecom company running. Utility companies give *power* to telecom companies, and telecom companies give back *revenue*.
7. **Local and national regulators**. Government agencies that provide *regulatory approval* to telecom companies. Among others: Federal Communication Commission (FCC), CTIA, and the National Cable and Telecommunication Association (NCTA). Telecom companies give back *information* and *revenue* (spectrum fees) to these agencies.
8. **Customers**. Individuals who use voice, SMS, and data plans from telecom companies.
9. **Investors**. Third party individuals or organizations that put money into the telecom companies with the expectation of achieving a profit. Therefore, investors give *investment* to telecom companies, and telecom companies give back *revenue*.
10. **Internet providers**. Companies who offer home internet service such as Comcast, Cox, AT&T, etc. Most customers in today's world have mobile and home internet access separately, sometimes from different companies. Therefore, internet providers were treated as a different stakeholder. Customers receive *internet* from internet providers, and they give back *revenue*.
11. **Content providers**. Companies that supply social content. They include companies such as Facebook, Google+, WeChat, LinkedIn, etc.
12. **Advertisers**. Companies who buy customer information from internet companies, such as Google, Facebook, and others, in order to deliver promotional marketing messages to consumers.
13. **Companies.** Companies that pay advertisers to promote their product to customers. These companies are from several industries such as clothing (Gap, Calvin Klein, etc.), consumer electronics (Sony, Canon, etc), food (Coke, PepsiCo, etc.), and automobile (Ford, Toyota, etc.).

Figure 6 shows the hub-and-spoke stakeholder map for the telecom industry. The stakeholder map shows the inflows and outflows from each stakeholder to another. The map is color coded based on the type of flow that is used. The diagram shows that telecom companies provide *voice, SMS, and data* to customers and customers give back *revenue* and *information.* This *information* is related to customer location. Telecom companies know customer location based on the cellphone tower being used when customers are traveling from one place to another. We know that later, this information is sold to third-party companies.[42] Therefore, telecom companies give *information* to advertisers, and advertisers give back *revenue*.

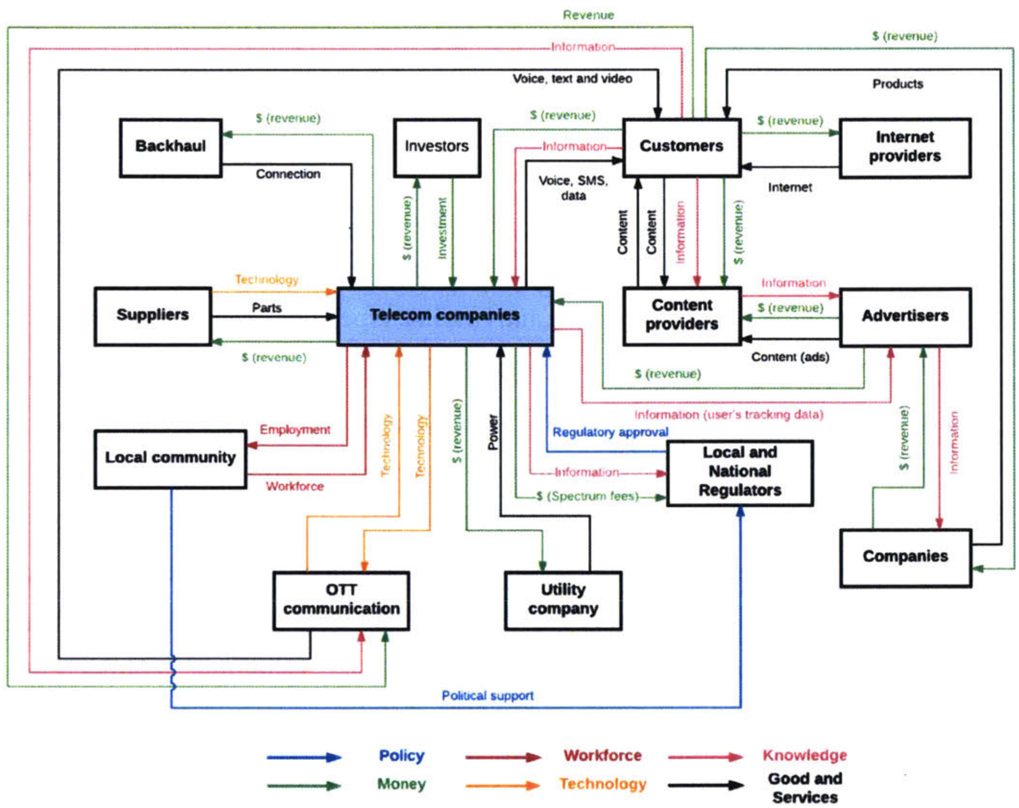

Figure 6 - Hub-and-Spoke stakeholder map for telecom industry

When people post a picture on Facebook, or make a comment on a friend's status, they are giving content to Facebook. When people click "like" or "dislike" on Facebook, they are giving information to Facebook about their preferences. In addition, when people perform purchases on games, they are giving revenue to Facebook. Therefore, customers give *content* and *information* and may give *revenue* to content providers; content providers give back *content.*

Advertisers give *revenue* to Facebook to promote their ads. Facebook displays these ads based on user preferences using algorithms in order to target users with advertisements more effectively.[43] We assumed Facebook would give feedback to advertisers. Therefore, there is an *information* outflow from Facebook to advertisers.

Later, advertisers receive *revenue* from companies and companies give back *information* as feedback. One of the indirect transactions, or *value loops*, that is generated is when customers buy the product that was advertised. So, customers would give *revenue* to companies, and companies would give back *product*. *Value loops* are defined as those transactions with one or more intermediaries between the firm and the end stakeholder.

Finally, customers use a mix of OTT and standard telecom communication services. Customers receive *voice-text-video* and give back customer behavior (*information*) and may give back *revenue*. This is the case of WhatsApp. WhatsApp uses a subscription-based approach to monetize its service. As of January 2017, WhatsApp had 1.2 billion monthly active users (MAUs).[44]

2.3.1 Ratings

The stakeholder map can also be represented in matrix form. This matrix is called an *adjacency matrix* (see Figure 7). This adjacency matrix is the same as the *design structure matrix* (DSM) used for designing, developing, and managing complex systems.[45] This graph represents the outflows from rows to columns. The number in the cells represents the number of flows. For example, telecom has one outflow to backhaul, and suppliers have two outflows to telecom.

Now that the stakeholder map is in matrix form, network theory can be applied using computational software such as MATLAB. Network properties such as nodes, edges, degree sequence, density, shortest path, diameter, etc., can be calculated. For example, this network has 13 nodes (stakeholders) and 38 edges (inflows/outflows).

To perform a qualitative analysis of the whole stakeholder map, inflows and outflows must be ranked by benefit and supplier power.[40]

	Telecom	Backhaul	Suppliers	Local communities	Competitors	Utility companies	Local and national regulators	Customers	Investors	Internet providers	Content providers	Advertisers	Companies
Telecom	0	1	1	1	1	1	2	1	1	0	0	1	0
Backhaul	1	0	0	0	0	0	0	0	0	0	0	0	0
Suppliers	2	0	0	0	0	0	0	0	0	0	0	0	0
Local communities	1	0	0	0	0	0	1	0	0	0	0	0	0
Competitors	1	0	0	0	0	0	0	1	0	0	0	0	0
Utility companies	1	0	0	0	0	0	0	0	0	0	0	0	0
Local and national regulators	1	0	0	0	0	0	0	0	0	0	0	0	0
Customers	2	0	0	0	2	0	0	0	0	1	3	0	1
Investors	1	0	0	0	0	0	0	0	0	0	0	0	0
Internet providers	0	0	0	0	0	0	0	1	0	0	0	0	0
Content providers	0	0	0	0	0	0	0	1	0	0	0	1	0
Advertisers	1	0	0	0	0	0	0	0	0	0	2	0	1
Companies	0	0	0	0	0	0	0	1	0	0	0	1	0

Figure 7 - Adjacency matrix for the telecom stakeholder map

The benefit ranking is performed using the Kano methodology. For each need, the Kano method asks how you would characterize the presence/absence of this need in terms defined as follows:

- **Must have:** Its presence is absolutely essential, and I would regret its absence. For example, "Car has good brakes."
- **Should have**: I would be satisfied by its presence, and I would regret its absence. For example, "Car is fuel efficient."
- **Might have:** I would be satisfied by its presence, but I would not regret its absence. For example, "Car has self-parking feature."

The supplier ranking is based on the availability of alternative suppliers for each flow. In theory, if the products of the alternative suppliers are substitutes, the presence of alternatives will dilute the bargaining power of suppliers. For example, in the U.S., the Federal Communication Commission (FCC) is the only government agency from whom you can get approval for the telecom industry. Since there is no substitute, this organization has very strong bargaining power. Figure 8 and Figure 9 show the rankings of benefit and supply, respectively, of all the inflows and outflows.

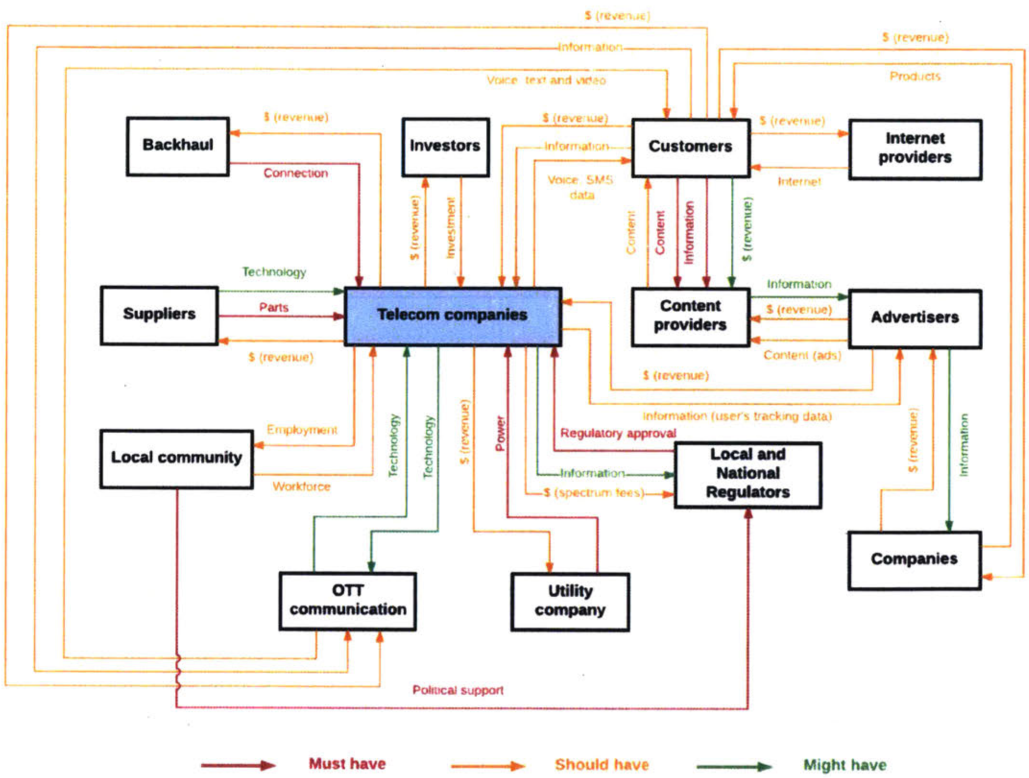

Figure 8 - Stakeholder map for the telecom industry, illustrating characterization of needs (benefit ranking)

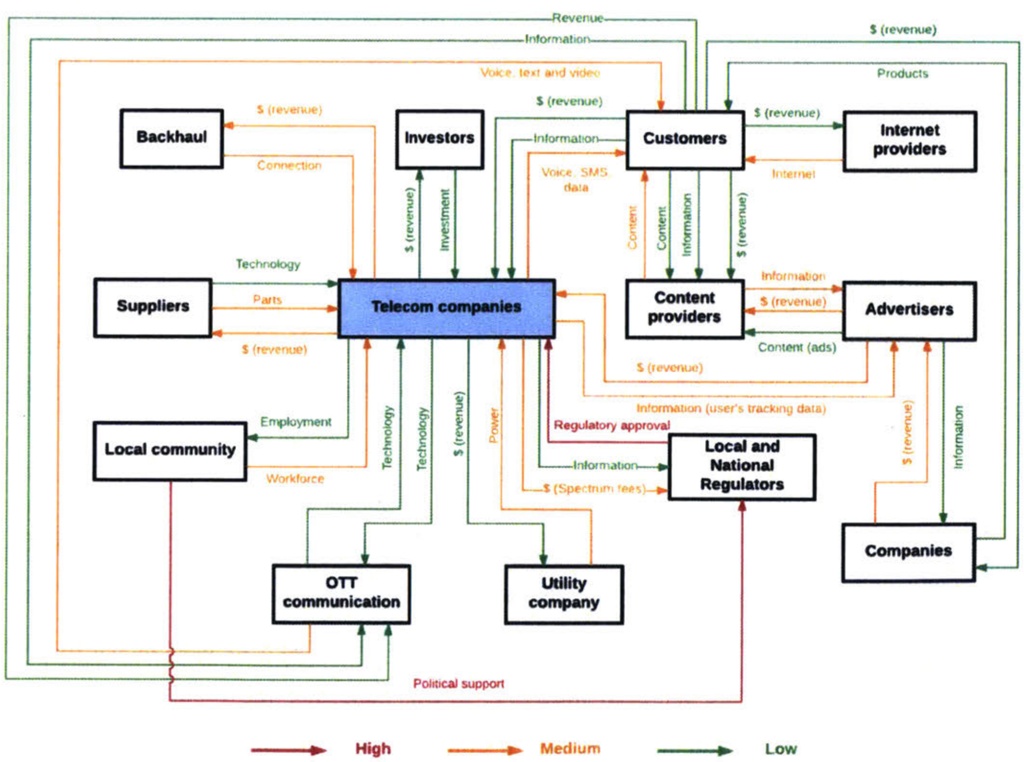

Figure 9 - Stakeholder map for the telecom industry, detailing availability of alternative suppliers (supply ranking)

Once both rankings are performed, values from Table 1 are used to create a single measure of the flow. These values were proposed by Crawley et al., 2015.

Table 1 Creating a single measure for each flow, a combination of the flow characterization (here represented as the supply availability) and the need characterization (from the Kano analysis)

	Benefit ranking		
Supply importance	Might have	Should have	Must have
High	0.3	0.5	0.95
Med	0.2	0.4	0.8
Low	0.1	0.2	0.4

(Source: System Architecture, Crawley et al., 2015)[40]

After assigning a value to each flow, we performed the following three calculations using the Java code provided by the MIT System Architecture lab website:

1. all the value cycles for the focal organization
2. the weighted value flow occurrence (WVFO), which is, basically, the importance of the value flow
3. and weighted stakeholder occurrence (WSO), which is, basically, the stakeholder importance[46]

Appendix A shows the input files and input parameters used in the Java code.

2.3.2 Numerical Results

Figure 10 shows that the top five outputs from the telecom companies are: 1) revenue to regulators, 2) revenue to suppliers, 3) revenue to the backhaul, 4) workforce to local community, and 5) revenue to utility companies.

A common mistake made by the industry is to select the most important stakeholder, considering only a "simple cycle." That is, they only consider the flows to and from the stakeholders around the firm. They do not consider the value loops. Results using the simple cycle methodology are shown in Figure 11. The most important stakeholders for the telecom industry, in this case, are the local and national regulators, followed by suppliers, backhaul, and utilities. Local community is in fifth place. When performing the stakeholder analysis taking into account the value loops, results still show the most important stakeholders for the telecom industry are the local and national regulators. However, local community moved to fourth place, and it is almost as important as the backhaul connectivity, which is in third place (see Figure 12).

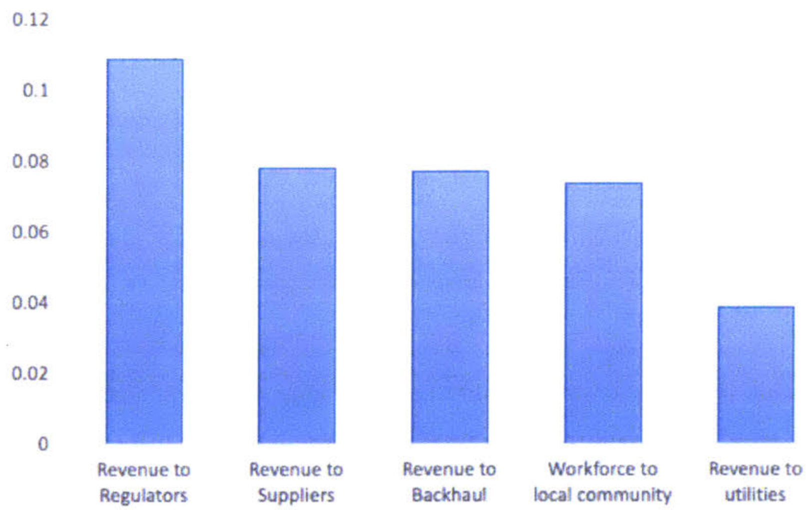

Figure 10 - Top five outflows from the telecom companies

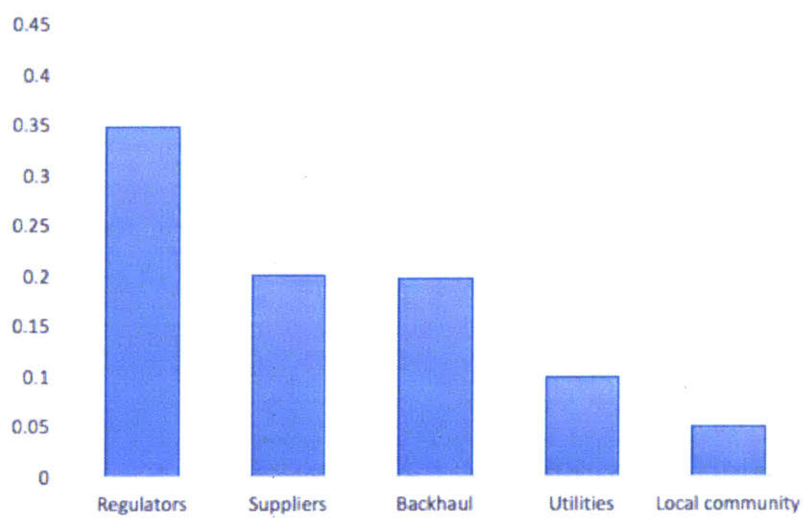

Figure 11 – Most important stakeholders for the telecom industry without considering value loops

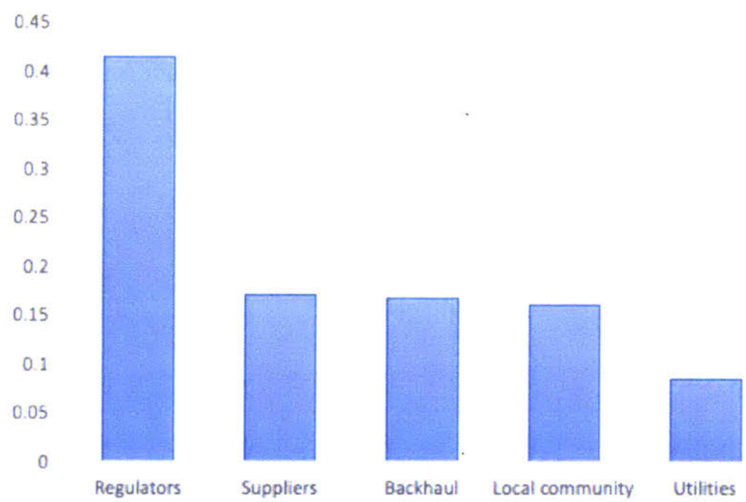

Figure 12 - Most important stakeholders for the telecom companies considering value loops

The *revenue* to regulators is the most important outflow because telecom companies and regulators have the strongest value loop in the system (see Figure 13). The same applies to local and national regulators. The reason local and national regulators are the most important stakeholders is because local and national regulators appear in two other very strong value loops.

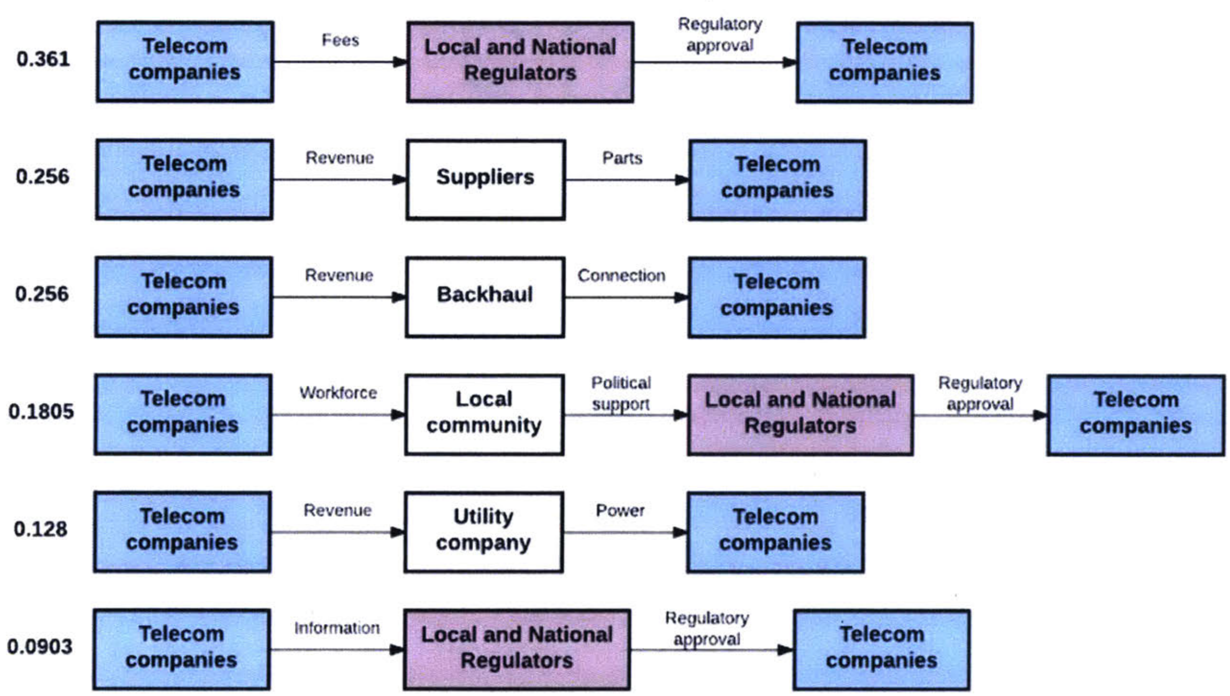

Figure 13 - Value cycles for the telecom companies

When we re-run the code considering the customer's perspective, our results (see Figure 14) show that the most important stakeholder is the content provider, followed by the telecom companies. Of course, this result is not good news for the telecom companies.

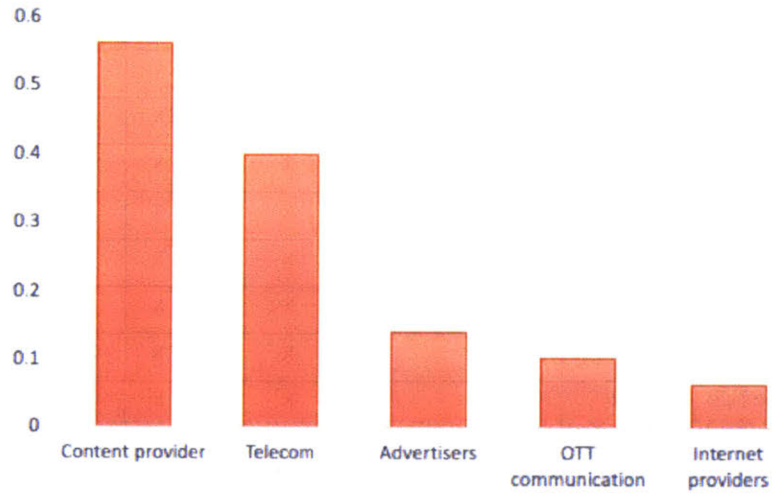

Figure 14 - Most important stakeholders for the customers

As mentioned earlier, nowadays, most customers keep their mobile and home internet access separate; sometimes they get these services from different companies. Part of our approach to gather data for this thesis was to interview industry experts. Among others, we talked with Vodafone Greece, Sunrise Switzerland, Verizon USA, and Rogers Canada. In the course of these interviews, we learned that, in Europe, you can bundle all your services (see Table 2). As it is the case with the insurance companies in the U.S., the more services you add to your bundle, the cheaper it gets. Bundling services is a win-win approach; customers get a discount for having more services, and telecom companies lock the users with higher switching costs. These results correlate with results obtained by Qualcomm in 2009. They found out bundling can substantially reduce customer churn.[47]

We re-ran the stakeholder analysis (see Appendix B for input files and input parameters) assuming this time that the telecom companies also provided home internet (see Figure 15). The benefit of the internet outflow was set to "should have," and the supply was "medium." In addition, the internet service from the internet providers became a "might have" with "low" supply rate. With these modifications, telecom increases its importance to customers. However, they are still in second place (see Figure 16).

Table 2 – Services provided by telecom companies in North America and Europe

Company	Location	Mobile	Home phone	Home internet	TV	Can you bundle all?
AT&T	US	x	x	x	x	No
Verizon	US	x	x	x	x	No
Sprint	US	x				No
T-Mobile	US	x			x	No
Comcast	US		x	x	x	No
COX	US		x	x	x	No
RCN	US		x	x	x	No
Google	US	x	x	x	x	No
Vodafone	Europe	x	x	x	x	Yes
Telcel	Mexico	x	x	x	x	No
Sunrise	Europe	x	x	x	x	Yes

Source: Companies' websites

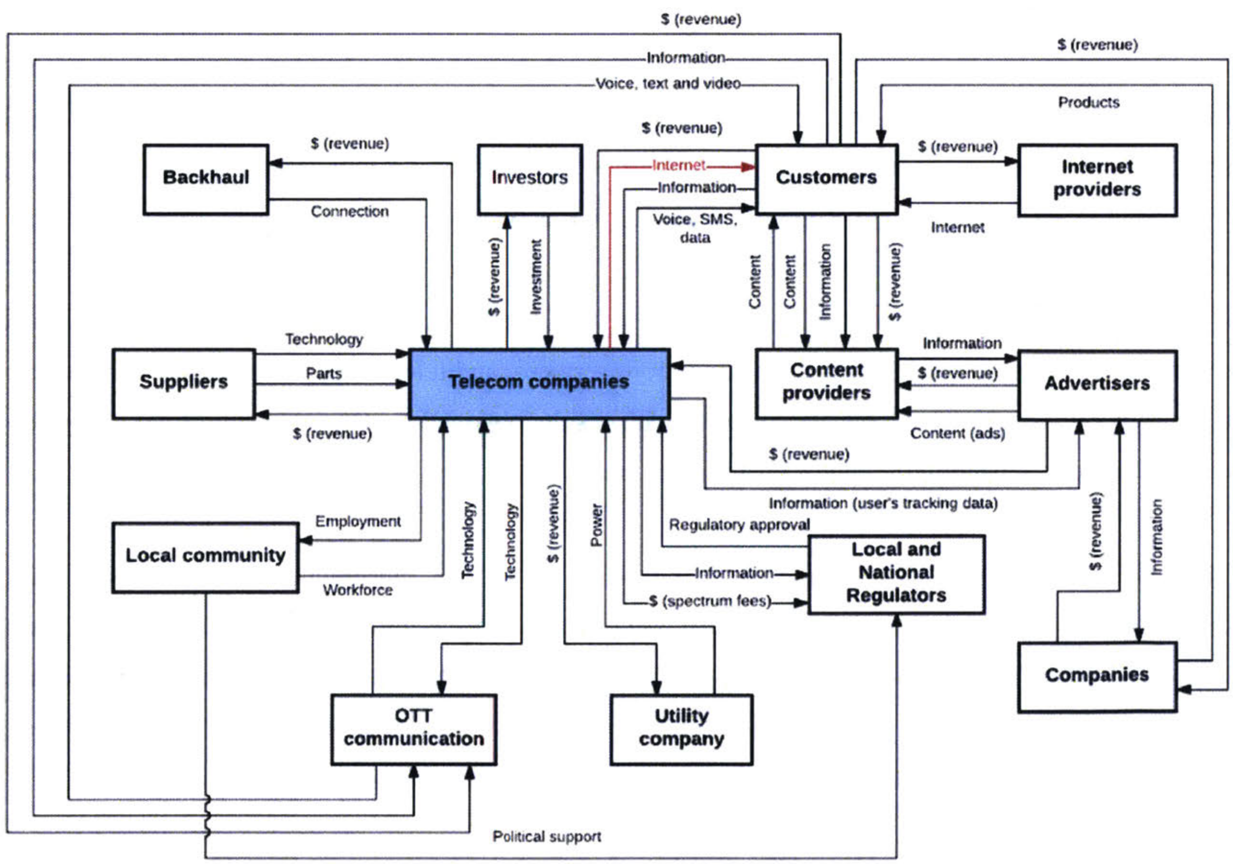

Figure 15 - Stakeholder analysis map for the telecom industry assuming they provide home internet as well

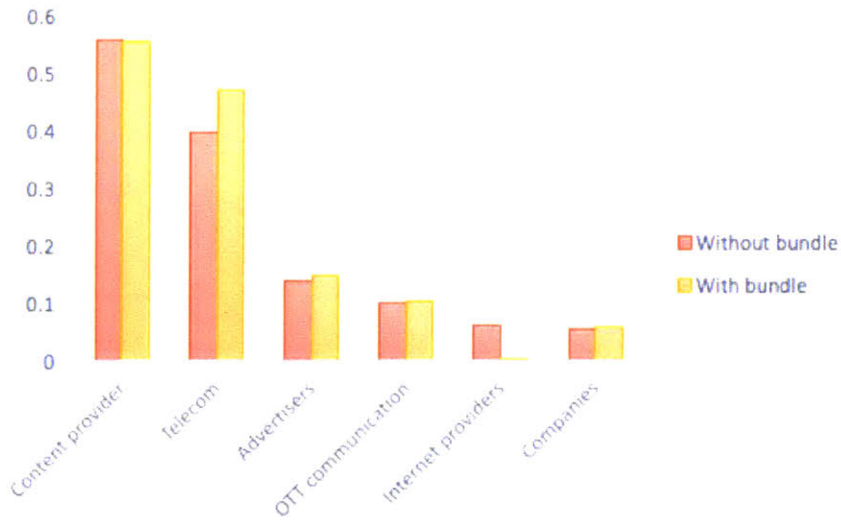

Figure 16 - Most important stakeholders for the customers after adding bundle option

2.4 5th Generation (5G) mobile networks

Wireless networks have evolved over the past 30 years, to support the growing demand of connected devices, from 1G to LTE Advanced. Mobile internet speed has increased from 0.3 Mbps with 2G up to 300 Mbps with LTE Advanced in 24 years. Table 3 summarizes the internet speed per generation of the mobile network and the percent of adoption.

Table 3 - The evolution of wireless technology

Year	Generation	Speed [Mbps]	Estimated time to download a 100min HD movie (sized at 1.4GB)	Americans with mobile subscription
1984	1G	0	n/a	<1%
1991	2G	0.3	10hrs 22min	3%
2001	3G/3G+	42	4 min 27sec	45%
2009	4G/LTE	129	1min 20sec	89%
2014/2015	LTE Advanced	300	37sec	96%

(Source: https://newsroom.intel.com/) [48]

The 5th generation mobile networks (5G), or 5th generation wireless systems, are the proposed next telecommunications standards beyond the current 4G/LTE-Advanced standards.

So far, the telecom industry has not finalized 5G standards, but many of the industry initiatives working on 5G have identified a set of eight requirements:

1. 1-10 Gbps connections to endpoints in the field
2. 1 millisecond end-to-end round-trip delay (latency)
3. 1000x bandwidth per unit area
4. 10-100x number of connected devices
5. (Perception of) 99.999% availability
6. (Perception of) 100% coverage
7. 90% reduction in network energy usage
8. Up to ten-year battery life for low power, machine-type devices[15]

To meet all these requirements simultaneously, several technologies are expected to do the most for 5G in the long run. The front-runners include millimeter waves, small cells, massive MIMO, full duplex, and beamforming.[49]

With 5G, new capabilities will be enabled, including: precise remote control, near-instantaneous communication, greater efficiency, seamless connectivity, and agile networks.[16] These capabilities will help industries to create new products and services to grow their markets, increase productivity and efficiency to reduce costs, or increase safety and security to reduce risk.

According to Ericsson, 5G technology will provide an innovation platform enabling emergent technologies such as the Internet of Things (IoT) to become integral parts of our economy and lifestyle. Some of the industries where 5G could make significant contributions are: automotive, utilities, public safety, hi-tech manufacturing, internet/digital natives, healthcare, financial services, media, and gaming.

Telecom companies can leverage 5G to surpass new entrants. A similar scenario happened in the gaming industry. Nintendo dominated the market with its 8-bit NES from 1983 to 1988. However, the reign of Nintendo was ended by Sega's 16-bit Genesis console in 1989, when Nintendo delayed the launch of its own 16-bit Super NES. Later, in 1994, Sega was dethroned by Sony with its PlayStation 32-bit console (see Figure 17).[50]

Figure 17 - Most popular video games consoles from 1983 to 1994

(Source: Google Images)

2.4.1 Summary

Our research shows that telecom companies are in a very tough position. From the investor standpoint, the telecom industry is not a very attractive industry because their ROIC (7%) is below industry average (14.9%). Telecom companies could be easily disrupted since the thread of new entrants is high, customer power is high, supplier power is moderate, threat of substitutes is high, and rivalry is high. In addition, the stakeholder analysis showed the customer's top stakeholder is not the telecom industry. Bundling services, a plan providing both home internet and mobile services, would increase the importance of the telecom companies. However, they are still not as important as the content providers in the U.S. The upcoming 5G provides a good opportunity for the telecom industry to leverage their competitive advantage. However, if nothing changes in the business model, telecom companies could become a commodity due to the disruption caused by OTT providers and content providers. In the following chapters, we will discuss how telecom companies could change their competitive advantage by using platform business models.

3 Opportunity Identification

3.1 Introduction

In the previous section, we described the tough times the telecom industry is facing today. One path for survival would be to experiment with platform business models. But, where should telecom companies start? According to Ericsson, there are at least eight industries where the next generation of connectivity—5G—may have an impact. These industries are: automotive, utilities, public safety, high-tech manufacturing, internet/digital natives, healthcare, financial services, and media, and gaming.[16] However, the sponsor for this project, Huawei Technologies, narrowed it down to the following areas: immersive media, drones, agriculture, connected automobiles, smart homes, smart cities, and wearables. They asked where telecom companies may have an impact in the next five years.

Even with this smaller scope, the question still applies: where should telecom companies start? To answer this question, Prof. Marshall Van Alstyne proposed to plot *interaction's perceived value* versus *interaction volume* because such a graph helps industries to identify the area where the platform could have the most impact. According to Professor Van Alstyne, companies should choose the opportunity that offers the higher number of interactions and the highest value. We will adopt this method.

Before we analyze the telecom industry, let's first analyze a simpler example: the video platform YouTube. YouTube has millions of videos of all types, and the perceived value for each video varies. For example, users can find do-it-yourself (DIY) videos, which could potentially save people a few hundred dollars—that is, they have high value interaction. In contrast, random videos may add no value—that is they have a lower value interaction. Ideally, to have a clear picture of YouTube's perceived interaction value versus interaction volume, we would sort the videos by type, assign a perceived value, and count the volume of views per video (interaction volume). However, this process would be extremely difficult without access to raw data. Therefore, for simplification purposes, we used average values.

Figure 18 shows the interaction's perceived value versus interaction volume of YouTube versus streaming American football in 2014. We considered the total number of hours people watched videos on YouTube, 1.395 billion hours/week, as the interaction volume (see Appendix C for calculations). To calculate the interaction's perceived value, we used the American Customer Satisfaction Index (ACSI) ranking in 2014, which was 73/100 for YouTube. In this case, the interaction volume for the streaming football was 119.3 million hours/week (see Appendix C for calculations). Customer value on sports, however, is a difficult parameter to determine. It depends on several parameters such as player performance, game atmosphere, opponent characteristics, etc.[51] For simplicity, in this example we will consider the value as high, 90/100, since fans spend an average of 7.7 hours per week watching sports on TV.[52]

To compare YouTube and streaming football, we plotted the isolines where value-volume is constant. Results show that even if the value for streaming football were 100/100, the interaction value-volume is lower than for YouTube. We concluded that this is one of the reasons YouTube is so successful. YouTube focus on high value-volume interactions rather than higher value content with very low interaction volume. Platform companies should pick businesses opportunities where interaction value-volume is on the top right quadrant.

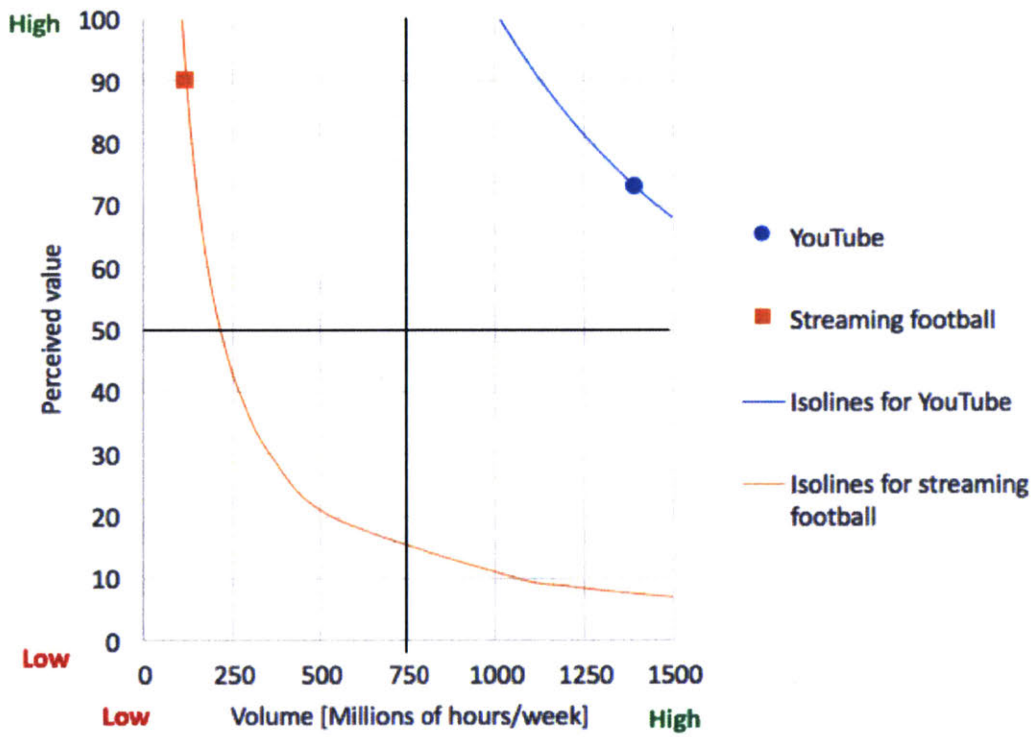

Figure 18 - Interaction perceived value vs. Interaction volume of YouTube vs. streaming American Football in 2014

3.2 Opportunity identification for the telecom industry

Building a similar graph for the telecommunication industry is more complicated. The platform does not exist yet, and estimating the value and volume of interactions for all these areas requires looking at forecasts and making some assumptions. In the following section, we describe how we estimated the interaction perceived value and the interaction volume.

3.2.1 Interaction Volume

Agriculture. Traditionally, agriculture is practiced by performing a task, such as planting or harvesting, following a predetermined schedule. But, by collecting real-time data on weather, soil and air quality, crop maturity, and even equipment, labor costs, and availability, predictive analytics can be used to make smarter decisions. This is known as precision agriculture.[53] Precision agriculture requires control centers to collect and process data in real time to help farmers make the best decisions about planting, fertilizing, and harvesting crops. Sensors placed throughout the fields measure the temperature and humidity of the soil and surrounding air. In addition, pictures of fields are taken using satellite imagery and robotic drones.[54] Internet of things (IoT) device shipments for agriculture are expected to reach 75 million by 2020.[55] However, the number of farmers in the U.S. has been forecast to decrease from 2.1 million in 2012 to 1.9 million in 2022.[56] This means there would be roughly 40 IoT devices per farmer by 2022. Even though a single IoT may collect hundreds of data points a day, farmers may use all these data to make only one decision per day. Farmers make daily decisions about input use, seasonal decisions about what to plant, annual decisions about farmland rental, and multi-year decisions about ownership and upkeep of land, machinery, and facilities.[57] If we assume that by 2022 farmers will take one meaningful decision (interaction) every day from the information their devices provide, this would mean a total of 1.9 million interactions per day.

Drones. Drones have a wide range of applications. They have been used for military purposes since 2000.[58] Companies such as Amazon,[59] UPS,[60] and DHL[61] are currently experimenting with using drones for package delivery. Big companies such as Facebook plan to use solar-powered UAVs hovering over the earth to provide internet access to the most remote areas of the planet. These UAVs will act as flying internet access points, or hotspots.[31] But, in general, drones are used for inspection purposes in areas where access is limited, risky, time consuming, or very expensive. Examples of these areas are: remote dams, power lines, oil pipelines, agricultural land, wind turbines, mines.[62] Among these, agriculture sector is, by far, the largest segment where drones will make an impact. The Association for Unmanned Vehicle Systems International estimates that agricultural drones will be 80% of its total commercial market.[63] In the previous section, we addressed the agricultural application and estimated that in this area the interaction is relatively low.

Other areas where industry experts believe that 5G and drones may have a big impact by 2020 is in law enforcement and emergency services.[64] According to the National Emergency Number Association, 240 million calls are made to 9-1-1 in the U.S. each year.[65] If we assumed drones would be used, initially, on 10% of the calls, this would mean 2.4 million interactions per day.

Wearables. In February 2016, CCS Insight forecast that 411 million smart wearables, worth $34 billion, will be sold in 2020 (see Figure 19),[66] where 42% correspond to Augmented Reality (AR) and Virtual Reality (VR) headsets, and 58% to smartwatches, wearable cameras, fitness trackers, and others. Even though CCS Insight considers AR/VR headsets as wearables, in this thesis we will consider immersive media headsets as a separate area.

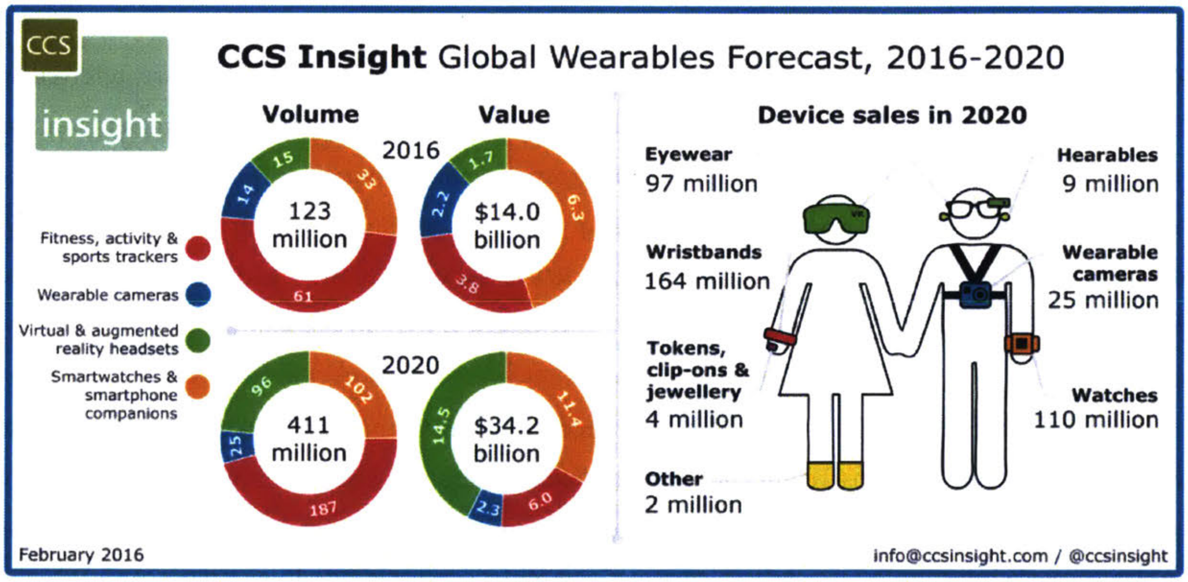

Figure 19 - Global Wearables Forecast, 2016-2020

(Source: http://www.ccsinsight.com)[66]

Today, wearables can track several parameters such as: steps, distance traveled, calories burned, active minutes, sleep time and quality, heart rate, etc.[67] Experts have identified some possible uses of wearable technology in the future. These areas are: healthcare, diet management, car insurance, police and security, outdoor pursuit navigation, personal training, arranging and meeting, and memory aid.[68] For example, if insurers could gain access to more accurate health data, they would be able to price policies better, specific to each customer. However, a meaningful interaction between any individual and their insurance company happens only once a year when they renew their policy even though their health data is collected every five minutes.

Another possible application for wearables is in diet management, especially for people who need a strict diet—people with diabetes among others. A person with type 1 diabetes needs to test their blood glucose at least 4 times a day.[69] If a wearable could measure glucose without using a needle, patients would probably test themselves more frequently (up to 8 to 10 times a day).[70] Experts predict that cloud-based companies will be able to analyze the glucose measurements to provide feedback to users about what and when they should eat.[68] Therefore, in this case, these users might have at least three meaningful interactions per day.

If we assume that 100% of the people using wearables in 2020 (314 million worldwide) will make 3 meaningful interactions a day, the total would be 942 million per day.

Immersive Media. Virtual Reality (VR) and Augmented (or mixed) Reality (AR) are referred to as immersive media. Areas where immersive media is, or may be, used include: gaming, entertainment, sports, real estate, retail, automotive, medical, and aerospace, among others.[71] Today, companies such as Facebook, Google, Microsoft, Samsung, HTC, and Sony are actively working on immersive media hardware and software. $2.3 billion was invested in AR/VR last year (2016),[72] and the market is expected to reach $80 billion by 2025.[73]

As we reported before, CCS Insight sales are forecast to be 97 million AR/VR headsets in 2020. However, not all AR/VR apps require a headset. Today, there are already several AR/VR apps, e.g. Google Cardboard, that require only a smartphone or a smartphone with an inexpensive viewer. Some examples of these apps are Nintendo's Pokémon Go mobile game, Google Expeditions, and Daydream. Strategy Analytics Research forecasts 2.4 billion downloads for the VR consumer market (excluding games) by 2022.[74] Moreover, Digi-Capital predicts the market for AR will be bigger than VR by a factor of 3 by 2020.[75] If we assume the proportion of app downloads is going to be similar, by a factor of 3, this means there will be 9.6 billion downloads of AR/VR apps by 2022.

As the YouTube example presented above shows, today a single application or service can create millions of interactions per day. However, if we are conservative and assume there will be one interaction per download per day by 2022, the number would be roughly 9.6 billion interactions per day.

Autonomous Vehicles. EY, the multinational professional service firm, in their Deploying Autonomous Vehicles report, forecast that only 4% of global automobile sales in 2025 will correspond to Autonomous

Vehicles.[76] The global sales for light vehicle production is estimated to be 111.2 million units in 2022.[77] If we assume that the percentage of autonomous vehicles in 2022 will be close to 4%, then their volume in 2022 will be 4.4 million. Autonomous cars are very expensive; some experts estimate their cost to be about $250,000.[78] Therefore, it is most likely that the first autonomous cars will be used for ride sharing. This is the case today. In April 2017, Waymo, Google's self-driving car spin-off, opened up its vehicles to members of the public for the first time in Phoenix, Arizona,[79] instead of selling the autonomous cars to the public in a dealership. Back to 2022: if we assume an average of 15 rides a day[80] and 4.4 million autonomous cars, this means an estimated 66 million interactions per day in 2022.

Smart Cities. Cities today are the major contributors to climate change. They cover less than 2% of the Earth's surface yet consume 78% of the world's energy, producing more than 60% of total CO_2 emissions.[81] By 2030, the world's population is projected to be 8.5 billion and increase to 9.7 billion by 2050 and 11.2 billion by 2100. Today, half of the human population lives in cities. Many cities are experiencing an exponential growth as more people move from rural areas into the cities in search of better jobs and education. Consequently, as cities adapt to support this population growth, their services and infrastructures are stretched to their limits in terms of scalability, environment, and security. Visionaries and planners seek a sustainable, post-carbon economy.[82] In recent years, a significant increase in the global energy consumption and the number of connected devices and other objects led government and industrial institutions to develop the concept of the smart city. There are several definitions of smart city concepts, but according to the European Parliament, a *smart city* is a city seeking to address public issues via information and communication technology (ICT) based solutions on the basis of a multi-stakeholder, municipally based partnerships.[83] According to the European Smart City Project, a smart city has six characteristics:

- Smart governance
- Smart economy
- Smart mobility
- Smart environment
- Smart people
- Smart living[84]

Each of these characteristics can be broken down to finer detail. For example, smart mobility consists of sustainable, safe, and interconnected transportation systems such as trams, buses, trains, metros, cars, cycles, and pedestrians in situations using one or more modes of transport. *Smart city* is a very broad topic. Therefore, due to time constrains, this thesis will not cover this topic.

Smart Homes. Smart home devices consist of smoke detectors, cameras, door and window position sensors, rain sensors, thermostats, temperature sensors, light switches, door locks, etc.[85] It is estimated that 1.1 billion smart home devices will be shipped by 2020.[86] According to Gartner, a typical family home could contain more than 500 smart devices by 2022.[4] If we divide 1.1 billion smart home devices by 500 devices per household, we can estimate that about 2.2 million households will be using smart home devices in 2022. Assuming that each household makes two meaningful interactions per day, we can conclude that a total of 4.4 million interactions will be made per day.

A summary of the volume of interactions for agriculture, drones, wearables, immersive media, autonomous vehicles, and smart homes is shown in Table 4.

Table 4 – Summary of volume of interactions

Topic	Volume [Millions of interactions/day]
Agriculture	1.9
Drones	2.4
Wearables	942
Immersive media	9600
Autonomous vehicles	66
Smart home	4.4

To make a sanity check of all the assumptions we just made, let's consider some forecasts at a higher level. According to the 2016 Ericsson Mobility Report, there will be 8.6 billion mobile phones and 2.1 billion cellular connection for IoT devices by 2022.[14] This fact puts immersive media on the high-volume side. Moreover, according to Intel, the distribution of IoT smart devices by 2025 will be 40.2% business and manufacturing, 30.3% healthcare, 8.3% retail, and 7.7% security.[87] If we assume that the volume of interactions may be correlated with the number of devices, then the volume of interactions for agriculture, drones, autonomous cars, and smart homes is going to be low.

3.2.2 Interaction Value

Since 2011, the Organization for Economic Co-operation and Development (OECD) has asked more than 100,000 people around the world what they think are the elements of a better life.[88] The result, called the Better Life Index, is intended to allow viewers to compare well-being across countries based on the 11 topics the OECD identified as essential in the areas of material living conditions and quality of life. Results for the U.S. are shown on Table 5.

Table 5 - Better Life Index for people in the U.S.

Topic	Index
Housing	7.9
Income	10
Jobs	8.4
Community	6.4
Education	7
Environment	7.5
Civil Engagement	6.5
Health	8.9
Life Satisfaction	7.3
Safety	7.5
Work-Life Balance	6.2

In this context, we believe drones can be related with safety (7.5); wearables with health (8.9); smart homes with safety (7.5) and housing (7.9); and agriculture with jobs (8.4) and income (10).

In 2016, the American Customer Satisfaction Index for Internet Social Media was 73/100, where YouTube ranked 77/100 and Facebook 68/100. For this work, we will assume immersive media can be categorized as internet social media. Therefore, we will use a 7/10 rating, the approximate average of YouTube and Facebook.

Table 6 and **Figure 20** summarize the interaction's perceived value versus volume for the areas Huawei requested to be included in this study. **Figure 20** shows isolines where the interaction's value-volume is constant. Based on this analysis, we conclude that immersive media is the area where telecom companies should focus the next five years due to the interaction's high perceived value and high interaction volume.

Table 6 - Summary of interaction perceived value vs. interaction volume

Topic	Volume [Millions of interactions/day]	Value of interactions
Agriculture	1.8	9.2*
Drones	2.4	7.5
Wearables	942	8.9
Immersive Media	9600	7
Autonomous vehicles	66	5.3
Smart home	4.4	7.7*

* average values

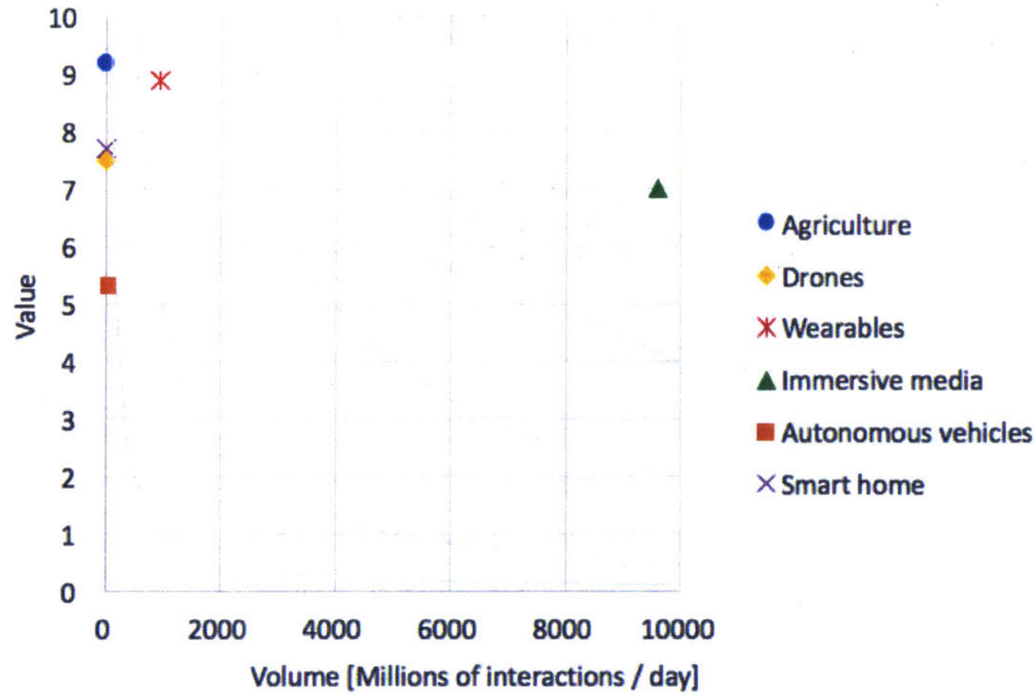

Figure 20 - Interaction's perceived value vs. interaction volume for six potential use cases of 5G

4 Platform selection

4.1 Introduction to Immersive Media

Virtual Reality (VR) and Augmented (or mixed) Reality (AR) are technologies known as *immersive media*. Immersion is what happens when technology tricks your brain into believing that you are somewhere else (see Figure 21). Or, in the case of AR, the technology adds something else to your environment that's not actually there (see Figure 22).

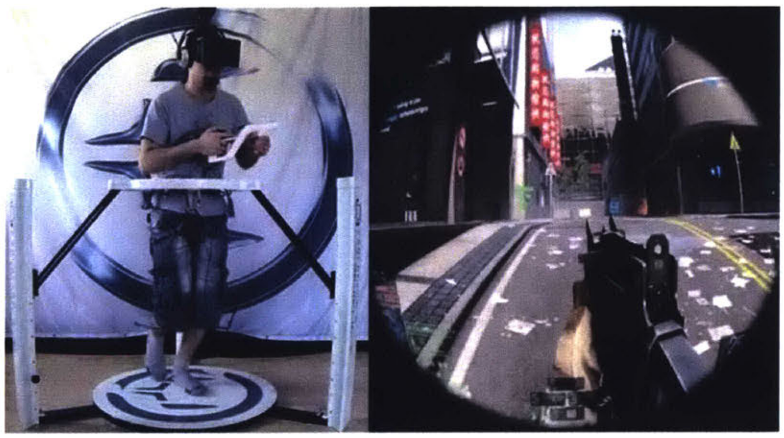

Figure 21 - User playing a VR game. Right side image shows what the user sees when using the headset

(Source: www.damngeeky.com)[89]

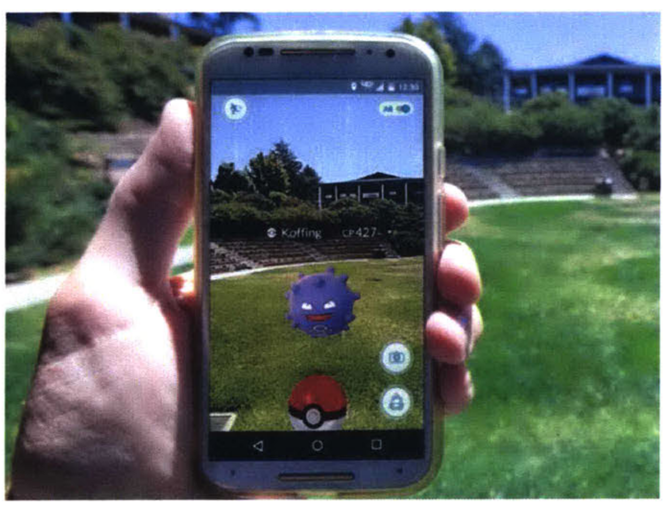

Figure 22 - Image of Pokémon Go mobile app

(Source: www.infotechlead.com)[90]

This type of media gives the viewer a sense of "presence," or a feeling of being inside the virtual world, or that virtual objects are part of the real world.[91] The ability to convincingly alter reality for a viewer has been a topic of science fiction[92] and much research and development. VR technology has existed since the 1980s, and VR headsets have been commercially available since the 1990s.[93] Recent advances in underlying technology have made immersive media more affordable, portable, comfortable, and less likely to make viewers sick from "VR sickness," which occurs when images in the headset do not match the vestibular sensation in the viewer's body.[71] [94]

VR is generally experienced via a headset that displays one image for each eye, creating a sense of presence with methods similar to 3D glasses (see Figure 23). Since VR headsets fully cover the field of view, the user does not move around significantly. Gaming and entertainment are the most popular initial use cases for VR because users are, generally, already stationary with the pre-existing technology.

As of May 2017, headsets range from $400 (PlayStation) to $800 (HTC). But there are cheaper alternatives. In 2014, at the annual I/O conference, Google gave each attendee a viewer made of cardboard (see Figure 24). It supported a virtual reality app for Android phones, appropriately called "Cardboard." This viewer, used with a smartphone, allows the user to experience virtual reality in a simple, fun, and inexpensive way.[95]

More affordable 360° video cameras are now available, making 360° video less expensive and faster to produce than computer graphics-based VR or AR, and aficionados or laypeople can capture real-life experiences to share. Samsung VR, Littlstar, NextVR, and JauntVR each feature collections of 360° videos on their websites.

Figure 23 - Most popular VR headsets

(Source: Google images)

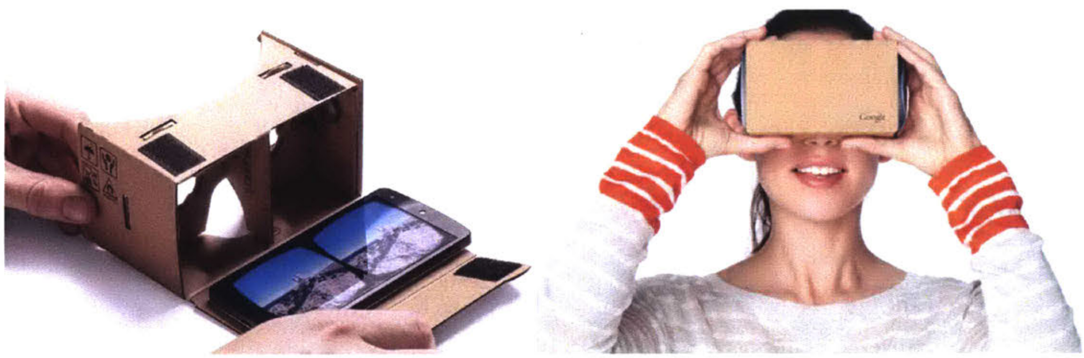

Figure 24 - Google Cardboard viewer

(Source: https://vr.google.com/cardboard)[96]

Whereas VR and 360° video fill a screen or field of view with images, AR headsets layer virtual objects onto real surroundings (see Figure 25). The virtual objects may range from information projected into the field of view (such as Head-Up Displays, or HUDs, which display on car windshields) to holograms (such as those that ship with the Microsoft HoloLens Developer Edition and display in the headset). The ability of the user to see the physical world around them makes AR well-suited to mobile uses. The Pokémon Go mobile game is an example of a recent popular AR application; it uses maps (usually already cached on a user's device), the smartphone camera, and low-fidelity images of Pokémon characters, so the game does not require abnormally high data usage.

Higher fidelity images or holograms will require the device to process more images of the user's surroundings, which will require more computing power and battery life. A very awkward backpack-style

Magic Leap prototype seen in leaked photos[97] suggests these challenges have not been solved. Smart glasses or AR headsets may make AR usage less obtrusive than it is today with smartphones, but the technology will need to advance significantly before high-fidelity uses are possible with unobtrusive glasses.

Figure 25 - Microsoft HoloLens

(Source: www.microsoft.com/en-us/hololens)

Given the technological advances that make immersive media more palatable and affordable, analysts and investors predict that AR and VR have the potential to become the next big computing platform.[73] $2.3 billion was invested in AR/VR last year (2016)[72]—over three times the $700 million invested in 2015. In January 2016, more than 1,000 Google Cardboard apps were available, and they had 25 million downloads; 500,000 students had taken Google Expeditions' virtual field trips.[98] Revenue projections include $80 billion from Goldman Sachs by 2025.[99] This "base case" projection includes $45 billion from hardware and $35 billion from software. Video games contribute the most revenue, with $11.6 billion.

While most uses of immersive media will at first be additive to existing media use (such as TV watching or smartphone use), some analysts believe that AR and VR could replace such usage in the future.[71] Factors that could speed or slow the rate of immersive media adoption, or change its direction, include:

- Technological advances (processing power, connectivity, mobility, display, tracking, battery life)
- Device (component) prices
- Content availability
- Safety, privacy

4.2 Existing Offers (Competitor Analysis)

Before we propose where to start, let's explore the AR/VR competitor landscape. As shown in Table 8, there are many tech companies and startups already building their AR/VR platforms. Some of the platforms, such as YouTube, Facebook 360, and Littlstar, only offer 360° video. Others, such as PlayStation VR, Viveport, and Oculus, focus more on hardcore VR games. In contrast, Daydream and Samsung VR provide a diversified VR content.

In terms of platform openness, YouTube is very open. It allows users to upload their content with almost no barriers. On the other hand, platforms such as Oculus, Viveport, and PlayStation, require access information to become a developer.

Table 7 - Companies that already have 360° video or VR content

Competitors	Immersive Media on Platform	Hardware required
YouTube	360° video	Smartphone with viewer. Videos can be played in a computer. But, it offers no VR experience
Daydream	VR games, sports, news, movies, etc.	Daydream Viewer and four selected smartphones
Facebook 360	360° video	Videos can be played on a computer or smartphone. But, it offers no VR experience.
Oculus	VR games, 360° video, social media (Facebook spaces)	Oculus Rift (headset), touch (hand control), and Oculus-ready computer
Samsung VR	VR games, sports, news, movies, etc.	Gear VR (viewer) and Samsung smartphone
PlayStation VR	VR games	Headset, PlayStation console, PlayStation Camera, PlayStation Move Motion Controller
Littlstar	360° video	Google Daydream Viewer + Smartphone, PlayStation VR headset, or Oculus Rift (headset)
NextVR	Live events such as sports broadcast in VR (NBA, NFL) and concerts	Google Daydream Viewer + Smartphone, or Oculus Rift (headset)
Viveport	VR games, VR videos	VIVE headset and computer
HoloLens (Microsoft)	AR	HoloLens headset
Facebook camera	AR	Smartphone

Source: Companies' website

4.3 Opportunity Identification Level 2

In chapter 3, we identified immersive media as the area where interaction's perceived value and interaction volume is high. Therefore, we recommended that telecom companies start there. But, where in the immersive media should they start? AR, VR, both? AR using smartphones only? VR with smartphones only? To clarify this, we need to research opportunity identification at a lower level. In product design, this is called Level 2. Before we identify the opportunity, let's analyze the constraints we have:

- ***Connection***. A platform should be identified where 5G connectivity may have a big impact.
- ***Time***. Identify a platform that could be feasible in the next five years.
- **Area**. Our sponsor suggested we should only look at the consumer market, i.e. Business to Customers (B2C).

4.3.1 Potential Opportunities

Screen resolution has evolved since the invention of the TV. Figure 26 shows the difference in screen resolution from 480p to 8K Ultra High Definition. For a movie or a TV show streamed from the internet to reach those resolutions, a certain internet speed is required. The internet download speed recommendations per stream for playing TV shows and movies at different resolutions can be found at the Netflix website and are shown on Table 8. In addition, the recommended connection speed for YouTube 8K full Ultra HD videos is 50 Mbps.[100] In Figure 27, we plotted the recommended connection speeds against the average fixed broadband download speeds in the U.S. (55 Mbps),[101] the mobile download speed for 4G LTE (10Mbps),[102] and 5G connection speed (10Gbps); from the data presented in Figure 27, we conclude that the next generation of screen resolution won't be supported by home Wi-Fi, nor by 4G speed. However, 5G may be used to support even higher resolutions than 8K Ultra HD.

Table 8 - Internet download speed recommendations per stream for playing TV shows and movies through Netflix

Internet download speed [Mbps]	Application
0.5	Required broadband connection speed
1.5	Recommended broadband connection speed
3.0	Recommended for SD quality
5.0	Recommended for HD quality
25	Recommended for Ultra HD quality (4k)

(Source: Netflix.com)[103]

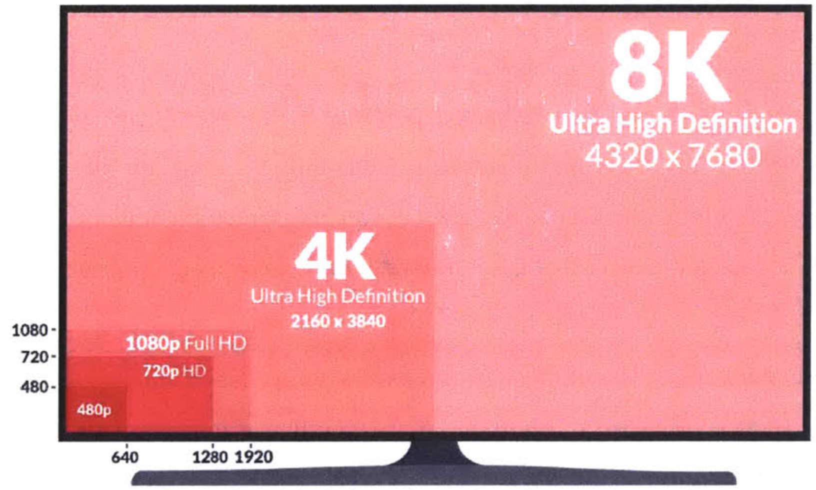

Figure 26 - Screen resolution comparison

(Source:www.audioholics.com)[104]

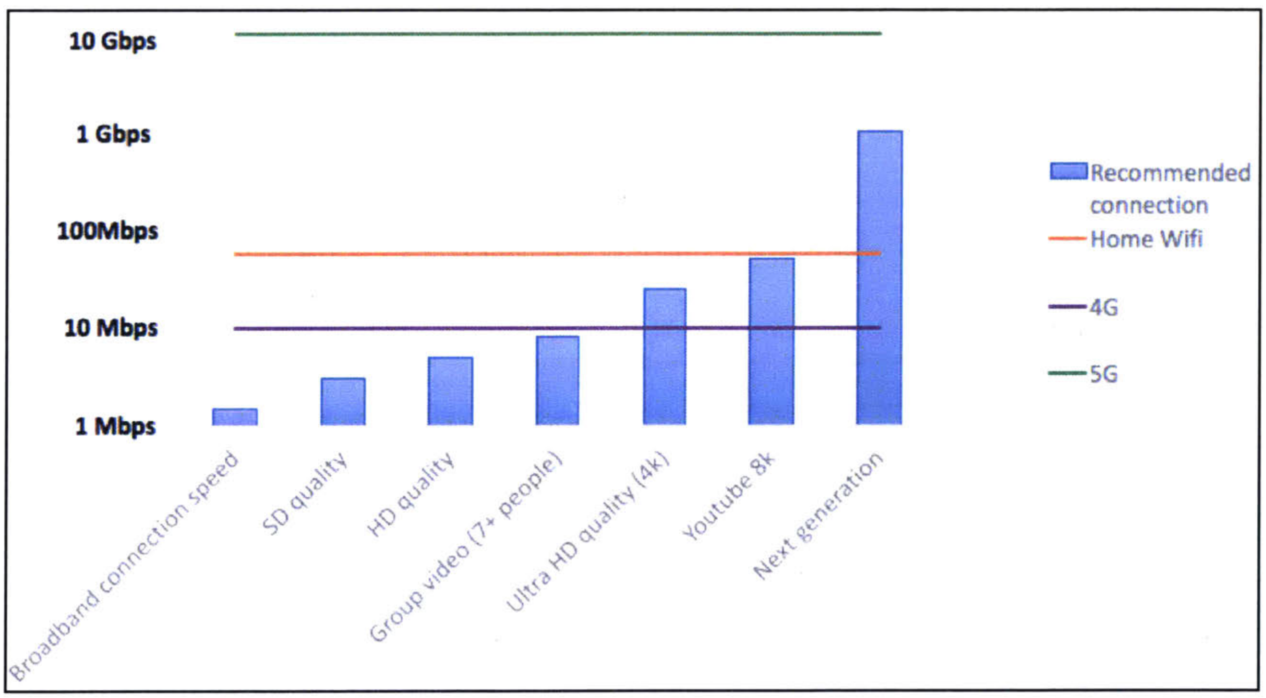

Figure 27 - Recommended connection requirements

Finally, telecom companies have millions of clients already. For example, in 2016 there were 262.2 million mobile phone users in the U.S.[105] Telecom companies could use these consumers to launch their platforms and potentially attract more users.

4.4 Opportunity Selection

Now that we have identified the constraints and opportunities, we need to decide where to start. To do that, we proposed to use the concept evaluation methodology used in the field of new product development. This methodology consists of two stages: concept screening and concept scoring.[106] Each of them is supported by a decision matrix that is used to rate, rank, and select the best concept(s).

4.4.1 Concept Screening

The purpose of concept screening is to narrow down the number of concepts quickly and to improve the concepts. The concept-screening matrix consists of selection criteria, which are the rows, and concepts to be evaluated, which are the columns. A relative score of "better than" (+1), "same as" (0), or "worse than" (-1) is placed in each cell of the matrix to represent how each concept rates in comparison to the reference concept relative to a particular criterion. In our case, the reference concept is the VIVEPORT platform from HTC. Table 9 shows the concept-screening matrix for the immersive media platform. We used five selection criteria that we considered important: need for connection speed, interaction, side switching, consumer side adoption cost, producer side adoption cost, and time to create content.

Need for high-speed connection. Telecom companies want to use 5G to leverage their competitive advantage. Therefore, we consider this as a selection criteria. Currently, VIVEPORT doesn't need 5G speed. Some of the apps recommend 15Mbps internet connection,[107] which is a standard Wi-Fi connection. AR is currently being used with smartphones and 4G connection as well. Some examples are the Snapchat and Pokémon Go apps. However, AR and VR may be widespread in consumer devices by 2020 if manufacturers can address bandwidth, content, design, processing power, and cost challenges.[108] Gaming, specifically *cloud gaming,* may be the main use at first, soon to be followed by its adoption in e-commerce, advertising, education, and medicine. *Cloud gaming* refers to videogames that users play on their computers or mobile devices through a "thin client" (e.g. a browser or a small app) and for which most of the code and computing action takes place on remote servers and is streamed in real time to users' devices.[50] The high content graphics in VR are going to require low latency, thus the need for 5G. For all these reasons, we rated AR/VR "better than" the reference. Finally, 360° HD video was rated "better than" as well, since, as we discussed before, the next generation of HD video will require 5G connection.

Table 9 – The concept-screening matrix for the immersive media platform

	VIVEPORT (reference)		AR		VR		Ultra HD 360° video	
Selection criteria	Comments	Rating	Comments	Rating	Comments	Rating	Comments	Rating
Need for high-speed connection	No	0	Yes	1	Yes	1	Yes	1
Interaction	High	0	High	0	High	0	Medium	-1
Side switching	Almost none	0	Almost none	0	Almost none	0	Medium	1
Consumer side adoption cost	Headset $800 + Computer	0	Smartphone, or smart glasses	1	Smartphone + viewer, or VR headset + computer	1	Smartphone + viewer, or VR headset + computer	1
Producer side adoption cost	High	0	High	0	High	0	Low	1
Time to create content	High	0	Medium	0	High	0	Low	1
Net score		0		2		2		4

Interactions. All platforms look for high-volume and meaningful interactions. A core interaction is defined as the single most important form of activity that takes place on a platform.[109] VIVEPORT already has multiplayer VR games, such as Arcade Saga, where players can interact.[110] Therefore, VR was rated "same as." AR was rated "same as" too, since it is currently being used for social activities. 360° HD video was rated "less than" since we believe its interactions may not be as high as the social interactions in AR and VR.

Side switching. According to Parker et al. 2016, side switching occurs when users of one side of the platform join the opposite side.[111] One example is when a guest in Airbnb becomes a host, or an Uber user becomes an Uber driver. Side switching and friction-less entry scales network effects. However, for AR and VR to do this will be difficult. Computer graphics are expensive. For example, the biggest, most polished games can cost hundreds of millions. Star Wars: The Old Republic, an online game released in 2011, is reputed to have cost between $150 and $200 million. Grand Theft Auto V, which came out two years later, reputedly cost $265 million.[112]These are called "hardcore" video games. In addition, there are "casual" games, such as Farmville, which don't require millions of dollars of investment.[113] Nevertheless, they would still require users to have high-level software skills to create AR/VR content. Therefore, we rated AR and VR "same as," although some people might argue that, from the standpoint of social media, the AR rating should be "better than." Facebook and Snapchat provide tools for users to make their own images using AR. Users are consumers when they see images from their friends or family, and producers when they use the tools to create their own images. But, here we are looking at this from the app store point of view, where you have app developers on one side and consumers on the other. Finally, side switching for 360° HD video would be easy since users would only need a camera and software to become producers. For this reason, 360° HD video was rated "better than."

Consumer-side adoption cost. This is the minimum hardware and software needed to adopt the platform. In the case of VIVEPORT, an $800 headset and a computer are needed. AR, VR and 360° HD video were rated "better than" since their minimum requirement is a smartphone for AR, and a smartphone and a viewer for VR and 360° HD video.

Producer-side adoption cost. This refers to the minimum cost required to become a producer. As we discussed in the side switching section, AR and VR require significant amount of resources, money, and time to develop an application. Therefore, they were rated "same as." On the other hand, 360° HD video was rated "better than" since its minimum requirement to become a producer is a 360° HD camera and the corresponding software.

Time to create content. For the reasons described on the producer-side adoption cost and side switching sections, AR and VR were rated "same as" since they require a significant amount of time to develop, and 360° HD camera was rated "better than" since the time for producing content could be minimum.

Finally, to conclude this section, we added the scores for each concept. Looking at the net scores, 360° HD video seems to be the most feasible solution for our needs.

4.4.2 Improvement of Concept

360° HD video is the most feasible solution for our needs. The question now is: what type of 360° HD video should we have on our platform? Should we focus on *head* end content or *long tail* content? The *long tail* concept is used to describe the retailing strategy of selling a large number of unique items with relatively small quantities sold of each—the "long tail"—in addition to selling fewer popular items in large quantities—the "head" (see Figure 28).[114]

With this in mind, we propose three concepts for the 360° HD video. **Concept No. 1** is a 360° HD video platform with live head-end content. Head-end content could be streaming sports from NFL, NBA, MLS, etc., or live concerts. **Concept No. 2** is a 360° live and recorded HD video platform with long tail content—in order words, content generated by users. Finally, **Concept No. 3** is a 360° HD video platform with high-quality recorded content. In other words, material that can only be generated by a production company.

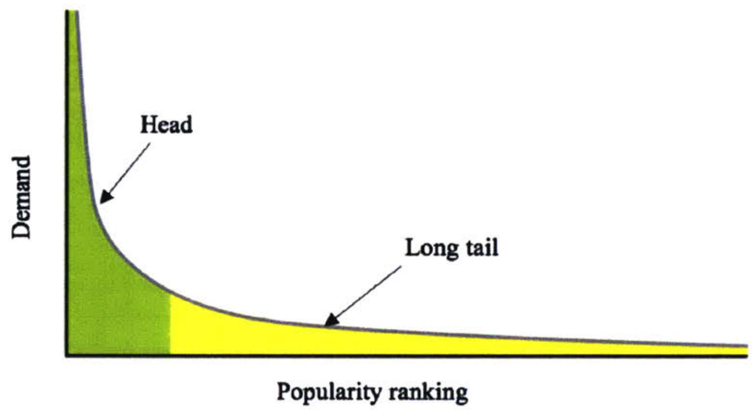

Figure 28 - An example of a power law graph showing popularity ranking

(Adapted from Wikipedia.com)[114]

4.4.3 Concept Scoring

The second stage of concept evaluation methodology is *concept scoring*. Concept scoring is used when increased resolution will better differentiate among competing concepts. In this stage, we will weigh the relative importance of the selection criteria and focus on more defined comparisons regarding each criterion. The concept scores are determined by the weighted sum of the ratings. The rating of the concepts is usually done on a 1 to 5 scale, where rating 3 is the same as the reference (see Table 10).

Table 10 – 1 to 5 scale used for concept scoring

Relative performance	Rating
Much worse than reference	1
Worse than reference	2
Same as reference	3
Better than reference	4
Much better than reference	5

(Source: Product Design and Development, Ulrich & Epingger, 2015)[106]

Table 11 shows the concept-scoring matrix for the 360° HD video platform. The selection criteria are the same we used in the concept-screening matrix. The highest weight was assigned to *need for high speed* since this is where the telecom companies want to have a competitive advantage. VIVEPORT is the reference concept; therefore, the rating is 3 on all criteria.

Table 11 - The concept-scoring matrix for the 360° HD video platform

		Viveport (reference)			360 live video - Head end content (sports, concerts)			360 live and recorded video - Long tail content			High quality entertainment 360 video - Head end content		
Selection criteria	Weight	Comments	Rating	Weighted Score	Comments	Rating	Weighted Score	Comments	Rating	Weighted Score	Comments	Rating	Weighted Score
Need for high speed	0.3	No	3	0.9	Yes	5	1.5	Yes	5	1.5	Yes	5	1.5
Interaction	0.2	High	3	0.6	Medium	2	0.4	Low	1	0.2	Low	1	0.2
Side switching	0.15	None	3	0.45	Low	2	0.3	High	5	0.75	low	2	0.3
Consumer side	0.15	High $800	3	0.45	Low	2	0.3	Low	2	0.3	Low	2	0.3
Producer side	0.1	High	3	0.3	Low	1	0.1	Low	1	0.1	Low	1	0.1
Time to create	0.1	High	3	0.3	Medium	1	0.1	Low	1	0.1	Medium	2	0.2
				3			2.7			2.95			2.6

After performing the scoring of each concept relative to VIVEPORT, results show that a 360° HD platform with live and recorded long tail content is the best solution for our needs. Using long tail content is not new. Several companies, such as Amazon, Netflix, and YouTube among others, have used this long tail theory to grow.

Chris Anderson, editor-in-chief of *Wired Magazine* coined the term "the long tail" in 2004 to describe a phenomenon in which niche products account for a much larger proportion of sales in internet markets than they do in brick-and-mortar markets.[115] In an earlier study of the internet's long tail phenomenon, Brynjolfsson et al. (2003) found that sales of niche books—books that are not typically stocked in brick-and-mortar bookstores—enhanced consumer surplus by $731 million to $1.03 billion in 2000.[116] The long tail theory suggests that the internet drives demand away from hit products with mass appeal and directs that demand to more obscure niche offerings.[117] An example can be seen for Amazon book sales between 2000 and 2008. Figure 29 shows the estimated linear relationship between Amazon sales and sales rank, with the 2008 results in blue and 2000 results in red. This graph provides some evidence that Amazon's long tail became longer and fatter in 2008 compared with 2000. As sales ranks increase, book sales decline. Such a decline is at a slower pace in 2008 than in 2000. Figure 30 shows the same data, but in logarithmic scale. The 2000 and 2008 curves cross when sales rank is 14,949. This means popular books (with sales rank below 14,949) tend to sell fewer copies in 2008 than in 2000, while niche titles (with sales rank above 14,949) tend to generate more sales in 2008 than in 2000.[118]

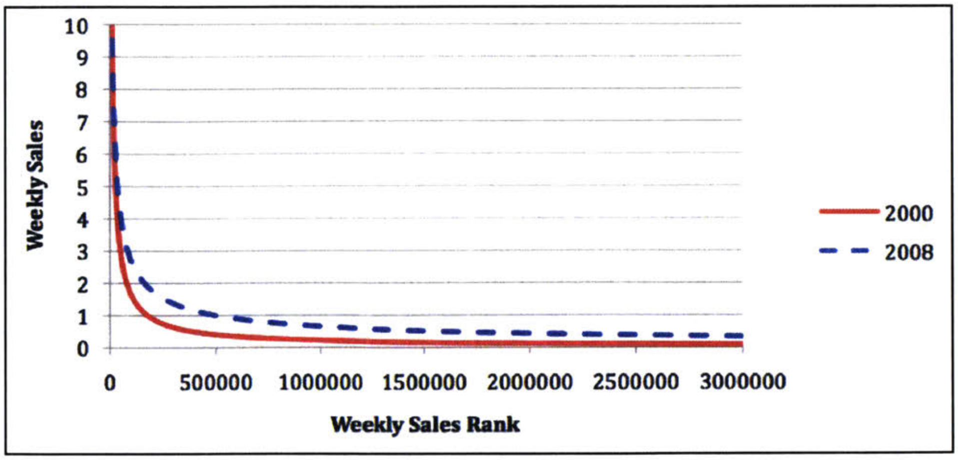

Figure 29 - Amazon long tail in 2000 and 2008

(Source: Brynjolfsson et al., 2010)[118]

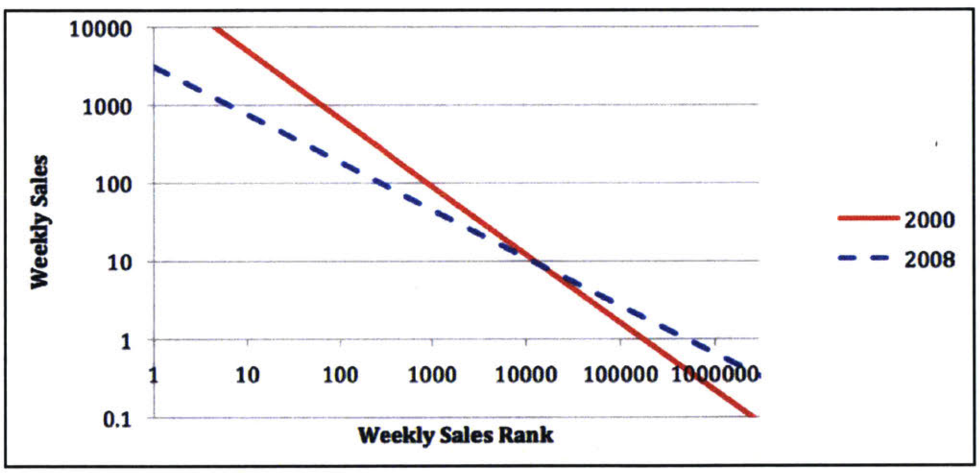

Figure 30 - Amazon long tail in 2000 and 2008, in log scale

(Source: Brynjolfsson et al., 2010)[118]

Summary

In this chapter, we used concept evaluation methodology to select the most feasible platform opportunity in the immersive media field for telecom companies. We analyzed the constraints and opportunities in the next five years and explored the existing offers. We concluded that a 360° HD platform with live and recorded long tail content would provide the best opportunity for the telecom companies. In the next chapter, we will structure the platform architecture.

5 Platform Architecture

5.1 Transforming Products Into Platforms

Andrei Hagiu and Elizabeth Altman wrote an article called "Transforming Products and Services Into Platforms," which is to be published in the *Harvard Business Review* in the summer of 2017. In this article, they describe four possible models for transforming products and services into multi-sided platforms (MSP). These models are: 1) opening the doors to third parties, 2) connecting customers, 3) connecting products to connect customers, and 4) supplier to multi-sided platform.[119] For our purpose, we chose scenario 2. According to Hagiu and Altman, if you are selling a product or service to two distinct customer segments that interact or transact with one another outside of your offering, you can become an MSP by modifying or expanding your offering so that at least a part of those interactions or transactions occurs through your product or service. As we saw in the stakeholder analysis in chapter 2, telecom companies are providing voice, SMS, and data to customers. The current mobile internet connection in the U.S. is 4G LTE. It will soon be 5G. If we believe that 5G will be needed for producers to upload their content and for customers to stream content, then telecom companies can become a platform by providing 5G connectivity to customers and producers, thus enhancing the interaction between producers and customers.

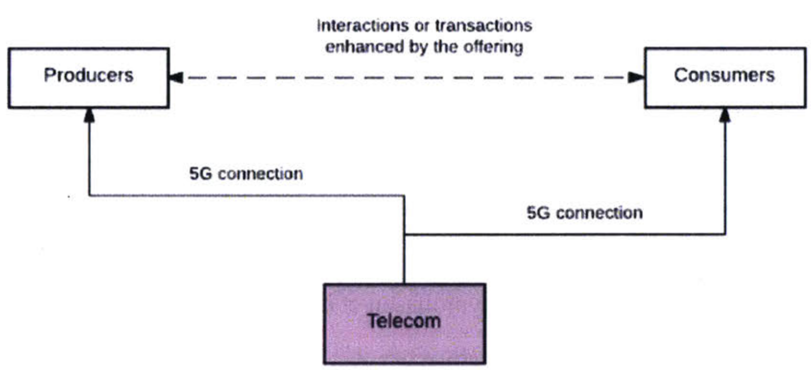

Figure 31 - Telecom companies will provide 5G to consumers and producers

(Image recreated from Hagiu and Altman, 2017)

5.2 Platform Architecture

When designing a platform, the first and most important step is to decide what the *core interaction* will be. The core interaction is the single most important form of activity that takes place on a platform, and it involves three key components: the *participants*, the *value unit*, and the *filter*.[111]

5.2.1 Participants

In our case, we propose the participants should be:

Side 1 – Viewers. People who are going to watch the 360° HD videos

Side 2 – Producers. People who are going to produce the 360° HD videos

Side 3 – Advertisers. Marketing companies that create audio or visual message to promote or sell a product, service, or idea

Side 4 – Software developers. People that develop add-ons to edit videos

5.2.2 Value unit

The value unit created by the producers is going to be live and recorded long tail 360° HD videos.

5.2.3 Filter

As we saw in the previous chapter, algorithms developed to match people's interests can increase the consumption of long tail content. Therefore, we propose the following filter:

- *Matching*. Like dating websites, we aim to develop an algorithm that matches other videos based on your preferences. The percentage would give you an idea of the likelihood the video offered matches your taste.

5.3 Platform Description

Up to now, telecom companies have had no option but to partner with OTT companies. Some telecom companies provide zero-rated content to customers to use OTT communication services.[120] However, as we know, telecom companies do not own these OTT communication services. Before we continue with the platform architecture, let's define what *zero-rating* and *net neutrality* are. The Federal Communications Commission (FCC) approved net neutrality rules in 2015 with the aim of preserving the open internet and ensuring that it could not be divided into pay-to-play fast lanes for web and media companies that can afford it and slow lanes for everyone else.[121] This means that internet service providers (ISPs) should treat all data on the internet the same rather than discriminating or charging differentially by user, content, website, platform, application, type of attached equipment, or mode of communication.[122]

Zero-rating, meanwhile, is when an ISP allows certain services to be streamed on its network with no effect on a user's data cap.[123] For example, in the U.S, subscribers of certain T-Mobile programs can stream Spotify, Apple Music, and Pandora without it counting against their plan's data allotment.[124] For this work, we want to take advantage of zero-rating.

Our platform idea is for the telecom companies to provide users zero-rating to watch 360° HD videos. In addition, telecom companies would give producers zero-rating for the upload of 360° HD. We believe this idea will pull customers to watch videos in this platform rather than on competitors' platforms. Certain community guidelines would be in place to curate content. For instance: no nudity, hateful content, violent content, etc. The platform would be relatively open so as to encourage innovation. However, some filters and tools would be in place to allow users to have meaningful interactions (see filter section above). The platform would be divided into several channels such as:

1. Sports
2. Education
3. Real estate
4. Tourism
5. Private personal communication, etc.

We mentioned when we discussed platform selection that this platform will support live 360° HD videos, which may be used for telecom companies to dominate person-to-person communication. For example, users could perhaps broadcast a family event (e.g. a wedding or party) or have a meeting with family members so they feel they are with them.

5.4 Tools for Producers

Companies such as Netflix and Amazon use data analytics to learn what people watch the most and what people like, then they create their own content based on these results. A clear example of this approach is a show created by Netflix, *House of Cards.*[125] Executives knew *House of Cards* was going to be a hit before the show was released to the public. Netflix used big data to analyze what the 27 million subscribers in the U.S. like and dislike. For our platform, we propose opening this information to producers so that they know what kind of shows to produce to get more viewers. This will create the virtuous cycle (reinforcing loop) shown in Figure 32. The more information producers get about what to produce, the more views they will get. Obtaining high views would translate to more producer success. If the chance for success is high in the platform, then more producers will be attracted to the platform. More producers plus knowledge of what to produce will create more popular content. More popular content will attract more users, thus more knowledge of what to produce.

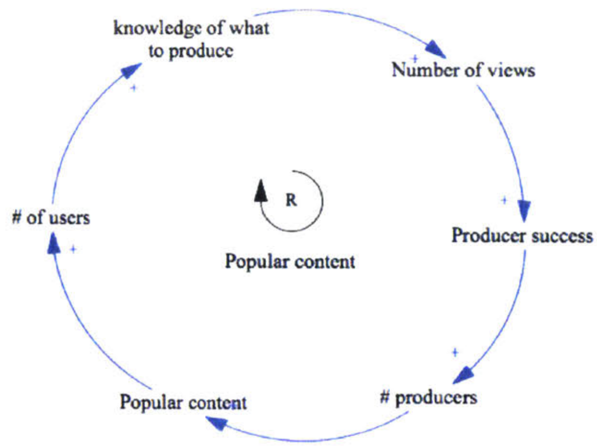

Figure 32 - Reinforcing loop created by sharing information with producers

5.5 Tools for users

Rating. This is a rating system with which users can rate each video. This rating will be shown on the video details so that people will know the average quality or popularity.

View counter. A view counter, similar to the ones that YouTube and other platforms have, would be helpful to let customers know what it is trending.

Share. Another helpful tool would be an option to share a video in through social media or text or even to email the link to other users that might be interested.

Suggestions. Nowadays, platforms use data analytics to identify what users like. However, almost none have a section where the customer can state their needs or preferences. We believe this would be an important feature on the platform. According to Parker et al. 2016, platform managers should also pay attention to failure to create a meaningful interaction, as is the case when users cannot find what they are looking for.

Software tools. These would be add-ins that users could use to edit their 360° HD videos without the need to buy expensive professional software. Snapchat was one of the first platforms that adopted an add-on to edit photos using AR. Now, Facebook with its Facebook camera[126] also offers this option. An example of a video edited using AR would be the recent Bruno Mars hit song, "That's What I Like," where the diamonds, strawberries, and ice that are mentioned in the lyrics are also shown in the video using AR (see Figure 33).

Figure 33 - Bruno Mars' hit song "That's What I Like" using AR

(Source: www.youtube.com)[127]

5.6 Network Effects

Network effects occur when the number of participants grows on both sides, with value increasing for the parties on each side.[5]. Network effects are important because, in contrast to price effects and brand effects, they create a virtuous cycle which leads to the building of a long-lasting network of users, a phenomenon called *lock-in.*[111]

Figure 34 shows the relatively complex causal loop diagram (CLD) of the 360° HD video platform. The foundation of this CLD is the bass diffusion model.[128] Frank Bass (1969) developed a model for the diffusion of innovations that overcomes the start-up problem.[129] The total adoption rate is the sum of the adoption resulting from worth of mouth and adoptions resulting from advertising and any other external influences (see Figure 35).

For our CDL, we added other stocks such as producers, content, advertisers, and user experience. In addition, we improved the model by adding: *virality* (orange loop*)* and *product attractiveness* (pink loop). In our case, product attractiveness helps to close a loop that creates *positive cross-side network effects*. According to Parker et al. (2016), the difference between virality and network effects is that virality is about attracting people who are off the platform and enticing them to join, while network effects are about increasing value among people on-platform.

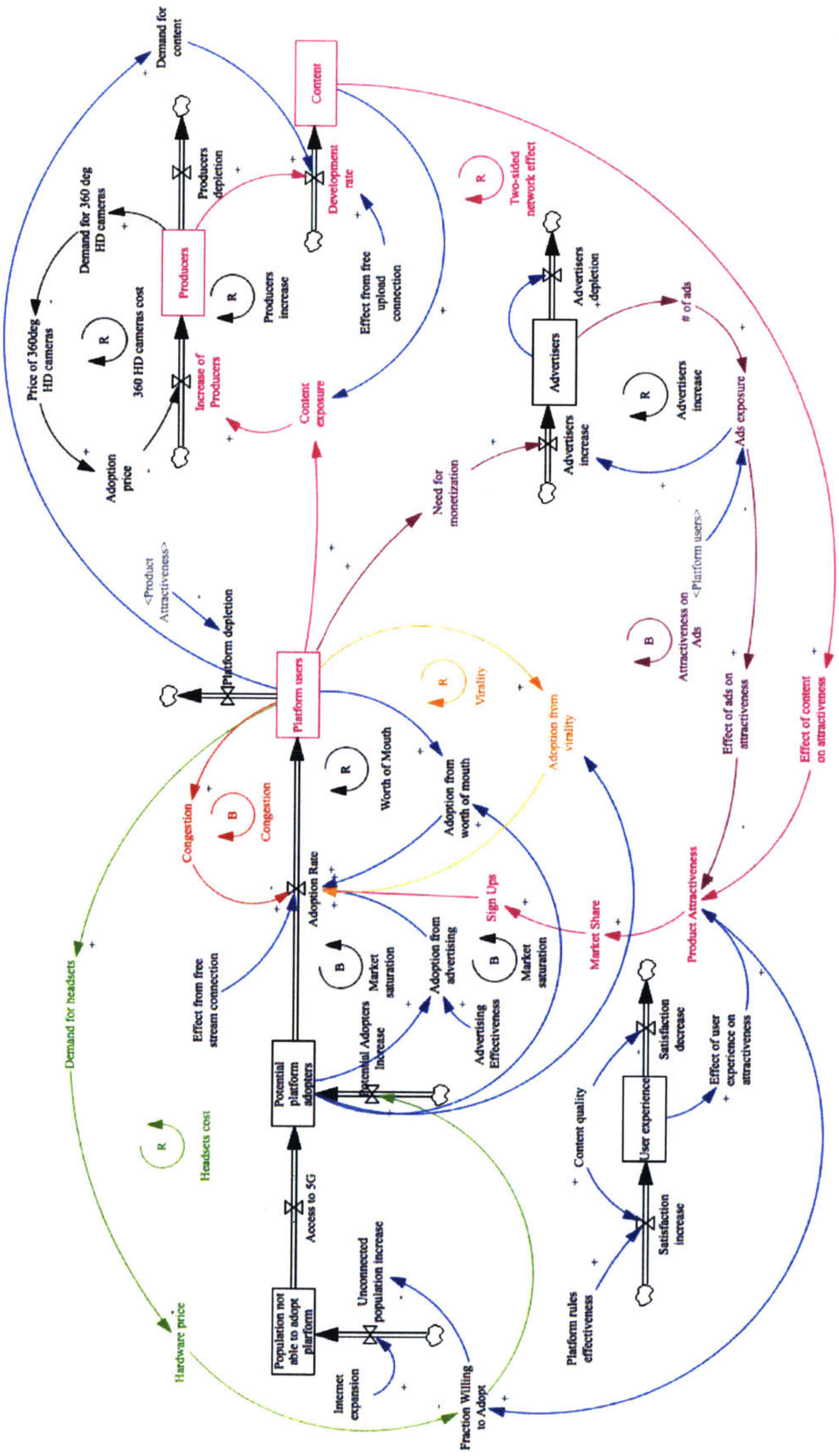

Figure 34 - CLD for 360° HD video

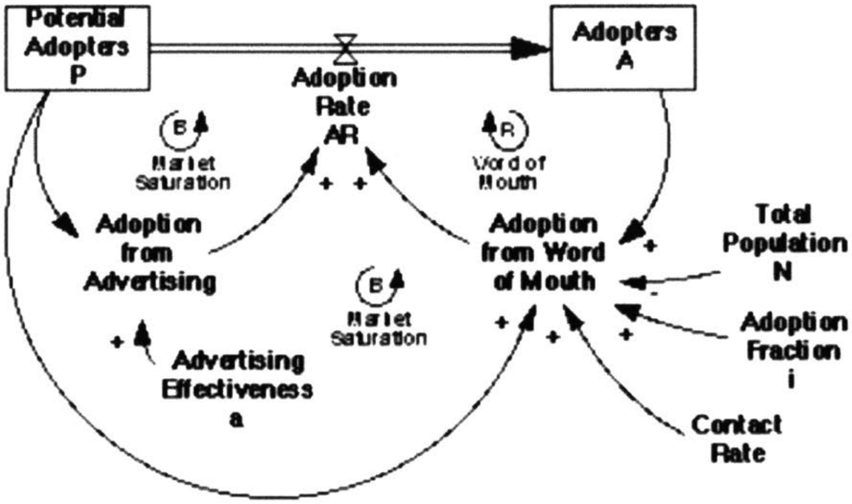

Figure 35 - Bass diffusion model

(Source: Business Dynamics, Sterman, 2000)

In general, CLD diagrams should be read as follows: if the polarity of the arrow is positive, this means both items increase or decrease simultaneously. In contrast, if the polarity is negative, this means that one increases and the other decreases, or vice versa. So, the pink loop reads as follows: if number of users increases, then content exposure increases. If content exposure increases, then producers willing to come to the platform increase. If producers increase, the amount of content increases. If content increases, the attractiveness of the platform increases as well—thus, an increasing adoption rate. If the adoption rate increases, platform users increase even more. Therefore, this creates the virtuous cycle we described earlier. Since this reinforcing loop creates value for both users and producers, we conclude this is a *positive cross-side network effect.*

On the user side, a feedback loop called *headsets cost* is generated (green loop). It reads as follows: if the platform users increase, demand for headsets will increase. If demand increases, due to economies of scale, headset price would go down. If headset prices go down, the fraction willing to adopt increases, thus increasing the number of potential adopters. If potential adopters increase, then the platform users increase even more. Therefore, this is a reinforcing loop that creates *positive same-side network effects.*

Similar behavior happens on the producer side. The *360° HD camera cost* is generated (black loop) and it reads as follows: as the number of producers goes up, demand for 360° video cameras goes up. If demand goes up, cost goes down. If cost goes down, this decreases the adoption price. If adoption price goes down, this increases the number of producers even more. Therefore, this is a reinforcing loop that creates *positive same-side network effects*.

All reinforcing loops also generate *balancing loops* or *negative feedback*. Negative loops are self-correcting. They counteract change. For example, as the platform users grow, this is going to generate congestion if the bandwidth and data speed are fixed. Therefore, it creates counter action on user adoption rate (see red loop). Another balancing loop we identified was the advertising effect. If there is too much advertising, then the attractiveness of the platform goes down, thus affecting adoption rate (purple loop). The bass model has two balancing loops by itself. Both of them refer to the market saturation; that is, the users will not increase exponentially forever. At some point, the number of potential adopters will dwindle sharply as the number of actual adopters reaches maximum capacity.

As in Netflix and YouTube, network effects are driven by the amount of content available. Users will join the platform not because their friends are there but because they can find a wide selection of content. For our platform, there are two more reason to join: 1) because it is zero-rated content and 2) because it is HD.

In chapter 4, we mentioned that side switching and frictionless entry are what scale network effects. Side switching in a 360° HD video platform would be easier than for an AR/VR platform. Recording a 360° HD video is easier than generating graphics for AR/VR. We believe side switching will happen frequently once the 360° HD cameras become more affordable.

5.7 Launch

In the previous section, we talked about network effects and how they create virtuous cycles that lead to the building of a long-lasting network of users. But, the million-dollar question is: How do you start that cycle? Users attract producers, and content attracts users. But where do you start? In the case of YouTube, they incentivize content creators to upload their videos. One of the first videos that reached one million views was a promo video from Nike. It was a clip of the Brazilian soccer player Ronaldinho receiving his pair of Golden Boots.[130] Nike was also one of the first major companies to embrace YouTube's promotional potential.

Parker et al. (2016) pointed out that there are at least eight strategies for beating this chicken-or-egg dilemma. One of them is the seeding strategy, where you create value units that will be relevant to at least one set of potential users. When these users are attracted to the platform, another set of users, who want to interact with the first, will follow. We believe the seeding strategy is the best option for the 360° HD video platform. It may appear that we could also use the piggyback strategy, since telecom could use its network of existing customers. However, this strategy will not work on its own. We have seen telecom carriers add applications to smart phones by default, hoping customers will adopt the app. But, this does not guarantee usage. For example, Verizon failed in its content strategy with Go90, in part because they relied on piggybacking and did not build up a user base for the content service.[131]

5.7.1 Strategy #1 – Seeding

Results from a VR focus group study conducted by the Consumer Technology Association (CTA) found that the most popular suggestions from consumers interviewed for VR content include lifestyle activities such as concerts, sports, and exercise.[132]. Therefore, we believe that seeding the market with music videos, concerts, or streaming sports would be a good strategy to encourage users to try the platform. As of today, nine out of the 10 most watched videos of all time on YouTube are music videos.[133] We believe partnering with some marquee or pre-marquee artist could increase the number of users. However, this content should be long tail content such as: behind the scenes of a popular video, rehearsals, etc.

In addition to the seeding strategy, to make this platform a success, a combination of the following strategies should be run in parallel.

5.7.2 Strategy #2 – Competitions and Lending Cameras to Content Developers

On the content developers side, we propose launching a 360° HD video competition, where the sponsor of the platform lends cameras to producers. The winners will get a cash prize plus the chance to keep the camera. We believe this competition would encourage producers to participate. In addition, the best producer will have the chance to keep creating content. Google, for instance, has just released a similar strategy for their Daydream platform: since many filmmakers can't afford to pay thousands of dollars for a VR camera, Google started a program called Jump Start where people submit an application to use a professional 360° HD camera (called Halo) for free along with the software needed to make VR films.[134]

5.7.3 Strategy #3 - Subsidizing

Nowadays, headsets are very expensive. They range from $400 (Sony PS VR) to $800 USD (HTC VIVE). Several smartphones can be used in combination with a less-expensive headset to experience VR. Inexpensive headsets, such as Google Cardboard, could encourage adoption. However, this viewer is not intended for long-term usage. Therefore, we believe either the telecom companies or Huawei should subsidize high-quality viewers used with smartphones or more advanced headsets to use with the VR technology embedded.

5.7.4 Strategy #4 – Zero-Rated for Users and Producers

As we mentioned in the platform description, we believe zero-rated content would encourage users to use the platform and producers to upload or stream their content. Zero-rated has been used as a differentiator for carriers but also as a way to get the carriers' customers in the habit of using their mobile devices and connectivity for more activities. If users don't have to pay for data related to immersive media, the friction for adoption would be reduced. Today, telecom carriers can do this—while Google and Facebook cannot.

5.7.5 Strategy #5 – Referral Program

We believe telecom companies should incentivize users to invite other users to the platform. This technique has been successfully applied by Dropbox, Uber, Lyft, etc. Dropbox, for example, encouraged existing users to invite their friends and family to become members. When a new member joins the platform, both the existing user and the invitee receive a 500MB increase in their storage capacity.[135] Using this technique, Dropbox went from 100,000 users to 4 million users in 15 months.[136] Telecom companies could use a similar technique. For example, they could offer a 5% discount on the member's phone bill when a friend or family member they invite joins in. Or, they could offer more data to use on other applications.

5.8 Monetization

Parker et al. (2016) mention in their book, *Platform Revolution: How Networked Markets Are Transforming the Economy—And How to Make Them Work for You*, that there are at least four ways to monetize a platform: 1) charging a transaction fee, 2) charging for access, 3) charging for enhanced access, and 4) charging for enhanced curation. They also point out that monetization in the early stages of platforms creates friction on entry into the ecosystem, discouraging many potential participants from becoming users. They summarize this last point by stating: "users first, monetization later." With this in mind, we propose avoiding monetization during the launch and growing phase. As we proposed on the launch section, rather than charging, telecom should be subsidizing users. Later, when users have reached critical mass, we propose an ad/subscription approach. Ads could be added to the videos to get revenue. If users don't want ads, they could pay a subscription fee. This ad/subscription fee would be shared with producers so long as they reach a certain number of views.

This type of monetization is already used by YouTube. Currently, YouTube has 1.3 billion users and generates $4 billion dollars of annual revenue for Google.[137] If our platform was global, the forecast for 5G subscriptions worldwide by 2022 would be 550 million.[14]

5.9 Openness

In a paper published in 2008 on platform openness,[138] Eisenmann et al. state that all the roles in the platform can be open or closed by degrees. For this platform, we recommend Huawei, as the sole sponsor, the telecom carriers he has selected as providers (see Table 12).

Table 12 - Platform Roles: Open or Closed?

Platform role	Open or closed	Huawei-Carrier Platform Strategy
Demand-side users (End users)	Semi-open	Platform is available to customers in 5G pilot markets
Supply-side users (Content & Tool Providers)	Semi-open	Carriers target high-quality content and tool providers; high standards
Platform provider	Closed	Huawei selects carriers, which enable access to the platform
Platform sponsor	Closed	Huawei controls the platform

(Adapted from "Immersive Media and the Possibilities of 5G" Hughes et al. 2017)[139]

The framework in Table 13 considers openness from the perspective of platform governance. Here, Huawei sponsors the platform but selects many carriers to provide the platform, which most resembles the licensing scenario.

Even though the proprietary model provides greatest control and facilitates the most closed system of operation, history has shown that the proprietary model does not always produce lasting economic results.[111] The licensing model is open on one end and closed on the other. We believe that opening one side will increase innovation. For example, some companies that have adopted the licensing model are Google Android and Microsoft Windows. In 4Q2016, Google Android (licensing model) had 81.7% of the market share compared to Apple iOS 17.9% (proprietary model).[140]

Table 13 - Four models for managing and sponsoring platforms

		Platform management	
		One firm	Many firms
Platform sponsorship	One firm	Proprietary model	Licensing model
	Many firms	Join Venture model	Shared model

(Adapted from "Opening Platforms: How, When and Why," Eisenmann et al., 2008)[138]

5.10 Financial analysis for the 360° HD video platform

In this section, we will calculate the *net present value* (NPV) of the 360° HD platform we proposed. The main question we want to answer is: Is it feasible for telecom companies to provide zero-rated content and still make a profit? In order to perform this NPV, we will use forecasts and the existing parameters used for television and other existing platforms.

5.10.1 Number of Users

The literature contains several forecasts for 5G subscribers. Some predict 5G won't be available until 2020. However, Verizon and AT&T announced early 5G deployment by the end of 2017.[141] [142] For our estimates, we will use the forecast from the Ericsson Mobility Report and GSMA. GSMA predicts there will be 1.1 billion 5G subscriptions by 2025.[143] The values for 2022 from GSMA correspond to Ericsson forecasts. Ericsson predicts there will be 550 million 5G subscriptions by the end of 2022.[14] Forecasts beyond 2025 are limited. Therefore, we extrapolated the values until 2030. We assumed not all 5G users would be interested in the 360° HD video platform. Therefore, we assumed that initial adopters (IA) would be 50% of total 5G subscribers (U) in 2021, with a 5% increase every year.

$$MAU = U * IA$$

Where:

MAU = monthly active users [Millions of users]

U = 5G users [millions of users]

IA = % of initial adopters [%]

5.10.2 Number of Hours Spent in VR

To estimate the number of hours users would spend in VR, we looked at what existing users spend on existing platforms. For instance, VIVE users spend in average of 5.03 hours/week in VR.[144] Other statistics show gamers spend an average of 6.5 hours/week in VR.[145] Four our platform, we are going to assume the hours spent on VR (t) would be 7 hours/week. We believe users would be more willing to use the platform since it is HD and there is no charge for it.

$$HV = MAU * t * 52\ weeks/year$$

$$\frac{millions\ of\ hours}{year} = (million\ users)\left(\frac{hours}{week * user}\right)\left(\frac{weeks}{year}\right)$$

Where:

HV = hours of video per year [millions of hours/year]

MAU = monthly active users [millions of users]

t = hours spent per week [hours/(week*user)]

5.10.3 Revenue

Currently, YouTube gets money from advertisers and splits that profit with producers. YouTube uses a 45/55 split for all content creators. This means that YouTube keeps 45% of the revenue from ads and the remaining 55% goes to the content creator. The way YouTube charges advertisers is by views. *Cost per thousand* (CPM) is an industry term that represents revenue per thousand views. For instance, in 2013, the average cost per thousand (CPM) for YouTube was $7.60.[146] On the other hand, Hulu has a CPM between $25 and $35 for a broad demographic, according to media buyers.[147]

For our platform, we propose having no ads for the first three years until the platform reaches at least 500 million users. After, we propose starting with 40 ads/hour and increasing it 25% every year until it reaches the standard number of ads on TV: 60 ads/hour (15 minutes of ads of 15-seconds length).[148] We propose and initial $35 CPM with a 5% increase every year and a 60/40 split with a 5% increase every year. We propose a higher split since our platform does not require home internet connection or charges to a data plan, and we charge more on CPM.

$$R = HV * Ads * Split * CPM$$

$$\frac{million\ \$}{year} = \frac{millions\ hours}{year} * \frac{ads}{hour} * \frac{\$}{1000\ ads}$$

Where:

R = revenue [millions of dollars]

HV = hour of video per year [millions of hours/year]

Ads = ads per hour [ads/hour]

Split = revenue the telecom keeps from ads [%]

CPM = average cost per thousand [$/1000 ads]

5.10.4 Expenses

In order to run this platform, there will be two types of expenses: expenses for data consumption and expenses to run the platform itself.

5.10.4.1 Expenses for Data Consumption

According to Netflix, streaming Ultra HD videos requires 7GB per hour.[149] Knowing the average number of hours spent per user and the number of users, we can estimate the total amount of data needed per year (GBY).

$$GBY = DU * HV$$

$$\frac{millions\ GB}{year} = \left(\frac{GB}{hour}\right)\left(\frac{millions\ hours}{year}\right)$$

Where:

GBY = number of GB per year [millions of GB/year]

DU = data usage for Ultra HD video [GB/hour]

HV = hour of video per year [millions of hours/year]

Moreover, mobile experts estimate the cost per GB (CPGB) for 5G will be cheaper than 4G. This is $0.25/GB with 5G compared to $2.2/GB for 4G.[150] For our NPV, we will assume the price per GB will go down 5% every year due to economies of scale.

If we multiply the amount of data per year (GBY) times the cost per GB (CPGB), we can calculate the total expenses for data consumption per year (CD).

$$CD = GBY * CPGB$$

$$\frac{millions\ \$}{year} = \left(\frac{millions\ GB}{year}\right)\left(\frac{\$}{GB}\right)$$

Where:

CD = cost of data [Millions of dollars/year]

GBY = number of GB per year [millions of GB/year]

CPGB = cost per GB [$/GB]

5.10.4.2 Expenses for Running the Platform

Currently, Google spends $6.3 billion dollars annually to run YouTube.[137] If YouTube has 1.3 billion users, the average cost per user is $4.88/year ($6.3/1.3). Another platform we can look at is Netflix. In Q3 2015, Netflix had 69.17 million users,[151] and a cost and operating expense of $1562 million.[152] Therefore, the cost to support each subscriber was $22.58/quarter or $90.3/year. Since our platform is going to offer long tail content, we believe the cost per user should be close to the cost of YouTube. We will assume an initial cost per user (CPU) of $15/year and a 7% decrease per year after launch.

$$TCP = CPU * MAU$$

$$[millions\ of\ \$] = \left(\frac{\$}{user}\right)(millions\ of\ users]$$

Where:

TCP = total cost for running the platform [millions of $]

CPU = cost per user [$/user]

MAU = monthly active users [millions of users]

5.10.5 Initial Investment

We will assume telecom would invest a few million dollars between now and 2020 in order to determine the feasibility of the platform then a $1 billion-dollar investment to start the platform. In addition, we considered the $5 million dollars in 2021 for the contest we described during launch strategy.

5.10.6 NPV Parameters

As we discussed in chapter 2, mobile networks evolve every 10 years. Therefore, for simplification purposes, we will only consider the NPV for 10 years after the deployment of 5G in 2021 (no perpetuity). In addition, we considered a 39% corporate tax[153] and a 15% discount rate.[154]

5.10.7 Results

Figure 36 shows the results we obtained using the assumptions we made. Results show telecom companies won't be making money for the first four years. However, the NPV is positive. It shows the 360° HD video platform is a $174 billion-dollar opportunity. These are very rough calculations. We didn't take into account depreciation and capital expenditure. There are some other financials we didn't consider here that are the way to keep customers with telecom companies. As we mentioned on chapter 2, telecom companies are being disrupted by the new entrants who threaten to provide mobile high-speed internet as well. Therefore, telecom companies need to find a way to keep customers engaged.

	Area	Variable	Units	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	Number of 5G users	U	[millions users]	100	300	550	800	1100	1447	1818	2216	2638	3083
Initial investment			[M$]	5									
Revenue													
	Cost per Thousand (CPM)	CPM	[$/1000 views]	$0.00	$0.00	$0.00	$35.00	$36.75	$38.59	$40.52	$42.54	$44.67	$46.90
	Average time per week	t	[hours/week*user]	7.00	7.35	7.72	8.10	8.51	8.93	9.38	9.85	10.34	10.86
	Initial adopters	IA	[-]	50%	53%	55%	58%	61%	64%	67%	70%	74%	78%
	Monthly Active Users	MAU	[Million users]	50	158	289	420	578	760	955	1163	1385	1619
	Hours of video per year	HV	[millions hours/year]	18200	60197	115878	176978	255512	353006	465672	595827	744793	914039
	Number of ads	ads	[Ads/hour]	0	0	0	60	75	60	60	60	60	60
	Platform charge	split	[%]	0%	0%	0%	60%	63%	66%	69%	73%	77%	80%
	Total	R	[M$/year]	$0	$0	$0	$222,992	$443,680	$540,643	$786,296	$1,109,188	$1,528,620	$2,068,267
Operating costs													
Expenses for data consumption													
	Ultra HD data usage	DU	[GB/hour]	7	7	7	7	7	7	7	7	7	7
	Number of GB per year	GBY	[Millions GB/year]	127400	421375.5	811147.8375	1238843.97	1788580.982	2471044.151	3259701.495	4170790.821	5213554.315	6398270.406
	Cost per GB	CPGB	[$/GB]	$ 0.25	$ 0.24	$ 0.23	$ 0.21	$ 0.20	$ 0.19	$ 0.18	$ 0.17	$ 0.17	$ 0.16
	Cost of data	CD	[M$/year]	$ 31,850	$ 100,077	$ 183,015	$ 265,538	$ 364,203	$ 478,012	$ 599,045	$ 728,155	$ 864,695	$ 1,008,127
Expenses for running the platform													
	Cost per user	CPU	[$/user]	$ 15.00	$ 13.95	$ 12.97	$ 12.07	$ 11.22	$ 10.44	$ 9.70	$ 9.03	$ 8.39	$ 7.81
	Total cost for running the p	TCP	[M$]	$ 750	$ 2,197	$ 3,746	$ 5,067	$ 6,480	$ 7,929	$ 9,265	$ 10,499	$ 11,625	$ 12,636
	Total			$ 32,600	$ 102,274	$ 186,761	$ 270,606	$ 370,683	$ 485,941	$ 608,310	$ 738,654	$ 876,319	$ 1,020,762
	EBITDA			($32,600)	($102,274)	($186,761)	($47,614)	$72,997	$54,701	$177,986	$370,534	$652,300	$1,047,505
	Depreciation												
	EBIT			($32,600)	($102,274)	($186,761)	($47,614)	$72,997	$54,701	$177,986	$370,534	$652,300	$1,047,505
	Interest												
	Taxes			($12,746.60)	($39,989.06)	($73,023.68)	($18,617.07)	$28,541.93	$21,388.25	$69,592.67	$144,878.89	$255,049.45	$409,574.54
	Net income												
	Capex												
	Change in working capital												
Cash flow				$ (19,858.40)	$ (62,284.75)	$ (113,737.65)	$ (28,996.92)	$ 44,455.34	$ 33,313.16	$ 108,393.71	$ 225,655.35	$ 397,250.93	$ 637,930.67
Present Value				$ (11,354.10)	$ (30,966.53)	$ (49,171.92)	$ (10,901.02)	$ 14,532.53	$ 9,469.68	$ 26,793.27	$ 48,503.09	$ 74,249.04	$ 103,681.57
NPV=	$ 174,172.56												

Figure 36 - Pro Forma for the 360° HD video platform

5.11 Stakeholder Analysis

As we described in chapter 2, stakeholder analysis is a very powerful tool that helps to understand who is the main stakeholder. We were curious to know who the main stakeholder is in an existing successful platform. Therefore, we performed a stakeholder analysis on Facebook. Facebook is an MSP with users, content developers, game developers, and advertisers, as shown in Figure 37. The stakeholder map consists of 15 stakeholders and 50 flows. The adjacency matrix and benefit and supply rankings for each flow can be found in Appendix D.

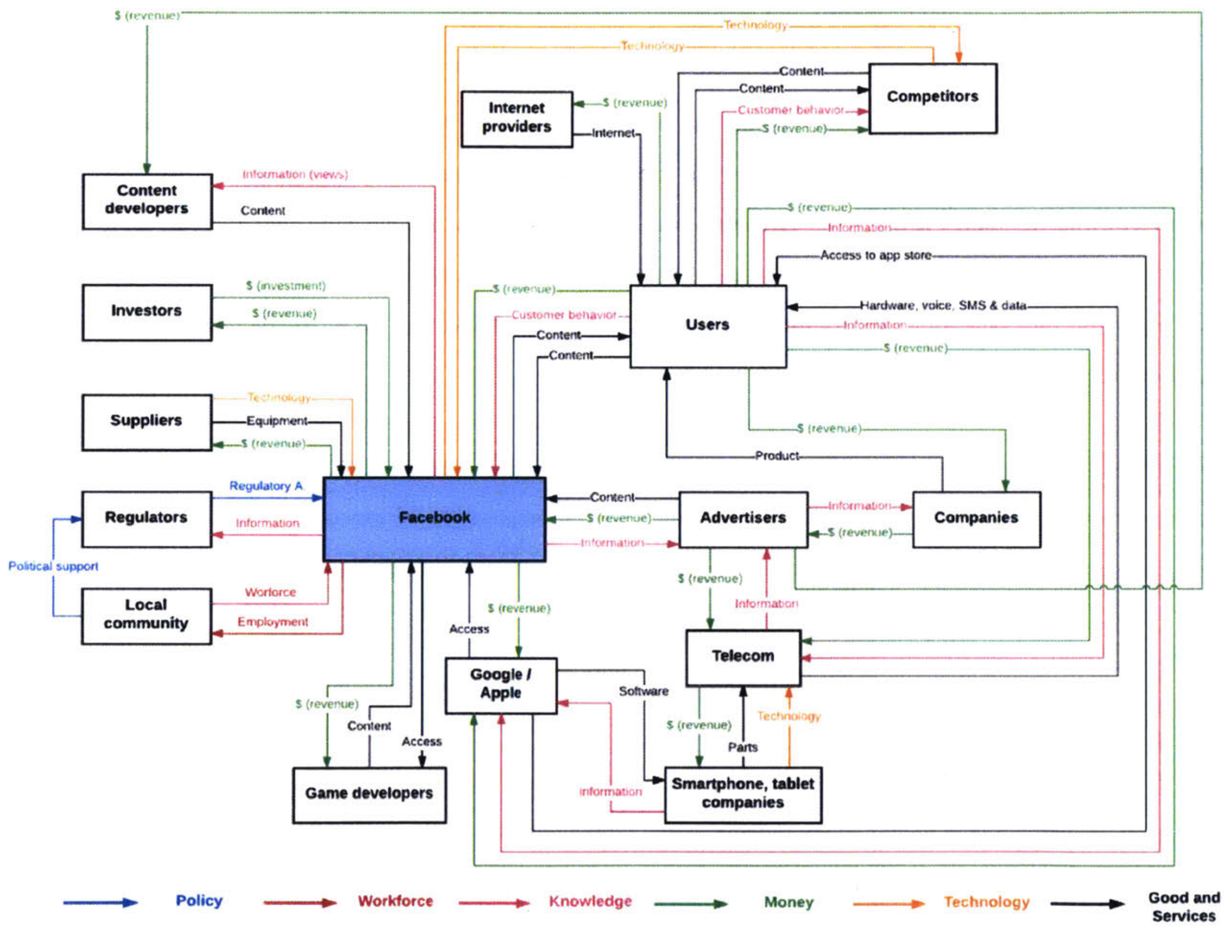

Figure 37 - Stakeholder map for an existing platform – Facebook

After we ran the code to calculate the WSO (see Appendix D for input files and parameters), we found that the top five stakeholders for Facebook are: regulators, local community, users, suppliers, and the app stores. This result makes sense since, if there is no content in Facebook from users, there is no Facebook.

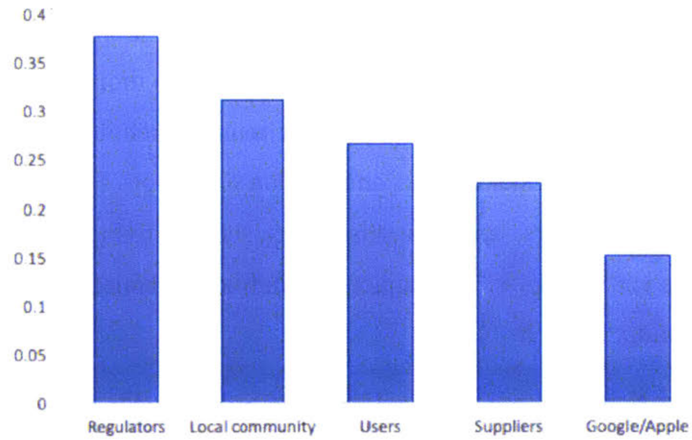

Figure 38 - Weighted Stakeholders Occurrence (WSO), top five stakeholders for Facebook

We re-ran the code, but this time from the user perspective (see Appendix D for input files and parameters). Results show that Facebook is the most important stakeholder, followed by the app store and telecom companies (see Figure 39). These results are similar to what we obtained in chapter 2 when we performed the stakeholder analysis for the telecom industry. As we discussed there, these are not good outcomes for the telecom companies. Telecom companies would like to be the most important stakeholder.

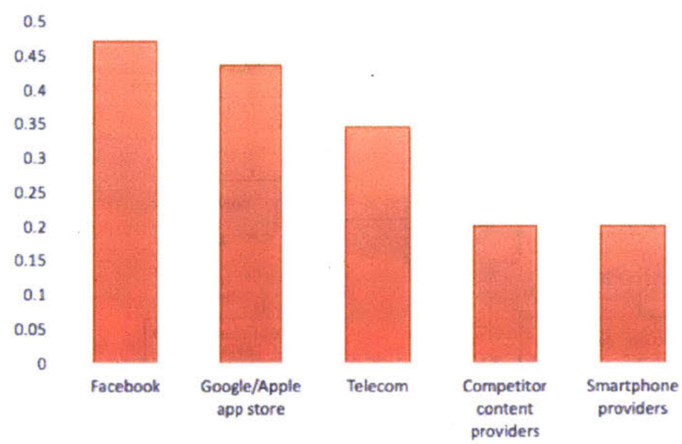

Figure 39 - Weighted Stakeholders Occurrence (WSO), top five stakeholders for users

Considering the platform architecture we proposed for the 360° HD video, we built another stakeholder map to understand what results Huawei and their telecom carrier clients might expect. The stakeholder map consists of 13 stakeholders and 48 flows (see Figure 40). Two of these flows correspond to the 5G connection, which is required for the live 360° HD video. In addition, the platform is managed by the telecom companies, as we suggested in the openness section. The adjacency matrix and benefit and supply rankings for each flow can be found in Appendix E.

Once all the flows had a numeric value (see Appendix E for input files and parameters), we ran the code from the telecom company's perspective. Our results show that regulators are still the most important stakeholder for the telecom industry (see Figure 41). We obtained similar results in chapter 3, when we analyzed the telecom companies as they are today. Second, we re-ran the code, this time from the perspective of the 360° HD video platform. We obtained similar results to the ones obtained using the Facebook platform: the most important stakeholder is the stakeholder that develops content; for Facebook, users are the ones who develop content, and for the 360° HD video platform, initially, content developers are the ones generating content (see Figure 42). Finally, we re-ran the code from the customer perspective. Our results show that telecom companies are the main stakeholders when using 5G (see Figure 43).

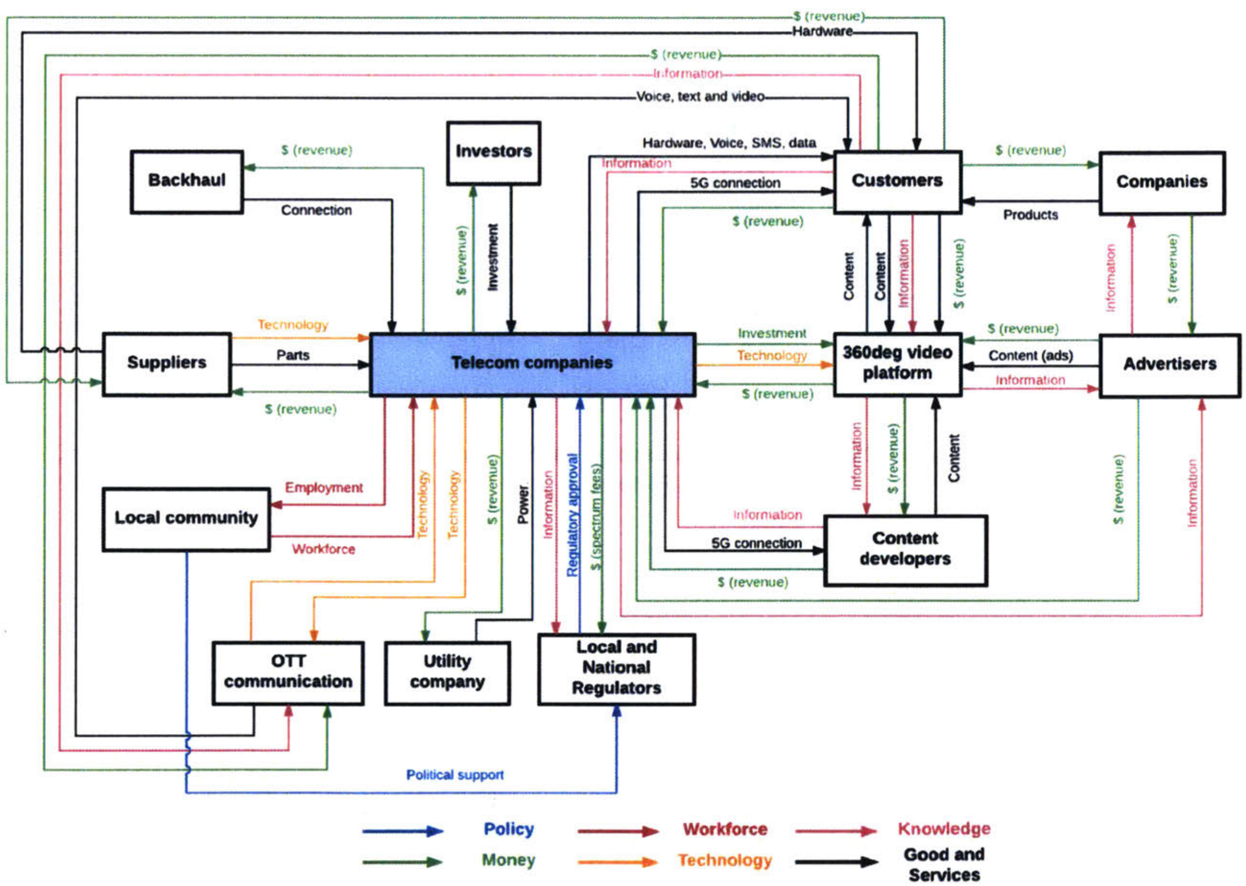

Figure 40 - Stakeholder map for the telecom industry after 360° HD video platform

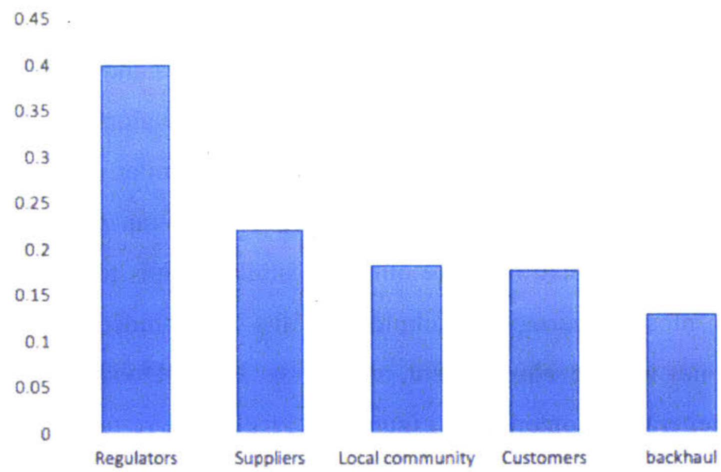

Figure 41 - Weighted Stakeholders Occurrence (WSO), top five stakeholders for telecom companies after managing a 360° HD video platform

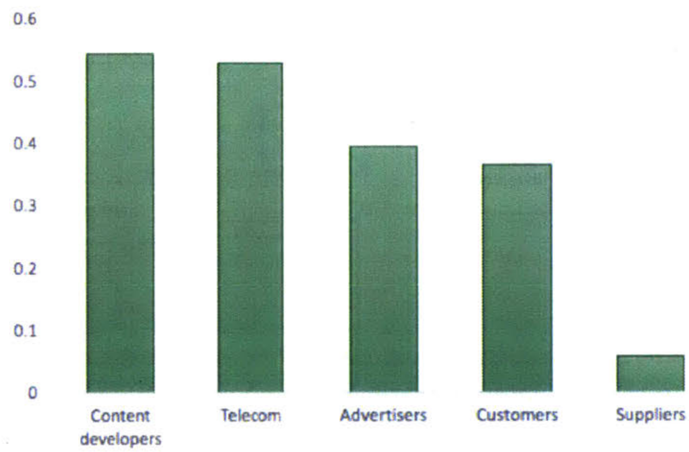

Figure 42 - Weighted Stakeholders Occurrence (WSO), top five stakeholders for the 360° HD platform

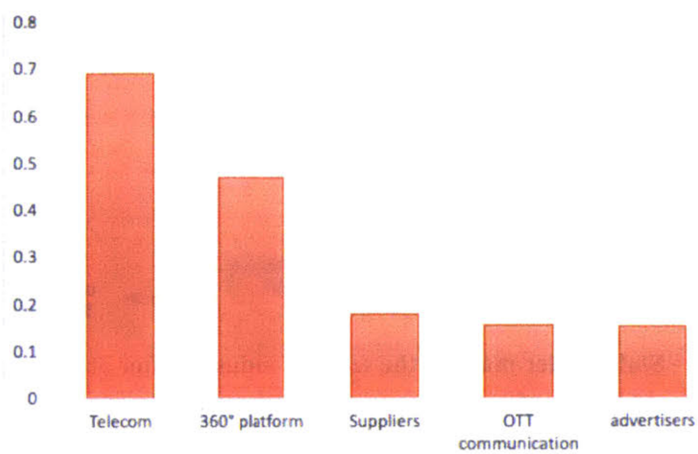

Figure 43 - Weighted Stakeholders Occurrence (WSO), top five stakeholders for platform users

Summary

In this chapter, we proposed how telecom companies can transform a product into a platform. The product in this case is 5G connectivity. We proposed a 360° HD video multi-sided platform that includes users, content developers and advertisers, and software developers. The core interaction for the platform was defined in detail, as well as network effects, launch strategies, monetization, and openness. Finally, a stakeholder analysis was performed to find out the position of the telecom industry with respect to the customers.

6 Conclusions

Telecommunication companies face increasingly difficult times in the digital economy. Telecom companies are being disrupted by OTT communication services in person-to-person communication. In addition, new entrants such as Facebook, SpaceX, Google, and OneWeb endanger profits on mobile internet services that used to be provided by the telecom companies only. The continued business disruption has driven telecom companies to investigate platform-based business models as key strategies for survival and success. In this thesis, we explore platform business models in the B2C area, where 5G can have an impact in the next five years. We used a technique developed by Professor Marshall Van Alstyne that consists of plotting an *interaction's perceived value* versus *interaction volume* of all those areas and selecting the area with the highest perceived interaction value and volume. Results show that immersive media has these characteristics. After we identified the area, we selected a platform using the concept evaluation methodology from Ulrich and Eppinger. Results show the most feasible MSP for the telecom industry in the next five years is a 360° HD video platform with live and recorded long tail content. The MSP consists of four sides: users, content developers, advertisers, and software developers. Launch, monetization, openness and network effects strategies are proposed. A financial analysis was performed. Results show the proposed platform is a feasible option. Finally, a stakeholder analysis is used to compare an existing digital platform to our proposed platform. Results show similar behavior.

If managed properly, platform business models could be a very powerful tool for increasing competitiveness. Technology giants such as Google, Facebook, Apple, Alibaba, etc., have used platform business models to grow exponentially.

In this thesis, we focused only on the type of MSP telecom companies should focus on. We deliberately omitted the regulatory context for telecom companies. Future work should look at regulation and governance models in case this platform is run by telecom companies from several countries. In addition, we omitted the B2B platforms. Future work could investigate B2B possibilities using the same technique to select the platform and compare that with the B2C.

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Appendix A

Input files for Java code, to perform a stakeholder analysis of the telecom industry

input_edge.dat

Revenue;tel;bac;0.4
Connection;bac;tel;0.8
Revenue;tel;sup;0.4
Technology;sup;tel;0.1
Parts;sup;tel;0.8
Workforce;tel;loc;0.4
Employment;loc;tel;0.4
Technology;tel;com;0.1
Technology;com;tel;0.1
Revenue;tel;uti;0.2
Power;uti;tel;0.8
Information;tel;reg;0.1
Regulatory approval;reg;tel;0.95
Voice_SMS_data;tel;cus;0.8
Revenue;cus;tel;0.2
Revenue;tel;inv;0.2
Information;cus;tel;0.2
Investment;inv;tel;0.2
Internet;int;cus;0.4
Revenue;cus;int;0.4
Information;cus;con;0.2
Content;con;cus;0.8
Content;cus;con;0.4
Revenue;cus;con;0.1
Information;con;adv;0.2
Revenue;adv;con;0.4
Content;adv;con;0.1
Political support;loc;reg;0.5
Voice_text_video;com;cus;0.4
Information;cus;com;0.2
Revenue;cus;com;0.2
Information;tel;adv;0.4
Revenue;adv;tel;0.4
Information;adv;cos;0.1
Revenue;cos;adv;0.4
Product;cos;cus;0.2
Revenue;cus;cos;0.2
Fees;tel;reg;0.4

input_edge.dat

tel
bac
sup

loc
com
uti
reg
cus
inv
int
con
adv
cos

Definition of edges

tel - Telecom
bac- Backhaul
sup- Suppliers
loc- Local communities
com- Competitors
uti- Utility companies
reg- Local and national regulators
cus- Customers
inv- Investors
int- Internet providers
con- Content providers
adv- Advertisers
cos- Companies

Parameters used to find: 1) all the value cycles, 2) WSO, and 3) WVFO; for the telecom companies **without** considering value loops

- *Utility function: 1*
- *Start vertex: tel*
- *End vertex: tel*
- *Multiplication steps: 2*

Parameters used to find: 1) all the value cycles, 2) WSO, and 3) WVFO; for the telecom companies considering value loops

- *Utility function: 1*
- *Start vertex: tel*
- *End vertex: tel*
- *Multiplication steps: 13*

Parameters used to find: 1) all the value cycles, 2) WSO, and 3) WVFO; from the customer perspective (considering value loops)

- *Utility function: 1*
- *Start vertex: cus*
- *End vertex: cus*
- *Multiplication steps: 13*

Appendix B

Input files for Java code, to perform a stakeholder analysis of the telecom industry with bundle

input_edge.dat

Revenue;tel;bac;0.4
Connection;bac;tel;0.8
Revenue;tel;sup;0.4
Technology;sup;tel;0.1
Parts;sup;tel;0.8
Workforce;tel;loc;0.4
Employment;loc;tel;0.4
Technology;tel;com;0.1
Technology;com;tel;0.1
Revenue;tel;uti;0.2
Power;uti;tel;0.8
Information;tel;reg;0.1
Regulatory approval;reg;tel;0.95
Voice_SMS_data;tel;cus;0.8
Revenue;cus;tel;0.2
Revenue;tel;inv;0.2
Information;cus;tel;0.2
Internet;tel;cus;0.4
Investment;inv;tel;0.2
Internet;int;cus;0.1
Revenue;cus;int;0.1
Information;cus;con;0.2
Content;con;cus;0.8
Content;cus;con;0.4
Revenue;cus;con;0.1
Information;con;adv;0.2
Revenue;adv;con;0.4
Content;adv;con;0.1
Political support;loc;reg;0.5
Voice_text_video;com;cus;0.4
Information;cus;com;0.2
Revenue;cus;com;0.2
Information;tel;adv;0.4
Revenue;adv;tel;0.4
Information;adv;cos;0.1
Revenue;cos;adv;0.4
Product;cos;cus;0.2
Revenue;cus;cos;0.2
Fees;tel;reg;0.4

input_edge.dat

tel
bac

sup
loc
com
uti
reg
cus
inv
int
con
adv
cos

Definition of edges

tel - Telecom
bac- Backhaul
sup- Suppliers
loc- Local communities
com- Competitors
uti- Utility companies
reg- Local and national regulators
cus- Customers
inv- Investors
int- Internet providers
con- Content providers
adv- Advertisers
cos- Companies

Parameters used to find: 1) all the value cycles, 2) WSO, and 3) WVFO; from the customer perspective (considering value loops)

- *Utility function: 1*
- *Start vertex: cus*
- *End vertex: cus*
- *Multiplication steps: 13*

Appendix C

Calculation of YouTube's interaction volume

In 2015, YouTube had 1 billion users*, and 6 billion hours of video were watched each month. Considering that the average number of weeks per month is 4.3, this translates as 1.395 billion hours/week (see below).

$$YouTube\ interaction\ volume = \frac{6\ billion\ (hours * users)/month}{1\ billion\ users \times 4.3\ (\frac{weeks}{month})} = 1.395\ billion\ hours/week$$

$$YouTube\ interaction\ volume = 1.395\ billion\ hours/week$$

* Marshall, C. 33 Amazing YouTube Facts and Stats to Tweet and Share. *Tubular Insights* (2014). Available at: http://tubularinsights.com/youtube-facts-stats-2014/. (Accessed: 26th April 2017)

Calculation of U.S. football's interaction volume

According to the Global Sports Media Consumption Report, in 2014, there were 168.9 million sports fans in the U.S., of which 96% fans consumed sports via TV, 68% online, and 42% via mobile devices. Sport fans spent on average 7.7 hours per week consuming sports content, of which 1.5 hour per week was spent watching sports via internet. This means that the total number of hours of sports watched online are 172.2 million hours/week (see below).

$$American\ football\ interaction\ volume = 168.9\ million\ users \times 68\% \times 1.5\ hours/(week * user)$$

$$American\ football\ interaction\ volume = 172.2\ million\ hours/week$$

Appendix D

Adjacency matrix, benefit, and supply ranking for Facebook stakeholder analysis

	Facebook	Content developers	Investors	Regulators	Local community	Game developers	Google and Apple	Advertisers	Users	Internet providers	Companies	Telecom	Smartphone suppliers	Suppliers	Competitors
Facebook	0	1	1	1	1	2	1	1	1	0	0	0	0	1	1
Content developers	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Investors	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regulators	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Local community	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Game developers	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Google and Apple	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0
Advertisers	2	1	0	0	0	0	0	0	0	0	1	1	0	0	0
Users	3	0	0	0	0	0	2	0	0	1	1	2	0	0	3
Internet providers	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Companies	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Telecom	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0
Smartphone suppliers	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0
Suppliers	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Competitors	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0

Figure 44 - Adjacency matrix for Facebook stakeholder analysis.

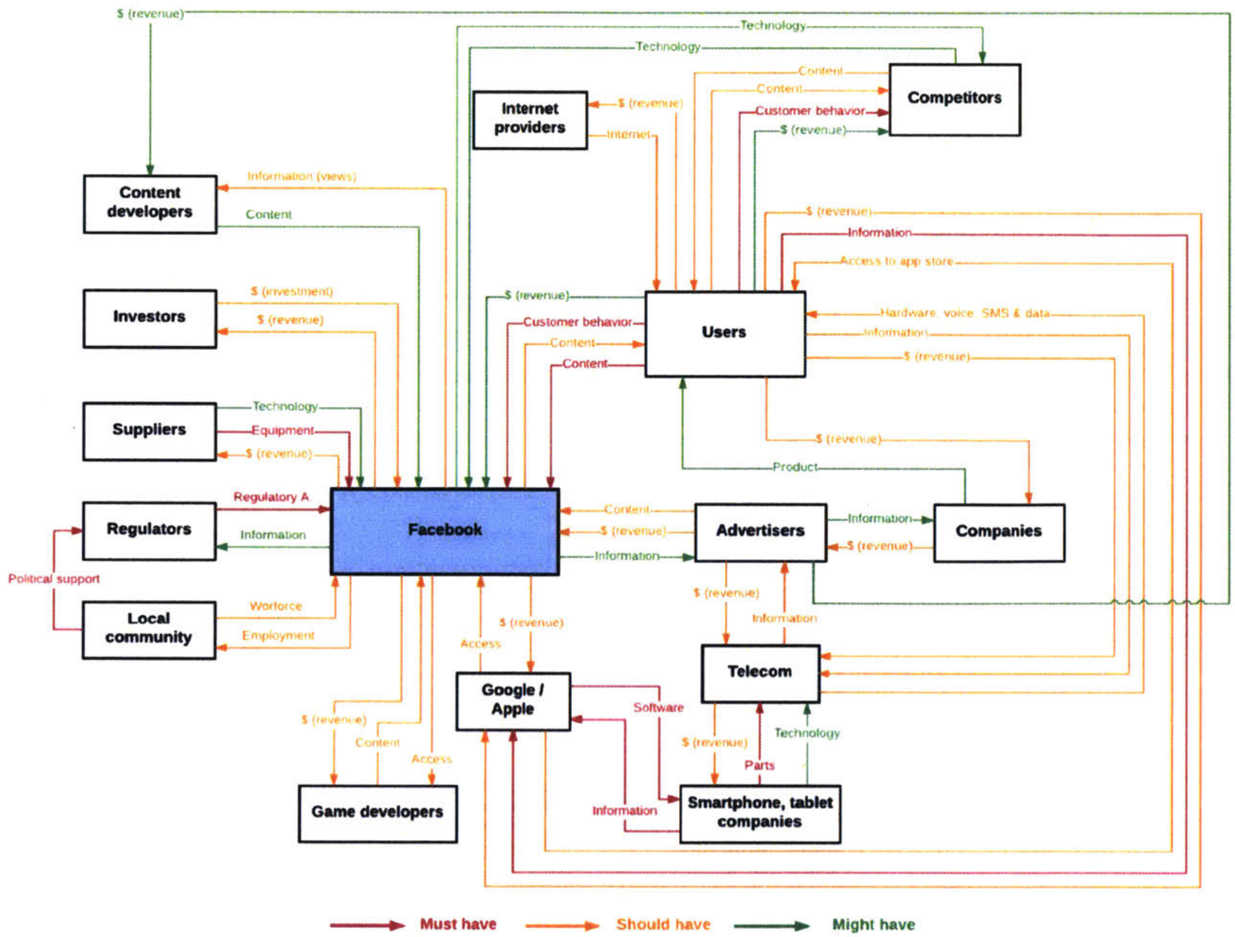

Figure 45 - Stakeholder map for Facebook, with characterization of the needs illustrated (Benefit ranking)

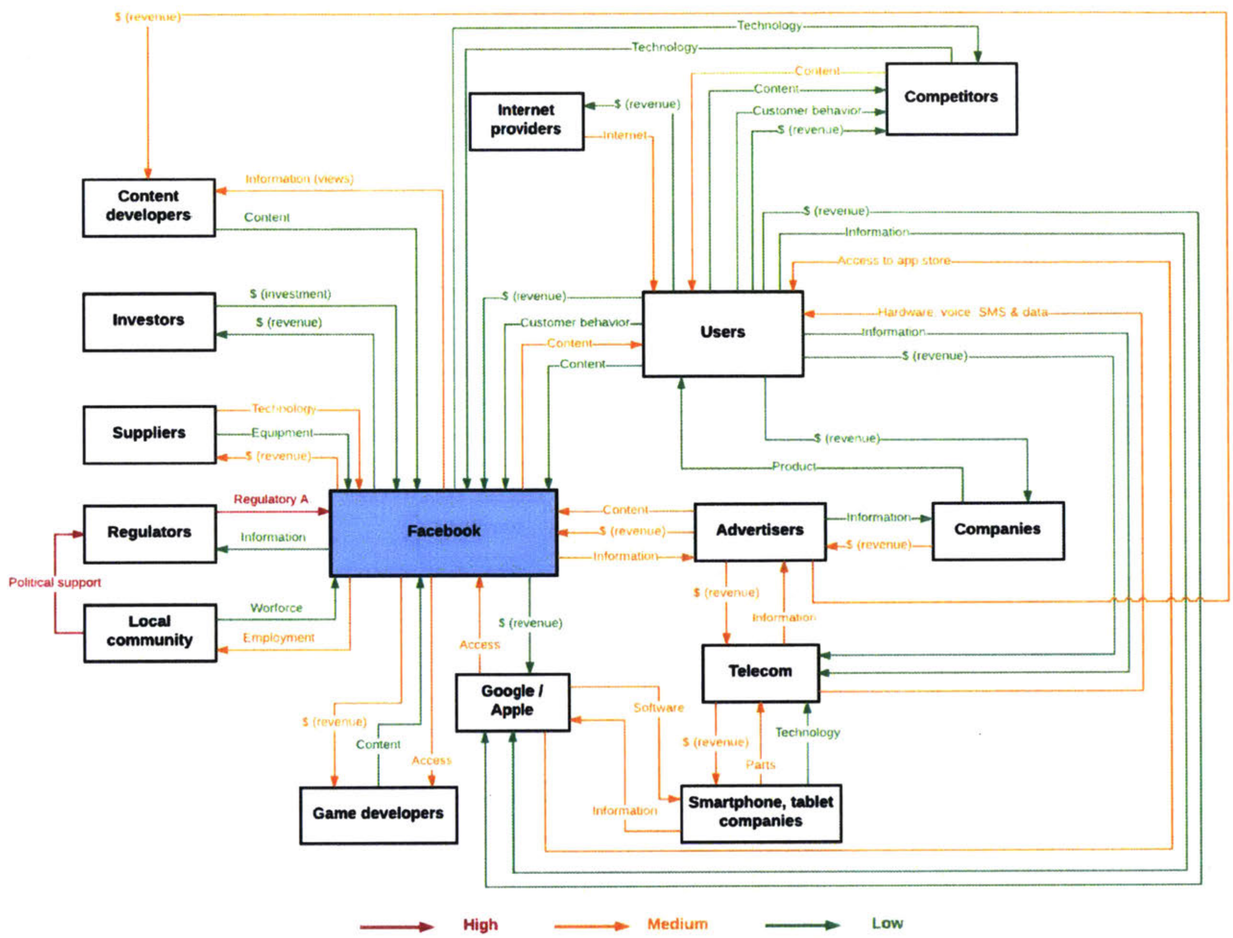

Figure 46 - Stakeholder map for Facebook, with details on availability of alternative suppliers (Supply ranking)

Input files for Java code, to perform a stakeholder analysis of Facebook

input_edge.dat

Information;fac;con;0.4
content;con;fac;0.1
Revenue;fac;inv;0.2
Investment;inv;fac;0.2
Information;fac;reg;0.1
Regulatory approval;reg;fac;0.95
Workforce;fac;loc;0.4
Employment;loc;fac;0.2
Access;fac;gam;0.4
Revenue;fac;gam;0.4
Content;gam;fac;0.2
Access;goo;fac;0.4
Revenue;fac;goo;0.2
Access;goo;use;0.4
Revenue;use;goo;0.2

Information;use;goo;0.4
Software;goo;sma;0.8
Information;sma;goo;0.8
Information;fac;adv;0.2
Revenue;adv;fac;0.4
Content;adv;fac;0.2
Information;use;fac;0.4
Content;fac;use;0.4
Content;use;fac;0.4
Revenue;use;fac;0.1
Internet;int;use;0.4
Revenue;use;int;0.2
Product;com;use;0.1
Revenue;use;com;0.2
Information;adv;com;0.1
Revenue;com;adv;0.4
Information;tel;adv;0.4
Revenue;adv;tel;0.4
Voice_SMS_data;tel;use;0.4
Revenue;use;tel;0.2
Information;use;tel;0.2
Revenue;tel;sma;0.4
Technology;sma;tel;0.1
Parts;sma;tel;0.8
Revenue;fac;sup;0.4
Technology;sup;fac;0.1
Parts;sup;fac;0.8
Information;use;riv;0.4
Content;riv;use;0.4
Content;use;riv;0.2
Revenue;use;riv;0.1
Technology;fac;riv;0.1
Technology;riv;fac;0.1
Political support;loc;reg;0.95
Revenue;adv;con;0.2

input_edge.dat

fac
con
inv
reg
loc
gam
goo
adv
use
int
com
tel
sma
sup

riv

Definition of edges

fac	Facebook
con	Content developers
inv	Investors
reg	Regulators
loc	Local community
gam	Game developers
goo	Google and Apple
adv	Advertisers
use	Users
int	Internet providers
com	Companies
tel	Telecom
sma	Smartphone suppliers
sup	Suppliers
riv	Competitors

Parameters used to find: 1) all the value cycles, 2) WSO, and 3) WVFO; from the Facebook perspective (considering value loops)

- *Utility function: 1*
- *Start vertex: fac*
- *End vertex: fac*
- *Multiplication steps: 15*

Parameters used to find: 1) all the value cycles, 2) WSO, and 3) WVFO; from the Customer perspective (considering value loops)

- *Utility function: 1*
- *Start vertex: use*
- *End vertex: use*
- *Multiplication steps: 15*

Appendix E

Adjacency matrix, benefit, and supply ranking for Telecom stakeholder analysis after owning a platform

	Telecom	Backhaul	Suppliers	Local communities	Competitors	Utility companies	Local and national regulators	AR/VR content developers	Platform AR/VR	Customers	Investors	Advertisers	Companies
Telecom	0	1	1	1	1	1	2	1	2	2	1	1	0
Backhaul	1	0	0	0	0	0	0	0	0	0	0	0	0
Suppliers	2	0	0	0	0	0	0	0	0	1	0	0	0
Local communities	1	0	0	0	0	0	1	0	0	0	0	0	0
Competitors	1	0	0	0	0	0	0	0	0	1	0	0	0
Utility companies	1	0	0	0	0	0	0	0	0	0	0	0	0
Local and national regulators	1	0	0	0	0	0	0	0	0	0	0	0	0
AR/VR content developers	2	0	0	0	0	0	0	0	1	0	0	0	0
Platform AR/VR	1	0	0	0	0	0	0	2	0	1	0	1	0
Customers	2	0	1	0	2	0	0	0	3	0	0	0	1
Investors	1	0	0	0	0	0	0	0	0	0	0	0	0
Advertisers	1	0	0	0	0	0	0	0	2	0	0	0	1
Companies	0	0	0	0	0	0	0	0	0	1	0	1	0

Figure 47 - Adjacency matrix for telecom stakeholder analysis after owning a platform

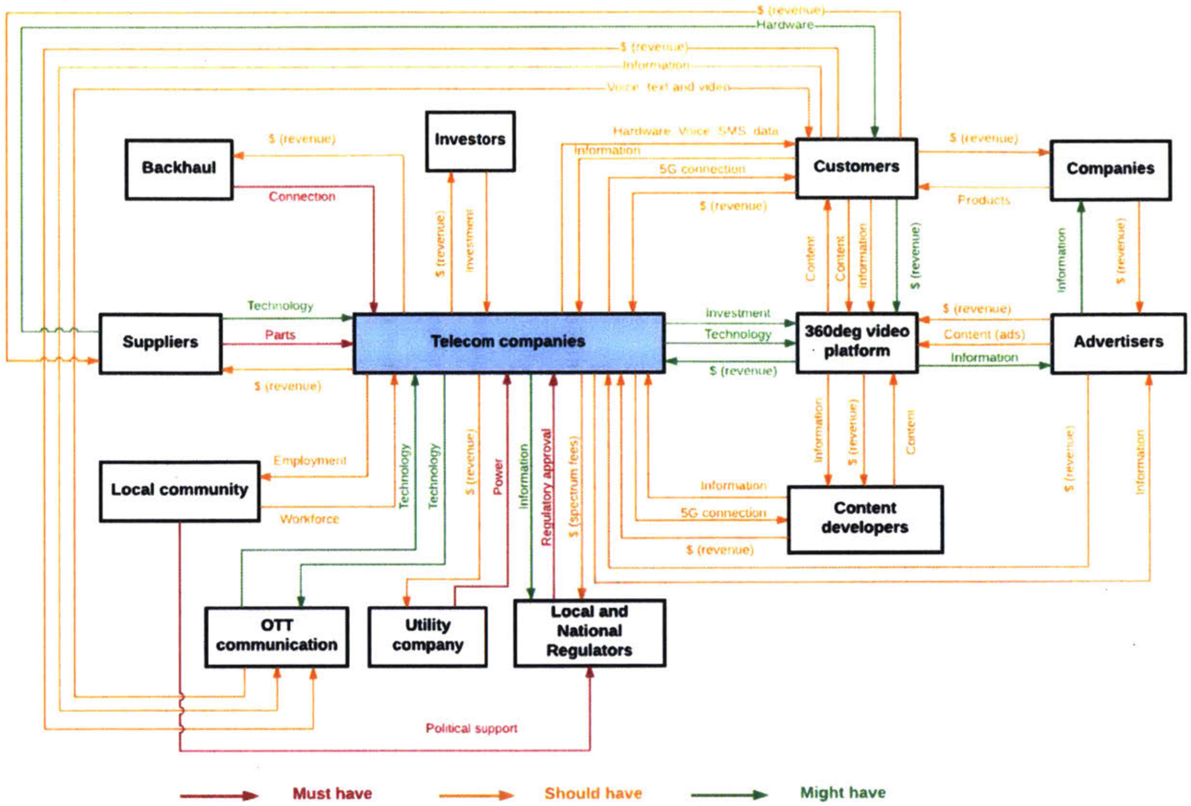

Figure 48 -Stakeholder map for telecom after owning a platform, with characterization of the needs illustrated (Benefit ranking)

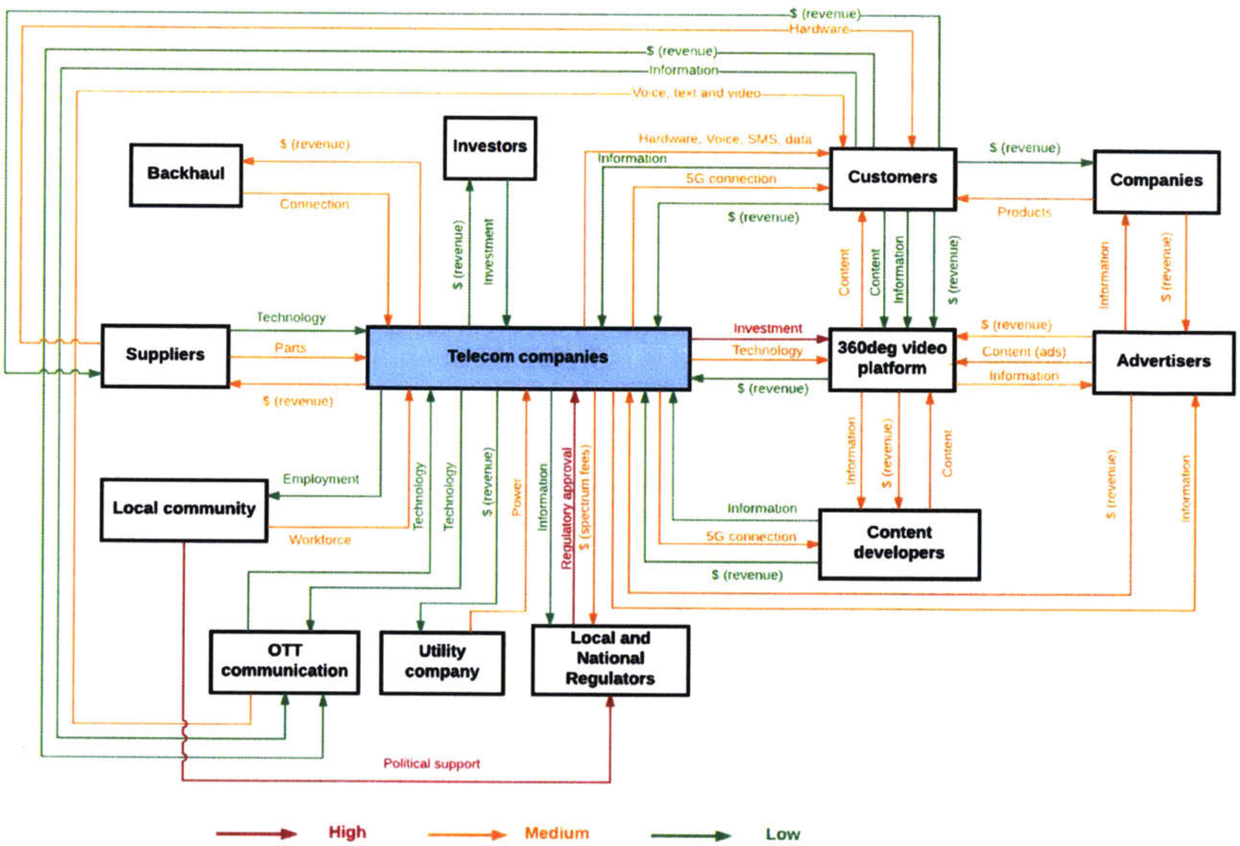

Figure 49 - Stakeholder map for telecom after owning a platform, with details on availability of alternative suppliers (Supply ranking)

Input files for Java code, to perform a stakeholder analysis of telecom companies after owning a platform

input_edge.dat

Revenue;tel;bac;0.4
Connection;bac;tel;0.8
Revenue;tel;sup;0.4
Technology;sup;tel;0.1
Parts;sup;tel;0.8
Workforce;tel;loc;0.4
Employment;loc;tel;0.2
Technology;tel;com;0.1
Technology;com;tel;0.1
Revenue;tel;uti;0.2
Power;uti;tel;0.8
Information;tel;reg;0.1
Regulatory approval;reg;tel;0.95
Harware_Voice_SMS_data;tel;cus;0.4
5G connection;tel;cus;0.4
Revenue;cus;tel;0.2

Information;cus;tel;0.2
Revenue;tel;inv;0.2
Investment;inv;tel;0.2
Information;cus;pla;0.2
Content;cus;pla;0.2
Content;pla;cus;0.4
Revenue;cus;pla;0.1
Information;pla;adv;0.2
Revenue;adv;pla;0.4
Content;adv;pla;0.4
Political support;loc;reg;0.95
Voice_text_video;com;cus;0.4
Information;cus;com;0.2
Revenue;cus;com;0.2
Information;tel;adv;0.4
Information;adv;tel;0.4
Information;adv;cos;0.2
Revenue;cos;adv;0.4
Product;cos;cus;0.4
Revenue;cus;cos;0.2
Content;dev;pla;0.4
Revenue;pla;dev;0.4
information;pla;dev;0.4
Product;sup;cus;0.2
Revenue;cus;sup;0.2
5G connection;tel;dev;0.4
Revenue;dev;tel;0.2
Information;dev;tel;0.2
Investment;tel;pla;0.3
Technology;tel;pla;0.2
Revenue;pla;tel;0.1
Fees;tel;reg;0.4

input_edge.dat

tel
bac
sup
loc
com
uti
reg
dev
pla
cus
inv
adv
cos

Definition of edges

tel Telecom
bac Backhaul

sup	Suppliers
loc	Local communities
com	Competitors
uti	Utility companies
reg	Local and national regulators
dev	AR/VR content developers
pla	Platform AR/VR
cus	Customers
inv	Investors
adv	Advertisers
cos	Companies

Parameters used to find: 1) all the value cycles, 2) WSO, and 3) WVFO; from the telecom companies perspective (considering value loops)

- *Utility function: 1*
- *Start vertex: tel*
- *End vertex: tel*
- *Multiplication steps: 13*

Parameters used to find: 1) all the value cycles, 2) WSO, and 3) WVFO; from the 360° HD platform perspective (considering value loops)

- *Utility function: 1*
- *Start vertex: pla*
- *End vertex: pla*
- *Multiplication steps: 13*

Parameters used to find: 1) all the value cycles, 2) WSO, and 3) WVFO; from the customer perspective (considering value loops)

- *Utility function: 1*
- *Start vertex: cus*
- *End vertex: cus*
- *Multiplication steps: 13*