

Google's Plan for Ubiquitous Internet: Strategy and Impact

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Introduction

Google's mission is to organize the world's information and make it universally accessible and useful¹. Nearly everyone that has used Google's search capabilities would agree that Google has done a phenomenal job on the first part of their mission statement, namely to organize the world's information. The second half, which focuses on making it universally accessible, may turn out to be more of a challenge given that nearly two thirds of the global population does not have Internet access². In typical Google fashion, Google has undertaken this challenge by making heavy investments in unique technologies. The following report will provide an overview of these technologies and evaluate both the financial and social impact of these programs. It will also answer the question: "Can Google make the Internet available to everyone on earth?"

Google's Business Strategy Behind BroadBand Everywhere

Revenue Overview

Google's product and service portfolio continues to evolve but the search engine has remained at the company's core since it was founded in 1998. According to recent estimates, Google is conducting upwards of 100 billion searches per month, which accounts for ~65% of the total Internet search volume³. Like the majority of Google's online products including YouTube, Google+, Google Maps, Google Drive, Google Mail, and Google Chrome, the Google search engine is free of charge to both private and professional users. The company generates revenue primarily by delivering relevant, cost-effective online advertising through its many user portals.

¹ <https://www.google.com>

² <http://www.internetworldstats.com/stats.htm>

³ <http://searchengineland.com/google-search-press-129925>

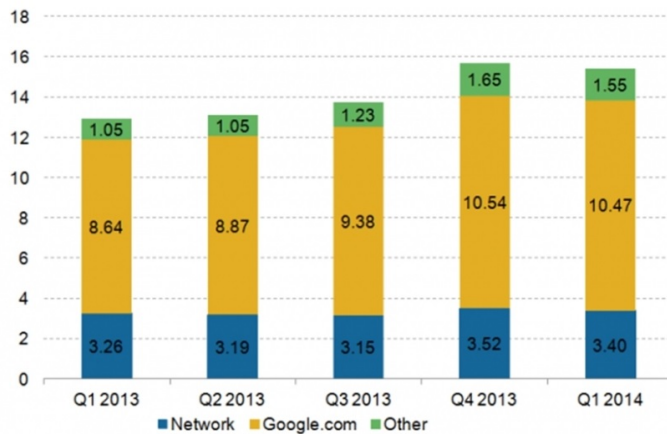


Figure 1. Google Revenue by Source (\$billion)⁴

Figure 1 above is normalized to exclude Google’s sale of Motorola Mobility to Lenovo earlier this year and shows that approximately 90% of the generated revenues (the y axis represents billions in United States dollars [USD]) are directly derived from online advertisements⁵. The yearly growth in the other categories is attributed to application and content sales in the Google Play store and from the sales of Chromecast devices.

Business Strategy

Google’s business strategy can be described as an *earn, entice, expand, and experience* approach as illustrated in Figure 2. The company predominantly *earns* by selling ads to businesses in a business –to-business (b2b) relationship. Google revolutionized the advertisement business model with the introduction of AdWords and AdSense. While traditional advertisements (newspapers, radio, TV) are very much broad in nature, AdWords will place specific, query related ads in search results, bringing highly targeted traffic to customer websites. Charges are typically accumulated on a pay-per-click bases, which makes this service extremely low risk and very attractive for advertisers. AdSense on the other hand allows website owners and bloggers to incorporate Google advertising in their domains. Whenever the site is visited, Google will upload additional context- related ads. If the ad is clicked, Google will charge its advertising customer and a small percentage of the revenue is being shared with the domain owner. AdSense essentially enables Google to continuously increase online ad space.

⁴ <http://marketrealist.com/2014/04/googles-q1-earnings-disappoint-lower-expected-profits/>

⁵ <http://www.investopedia.com/stock-analysis/2012/what-does-google-actually-make-money-from-goog1121.aspx>



Figure 2. Google Business Strategy⁶

Because Google services are mostly free, new products using these services will quickly proliferate and *entice* potential users to evaluate and hopefully adapt everything Google offers. This increases traffic on Google sites, which in turn increases the amount of advertising that is being sold. Almost everything that the company does can be traced back to a vehicle that delivers ads or a means to collect information in order to improve advertisement and make it more effective.

There are two fundamental methods for Google to *expand* and grow within its current business model. The first method is to generate more services that can be adapted by existing Internet users. The second method is to expand the overall Internet access in order to increase the amount of global Internet users⁶. Either method will result in an increase of advertisement revenue. Google has made efforts to broaden its product portfolio and break into the mobile hardware and application space. Several hardware products were developed (including tablets and phones) and Motorola Mobility was acquired. So far, all attempts to diversify had little effect on overall revenues and earnings. Motorola was sold off after a little over a year.

While Google employs a dedicated research group for new product developments, true experimental, “moonshot” projects are run within the Google X laboratories. Part of the “X mission” is to find unusual solutions to huge global problems⁷. Projects are very secretive and can have up to a ten year development cycle before they either head for commercialization or cancellation. Project Loon and the

⁶ <http://www.forbes.com/sites/stevefaktor/2013/05/23/featuredeconstructing-googlersquos-strategy-will-google-eat-your-business-next/>

⁷ <http://www.fastcompany.com/3028156/united-states-of-innovation/the-google-x-factor>

driverless car are two of the most publicized ongoing projects from Google X. Google glass was one of the first moonshot projects that started the transition into commercialization.

Market Developments

There are two significant trends that pose an ongoing threat to Google’s current revenue streams and future growth development.

1. The overall growth rate of the Internet (illustrated in Figure 3) has peaked and started to decline despite the fact that 2/3 of the global population does not have access to the web. The decline in internet adaptation will consequently slow down Google’s future growth as the company will have to compete within a market size that has started to saturate.

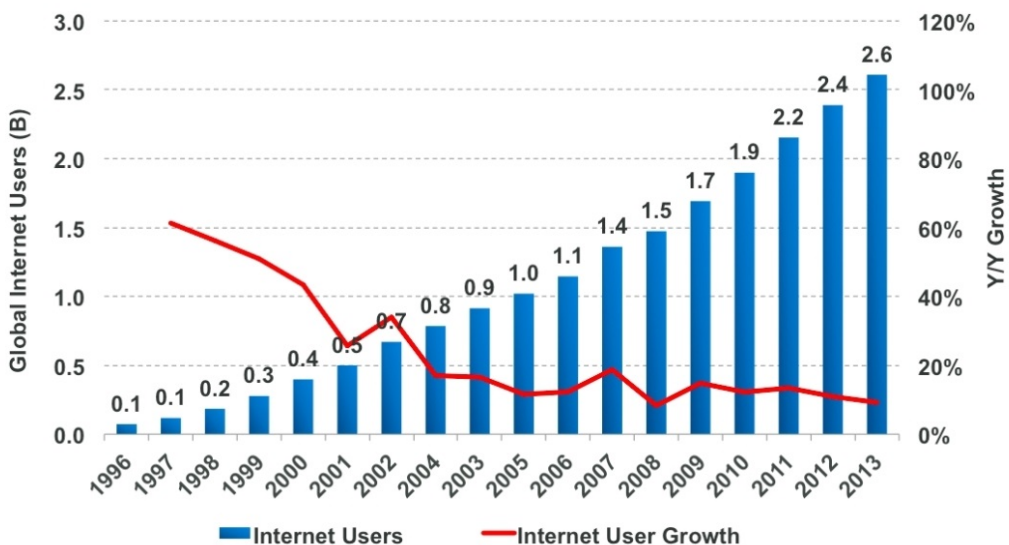


Figure 3. Global Internet Use and Growth Rate⁸

2. Figure 4 shows the usage of mobile devices will soon surpass the personal computer as primary means to access and search the internet. While this trend drives an increase in devices that are connected to the internet, the size of displays and therefore space for advertisement opportunities is quickly decreasing.

⁸ <http://www.businessweek.com/articles/2014-05-28/mary-meekers-state-of-the-internet-stars-mobile-devices-and-china>

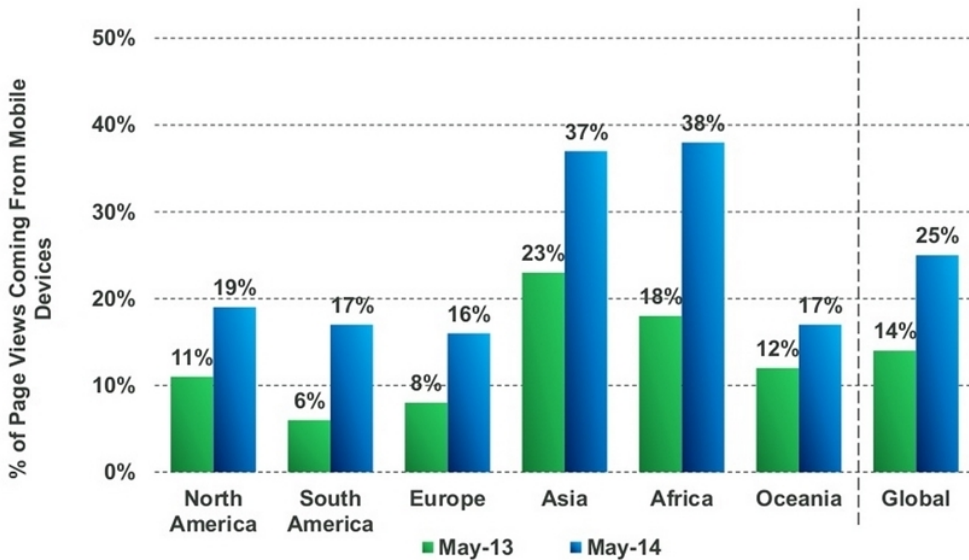


Figure 4. Mobile Usage as % of Web Usage, by Region⁵

In anticipation of these threats to its future growth, Google has been and continues to be very active in addressing these long-term business concerns.

Mobile Applications

One way Google addresses the threats to growth is through the acquisition of upwards to 150 companies since early 2001⁹. However, the majority of the acquisitions were focused on the expansion of the company’s core advertisement business. In 2005, Google began to get heavily engaged in mobile applications with the acquisition of Android. This marked a distinct shift in the company focus as Google now started to get into the more “physical” business of context delivery, i.e. the company started to move down the stack and began to diversify its product offering. This trend continues, and has been more extensive in recent years, with acquisitions of Motorola Mobile and NEST.

⁹ http://en.wikipedia.org/wiki/List_of_mergers_and_acquisitions_by_Google

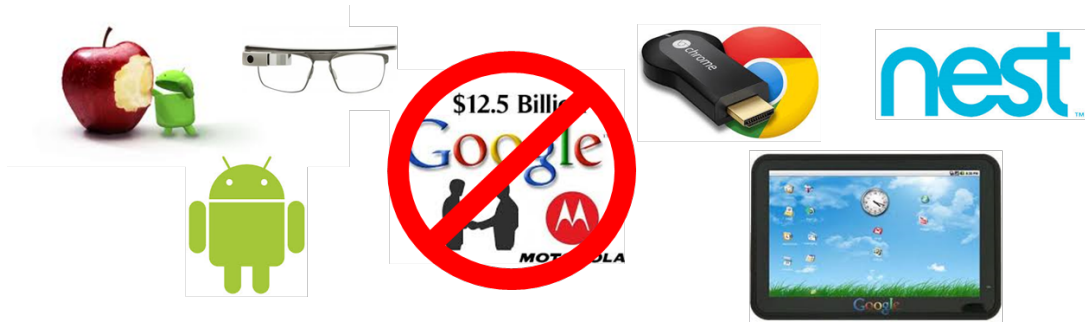


Figure 5. Google's Mobile-Centric Project

The acquisition of Android and its immense adaptation rate in the market place has allowed Google to play a major role in the way people interact with their everyday devices¹⁰. The operating system has become an important backbone for the Internet of things where it is ported into tables, “wearables”, smart home applications, car applications, and everything mobile. Owning the operating system puts Google at the controls of any interface connection. This gives the company a tremendous competitive advantage as Google can now shape how context and therefore possible advertisement is delivered.

Google – Internet Service Provider (ISP)

Google is a global technology leader focused on improving the ways people connect with information. We aspire to build products that improve the lives of billions of people globally. Our mission is to organize the world’s information and make it universally accessible and useful¹¹. – Google Annual Report

In recent years Google has started to increase its focus on the *accessibility* part of the mission statement. As the internet adaptation rate is slowing down, Google is not only trying to bring internet access to rural and previously un-served areas, it is also trying to increase internet speed 100 fold in highly populated areas.



Figure 6. Possible ISP Projects and Participants

¹⁰ <http://www.csmonitor.com/Innovation/Horizons/2014/0626/What-does-Android-Everywhere-mean-for-you>

¹¹ https://investor.google.com/documents/20101231_google_10K.html

Google’s fiber program, delivering 1 Gb/s broadband access, is already operating in a small number of locations and the company recently announced that 34 other locations are being vetted for implementation¹². On the other end of the spectrum, Google has generated a tremendous amount of publicity with moonshot project “Loon” which is a rather unconventional way of delivering Internet access to rural locations by means of balloons floating in the stratosphere. In addition, Google recently acquired drone maker “Titan Aerospace” and satellite company “Skybox”; two companies that could be used to supplement Google’s plan for a high altitude broadband connectivity system¹³.

Project Viability and Technologies

Google Fiber

Google Fiber is the name given to Google’s Fiber to the Home (FTTH) initiative in the United States. This service brings fiber optic cabling from Fiber Hubs that house active equipment to individual houses via a Passive Optical Network (PON). Because the transmission medium is fiber optic, significantly higher bandwidths can be supported when compared to traditional broadband techniques like DSL or CMTS Cable Modems. PON architecture has been around for some time and Google is certainly not the first to deploy it. Verizon’s Fios solution, launched in 2005, was the first major deployment of PON, and is widely available in 16 states¹⁴. In addition to Verizon Fios, many other service providers, municipalities, and even utilities have now provided FTTH based on PON architecture.

What differentiates Google Fiber from these solutions is that Google was the first to widely deploy Gigabit speeds to the home. For comparison, Verizon’s fastest speed today is 500 Mb/s for which they charge over \$300 per month. More typical speeds are between 5 Mb/s for which Verizon charges \$70 per month. For this same price Google will provide Gigabit service, twice as fast as Verizon’s top tier service at a fraction of the price¹⁵. For \$120 per month, Google will also offer TV services that include 1 terabyte of storage on Google Drive, a local DVR, and a Nexus Tablet to use as a remote (see Figure 7). Additionally, Google has the ability to offer “free” Internet access at slower speeds. All they require is that the user pay a \$300 installment fee that can be paid over several months.

¹² <https://fiber.google.com/newcities/>

¹³ <http://america.aljazeera.com/articles/2014/6/2/google-satelliteinternetaccess.html>

¹⁴ <http://www.fiberexperts.com/fios-availability.html>

¹⁵ <http://www.businessweek.com/news/2013-07-22/verizon-raising-fios-speed-to-500-megabits-in-race-with-comcast>

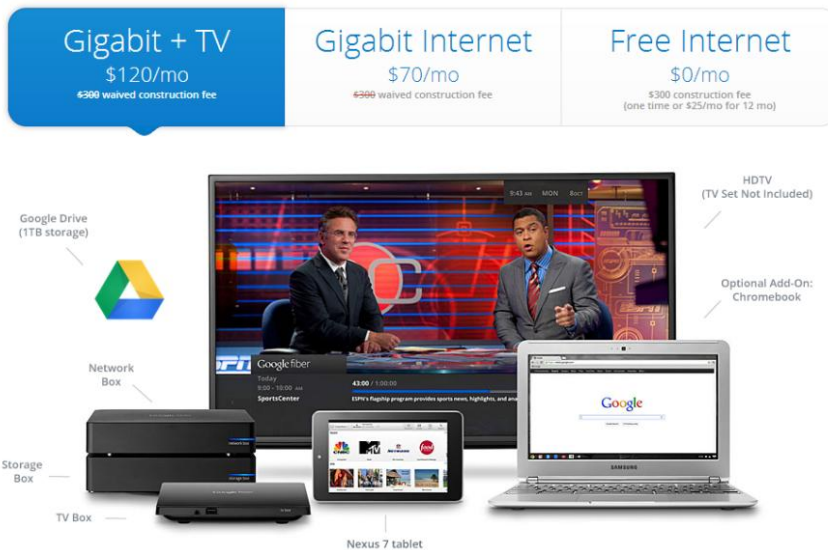


Figure 7. Google Fiber service offer

So how is Google able to offer such a great bundle at significantly higher speeds and lower prices than their competition? The answer is alternate technology and an alternate business model.

Alternate Technology: WDM-PON

Traditional FTTH architecture relies on GPON technology, which allows for 2.4 Gb/s downstream and 1.2 Gb/s upstream, however this bandwidth is shared over all of the users on the same node (64 for more). WDM-PON (see Figure 8) uses Wavelength Division Multiplexing (WDM) to allow significantly higher bandwidth currently up to 1 Gb/s per customer¹⁶. This is the technology that Google is using to provide significantly higher bandwidth per customer without significantly more expensive equipment.

¹⁶ <http://www.lightwaveonline.com/articles/print/volume-31/issue-2/features/wdm-pon-is-a-key-component-in-next-generation-access.html>

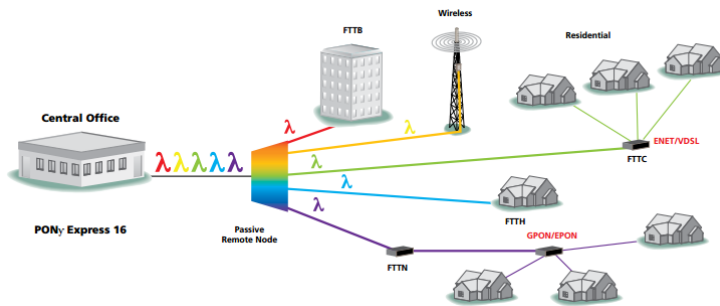


Figure 8. WDM-PON (Image Courtesy of TE Connectivity)

Alternate Business Model: Fiberhoods

When a traditional carrier like Verizon deploys FTTH services, they cover the entire city just like they would with phone service. This requires them to build an infrastructure to support many homes that will never buy their service. It is currently estimated that just under 42% of customers that can have fiber services have purchased it¹⁷. This is due to a variety of factors including competition from wireless and cable companies, as well as certain populations that do not choose to have any broadband service. Google Fiber by contrast has negotiated very favorable terms with the cities where they are currently deploying services. One of these key provisions is the ability to selectively deploy services to small sections of a city called “fiberhoods”. Google will only deploy after a specified number of customers have signed up and paid \$10 via an online form. This allows Google to know ahead of time the take rate for their services and only deploy to areas that have sign up rates that exceed their targets. This self-selection process reduces the costs of Google Fiber by eliminating unprofitable neighborhoods where take rates are very low.

Google’s initial deployment occurred in Kansas City, but has expanded to Provo, UT and Austin, TX. In addition to this they have announced a total of 34 cities in 9 metro areas of the US that are currently being considered for deployment (see Figure 9).

¹⁷ <http://www.bbpmag.com/Features/0612feature-FTTH.php>

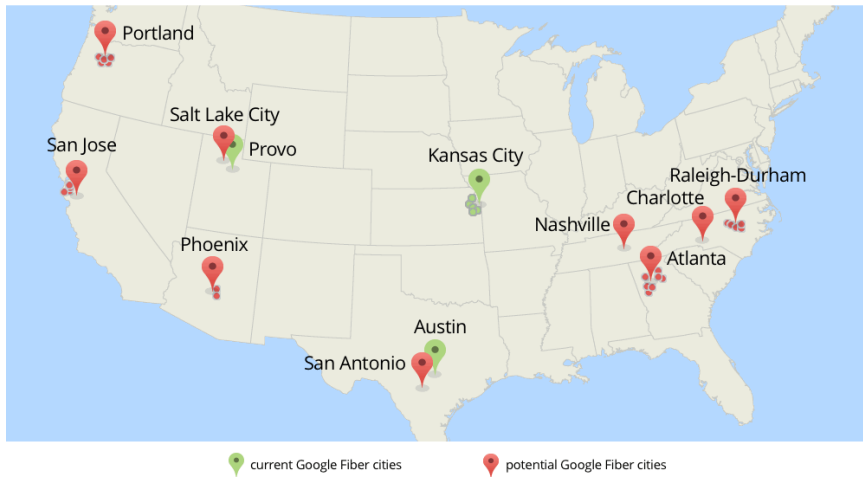


Figure 9. Announced Google Fiber Cities¹⁸

So why is this important for the US, and why is Google pursuing broadband speeds over 10 times faster than most of the country is at today? Although the US is one of Google’s largest individual markets, there is currently 6% of the US population without any broadband access, and another 100 million that have access but do not subscribe¹⁹. This equates to over 114 million untapped customers that Google can gain. Furthermore, the US ranks 16th the world in terms of broadband speed, so even in the population that has access to the internet, we are slow by top tier international standards²⁰. Slower speeds equate to fewer searches on Google, and less ads (still the primary source of income) offered and clicked on. Thus, increasing high speed broadband adoption directly equates more revenue for Google.

Initially, many viewed Google Fiber as being an experiment or a publicity stunt to encourage other service providers to build out their own networks, but with the recent announcement of 34 new cities in 9 new metro areas being evaluated by Google Fiber it seems clear that Google Fiber is a key initiative for the company. Google certainly is not shy about making investments in technology, and this is no exception. Google Fiber caters to developed countries where Internet is already available to most of the population. In order to reach rural or developed areas, Google had to look at alternate technologies like “Project Loon”.

¹⁸ <https://fiber.google.com/newcities/>

¹⁹ <http://www.fcc.gov/reports/eighth-broadband-progress-report>

²⁰ <http://www.forbes.com/sites/halsinger/2013/02/26/is-the-u-s-losing-the-broadband-race-as-it-turns-out-we-look-a-lot-like-danica-patrick/>

Project Loon

The abbreviated project description for “Project Loon” is a mesh network consistent of weather balloon like objects, circling earth within the stratosphere, enabling broadband internet connectivity in remote areas. If the project is successful, there is the potential that Google would become the first truly global Internet service provider, brought to users from the sky.

Project Loon was first made public about a year ago and has been one of the most publicized Google X projects ever since. The idea of using a mesh network in an effort to establish global connectivity is not necessarily new. During the late nineties several attempts were made to commercialize low orbit satellites systems that could provide global broadband access. Most notably the Iridium and Globalstar systems were implemented but eventually declared bankruptcy.

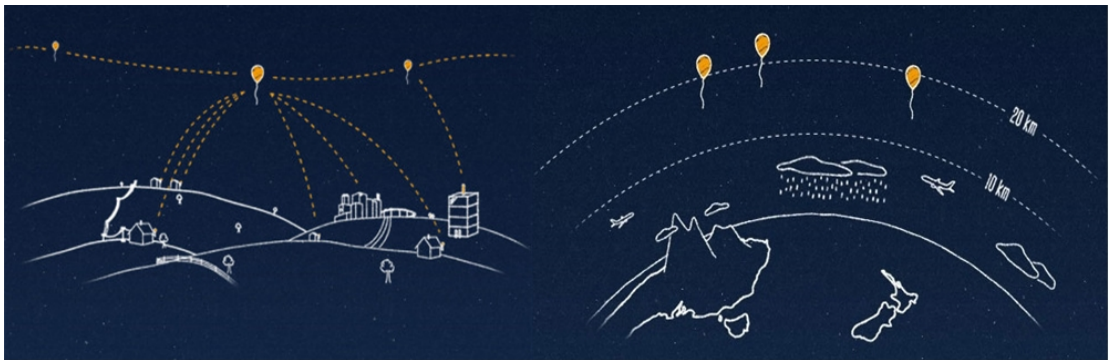


Figure 10. Project Loon - Concept²¹

Project loon’s main differentiator when compared to a geo-stationary satellite system is the inexpensive commissioning process and the much lower maintenance costs. While Google has not published official data on costs, industry experts estimate the price point for a single balloon to be in the several thousand-dollar range²². Loons will fly approximately 20km above sea level, where they are not interfering with regular air-traffic and are not exposed to changing weather conditions. Each balloon has a surface area of 500m², is solar powered, and can provide broadband access of 5 Mb/s to 20 Mb/s (depending on antenna or cellular connection) to an area of an estimated 1000km².

²¹ <http://ideasgn.com/technology/project-loon-google/>

²² <http://www.theverge.com/2014/3/7/5473692/facebook-drone-titan-aerospace-project-loon>



Figure 11. Project Loon - Concept Continued²³

A central control station is able to steer the balloons through altitude changes that make use of predominate wind patterns existing within the stratosphere. When balloons have to be decommissioned the central station will coordinate a controlled decent with local air traffic controls in a designated landing area. While several balloons were able to surpass the 100-day in-flight requirement, most were not. Improving the overall flight duration and consistently being able to have a fleet of 300 to 400 balloons operational is the next major project milestone. This benchmark would trigger a pilot program that can bring continuous broadband coverage to a target area within a designated latitude²⁴.

Google abandoned earlier plans to buy a harmonized frequency spectrum in order to deliver the complete end-to-end broadband solution to customers. Instead, the current strategy is to partner up with telecommunication companies and lease the proposed Loon technology and infrastructure to local carriers²⁵. This implementation approach will circumvent several technology concerns in regards to bandwidth throughput but more importantly will open the door to engage with local companies and governments to address air-space and nation sovereignty concerns.

The project has had a recent setback when a rogue balloon crashed into power lines near a suburban development in Washington State and disrupted power to a small number of residents²⁶. Despite the fact that nobody was harmed and reports were confirmed that Google alerted local air traffic control of the potential threat, an uncontrolled loon accident has the potential to seriously derail the project. What would happen in case of equipment failure, when a balloon descends rapidly without prior warning especially to rural populations in developing countries with limited alert or warning systems? Do they pose a serious threat? According to Google, every balloon is equipped with a parachute that will be deployed in case of emergency.

²³ <http://gadgets.ndtv.com/internet/news/project-loon-7-things-to-know-about-google-internet-beaming-balloons-379890>

²⁴ <http://www.wired.com/2014/06/google-balloons-year-later/>

²⁵ <http://www.theverge.com/2014/5/6/5687534/google-will-partner-with-wireless-carriers-project-loon>

²⁶ <http://techcrunch.com/2014/06/03/one-of-googles-project-loon-balloons-crashed-into-power-lines-in-washington-state/>

Drone and Satellite Broadband

In addition to Project Loon, Google has also made significant investments in alternate technologies to provide broadband Internet access to remote areas over a wide range. Examples include Google’s acquisition of drone provider Titan Aerospace, and Google’s \$1B investment in O3B Networks, a company that is currently launch Medium Earth Orbit (MEO) satellites to provide Internet access to “the Other 3 Billion” (O3B) people that do not have access globally²⁷. On the Drone front, Google outbid Facebook’s \$60 million offer to acquire the New Mexico startup. Although Titan Aerospace is still in the early stages of development, the drones could be used for both updating maps (Google Maps app) and for Internet access over a broad area, although no such offer is currently available. The key differentiator between the Drone offering and that of other programs like Project Loon is longevity. Reportedly, the design from Titan Aerospace can stay aloft for up to 5 years²⁸. In terms of longevity, the satellite design from O3B still wins, with their reported 10-year lifespan. The company currently has 4 active satellites, with plans to launch 4 new satellites imminently. The technology difference with O3B is in their orbital pattern, which is intentionally equatorial and in a medium earth orbit. By doing this, they can provide the largest coverage area with the fewest number of satellites. The medium earth orbit also allows them to provide significantly lower latency (less than 150 ms) than traditional geosynchronous orbits, which are much higher (35,000 km)²⁹. Although the medium earth orbits has clear benefits, it is unable to reach areas that are at latitudes far away from the equator such as Canada, the Northern US, Northern Europe, or Russia (see Figure 12).



Figure 12. O3B Potential Coverage Area (image courtesy of O3B Networks)

Such limitations within each technology may explain why Google is placing so many diverse bets on different methods of providing broadband internet. Drone, Loon balloons, may augment coverage from a satellite and higher speeds fed by Google

²⁷ <http://online.wsj.com/articles/google-invests-in-satellites-to-spread-internet-access-1401666287>

²⁸ <http://money.cnn.com/2014/04/14/technology/innovation/google-titan-drone/>

²⁹ <http://www.technologyreview.com/news/527831/how-google-could-disrupt-global-internet-delivery-by-satellite/>

Fiber. The chart below outlines key aspects of the different technologies that Google has invested in to provide ubiquitous Internet globally as well as their key differences:

Table 1. Broadband Technology Comparisons.

Technology	Investment	Investment/Offering	Coverage Area	Bandwidth Capability
Google Fiber	\$4.5 Billion	Construction of FTTH Network	12 Metro Areas within US	1000 Mb/s
Project Loon	Not Disclosed	Global network of high altitude balloons	40 kilometer diameter	3G/LTE Speeds
TV Whitespace	Not Disclosed	Development of Algorithm for Allocation of unused Spectrum	20 Kilometer diameter	4-12 Mb/s
Titan Aerospace	Over \$60 million	Drones capable of mapping and possibly providing internet access	Not Disclosed, No Current Offering	Not Disclosed, No Current Offering
O3B Networks	\$1 Billion	Investment in O3B to launch MEO Satellites	700 kilometer diameter	1-2 Mb/s

Each of the technologies discussed has unique properties that may make it more viable in some regions than in others. Google’s investment covers a broad range of technology and investment methods ranging from outright ownership and deployment of the technology to pure financial investment. Regardless of the future direction or success of any individual technology, it is clear that Google has diversified their investments so that they may participate in any or all of the technologies as they continue on their quest to bring Internet access to everyone globally.

Unused TV Spectrum (White Space)

Broadcast Television, a technology that is taken for granted or forgotten in our age of streaming media, may hold the key to unlocking broadband access to the internet for millions of people in Africa. Unused spectrum (channels) called “white space” can be used with new technologies to deliver high speed internet across distances up to 10 kilometers without the need for building out new infrastructure. The technology could be analogous to Wi-Fi but over a much greater coverage area. This is a critical need in the countries of sub-Saharan Africa, where the percentage of the population with Internet access in many countries is less than 25% of the population, where as in the US it is 80% and in Iceland it is 96%³⁰. Because of the coverage area, these solutions are also very low cost for rural areas as a result of the number of people that can be served by a 10 km radius.

³⁰ <http://www.broadbandcommission.org/Documents/publications/bb-annualreport2013.pdf>

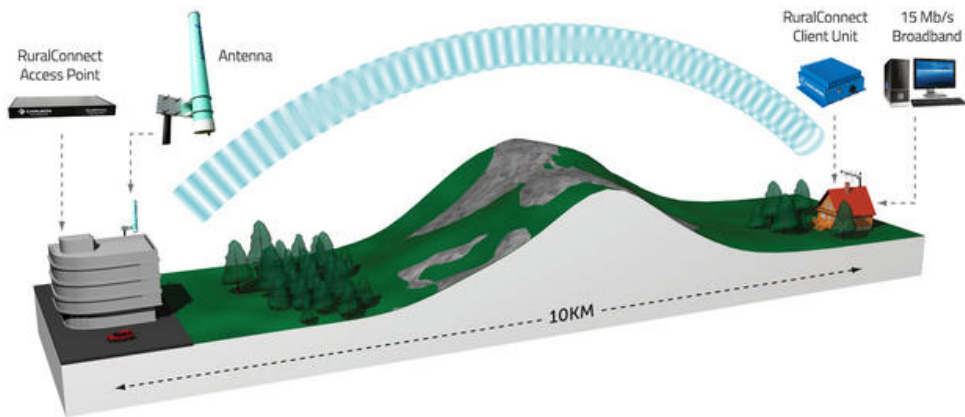


Figure 13. White Space Technology (image courtesy of Carleson Wireless)

Google’s focus in this technology has been in tracking and managing the use and availability of White Spaces via their spectrum database³¹, and have a trial of the technology-in-place with 10 schools in South Africa to provide high speed internet³². An entry in Google Africa’s blog also seems to indicate that they will be exploring more options for deploying TV Whitespaces in Africa as an alternative to expensive infrastructure build-outs³³.

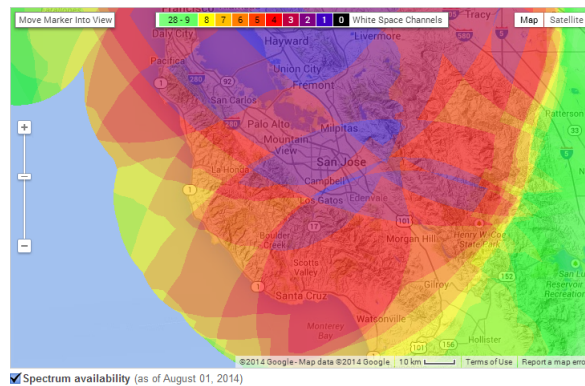


Figure 14. Image of Available Spectrum near Stanford University

³¹ <http://www.google.com/get/spectrumdatabase/channel/>

³² <http://www.cnet.com/news/fcc-approves-googles-white-space-database-operation/>

³³ <http://google-africa.blogspot.com/2013/06/more-than-15-african-countries-gather.html>

Impact on Google Financials

“If Google devoted 25% of its \$4.5bn annual capex to this project, it could equip 830K homes per year, or 0.7% of US households. As such, even a 50mn household build out, which would represent less than half of all US homes, could cost as much as \$70bn” Jason Armstrong – Goldman Sachs Analyst commenting on Google Fiber project³⁴

Providing the world with ubiquitous Internet is a daunting task, even for a company with as deep of financial pockets as Google. Of the projects that Google is currently exploring and/or deploying, the Google Fiber project is the most capital intensive (see Table 2).

Table 2. Financial Estimates of Google Fiber Deployment³⁵

	Population (2010 Census)	Number of Households	Eligible for Google Fiber	Take Rate	Cost/Home	Revenue/Home/Month
				60%	50%	\$ 1,100.00
Atlanta	5,910,296	2,264,481.23	1,358,688.74	679,344.37	747,278,804.60	876,354,234.48
Raleigh	1,912,729	732,846.36	439,707.82	219,853.91	241,839,298.85	283,611,541.38
Charlotte	2,375,675	910,220.31	546,132.18	273,066.09	300,372,701.15	352,255,258.62
Nashville	1,788,434	685,223.75	411,134.25	205,567.13	226,123,839.08	265,181,593.10
Kansas City	2,343,008	897,704.21	538,622.53	269,311.26	296,242,390.80	347,411,531.03
Austin	1,716,289	657,581.99	394,549.20	197,274.60	217,002,057.47	254,484,231.03
San Antonio	2,142,508	820,884.29	492,530.57	246,265.29	270,891,816.09	317,682,220.69
Phoenix	4,192,887	1,606,470.11	963,882.07	481,941.03	530,135,137.93	621,703,934.48
Provo	526,810	143,695.00	86,217.00	43,108.50	47,419,350.00	55,609,965.00
Salt Lake City	2,271,696	870,381.61	522,228.97	261,114.48	287,225,931.03	336,837,682.76
San Jose	8,153,696	3,124,021.46	1,874,412.87	937,206.44	1,030,927,080.46	1,208,996,303.45
Portland	2,921,408	1,119,313.41	671,588.05	335,794.02	369,373,425.29	433,174,289.66
				Totals	4,564,831,832.76	5,353,302,785.69

As mentioned earlier in the report, the bulk of Google’s current capital expenditures are currently funding data center builds to support Google’s core business of search and Adwords. Just the 12 metro areas that Google is currently looking to deploy Google Fiber would consume over \$4.5 billion in cash. With over \$60 billion in cash, Google is one of the few companies that can afford this, but to do so will essentially consume all of Google’s free cash flow for a quarter, see Figures 15 and 16.

³⁴ <http://www.dsreports.com/shownews/Nationwide-Google-Fiber-Build-Estimate-140-Billion-122347>

³⁵ <http://www.census.gov/and team estimates for take rate and cost/home passed>

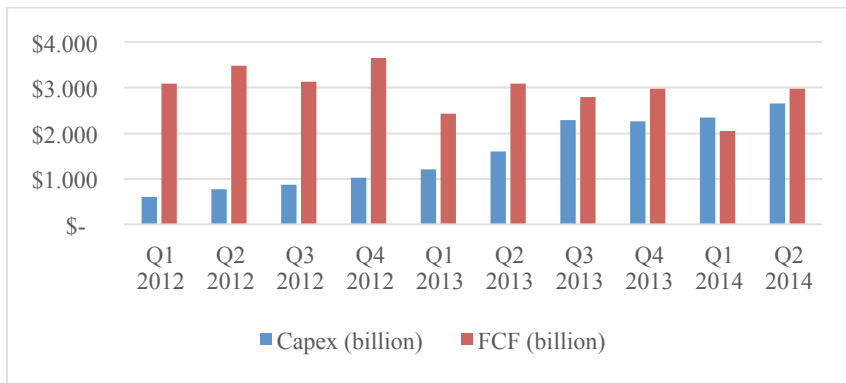


Figure 15. 10 Quarter History of Google Capex and Free Case Flow (FCF) (Source: Google 10Q)

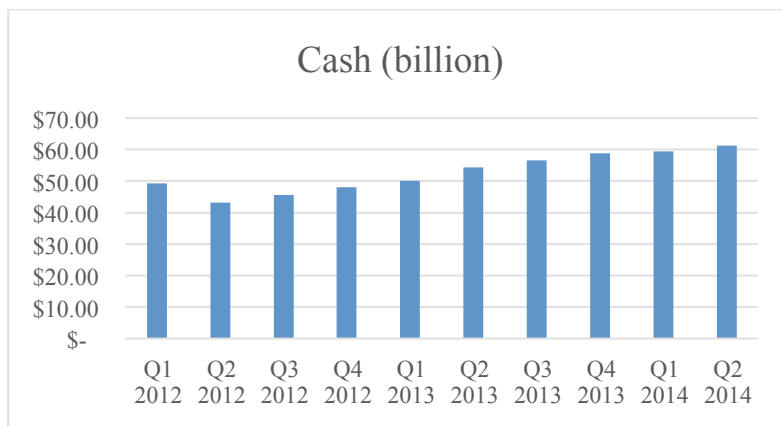


Figure 16. Google's Cash and Equivalent Past 10 Quarters (Source: Google 10Q)

These expenditures would probably not have an impact on Google's financials in the long term, but a massive deployment either in the US or globally could very quickly consume all of Google's cash reserves. It is unlikely however that this is Google's end game. It is more likely that Google is positioning the technologies discussed in this paper to motivate other companies, both startups and established, to deploy these technologies as competitors to help increase broadband speed and penetration to the world. In the broadband race, even if Google's competitors win, Google benefits. The reason is simple, the build of Google's revenue is still derived from search ads, and estimates are that Google's revenue exceeds \$24 per unique visitor annually³⁶. Growing the number of unique visitors directly impacts revenues, and Google has done an admirable job of growing and maintaining their user base, which now stands at over 180 million unique visitors per month (see Figure 17).

³⁶ <http://www.businessinsider.com/chart-of-the-day-revenue-per-unique-visitor-2011-1>

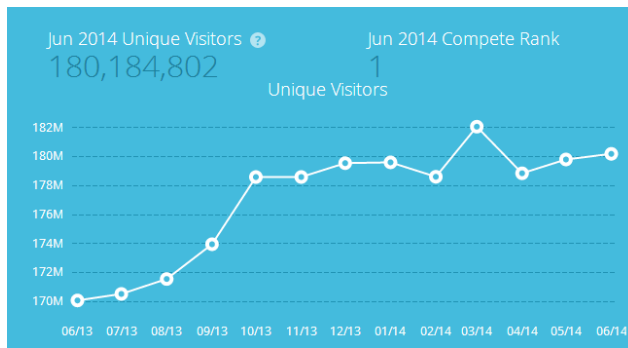


Figure 17. Google Unique Visitors per Month³⁷

At the rate of \$24 in revenue per unique user, Google can add over a billion in revenues to their business for every 42 million users that come onto the Internet. Clearly a focus on underserved areas such as Africa is a strategic imperative for Google to continue to grow. Even within the US, there is enough of the population without internet access that Google could add over \$2 billion in revenues if every person in the US had broadband access. The economics are even more compelling for underserved regions such as sub-Saharan Africa where population is high and broadband penetration is very low.

Looking at any of Google’s projects through the lens of the project’s impact on time, and number of people spent on the Internet, puts all of Google’s investments in perspective. Even a self-driving car can become a clear investment opportunity. After all, what will people do with the extra time freed up by not driving? Most will spend time on their mobile devices doing searches and surfing the Internet. And therein lies the elegance of Google’s plans. They can afford to take major risks on projects such as Loon or Google Fiber, because if they fail, the cost impacts will be small relative to Google’s financial strength. However, if these projects succeed, the impact on Google’s revenues can quickly exceed billions of dollars. Google has more to gain than to lose. The economics are quite simple and straightforward, if it drives more adoption of people using the internet, or increases the time each user spends on the internet, Google will have an immediate win financially.

³⁷ <https://siteanalytics.compete.com/google.com#.U9vXwPldWSo>

Implementation Challenges

As previously mentioned, large portions of the world (particularly the developing world), still don't have access to the Internet. Africa in particular has the lowest broadband penetration in the world. Mobile penetration stands at just 3.6% per 100 mobile broadband users and 0.2% per 100 fixed broadband users⁴².

Governments

Governments have to play an important and necessary role in ensuring a stable regulatory and legal framework to foster and incentivize investments in their countries, create a level playing-field amongst different portions of the market, establish adequate broadband policy, and ensure long-term and sustainable competition.

Studies have shown that countries who have established national broadband plans (NBPs) have seen a 7.4% increase in mobile-broadband penetration than those countries without NBPs. Figure 18 below shows that by 2013, 134 (69% of countries all over the world) have a national broadband plan (NBP), strategy, or policy to promote broadband. However, 47 (25%) of all countries in world still do not have any NBP while the remaining countries have plans in work.

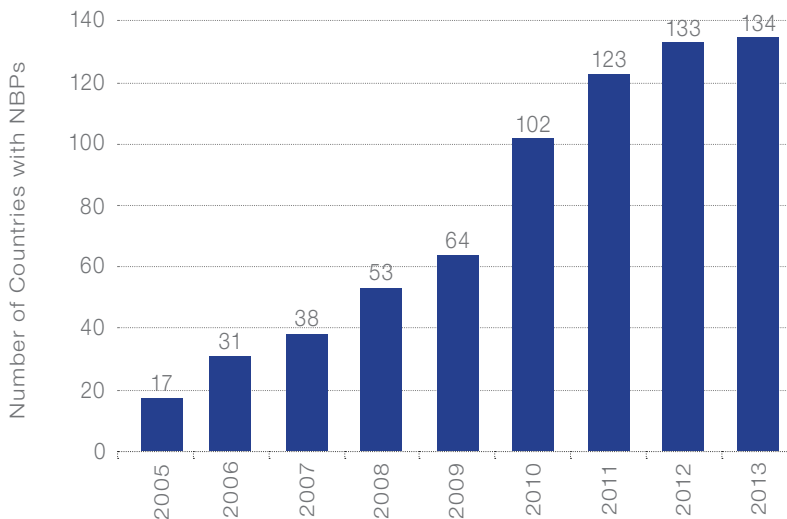
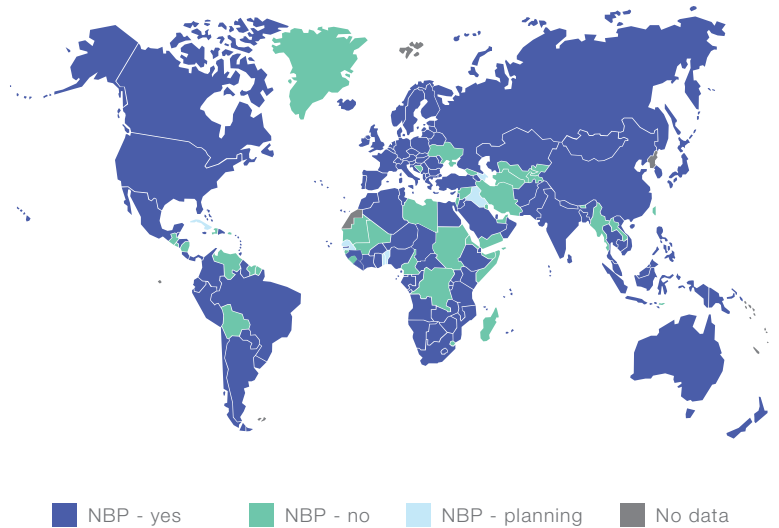


Figure 18. Growth in National Broadband Plans, 2005 – 2013⁴²

Figure 19. Status of NBP Plans (mid 2013)⁴²

Lack of Basic Infrastructure

According to the Broadband commission, 75% of Kenyans lack access to power. Without power, Kenyans will not be able to keep their mobile devices charged, let alone access the Internet. Some Kenyans “borrow” power from buildings in large cities in order to charge their phones. This however, is illegal and dangerous. There is also a distinct lack of existing wireline and wireless technologies. The Google Fiber effort being implemented in the United States would therefore be ineffective in developing countries without the necessary infrastructure to support it. Project Loon however, would be very effective in developing countries since it does not require an infrastructure on the ground.

Expensive

Broadband is still expensive in developing countries. In 2012, fixed broadband services remained expensive costing 30.1% of average monthly incomes in developing countries versus 1.7% in developed countries⁴². This means that in order to have broadband, households in developed countries were spending close to the same percentage of their income that household in developed countries would spend on a car. The Broadband Commission estimated that fixed broadband access is unaffordable for 3.9 billion people and mobile broadband is unaffordable for over 2.6 billion people. As mentioned in the previous section, encouraging competition for broadband services will help drive broadband prices lower. Access to affordable mobile devices will also increase user access to broadband. Smartphones are expensive both in cost and power. Phones like the Android One and the Nokia X will enable more access to mobile-broadband services.

Gender Inequality

Different cultures have different views about the rights of women in society. In developing countries and across the world, there is a noticeable difference between the number of women who have access to the Internet compared to the number of men. This puts women at a marked disadvantage in accessing information and expressing their thoughts and beliefs. In order for women to reap the benefits of internet access, they must be given equal access to mobile devices.

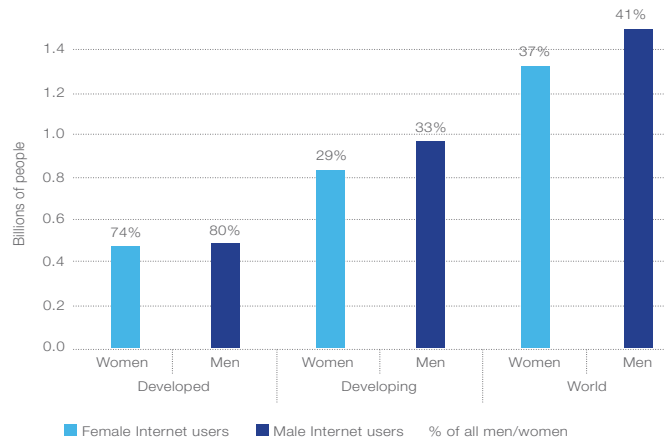


Figure 20. Internet Access Comparison Between Men and Women³⁸

Impact on Financials of Rural Areas and Developing Countries

A previous 2010 study on the impact of broadband penetration found that the socioeconomic effects of broadband penetration investments are significant to the economy. For example, the telecommunications industry in sub-Saharan Africa region grew and became one of the main sources of income to the government's revenues, posting a greater share in the nations' GDP³⁹. Results showed an approximate 1 percent increase in GDP for every 10 percent increase in penetration rate, and 80 new jobs for every 1,000 new broadband users. It is important to note that this data has been analyzed to identify patterns and relationships however, as with any complex set of variables, it is difficult to declare an exact causation relationship.

Ericsson performed a study, which showed that speed upgrades have a positive impact on the overall income for the household. Figure 21 shows that there is no significant impact to household incomes in developed countries at lower broadband speeds but there is in households in developing countries. However, as the broadband speed increased, the household income increased in developed countries but remained

³⁸ <http://www.girlguides.co.za/2013/09/27/un-200-million-fewer-women-have-access-to-the-internet-than-men/>

³⁹ <http://www.technologytimesng.com/news/wp-content/uploads/2012/09/West-African-Broadband-Study-by-Ehikioya.pdf>

relatively stable in developing countries. This could be related to the types of mobile devices that are accessible in developed countries versus developing countries. For example, if the “PC of Africa” is a simple Nokia cell phone, faster broadband speeds may not have as much of an impact on income compared to countries with access to mobile watches, cars, tablets, and laptops. *Note: BIC are the developing countries of Brazil, India, and China while OECD stands for Organisation for Economic Co-operation and Development, which contains developed countries like the United States, Great Britain, and Japan.*

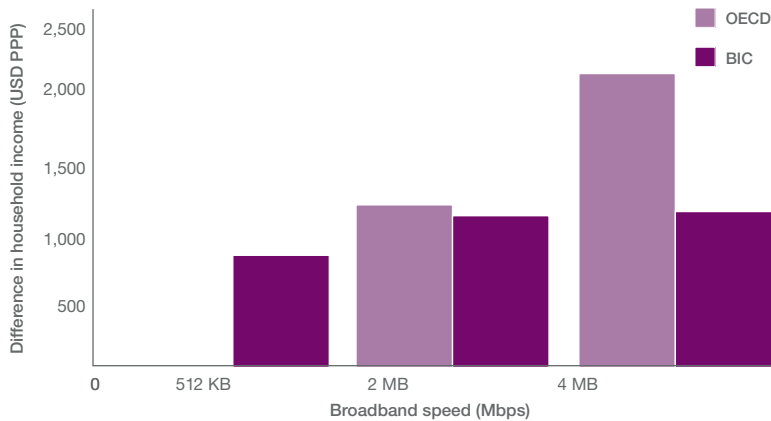


Figure 21. Income vs. broadband speed⁴⁰

Social Impact on Broadband Penetration

Freedom of Speech

Access to broadband, and through it social media, has helped break down the socio-economic barriers that exist between the populace in developing countries and their governments. According to the Academic Center for Strategic Studies, advances in electoral technology and the expansion of social media help deter fraud and prevent electoral violence⁴¹. Elections can now be monitored real-time and bring transparency to the electoral process. This transparency has given rise to political “activism” (violent and non-violent) against fraudulent elections and corrupt politicians as well as an increase in demand for fundamental rights of equal representation. During the 2011 uprisings across North Africa, mobile phones were able to transform ordinary citizens disenchanted by governments into resistance fighters. The resistance posed such a threat to Hosni Mubarak, the Egyptian president at the time, that he put pressure on Egypt’s mobile phone networks to pull the plug and slow down the opposition. On

⁴⁰ <http://www.ericsson.com/res/thecompany/docs/corporate-responsibility/2013/ericsson-broadband-final-071013.pdf>

⁴¹ <http://www.africom.mil/Newsroom/Article/10883/acss-symposium-in-kenya-examines-social-media-electoral-security>

January 2011, all mobile phone networks in Egypt went dead. In the bloody aftermath of the Kenyan elections in 2013, citizens reported violent occurrences via text messages to servers that were viewed around the world.

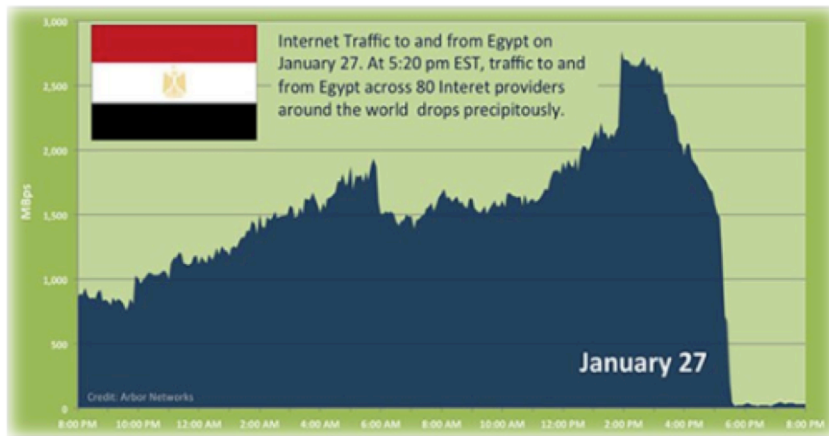


Figure 22. Egypt’s internet service in 2011 (source IEET)

Education

Currently, mobile phones are cheaper to own than personal computers, laptops, and tablets. They also require less power. This has encouraged the development of learning tools that are compatible with standard (not smart) and affordable mobile phones. For example, Nokia has capitalized on popularity of social networking in South Africa to launch MoMath (math teaching tool) that targets users of instant messaging platform Mxit.⁴² Mxit is South Africa’s most popular social media platform with over 10 million active users. Prior to the start of the program, little was known about mobile penetration at schools and amongst South African youth in different kinds of South African schools.⁴³ The research related to the MoMath project showed that the results for the learners who used Nokia MoMaths service regularly were 7% better on average than their peers who did not use the service regularly. The e-learning benefits and access that mobile devices can provide has been extensively recognized in developed countries. The main difference is that laptops and PC’s are the more popular e-learning devices that are used in developed countries. However, mobile phones are steadily becoming the “PC’s of Africa.”

⁴² <http://www.broadbandcommission.org/documents/bb-annualreport2013.pdf>

⁴³ <http://www.un.org/en/ecosoc/innovfair2011/docs/nokia.pdf>

Health

The amount of counterfeit drugs, especially in developing countries, is staggering. According to the World Health Organization (WHO), in 2005, the Pharmacy and Poisons Board found that almost 30% of the drugs in Kenya were counterfeit and in 2004, the Ebonyi State Task Force on Counterfeit and Fake Drugs in Nigeria reported that approximately 48% of goods and drugs imported into the country were substandard or counterfeit.⁴⁴ In 2009, nearly 100 Nigerian babies died after being given teething medicine that contained a solvent commonly found in antifreeze. These tragedies drove technology innovators like Bright Simons to develop a system (mPedigree Network Simons) that empowers consumers to instantly verify with a free text message whether their medicines are safe and not counterfeit.

Given the current outbreak of the Ebola virus in West Africa, governments all over the world (especially in Africa) are hoping that social media sites, like Twitter, can help prevent the spread of the deadly virus. The Lagos-based digital publishing company, Big Cabal Media, has embarked on social media campaigns to inform people about Ebola.⁴⁵ Their intent is to spread information about the virus, how it is transmitted, where current outbreaks are using popular sites like Twitter and Facebook. Though internet access is still limited in heavily impacted areas of Africa, the SMS social media has proven to be very useful in spreading information quickly once again showing that cell phones are the PC's of Africa.

Agriculture

Given the broadband penetration, farmers are better able to share weather information, market prices, and micro-insurance schemes with one another as well as ascertain what the current market prices are for crops. If a farmer learned that bad weather is approaching that may endanger his crop that season, he or she may be able to mitigate the impacts by properly protecting them. If a farmer knew that a region was experiencing a drought and some crops are not as available, he may be able to sell more of his crops in that location due to the increased demand with decreased supply. Kenya's Agricultural Commodities Exchange partnered with mobile operator Safaricom to launch SokoniSMS64 (text messaging platform) to provide information to farmers.

⁴⁴ http://www.who.int/medicines/services/counterfeit/impact/ImpactF_S/en/index1.html

⁴⁵ <http://www.bdlive.co.za/life/gadgets/2014/08/13/social-media-do-their-bit-on-ebola>

Conclusions and Recommendations

In the preceding pages we have explored how Google is making investments to provide the world with ubiquitous Internet access. Through our analyses, we have determined that enabling vast populations of people with broadband access provides tangible benefits both economically and socially, driven by an increase in communication, collaboration, and timely access to information. It is also apparent that with over \$60 Billion in cash, Google has the financial strength to continue to invest in these technologies. At present, the most capital-intensive technology appears to be Google Fiber and a global or even national rollout in the US is unlikely due to cost and other challenges like infrastructure and cost. However projects that provide a wide range coverage such as Loon and O3B satellites could provide near ubiquitous access to broadband globally, for much less investment. Given the amount of revenue that Google derives from each unique user (\$24 annually), growing the global population of users is a strategic imperative for the company. As such, Google should continue to invest heavily in these technologies. A key observation however, is that it appears that Google's efforts are disjointed. A higher level of project coordination is required to make sure that lessons learned from Project Loon can be applied to potential offerings from Titan Aerospace or O3B, even though these are essentially competing technologies. One recommendation for Google to consider is placing an overall lead in charge of all "Access Technologies" to ensure the proper level of coordination. This leader could also make the tough calls if a technology turns out to not be viable and redeploy resources to make sure one or more of these technologies eventually scales. Google's efforts at this point appear to be bets made on multiple ideas rather than a single cohesive strategy, this however, is quite typical of Google and has been seen in other areas of business. To answer the question posed at the beginning of the paper, yes, Google does have both the technology and the capital to implement their dream of bringing broadband access to every person globally. Less clear is which technology will win out. Google Fiber is a clear winner from a bandwidth perspective, but scaling is a challenge, particularly in undeveloped areas. From a scale perspective, the O3B satellites can bring basic services to a broad swath of people globally, but the service is just that, basic, and it relies on expensive satellite technology. In the end, Google has placed their bets, and we expect they will continue to fund multiple methods of providing the world with access to broadband. As long as people continue to search on Google, Google will search for a way to bring Google to them.

Table of Figures

Figure 1. Google Revenue by Source (\$billion).....	2
Figure 2. Google Business Strategy.....	3
Figure 3. Global Internet Use and Growth Rate.....	4
Figure 4. Mobile Usage as % of Web Usage, by Region ⁵	5
Figure 5. Google's Mobile-Centric Project.....	6
Figure 6. Possible ISP Projects and Participants.....	6
Figure 7. Google Fiber service offer.....	8
Figure 8. WDM-PON (Image Courtesy of TE Connectivity).....	9
Figure 9. Announced Google Fiber Cities.....	10
Figure 10. Project Loon - Concept.....	11
Figure 11. Project Loon - Concept Continued.....	12
Figure 12. O3B Potential Coverage Area (image courtesy of O3B Networks).....	13
Figure 13. White Space Technology (image courtesy of Carleson Wireless).....	15
Figure 14. Image of Available Spectrum near Stanford University.....	15
Figure 15. 10 Quarter History of Google Capex and Free Case Flow (FCF) (Source: Google 10Q).....	17
Figure 16. Google's Cash and Equivalents Past 10 Quarters (Source: Google 10Q)...	17
Figure 17. Google Unique Visitors per Month.....	18
Figure 18. Growth in National Broadband Plans, 2005 – 2013 ⁴²	19
Figure 19. Status of NBP Plans (mid 2013) ⁴²	20
Figure 20. Internet Access Comparison Between Men and Women.....	21
Figure 21. Income vs. broadband speed.....	22
Figure 22. Egypt's internet service in 2011 (source IEET).....	23