MSIS 2604 - Information Systems Policy and Strategy

Project Report on,

Broadcom Inc.

Submitted by

Apeqsha, Harshada Boob, Aishwarya Dingre, Aditi Tupsakhare

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Executive Summary

Broadcom is among the top 5 semiconductor industry worldwide, with 3% market share in global semiconductor and electronic parts manufacturing industry[1]. Under the leadership of its President and Chief Executive Officer Hock E. Tan, Avago acquired Broadcom Corp. in 2016 to become Broadcom Inc[2]. Broadcom follows the strategy to invest in R&D by acquiring a company with in-process R&D and using it to quickly develop commercial products in that market and offer them at competitive prices[3]. his is evident from their acquisition of companies like Broadcom Corp, Brocade and CA technologies[4]. With acquisition of Broadcom Corp. by Avago to become Broadcom Inc, it has become a key player in Wireless LAN infrastructure segment by offering various 5G Wifi chipsets and SoCs[5]. Broadcom's primary competitors in wireless segment are Murata Manufacturing Co., Ltd., Qorvo, Inc. and Qualcomm Inc.[6]. Broadcom has major rivals in semiconductor industry like Intel, Qualcomm, Marvell and others[7] also offer similar wifi chipsets and SoCs product lines. From various analysis done, we can infer that semiconductor industry has growth potential but will result in lower profit margins because of high rivalry. Broadcom is also an early mover in Wifi 6 technology with Ron Porat[8] (Technical Director at Broadcom Inc.) being 1st Vice Chair of the Task Group formed to develop IEEE standard 802.11ax (Wifi 6 technology). Hence, we believe Broadcom has competitive

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[1] https://clients1.ibisworld.com/reports/gl/industry/majorcompanies.aspx?entid=960

[2] https://en.wikipedia.org/wiki/Broadcom_Corporation

[3] https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/semiconductors/pdfs/mosc_1_business_models.ashx

[4] https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s8C46F8A8AC6B5F8AB0811E531C35BEA5 - Recent Developments

[5] https://en.wikipedia.org/wiki/Broadcom_Corporation

[6] 10-K 2018 Business, https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s8C46F8A8AC6B5F8AB0811E531C35BEA5 - Competition

[7] https://clients1.ibisworld.com/reports/gl/industry/majorcompanies.aspx?entid=960

[8] http://www.ieee802.org/11/Reports/tgax_update.htm

advantage over its competitor in the highly potential Wifi 6 and IoT segment as it can influence 802.11ax standard.

Company Overview

Broadcom Inc. (NASDAQ:AVGO) is a globally leading firm which designs, develops and supplies a vast range of digital and analog semiconductor connectivity and infrastructure solutions catering to primary end markets such as wired infrastructure, wireless communications, enterprise storage and industrial along with other[9] [10]. After the redomiciliation from Singapore, now this fabless semiconductor firm is headquartered in San Jose, California[11]. Broadcom Inc. was established in 1961 with numerous acquisitions over its course of history, significant one being the acquisition of Broadcom Corp. by Avago Technologies for $37B in 2015.[12] The company boasted a revenue of $20.85B in 2018 which helped it secure 5th position on the industry leaderboard[13,14,15]. Given Broadcom's nature of vastness, our focus will be on the company's largest revenue sector, wireless communications segment, which approximately yields 31% of company's revenue[16].

[9] 10-K 2018 Revenue by Segment, http://investors.broadcom.com/phoenix.zhtml?c=203541&p=irol-reportsannual

[10] About Broadcom Inc. :http://investors.broadcom.com/phoenix.zhtml?c=203541&p=irol-newsArticle&ID=2341156

[11] http://investors.broadcom.com/phoenix.zhtml?c=203541&p=irol-newsArticle&ID=2341156

[12] Broadcom Ltd. from https://clients1-ibisworld-com.libproxy.scu.edu/reports/gl/industry/majorcompanies.aspx?entid=960

[13] Broadcom. *Broadcom's revenue worldwide from 2014 to 2018 (in billion U.S. dollars)**. https://www-statista-com.libproxy.scu.edu/statistics/977066/broadcom-revenue/ (accessed 3/17/19, 9:18 PM).

[14] IC Insights. *Leading semiconductor companies (including foundries) from 2014 to 2018, by sales revenue (in billion U.S. dollars)*. https://www-statista-com.libproxy.scu.edu/statistics/283359/top-20-semiconductor-companies/ (accessed 3/17/19, 9:19 PM).

[15] http://www.mergentonline.com.libproxy.scu.edu/competitors.php?compnumber=128065

[16] 10-K 2018 Revenue by Segment, http://investors.broadcom.com/phoenix.zhtml?c=203541&p=irol-reportsannual

Industry Overview

Broadcom belongs to the family of Global Semiconductor and Electronic Parts Manufacturing industry. This industry generated a total market revenue of $739B in 2018[17]. With the increasing internet connectivity and use of semiconductor based parts like commodities, the demand for downstream consumer electronics has increased which is helping this industry to grow.[18] The industry oscillates due to fluctuating product and input prices along with currency exchange rates. Over the next 5 years, it is estimated that due to development of powerful semiconductors, the need for new solutions to meet the requirements of more functional and compact products, rise in Internet of Things commodities and development of 802.11ax IEEE WLAN standard along with other major factors will contribute to the growth of this industry.[19] It is forecasted that the industry will see an annualized 4.3% growth to $866.9B till 2023.[20] Hence, growing use of electronics in all markets will promote the expansion of this industry in coming years[21].

Financial Analysis

Before the existence of Broadcom Inc. the company was listed under the name Avago Technologies with revenue $4.27B and $6.82B in 2014 and 2015, respectively. In early 2016, Avago Technologies acquired Broadcom Corp. for $37B ($17B cash and $20B in shares) and rebranded this merged entity as Broadcom Inc[22]. Broadcom Corp. hence started operating as a fully owned subsidiary of this merged entity. This merger strengthened Avago Tech's patent

[17] https://clients1-ibisworld-com.libproxy.scu.edu/reports/gl/industry/keystatistics.aspx?entid=960
[18] https://clients1-ibisworld-com.libproxy.scu.edu/reports/gl/industry/ataglance.aspx?entid=960
[19] https://clients1-ibisworld-com.libproxy.scu.edu/reports/gl/industry/ataglance.aspx?entid=960
[20] Executive Summary from https://clients1-ibisworld-com.libproxy.scu.edu/reports/gl/industry/ataglance.aspx?entid=960
[21] https://clients1-ibisworld-com.libproxy.scu.edu/reports/gl/industry/ataglance.aspx?entid=960
[22] http://investors.broadcom.com/phoenix.zhtml?c=203541&p=irol-newsArticle&ID=2053937

positions significantly in various sectors including IoT and boosted its position to ninth largest[23] holder of patents among the top semiconductor vendors. Hence, in 2016 the company reported a revenue of $13.24B which was an increase of 94.13% from previous year due to the acquisition. The company saw a steady growth in its revenues in 2017 and 2018 as well and reported the revenues worth $17.64B and $20.85B, respectively. Broadcom saw a yearly growth in its net income from 2014 to 2018 except for 2016 which was the year when the acquisition took place ***(Exhibit 1).*** Broadcom's operating expenses increased by 14.46% from 2014 to 2016 and was at the peak at the time of acquisition in 2016 and subsequently it decreased by 21.1% from 2016 to 2018 ***(Exhibit 2)***. In terms of Price-to-Earnings Ratio, Broadcom's PE ratio on Dec 31st 2018 was 8.966 while the PE ratio for semiconductor industry was 19.24. Earning per share for Broadcom has also improved in 2017 and 2018 ***(Exhibit 3)***. This means that Broadcom is undervalued and can be a favorable investment option [24,25]. Broadcom invests approximately 17.7% of its revenue in semiconductor R&D which is worth $3.7B ***(Exhibit 4).*** Broadcom invested 17.7% of its revenue in 2018 while its major competitors like Qualcomm and Intel invested 25% and 20.55% of their revenues in R&D.[26,27,28.] After the acquisition, Gross Margin has improved from 44.86% in 2016 to 51.48% in 2018.

[23] https://www.eetimes.com/author.asp?section_id=36&doc_id=1326798#
[24] https://ycharts.com/companies/AVGO/pe_ratio
[25]https://ycharts.com/companies/SMI/pe_ratio
[26] https://investor.qualcomm.com/static-files/bde24726-605c-4118-92db-7190e0f58e53
[27] https://www-statista-com.libproxy.scu.edu/statistics/270590/global-revenue-generated-by-semiconductor-vendors-since-2009/
[28] https://www-statista-com.libproxy.scu.edu/statistics/263562/intel-expenditure-on-research-and-development-since-2004/

Technology Adoption (S-curve Analysis)

Semiconductor industry thrives on ever-growing demand for electronics. This industry has become a backbone for technological development. The beginning point of semiconductor industry can be traced back to 1947-48 when first point of contact & junction transistors were invented. Based on the trends observed from **Exhibit 5** and **Exhibit 6**, we can see that the industry has had its fair share of rapid growth and plateaus in terms of revenue. While factors such as market saturation, limitations on profit markets due to high rivalry, recession and others have slowed down the industry, continuous technological developments have facilitated breakthrough solutions which has helped to maintain the overall growth and profitability in the industry *(Beginning of new S-curves when previous technology starts nearing plateau phase)*.

Various complementing markets to semiconductors such as network infrastructure industry has witnessed several technological developments and have grown along with this industry. This led to the advancement of powerful switches and routers whose demand is increasing along with other supporting hardware for the networks **(Exhibit 7)**. Wireless LAN technology has grown over the years which has accelerated the developments in 802.11 WLAN protocols. 802.11b and 802.11a standards were introduced in the market in the year 1999.[29] 802.11g, 802.11n and 802.11ac(WiFi 5) entered the market in the years 2003, 2009 and 2014, respectively.[30] WiFi 5 is known as 5G WiFi since it operates in 5 GHz frequency band.[31] 5G WiFi offers speed upto 1 Gbps over indoor range of 90 ft maintaining backward compatibility to 802.11n **(Exhibit 8)**. The 802.11ax known as WiFi-6 is the much awaited WiFi standard which will offer enhanced combined advantages of 802.11ac and 802.11n and, various semiconductor chip-makers such as

[29] https://www.theverge.com/2018/10/3/17926212/wifi-6-version-numbers-announced
[30] https://www.theverge.com/2018/10/3/17926212/wifi-6-version-numbers-announced
[31] https://www.howtogeek.com/398620/whats-the-difference-between-5g-and-5ghz-wi-fi/

Broadcom, Qualcomm and Intel are racing to capture this market.[32] WiFi-6 or 802.11ax IEEE draft was passed in 2016 and 2017 and, it failed in both years so the improvised draft is expected to pass in late 2019.[33] As we can see in **Exhibit 10**, WiFi 6 is still in its initial phase but has quite a lot of potential before it reaches to its plateau phase due to features shown in **Exhibit 9**. **Exhibit 10** also shows that 5G WiFi is nearing its plateau phase but might coexist with WiFi 6. WiFi 6 can support the worldwide increasing IoT market due to significant feature enhancements and backward compatibility with other standards**(Exhibit 11)**. The semiconductor industry has benefited from all these evolving WiFi standards and technologies such as IoT and others since these industries form their major consumer market. We can see that how these technologies have impacted the semiconductor industry through all these years by mapping each emerging technology with the industry revenue **(Exhibit 12)**.

Competitive Analysis

Broadcom is a fabless semiconductor company which owns 3% of the global semiconductor market and ranks 5th in the industry revenue wise.[34] Broadcom's business model divides the business into four prominent sectors out of which wireless communications sector that includes wireless embedded solutions and RF components contributed 31% to the company's revenue in 2018. [35] Broadcom Corp. was acquired by Avago Technologies for $37B in 2016.[36] The merged entity Broadcom Inc. became a patent powerhouse and is now among top 10 patent holders in semiconductor industry.[37] Broadcom's major competitors in WiFi chip market include Intel,

[32] https://www.marketwatch.com/story/the-battle-for-next-gen-wi-fi-pits-qualcomm-against-broadcom-2018-09-10
[33] https://www.gartner.com/document/3882465?ref=solrAll&refval=218445062&qid=93aa94e7ba2c7ee41d23ebeb8
[34] Broadcom Ltd. from https://clients1-ibisworld-com.libproxy.scu.edu/reports/gl/industry/majorcompanies.aspx?entid=960
[35] 10-K 2018 Revenue by Segment, http://investors.broadcom.com/phoenix.zhtml?c=203541&p=irol-reportsannual
[36] Broadcom Ltd. from https://clients1-ibisworld-com.libproxy.scu.edu/reports/gl/industry/majorcompanies.aspx?entid=960
[37] https://clients1-ibisworld-com.libproxy.scu.edu/reports/gl/industry/majorcompanies.aspx?entid=960

Qualcomm, Murata Manufacturing Co. Ltd., Qorvo Inc., TDK-EPC Corp. and others.[38] [39] Broadcom was the first mover in 5G WiFi chip market which helped it to gain customers and secure customer loyalty initially.[40] Although soon after, 5G WiFi chip market became crowded as competition increased.

Broadcom has diversified revenue streams which gives it a competitive advantage in case of economic slowdown in one market.[41] Broadcom has comparatively less but huge clients such as Huawei, Apple, Samsung, LG and others. Broadcom's revenue might be affected with even loss of one client since they constitute significant portion of their revenue. Broadcom Inc. carries forward the legacy of Avago of investing in R&D through acquisitions to break the barriers to enter new market which are protected by IP and to sustain its position in the market. Broadcom tried to acquire Qualcomm to strengthen its market position by massive offering of $117B but, the deal was stopped by President Trump citing national security issues since Qualcomm is one of the suppliers for defense and Broadcom was domiciled in Singapore, at the time of the deal.[42] Broadcom redomiciled to Delaware after the deal fell apart and pledged to make US a global leader in 5G.[43] Qualcomm has since then been a major competition to Broadcom and is investing aggressively in R&D as compared to Broadcom. [44] This could be a major benefit for Qualcomm in coming future which will make things harder for Broadcom.

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[38] 10-K 2018 Business, https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s8C46F8A8AC6B5F8AB0811E531C35BEA5 , Competition

[39] https://wikidevi.com/wiki/List_of_Wi-Fi_Chipset_Vendors

[40] https://www.engadget.com/2013/01/07/broadcom-wifi-5g-lg/

[41] 10-K 2018 Business, https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s8C46F8A8AC6B5F8AB0811E531C35BEA5, Segment Reporting

[42] https://money.cnn.com/2018/03/14/news/companies/broadcom-qualcomm-deal-trump/index.html

[43] https://www.broadcom.com/company/news/financial-releases/2336707

[44] https://www.forbes.com/sites/tiriasresearch/2018/01/17/qualcomm-challenges-broadcom-where-it-counts-most-networking/#56665a104718

Porter's Five Forces:

Porter's Five Force Analysis of Semiconductor Industry in General

Degree of Existing Rivalry - High:

Intensifying Factors:

1) Tough competition from the industry since there are many major players such as Intel, Qualcomm, Samsung, SK Hynix[45]
2) It is a large industry with revenue of $738.495 B [46]
3) Exit barriers are high since investment and skills are for a specialized environment, which makes it difficult for a company to leave or move to another industry
4) Products are not highly differentiated which makes the market aggressive

Weakening factors:

1) Switching cost promotes customer loyalty, since switching costs are high for customers. The customer product architecture is dependent on the semiconductor components that they buy from a particular vendor
2) High sunk costs limit competition
3) Brand value matters to customers because they invest large capitals and expect equal returns

Threat of New Entrants - Low to Moderate:

Intensifying Factors:

1) Promising industry with a high chance of success as semiconductors are the core of electronic devices[47].

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[45] https://clients1.ibisworld.com/reports/gl/industry/majorcompanies.aspx?entid=960 - Major Companies
[46] https://clients1-ibisworld-com.libproxy.scu.edu/reports/gl/industry/keystatistics.aspx?entid=960
[47] https://clients1.ibisworld.com/reports/gl/industry/ataglance.aspx?entid=960

2) Many buyers and innovation in the industry, which encourages new entrants in the space[48]. Industry has vast range of segment such as wired network devices, wireless LAN infrastructure, consumer electronics, government and defense[49], which gives new entrants plenty of options to choose the target segment in the industry

Weakening factors:

1) High and steady entry barrier, since the industry requires a large capital investment, requirement of skilled employees and several such factors[50]
2) Regulatory framework standards are challenging[51]
3) Switching cost is high for customers
4) Patents limit new competition
5) Geographical challenges with regards to manufacturing costs, proximity to suppliers and customers and government support for manufacturing[52]

Bargaining Power of Suppliers - Moderate to High:

Intensifying Factors:

1) This industry is dependent on several suppliers of raw materials such as silicon, metals, crystal quartz (High dependability on wide range of materials)[53]
2) Dependency on manufacture of customised products [54]

Weakening factors:

[48] https://clients1-ibisworld-com.libproxy.scu.edu/reports/gl/industry/industryoutlook.aspx?entid=960
[49] https://clients1.ibisworld.com/reports/gl/industry/productsandmarkets.aspx?entid=960 - Major Markets
[50] https://clients1.ibisworld.com/reports/gl/industry/competitivelandscape.aspx?entid=960#BTE - Barriers to Entry
[51] https://ieeexplore.ieee.org/browse/standards/number/ieee/
[52] https://clients1.ibisworld.com/reports/gl/industry/productsandmarkets.aspx?entid=960 - Business Locations
[53] https://clients1.ibisworld.com/reports/gl/industry/productsandmarkets.aspx?entid=960#SC - Supply Chain
[54] https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s8C46F8A8AC6B5F8AB0811E531C35BEA5 - Materials and Supplies

1) High competition among suppliers and low switching that is facilitated by procurement on purchase order basis [55],[56]

Bargaining Power of Buyers -Moderate to High:

Intensifying Factors:

1) Multiple providers of undifferentiated product
2) Individual customers contributing to large amount of sales

Weakening factors:

1) High switching cost
2) Architectural dependency on customised products

Threat of Substitutes - Low: No apparent substitutes in this industry, as of now.

Role of Complements - High: Distribution channels are critical to the success of this industry. Prevalence of consumer products complements the use of semiconductors. Highly dependent on manufacturing fabs, like TMSC[57], and raw material suppliers

Conclusion: The semiconductor industry has strong potential for the future but with low profit margins.

Porter's Five Force Analysis of Companies who are a part of Wireless LAN infrastructure:

Communications and network equipment manufacturers is second largest major market for semiconductor industry with 22.10%[58] and Broadcom Inc. being an earlier mover in 5G Wifi and Wifi 6 technology, we decided to focus on Wifi chipset and SoC segment of wireless communication market. Since the Wireless LAN Infrastructure industry of Broadcom is a

[55] 10-K 2018 Business, https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s3BD62B5A7CBF5A61893DB9E226CFE1FE , Materials and Suppliers

[56] https://investor.qualcomm.com/static-files/3bee5a52-757b-4ac6-9468-b0102bdc4418 , Part 1 - Business - Operating Segments

[57] https://en.wikipedia.org/wiki/TSMC

[58] https://clients1.ibisworld.com/reports/gl/industry/productsandmarkets.aspx?entid=960

segment of the Semiconductor industry, most of the Porter's Five Force Analysis holds true for this industry as well, apart from the below:

Degree of Existing Rivalry - High:

Intensifying Factors:

1) Tough competition in this niche segment of the semiconductor industry, due to the presence of competitors such as Murata Manufacturing Co., Ltd., Qorvo, Inc., Qualcomm Inc., Skyworks Solutions Inc., and TDK-EPC Corporation[59].
2) Recent rise in demand for wireless devices and IoT has attracted major players into this segments[60]

Bargaining Power of Buyers - Low to Moderate:

Intensifying Factors:

1) Competitive product line offered by selected manufacturers

Weakening factors:

1) Not many suppliers in the market for buyers to choose from
2) Recent technology which is not fully evolved

Role of Complements - High: Increase in demand of mobile portable devices[61], advancements in Artificial Intelligence has led to increased demand of Wireless Semiconductor Chipsets

Conclusion: Since the Wireless LAN Infrastructure industry is a relatively new industry, it has a high potential in the future. Due to the increase in mobile devices and Artificial Intelligence, wireless components play a major role in the technology market.

[59] 10-K 2018 Business, https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s3BD62B5A7CBF5A61893DB9E226CFE1FE , Competition

[60] https://clients1-ibisworld-com.libproxy.scu.edu/reports/gl/industry/industryoutlook.aspx?entid=960

[61] ibid

SWOT Analysis :

Strengths:

1) Provides a diversified product families in 4 main segments: Wired Infrastructure, Wireless Communications, Enterprise Storage and Industrial & Other. Their major product families such as Broadband Access, Data Centers, Mobile Handsets, Servers and storage systems and displays and lightings, thus covering a large variety of consumer applications[62]
2) Committed to innovation and R&D with a focus on introducing new and proprietary products. Broadcom has been the first to ship 7th generation Fibre Channel[63], delivered the world's first xDSL CPE SoC with integrated 802.11ax Wi-Fi 6 Technology[64], introduced the world's first 5G Radio Switch[65] and many such other innovations.
3) Acquisition of several companies has improved Broadcom's reputation. Some of their recent acquisitions include CA, Inc and Brocade[66]
4) Broadcom's revenues have been improving since 2016, 20.848 B in 2018 from 13.204 B in 2016[67]. Their strong financial performance has increased the company's ability to allocate sufficient financial resources for their future growth as well as provide greater returns to their shareholders.

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[62] 10-k 2018 Business, https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s8C46F8A8AC6B5F8AB0811E531C35BEA5 , Products and Markets

[63] https://www.broadcom.com/company/news/product-releases/2379803

[64] https://www.broadcom.com/company/news/product-releases/2372949

[65] https://www.broadcom.com/company/news/product-releases/2337544

[66] 10-k 2018 Business, *op. cit.*, Recent Developments

[67] 10-K 2018 Selected Financial Data https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s7533AC778AAF59C18631AE39AB116D95

5) Customer base and sales and distribution network are strong. Direct sales are more focused on their large Original Equipment Manufacturer (OEM) customers, while their sales distribution network focuses on serving customers globally[68]
6) Broadcom's Intellectual Property has proved to be a great strength for their company. As of Nov 2018, Broadcom Inc. has 20,898 U.S and other patents and 1,655 US and other pending patent applications[69]

Weaknesses [70]:

1) Bargaining power of suppliers is high because of the dependency on limited number of suppliers for a critical material and components
2) Broadcom's 10-K report mentions that their success depends largely on the company's CEO, which means that the company is highly dependent on the senior management's leadership
3) Broadcom primarily operates on an outsourced manufacturing business model. They have a high dependency on contract manufacturing and outsource their supply chain and any disruption in these facilities could affect Broadcom's financial condition adversely

Opportunities:

1) Being a major player in the 5G-Wifi and 6G-Wifi technologies, they can leverage their position to become an early mover in the 5G Cellular Market
2) Explore new market segments such as self-driving cars and other artificial intelligence technologies

Threats [71]:

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[68] 10-K 2018 Business, https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s8C46F8A8AC6B5F8AB0811E531C35BEA5, Overview

[69] 10-K 2018 Business, *op. cit.,* Intellectual Property

[70] 10-K 2018 Risk Factors, https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s3BD62B5A7CBF5A61893DB9E226CFE1FE

1) The semiconductor industry is highly cyclical, which could be subject to significant downturns
2) Adverse global economic conditions could have a negative effect on the business, as the company may not be capable of sustaining itself
3) High level rivalry in semiconductor industry could prevent increase in Broadcom's revenue, as competitors can offer similar products
4) Possible litigations related to Intellectual Property
5) Due to local government restrictions on use of lead and other hazardous substances in semiconductor based electronics, there could be a change in requirements of material composition in Broadcom's products. This could adversely affect inventory and operation

Value Chain Analysis:

Primary Activities:

Inbound Logistics: Broadcom has numerous suppliers all over the globe and they procure semiconductor and electromechanical parts. Purchase order basis so low switching costs are associated for most of the products[72]. Most of the suppliers are from Asia where manufacturing costs are low as compared to developed countries[73]

Operations[74]: Broadcom's majority of the operations of front end wafer manufacturing are primarily outsourced to external foundries including Taiwan Semiconductors Manufacturing Company Ltd. (TSMC) and United Microelectronics Corporation, SMIC, GlobalFoundries, TowerJazz and WIN Semiconductor. Broadcom uses third party contract manufacturer for most

[71] 10-K 2018 Risk Factors, https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s3BD62B5A7CBF5A61893DB9E226CFE1FE
[72] 10-K 2018 Business, https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s8C46F8A8AC6B5F8AB0811E531C35BEA5 , Materials and Suppliers
[73] 10-K 2018, *op. cit.,* Customers, Sales and Distribution
[74] 10-K 2018 Business, *op. cit.,* Operations

of their assembly and test operations. They use internal fabrication facilities for products utilizing their innovative and proprietary processes to stronger protection of their IP and for product acceleration to the market. Majority of their internal III-V semiconductor wafer fabrication is done in US and Singapore (current and former headquartered countries). Broadcom depends on their own or a particular contractor and in many instances just one manufacturer to produce certain parts of their products.

Outbound Logistics[75]: Broadcom sells its products through global distributors as well as direct sales, that is mainly focused on their large OEM customers. In some cases where time-critical delivery of products is essential, contracts with the customers are signed with contract manufacturers as inter-mediators. Broadcom has a significant presence in Asia which is an attractive market in the electronics supply chain.

Marketing and Sales[76]: As seen from outbound logistics, Broadcom has efficiently placed and maintained its various distributors and regional distributors such that it reaches as many customers as possible.

Service: To assist their customers with various issues and with logistics and other order fulfilment requirements, Broadcom maintains dedicated regional customer support call centers[77]. Brocade, which has been acquired by Broadcom, has a Switch Maintenance and Support segment. This segment provides contract options to customers for service and maintenance of switches that are purchased through the Brocade platform[78]. Broadcom provides easy support and knowledge to its customers in all stages of their product development by locating their

[75] 10-K 2018 Business, *op. cit.,* Customer Sale and Distribution

[76] 10-K 2018 Business, https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s8C46F8A8AC6B5F8AB0811E531C35BEA5 , Customers, Sales and Distribution

[77] Ibid

[78] https://docs.broadcom.com/html-docs/SANnav110/index.html#page/SANnav110/v24521913.html

highly skilled engineers close to customer sites[79]. This proves to be advantageous to customers at their production location.

Supporting Activities:

Firm Infrastructure: Broadcom has a fabless business model. The company outsources a major portion of its manufacturing operations through third-party foundry, assembly and test capabilities. The company has outsourced some of its corporate infrastructure functions as well[80]. In order to manage their global operations, Broadcom has employed third-party IT systems and the company depends heavily on them [81].

Human Resource Management: From the risk factors mentioned in the 10-K, we have deduced that Broadcom considers its engineering and technical personnel, and the existing members of senior managements very valuable. Also, integrating and managing personnel after a merger or acquisition is of critical importance to the company[82].

Technology Development: Broadcom's key strategy includes investing in product development via acquisition and inhouse R&D. The company also invests in process development and fabrication capabilities in order to optimize the internal device manufacture process[83].

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[79] 10-K 2018 Business, *op. cit.,* Research and Development

[80] 10-K 2018 Business, *op. cit., Overview*

[81] https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s3BD62B5A7CBF5A61893DB9E226CFE1FE

[82] https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s3BD62B5A7CBF5A61893DB9E226CFE1FE

[83] 10-K 2018 Business, https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s8C46F8A8AC6B5F8AB0811E531C35BEA5 , Research and Development

Stakeholder Analysis:

Broadcom's primary stakeholders are Investors, Large Shareholders and Board Members. The company's secondary stakeholders are Suppliers and Manufacturers, Individual Shareholders, Customers, Distributors, Government, Employees and the company's Rivals. All stakeholders apart from Government and Rivals have a common desire, that the company's growth and revenue witnesses an upward trend, which would help the company to capture a major market share in the industry. It would also be ideal for the stakeholders when Broadcom's stock grows exponentially, so that they ripe the benefits of their investment. Exhibit 13 depicts a clear picture of the company's stakeholders, their areas of interest, desired values and resources contributed.

Balanced Scorecard:

Balanced Scorecard is used to measure a firm's performance with respect to its strategic objectives. It emphasizes on four perspectives of the firm: Financial perspective, Customer perspective, Internal perspective and Innovation and Learning perspective[84]. Exhibit 14 provides a detailed overview of the Balanced Scorecard for Broadcom Inc. the Mission and Vision of Broadcom has been taken from the company website[85].

Definition of Strategic Business Unit	Broadcom belongs to the semiconductor and electronic parts manufacturing indisty and its product offererings are classified into 4 segments: Wired Infrastructure, Wireless Communication, Enterprise Storage and Industrial & others
Mission	Broadcom is focused on technology leadership and category-leading semiconductor and infrastructure software solutions. The company is a global leader in numerous product segments serving the world's most successful companies.
Vision	Broadcom Inc. combines global scale, engineering depth, broad product portfolio diversity, superior execution and operational focus to deliver category-leading semiconductor and infrastructure software solutions so its customers can build and grow successful businesses in a constantly changing environment.

[84] Strategic Management of Technological Innovation, Schilling, Melissa A., Fourth Edition - Part 2, Chapter 6, page 122

[85] https://www.broadcom.com/company/about-us/

	Financial Perspective	Customer Perspective	Internal Perspective	Innovation and Learning
Critical Success Factors	Focusing on innovation and R&D and strive to become a market leader Close collaboration with distributors to improve network sales and establish customer base in various geographical areas Company follows a fabless strategy and has most of its manufacturers in Asia	Improve Customer Loyalty Widely distributed sales centers across the globe to increase customer reachout Provide safe, quality and reliable products Support selected customers for their just-in-time production	M&A with companies to enter new technology segments	Launch new technology that is critical for the use of 5G Wifi and Wifi 6 Merge or Acquire companies to develop their in-process R&D projects Focus on building Intellectual Property
Critical Measurements	Increase in Net Revenue Decrease in Operating Expense Increase in Year-On-Year Earnings	Customer retention Acquiring new customers Country wise increase in revenues Products operating at industry standard Maintain finished good inventories near customer sites	Increased Return on Investment Enhanced capabilities of Broadcom's products	Introduced world's first 5G Radio Switch, Wifi 6 Access Point SoC Successfully create commercially viable products from technologies acquired from M&A Increase in number of patents

Future Risks:

From the analysis made above and risks mentioned in Broadcom's 2018 10-K report, the team has deducted possible future risks below [86]:

- Broadcom has small number of customers, so reduction in demand or loss of one or more significant customers may affect its business adversely
- High dependency on third party international suppliers for customized and critical components and sole dependency on integrating foundry may affect time to market of their products and reputation
- Improper protection or loss of IP may lead to significant loss of revenue and architectural control and the company may incur large litigation expenses

[86] https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s3BD62B5A7CBF5A61893DB9E226CFE1FE

- Broadcom's business model is based on mergers and acquisitions, as seen in the value chain analysis. Mismanagement of future mergers and acquisitions could affect planned innovation, R&D as well as value of common stock and revenue
- Introduction of substitutes in the near future that could eliminate the need for semiconductors
- Being a global company, fluctuations in currency exchange and interest rates could affect the company's net income and revenue adversely

Exhibits

Exhibit 1: Net Income of Broadcom Inc. from 2014-2018 [87]

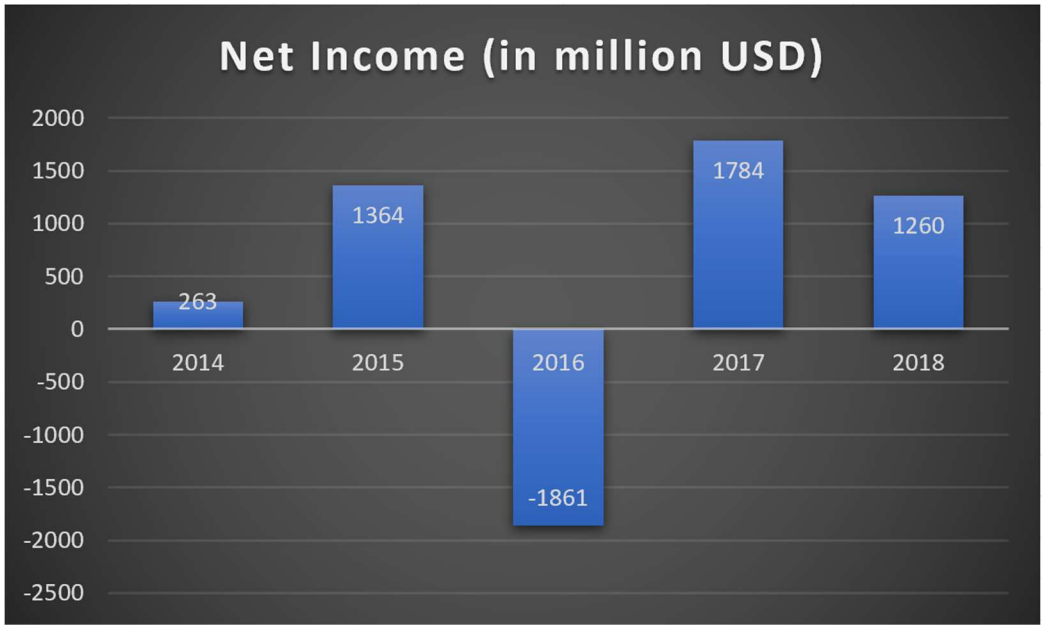
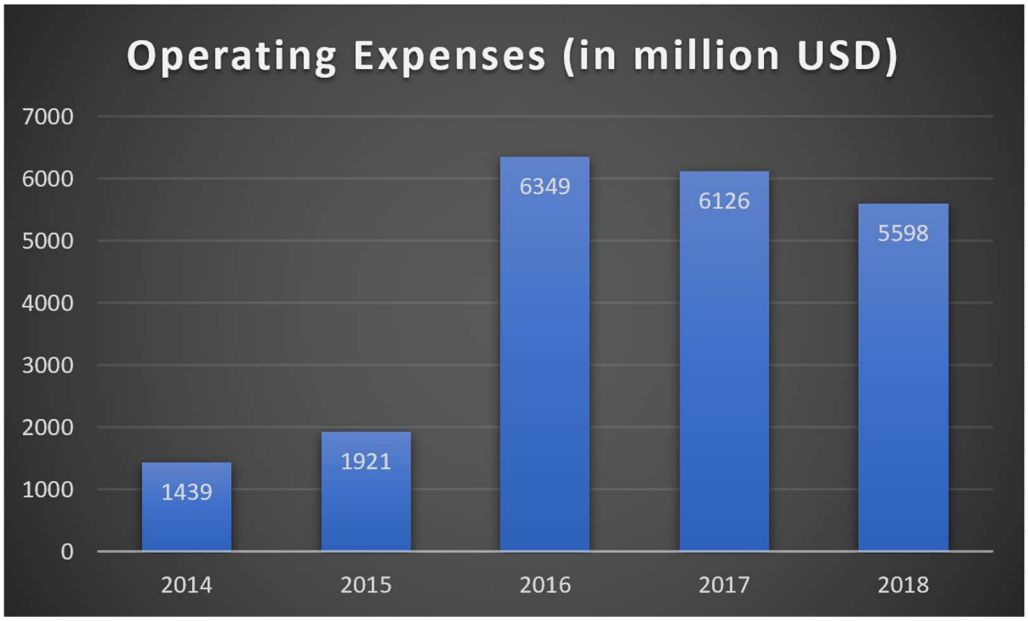


Exhibit 2: Operating Expenses of Broadcom Inc. from 2014-2018 [88]



[87] https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s7533AC778AAF59C18631AE39AB116D95, Selected Financial Data

[88] *ibid*

Exhibit 3: Earnings per share of Broadcom Inc. from 2014-2018 [89]

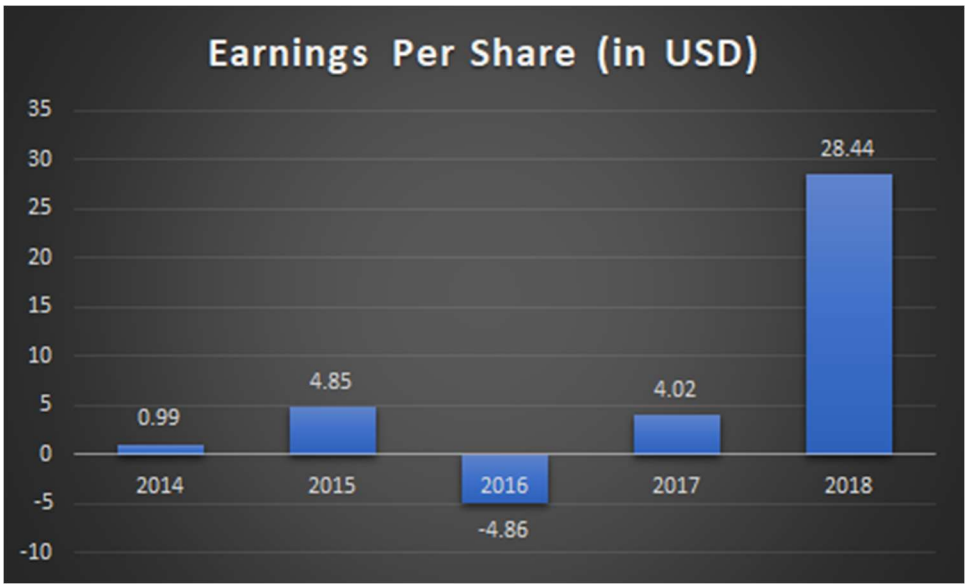


Exhibit 4: R&D Expenses of Broadcom Inc. from 2014-2018 [90,91]

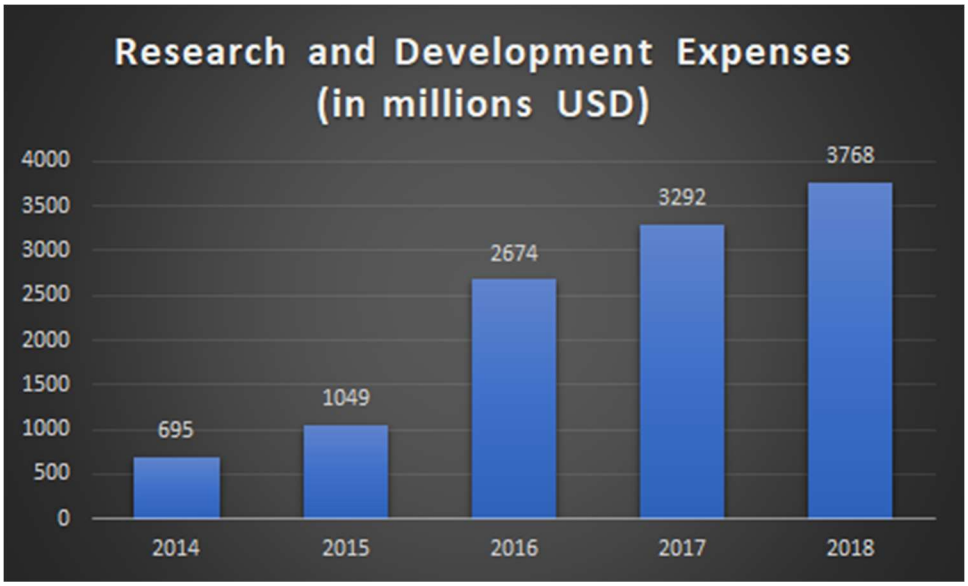


Exhibit 5: Global semiconductor industry revenue growth from 1988 to 2019[92]

89 https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s7533AC778AAF59C18631AE39AB116D95 , Selected Financial Data

90 https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s7533AC778AAF59C18631AE39AB116D95 , Fiscal Year 2017 Compared to Fiscal Year 2016

91 http://investors.broadcom.com/phoenix.zhtml?c=203541&p=irol-reportsannual - 10-K report for 2016

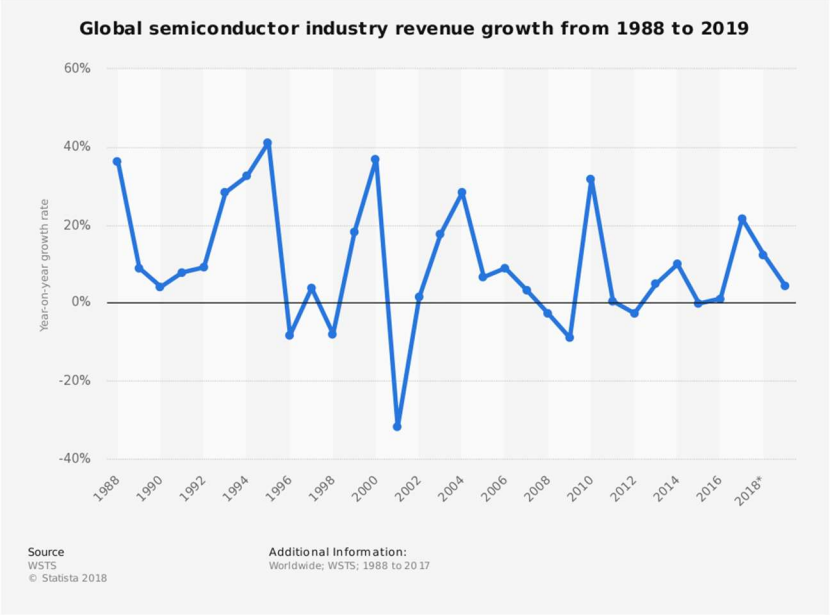
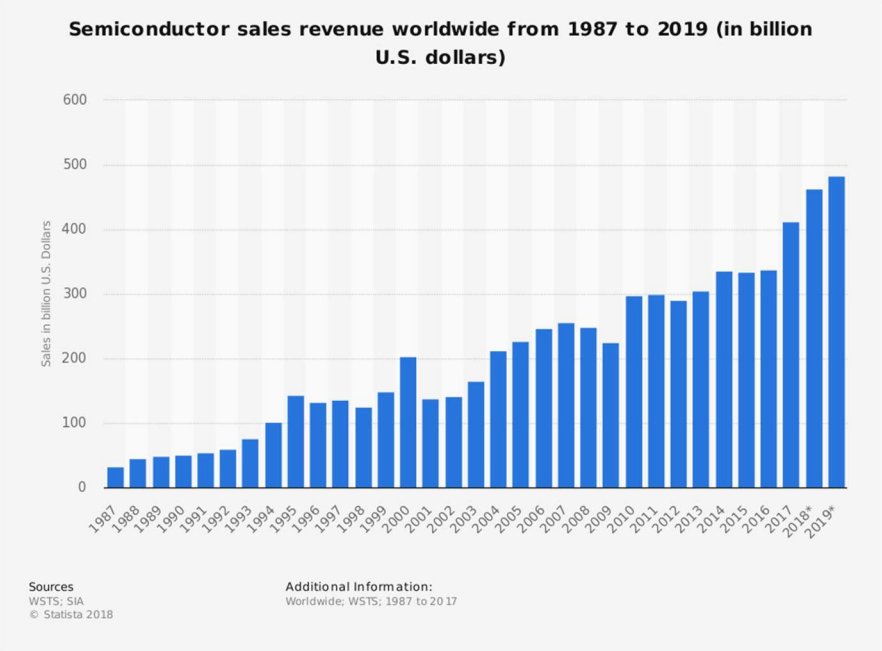


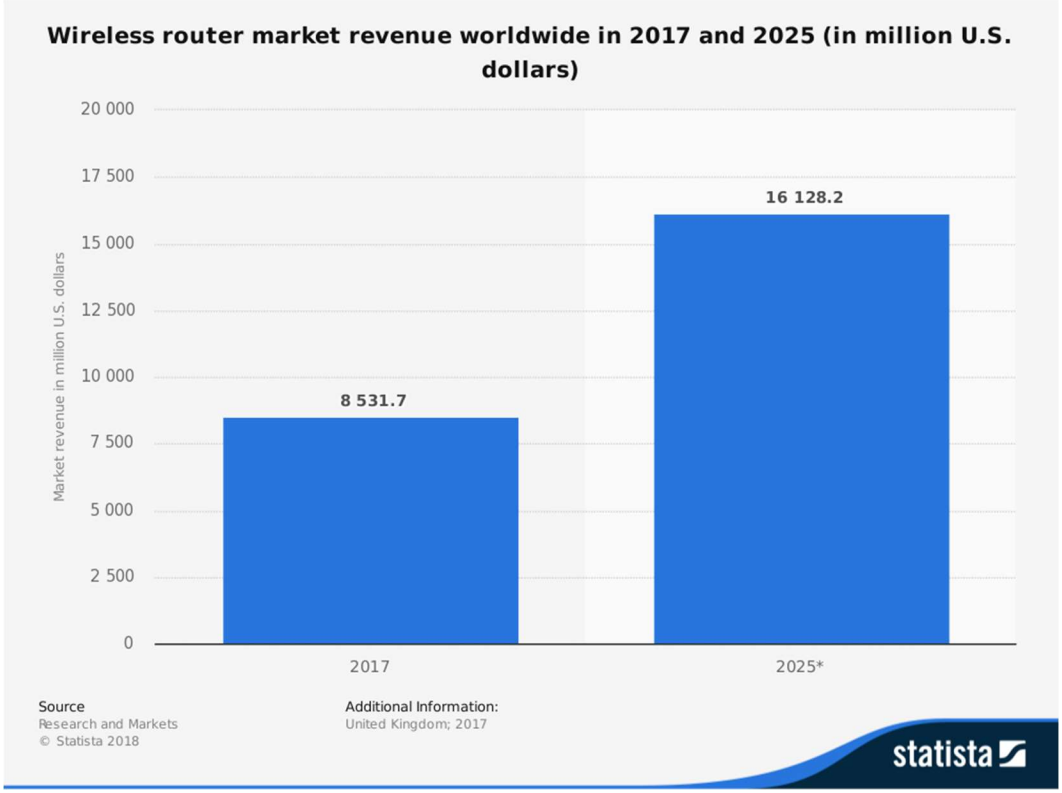
Exhibit 6: Semiconductor sales revenue worldwide from 1987 to 2019 (in billion USD)[93]



[92] WSTS. *Global semiconductor industry revenue growth from 1988 to 2019*. https://www-statista-com.libproxy.scu.edu/statistics/266976/forecast-revenue-growth-in-the-semiconductor-industry-worldwide/ (accessed 3/15/19, 8:41 AM).

[93] WSTS, and SIA. *Semiconductor sales revenue worldwide from 1987 to 2019 (in billion U.S. dollars)*. https://www-statista-com.libproxy.scu.edu/statistics/266973/global-semiconductor-sales-since-1988/ (accessed 3/15/19, 8:29 AM).

Exhibit 7: Wireless router market revenue worldwide in 2017 and 2025 (in million USD)[94]



[94] Research and Markets. *Wireless router market revenue worldwide in 2017 and 2025 (in million U.S. dollars)*. https://www-statista-com.libproxy.scu.edu/statistics/947604/worldwide-wireless-router-market-value/ (accessed 3/15/19, 9:12 AM).

Exhibit 8:IEEE 802.11 WLAN Standards[95]

802.11 Wireless Standards					
IEEE Standard	802.11a	802.11b	802.11g	802.11n	802.11ac
Year Adopted	1999	1999	2003	2009	2014
Frequency	5 GHz	2.4 GHz	2.4 GHz	2.4/5 GHz	5 GHz
Max. Data Rate	54 Mbps	11 Mbps	54 Mbps	600 Mbps	1 Gbps
Typical Range Indoors*	100 ft.	100 ft.	125 ft.	225 ft.	90 ft.
Typical Range Outdoors*	400 ft.	450 ft.	450 ft.	825 ft.	1,000 ft.

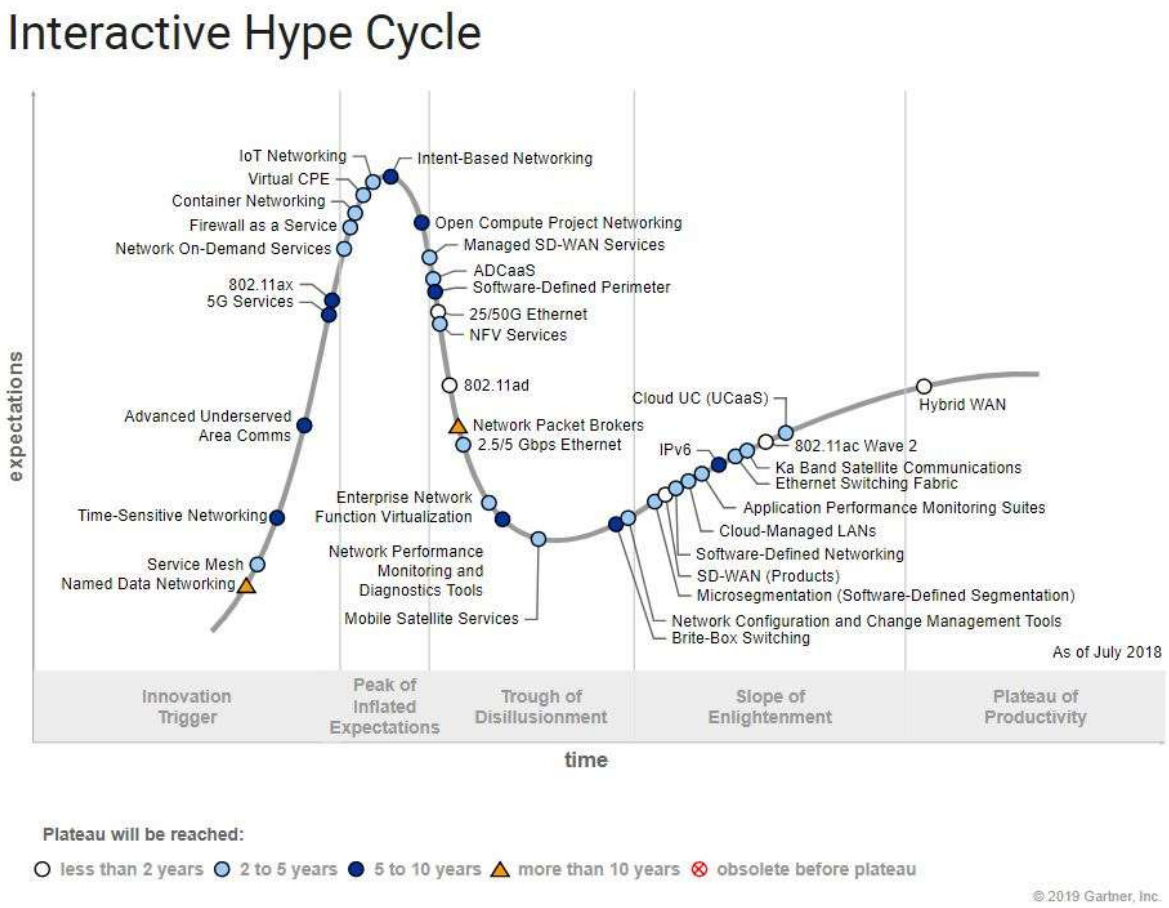
Exhibit 9: 802.11ac(WiFi 5) and 802.11ax(WiFi 6) Comparison Chart[96]

	802.11ac	802.11ax
BANDS	5 GHz	**2.4 GHz** and 5 GHz
CHANNEL BANDWIDTH	20 MHz, 40 MHz, 80 MHz, 80+80 MHz & 160 MHz	20 MHz, 40 MHz, 80 MHz, 80+80 MHz & 160 MHz
FFT SIZES	64, 128, 256, 512	256, 512, 1024, 2048
SUBCARRIER SPACING	312.5 kHz	**78.125 kHz**
OFDM SYMBOL DURATION	3.2 us + 0.8/0.4 us CP	**12.8 us + 0.8/1.6/3.2 us CP**
HIGHEST MODULATION	256-QAM	**1024-QAM**
DATA RATES	433 Mbps (80 MHz, 1 SS) 6933 Mbps (160 MHz, 8 SS)	600.4 Mbps (80 MHz, 1 SS) 9607.8 Mbps (160 MHz, 8 SS)

[95] http://www.l-com.com/blog/post/2015/12/17/WiFi-Alphabet-Soup.aspx

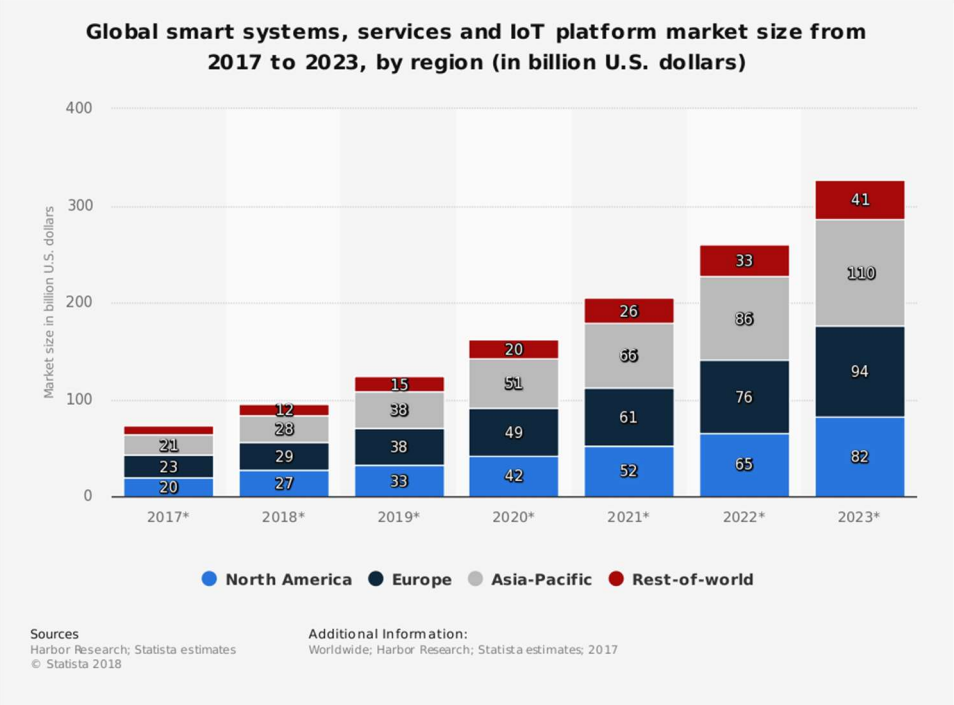
[96] https://www.cnx-software.com/2016/05/27/802-11ax-wifi-aims-to-deliver-higher-throughput-up-to-10-gbps-in-high-density-scenarios/

Exhibit 10: Hype Cycle for Enterprise Networking and Communications[97]



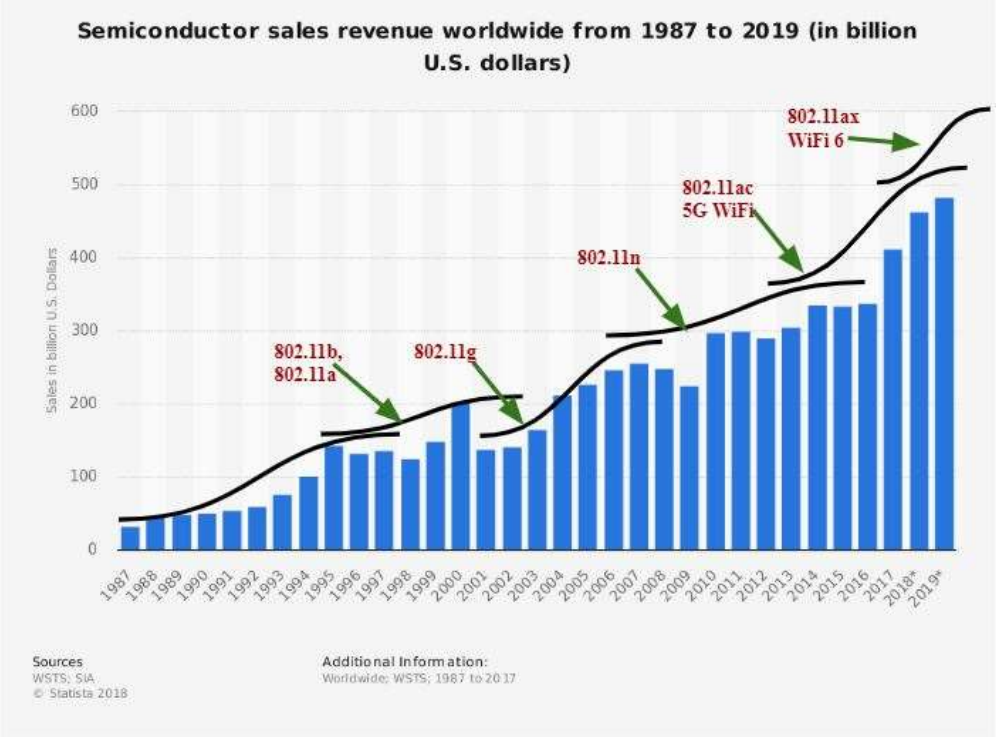
[97] https://www.gartner.com/document/3882465?ref=solrAll&refval=218445062&qid=93aa94e7ba2c7ee41d23ebeb8

Exhibit 11: Global smart systems, services and IoT platform market size from 2017 to 2023, by region in billion USD[98]



[98] Statista. Global smart systems, services and IoT platform market size from 2017 to 2023, by region (in billion U.S. dollars). https://www-statista-com.libproxy.scu.edu/statistics/805061/global-smart-systems-services-iot-platform-market-size-by-region/ (accessed 3/15/19, 10:23 PM).

Exhibit 12: WLAN S-Curve Plot on Semiconductor Industry Revenue[99] [100] [101]



[99] http://www.l-com.com/blog/post/2015/12/17/WiFi-Alphabet-Soup.aspx

[100] WSTS, and SIA. *Semiconductor sales revenue worldwide from 1987 to 2019 (in billion U.S. dollars)*. https://www-statista-com.libproxy.scu.edu/statistics/266973/global-semiconductor-sales-since-1988/ (accessed 3/15/19, 8:29 AM).

[101] https://www.cnx-software.com/2016/05/27/802-11ax-wifi-aims-to-deliver-higher-throughput-up-to-10-gbps-in-high-density-scenarios/

Exhibit 13: Stakeholder Analysis

Stakeholder Analysis[102]			
	Areas of Interest	**Desired Values**	**Resources Contributed**
Investors and Individual Shareholders	Market Share Revenue and Profit Margins Stock Value	Large Market Share Increase in revenue and high dividends Upward growth of Stock Prices	Capital
Customers of Broadcom	Customer Support Price of products Innovation in products	Strong customer service Competitive prices Innovation that makes customer's life and tasks easier	Source of Revenue
Suppliers and Manufacturers	Company Growth Increase in number of Broadcom's customers Contract Pricing	Long term contracts with Broadcom Increase in Broadcom's customers will lead to increase in number of contracts with suppliers and manufacturers Competitive pricing in contracts	Underlying Materials and Components used in the manufacturing of Broadcom's products
Distributors	Customer Segments Innovative Products	More customer segments means more sales Innovative and quality products enables reach in larger audience and increases sales	Sales Channel to reach customers globally

[102] Strategic Management of Technological Innovation, Schilling, Melissa A., Fourth Edition - Part 2, Chapter 6, page 113

Government	Environmental Standards Country's Economy Legal Regulations	Environmental standards should be adhered Contribute towards growth in economy No fraudulent activities. Abide to all legal regulations	liberal trade policies and basic infrastructure like electricity, roads, land
Board Members	Market Share Revenue and Profit Margins Stock Value	Acquire greater Market Share and strive to be the Market Leader Increase in revenue Upward growth of Stock Prices	Valuable Leadership and Strategic Insights
Employees	Revenue and Profit Margins Sustainable growth of company	Salary hikes and bonuses Job Security, competitive benefits	Valuable Skill Set and Labor
Rivals	Breakthrough Technology	Gain benefits from deduced innovation by offering similar products at lower prices	Competition in the industry

Exhibit 14: Balanced Scorecard

Balanced Scorecard:

Financial Perspective:

1) *Critical Success Factors:* Broadcom has continuously made investments in innovation and research and development via inhouse R&D[103] . Broadcom has strategically managed their sales channels to have distributors in various geographical regions to reach a wide customer base. They have set up manufacturing plants mainly in Asia, so as to be cost effective [104,105]
2) *Critical Measurements:* The above strategies have been measured in the company's 10-K report. The research and development cost for 2018 was 18% of its revenue and 2017 was 19% of revenue resulting in the net revenue of $20.8 B in 2018 and $17.6B in 2017, thus showing a year on year growth of earnings. The net revenue from distributors accounted for 34% and 28% for the years 2018 and 2017 respectively. The company's operating expense was reported to be $5.6B in 2018 and $6.1B in 2017 [106]

Customer Perspective:

1) *Critical Success Factors:* Since Broadcom thrives on a small number of customers on their income, it is necessary for them to maintain their customer loyalty as well as attract new customers [107]. The company is implementing this by providing them with safe and reliable products as well as provide support services for selected customer's production environment (just-in-time production), by maintaining finished goods inventory near the

[103] 10-K 2018 Business, https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s8C46F8A8AC6B5F8AB0811E531C35BEA5, Recent Developments, Research and Development
[104] 10-K 2018 Business, *op. cit.,* Customers, Sales and Distribution
[105] 10-K 2018 Business, *op. cit.,* Overview
[106] https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s7533AC778AAF59C18631AE39AB116D95, Summary of Five Year Selected Financial Data
[107] 10-K 2018 Business, *op. cit., Customers, Sales and Distribution*

customer sites [108]. They also try to acquire new customers by expanding their distribution network across the globe [109]

2) *Critical Measurements:* Broadcom has managed to capture two direct customers which account for 20% and 14% of their net accounts receivable in the year 2018, whereas in the previous year of 2017, Broadcom had one customer which accounted for 17% of their net account receivable. Expansion in distributor network helped in increasing revenue across countries, especially China, which was generating the maximum revenue at approximately 50%, in 2018 [110]

Internal Perspective:

1) *Critical Success Factors:* Over the past few years, Broadcom has made several Mergers and Acquisitions. For example, Broadcom had acquired Brocade Communication Systems for approximately $5.3B in cash and paid $701M to retire Brocade's term loan in 2017, and CA Inc for $18.8B in cash and assumed $2.25B of outstanding unsecured bonds, in 2018[111]

2) *Critical Measurements:* With the acquisition CA Inc, Broadcom enhanced their infrastructure software capabilities. Broadcom shifted their reputation from being a predominately to a broad-based infrastructure technology provider. Acquisition of Brocade led Broadcom to become the leading supplier of networking hardware and

[108] 10-K 2018 Business, https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s8C46F8A8AC6B5F8AB0811E531C35BEA5 Operations
[109] 10-K 2018 Business, *op. cit., Customer Sales and Distribution*
[110] 10-K 2018 Financial Statements and Supplementary Data, https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s05440D0615E353C1A43F6C2E00C22672, 11. Segment Information
[111] 10-K 2018 Business, *op. cit.,* Recent Developments

various networking software and services. Broadcom sold Brocade's IP networking business for $800M cash and thus gaining immediate assets out of these acquisitions[112]

Innovation and Learning :

1) *Critical Success Factors:* Being the leader in the communications technology, Broadcom is committed towards being the global leader in the WiFi technology[113]. In an attempt to continue leading the wireless segment, Broadcom offered to acquire Qualcomm for its 5G cellular[114]. However, due to political and legal interference, Broadcom withdrew this offer[115]
2) *Critical Measurements:* Broadcom was the first company to introduce 5G Radio Switch, in March 2018, that was a groundbreaking solution to many fundamental problems in products related to switching [116]. Broadcom was also the first to ship a fully compliant Wifi 6 access point SoC in September 2018[117]. This proved Broadcom's deep commitment to innovation and strategic R&D innovation

[112] 10-K 2018 Business, https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s8C46F8A8AC6B5F8AB0811E531C35BEA5, Recent Developments
[113] http://investors.broadcom.com/phoenix.zhtml?c=203541&p=irol-newsArticle&ID=2336707
[114] http://investors.broadcom.com/phoenix.zhtml?c=203541&p=irol-newsArticle&ID=2337280
[115] http://investors.broadcom.com/phoenix.zhtml?c=203541&p=irol-newsArticle&ID=2337987
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7. https://clients1.ibisworld.com/reports/gl/industry/majorcompanies.aspx?entid=960
8. http://www.ieee802.org/11/Reports/tgax_update.htm
9. 10-K 2018 Revenue by Segment, http://investors.broadcom.com/phoenix.zhtml?c=203541&p=irol-reportsannual
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14. IC Insights. Leading semiconductor companies (including foundries) from 2014 to 2018, by sales revenue (in billion U.S. dollars).https://www-statista-com.libproxy.scu.edu/statistics/283359/top-20-semiconductor-companies/ (accessed 3/17/19, 9:19 PM).

15. http://www.mergentonline.com.libproxy.scu.edu/competitors.php?compnumber=128065

16. 10-K 2018 Revenue by Segment, http://investors.broadcom.com/phoenix.zhtml?c=203541&p=irol-reportsannual

17. https://clients1-ibisworld-com.libproxy.scu.edu/reports/gl/industry/keystatistics.aspx?entid=960

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34. Broadcom Ltd. from https://clients1-ibisworld-com.libproxy.scu.edu/reports/gl/industry/majorcompanies.aspx?entid=960

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38. 10-K 2018 Business, https://www.sec.gov/Archives/edgar/data/1730168/000173016818000084/avgo-11042018x10k.htm#s8C46F8A8AC6B5F8AB0811E531C35BEA5 , Competition

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