

Deutsche Bank Markets Research

Rating

Hold

North America

United States

Company

Apple Inc.

Date

23 April 2018

Company Update

TMT

IT Hardware and Supply Chain

Reuters

AAPL.OQ

Bloomberg

AAPL US

Exchange

NSM

Ticker

AAPL

Price at 20 Apr 2018 (USD)

Price target

52-week range

165.72

152.00

181.72 - 142.27

HomePod: A missed opportunity to control the smart home

Missteps make it unlikely HomePod will be a serious smart home player

We believe that Apple had a real opportunity to become a major player in the smart home with its introduction of the HomePod smart speaker. However, poor reviews and a signiﬁcant fall oﬀ in demand post the launch suggest the company has missed the mark. In our view, a key drawback of Apple's approach to the smart home is tethering control to the iPhone. In addition, the company misstepped in overemphasizing music functionality at the expense of smart home interoperability, limiting music streaming services to Apple Music, and charging too much for the device. Given current drawbacks, we expect Apple to ship less than 5M HomePods in 2018, which suggests the product will be immaterial to the company's sales and earnings.

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Price/price relative

VPAs to be the hub of the future smart home

In our view, the home represents one of the few remaining under-penetrated market opportunities for large tech vendors. While smart home technology adoption remains low today, interest is growing, and we see this area as a unique opportunity for tech vendors. We also believe that voice control will be the primary way users manage their smart homes in the future, and to that end, virtual personal assistant (VPA) devices will be a critical part of future connected home

200

150

100

50

Jul '16 Jan '17 Jul '17 Jan '18

**Apple Inc. S&P 500 INDEX (Rebased)**

solutions. Amazon and Google are ahead in this market, and being ﬁrst may prove to be the winning strategy. While Apple was the ﬁrst to market with a voice assistant in Siri, the company hasn't found a way to leverage Siri into a market- leading position in the home.

HomePod won't be material to Apple, but is a baby step into smart home

Given its limited appeal to just the iPhone installed base, we do not believe HomePod will be a needle mover for Apple over the next 5 years. We view the product as more of a late initial baby step into the smart home ecosystem, although not a very compelling one so far. Our supply chain checks suggest HomePod production has been cut to 200,000-300,000 per month, and we estimate Apple will sell fewer than 5M HomePods in 2018. Assuming company average margins, this would add only about 1% to our current EPS estimate, which is largely immaterial. For the HomePod to be more of a needle mover, Apple would need to sell at least 40M HomePod speakers, which would be equal to the size of the current Apple Music paid subscriber base. At these levels, Apple would be able to generate roughly $0.90 in additional EPS, or 8% more than our current FY-18 estimate. We think the most likely scenario is that HomePod remains ﬁnancially immaterial over the next few years, and we believe Apple

Performance (%) 1m 3m 12m

Absolute -5.4 -7.1 16.3

S&P 500 INDEX -1.7 -5.0 13.3

*Source: Deutsche Bank*

needs to introduce a more compelling and open product to become a signiﬁcant player in the future smart home.

Evaluating the VPA and smart home market opportunities

In this report, we analyze the positives and negatives of the HomePod as well as its potential to be a needle mover for Apple. We also deﬁne the virtual personal assistant (VPA) market, which we believe will be the brains of the future smart home. In our view, Amazon and Google are currently the best positioned to control the future smart home, based on their ﬁrst-mover advantage, skills, and breadth of products across price points. We also assess assistants from other companies like Facebook, Microsoft, and Samsung. Our report focuses on the companies we expect to rule the smart home in the U.S., Europe, and Australia, all countries with large populations that speak English. However, top technology vendors in China, like Alibaba, Baidu, and Tencent, are also developing solutions, and we would expect these vendors to eventually dominate the large market for Chinese- language smart home devices and solutions.

# HomePod, a missed opportunity?

The home represents one of the few remaining under-penetrated market opportunities for large tech vendors. While businesses and cities have been moving towards an infrastructure of smart and connected devices, today's home products remain largely unconnected and unintelligent. Appliances and devices like refrigerators, thermostats, water heaters, garage door openers, and ovens are, for the most part, exactly the same as they were 40 years ago. Today, only a few devices are available to make the home truly smart, and no clear standards have emerged to connect these devices together. In addition, the smart home market remains fragmented, with diﬀerent vendors, connection protocols, and conﬁgurations. However, we believe there will be consolidation in the industry and that a few ecosystems will emerge to rule the smart home. As winners and laggards emerge, we expect device manufacturers and application developers to focus their eﬀorts on the leading companies, which could help accelerate consolidation in the industry.

We believe voice control will be the primary way users manage their smart homes, and to that end, having a virtual personal assistant will be a critical part of future connected smart home solutions. Today's virtual personal assistant (VPA) devices market remains small, with only tens of millions of devices sold since Amazon introduced the Echo in 2014. However, we think big tech companies have larger intentions beyond giving consumers an amusing way to get the weather or play music. While today's devices are relatively simple and have limited capabilities, we believe they represent the future of how consumers will interact with their home environment. In our mind, these devices are the ﬁrst explorers making contact in a new world; behind these devices we see a wave of new solutions, tied to the VPA, that are ready to take over the rest of the home. As a result, being early may be critical to a company's success as it drives initial lock-in. In addition, once these devices are connect to other devices in the home, the artiﬁcial intelligence expands as it ingest more and more data on its owners. As the artiﬁcial intelligence capabilities of these devices improve, we believe these devices will become more helpful at solving problems and controlling the home with limited interaction, creating a virtuous cycle that furthers vendor lock-in.

## A missed opportunity

We believe that Apple had a real opportunity to become a major player in the smart home with its introduction of the HomePod smart speaker. However, poor reviews and a signiﬁcant fall oﬀ in demand post the launch suggest the company has missed the mark. In our view, a key drawback of Apple's approach to the smart home is tethering control to the iPhone. Unlike Amazon and Google who allow users to interact with their home through voice and independent of a smartphone, Apple's HomePod solution forces everything to tie back to the iPhone. HomePod speakers can only be set up with an iPhone, and many of the features are controlled through an iPhone, which limits the available market for the device to iPhone owners. While this may make sense for a company that generates the majority of its proﬁt and sales from smartphones, we don't think it will prove to be a winning strategy when it comes to the smart home. Voice is the most natural way humans communicate, and we believe the future home will

be controlled by voice, where users can move through their homes and control it without having to pick up a hardware device.

Another missed opportunity is the speaker's over-emphasis on music. While streaming music remains an important feature of VPA devices in the home, it is only one of many things consumers use their VPAs for. From our perspective, Apple introduced the HomePod as merely another accessory in its music ecosystem, and did not see it as a key device for interacting with the home. This view is supported by multiple negative product reviews which note that, relative to other VPAs, the capabilities of HomePod are extremely lacking. Gizmodo found HomePod fell short of other VPAs, due to its lack of "compatibility with other gadgets in your home because it only works with newer HomeKit-enabled accessories," noting that "Siri is also a unique assistant in that she can't do that much." In addition to Siri's weaknesses, Verge and Gizmodo reviews noted HomePod's inability to do basic tasks that Alexa and Google already perform, including setting multiple timers, controlling non HomeKit smart devices, linking multiple speakers in the home, or making calls from the device.

HomePod's lack of integration with other music services is a meaningful shortfall of the devices and further supports the view that Apple sees HomePod as merely an extension of its Apple Music business. Unlike other VPAs and wireless speakers, HomePod will only play music from Apple Music. This decision limits the HomePod's addressable market to current Apple Music subscribers, and makes the device unattractive to everyone else, including market leader Spotify's 73M subscribers. In a market with multiple competitive smart speakers, we view limiting users to only one music streaming service as a poor choice. In addition, some of these competitive products, like the Sonos One and Google Home Max, scored higher on overall sound quality than the HomePod. Consumer Reports found that the HomePod's bass was "boomy and overemphasized," while the device's treble sounds were "underemphasized."

All of these shortfalls may have been less relevant if Apple had chosen to price the HomePod competitively. However, Apple decided to stick with its premium pricing strategy, introducing the HomePod at $349. In our view, this essentially limits the product's market appeal to Apple fans who will pay anything for a new Apple device and to consumers with high disposable income. Highlighting the excessive price of the HomePod, during the product's ﬁrst weeks of availability, Sonos was oﬀering a deal on its Sonos One smart speaker where consumers could buy two speakers for the same $350 price as one HomePod. While HomePod's $350 price isn't out of line with high-end oﬀerings from Google (Home Max at $399) and Amazon (Echo Show at $230), both of these companies also have VPA products in the $40-$50 range. This range of prices, something Apple doesn't oﬀer, makes smart home capabilities from these companies accessible to a wider range of consumers. Once customers are locked into one eco-system, we think it will be diﬃcult to incentivize them to switch.

## Even if successful, HomePod won't move the needle

Given the HomePod has restricted its usability to people who already own an iPhone and those who are willing to maintain an Apple Music account, we see a more limited market opportunity for the product versus devices from Amazon and Google. With the HomePod's strong emphasis on music, one metric to judge the product's market opportunity is the current Apple Music subscriber base. In an April memo announcing the promotion of Oliver Schusser to VP of Apple Music,

the company's Senior VP of Internet Software and Services, Eddy Cue, noted that Apple Music had 40M paid subscribers. As seen in the chart below, this number continues to grow, but still lags market leader Spotify with 73M subscribers as of A

*Source: Company data*

If we were to assume that all 40M Apple Music subscribers purchased a HomePod in one year, and that the device had the same gross margin as the company's corporate average, Apple would be able to generate roughly $0.90 in additional EPS, or 8% more than our current FY-18 estimate. However, we view this assumption as unrealistically high. Not all Apple Music subscribers will want a HomePod, and no other Apple product has reached these levels of sales in the ﬁrst year of availability. As seen in Figure 2, iPad saw the fastest growth of any of Apple's new products, reaching unit sales of 40M in its second year. iPhone took four years to reach shipments of more than 40M, while iPod took ﬁve years, and Apple Watch is still well below these shipment levels. In addition, shipments of 40M would put the HomePod on similar shipment levels as the current iPad, which has signiﬁcantly more use cases for business and the home, than HomePod.

A recent Voicebot.ai survey suggested that consumer intentions to buy the HomePod are in the 5M range. This estimate would still be higher than both Amazon and Google's ﬁrst year's sales, but these products were introduced late in the year and did not have the same type of passionate and loyal customer base that Apple commands. Shipments of 5M HomePods in FY-18 would add about 1% to our current EPS estimates, which is largely immaterial.

While Apple may be able to ship as many as 5M HomePod units in its ﬁrst year, this estimate seems high to us. Our supply chain checks suggest HomePod production has been cut to 200,000-300,000 per month, implying about 3-4M HomePods will be made in 2018. Also, we estimate that Amazon's VPA installed base is roughly 30M, while Googles is just under 10M. Both of these vendors sell VPAs at various price points, and did not achieve signiﬁcant sales volumes of their VPAs until the introduction of their lower priced models the Echo Dot ($50) and the Google Mini ($50). At $349, HomePod remains well above these more approachable consumer price points, which we expect will limit demand. This suggests the EPS impact of HomePod will remain largely immaterial to the company.

# Siri

An analysis of Apple's capabilities in the VPA devices market and its potential to control the smart home is really an analysis of its virtual personal assistant Siri. All of Apple's voice control functions on all of its devices use Siri as the interface. As a result, we view Siri's skills and capabilities as the key driver of Apple's future potential in the home.

Siri was released as a voice-enabled search engine app on iOS in February 2010. Two months later, Apple acquired the technology and subsequently rolled out Siri as an integrated voice-based virtual assistant in 2011 on the iPhone 4s. Siri has been included on all of the subsequent versions of the iPhone, and became available on the iPad in October 2012. All other Apple products now have Siri integrated into their operating systems, including the Apple TV, Apple Watch, and Mac. Siri is the brains behind Apple's HomePod smart speaker, which was released in February 2018.

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*Source: Apple.com*

*Source: Apple.com*

Siri was the ﬁrst of the current generation of voice-activated virtual assistants to be commercially available and was viewed as a highly innovative and unique feature of the iPhone 4s. At the time, Apple billed Siri as an intelligent assistant, able to “understand what users say, know what they mean, and help with every day task and information requests” including sending messages, making phone calls, and scheduling appointments. However, Siri’s initial voice-recognition

capabilities, which were based on somewhat rudimentary AI technology licensed from third parties, received mixed reviews due to inaccuracy. In 2014, Apple began revamping Siri’s voice recognition and natural language processing skills with proprietary neural network technology which drastically lowered Siri’s error rate.

In 2016, Apple opened Siri to third-party developers for certain app types, including ride-sharing and payment apps, and has since expanded to bank account and note apps. According to Apple, Siri has over 375 million monthly users across all active iOS devices which reportedly total 1.3 billion. Siri is currently available in 21 languages, can be a male or female voice, and is able to translate from English into ﬁve languages.

Siri's positives

One of Siri’s key attributes is its theoretically large user base. Apple has indicated that it has 1.3 billion installed devices and the company has indicated that it has "over half a billion" devices that are actively using Siri. Both Siri’s tenure in the market and large potential user base suggest Apple has access to a large amount of data to train Siri. Also, according to Alex Acero, the leader of the speech team for Siri, Apple’s proprietary hardware components and design have allowed the company to optimze Siri’s performance.

The privacy of Apple’s user data is paramount to the company, which may also be viewed positively by some consumers. Unlike its peers, Apple did not initially train Siri or its algorithms through leveraging its large pool of user data, as the company has a publicly-stated policy of protecting user privacy. In the past, Apple relied on public datasets to develop its artiﬁcial intelligence capabilities. However, in order to help Siri keep pace with peers, Apple started to train Siri using iCloud data in 2017. The company uses a process it terms "diﬀerential privacy," which reportedly makes the user data unidentiﬁable. Apple has also provided an opt-out if users prefer to not have their data included in the training. Another privacy feature of Apple devices is that all AI processing is done on the device, instead of in the cloud, avoiding the need to encrypt and send user data for remote processing.

Siri's challenges

As the ﬁrst-mover in the voice-activated virtual assistant market, Siri has the advantage of broad name recognition in the market place. However, despite Apple’s head start in the virtual assistant market, Siri ranks below Google Assistant and Alexa in usefulness. In an April 2017 study by digital marketing ﬁrm Stone Temple, Siri responded to 22% of 5,000 trivia questions with a 38% error rate which was signiﬁcantly worse than peers. In addition, Siri does not have as many cross-app capabilities as its peers. Siri was not made available to third- party app developers until June 2016. The delay in third-party development and limitations on app development to certain app types has limited the expansion of Siri’s skill set. Apple does not disclose a comprehensive list of Siri commands but commented at its developer conference in June 2016 that it had added 150 new commands or “intents.” We do believe that Siri is behind Google Assistant and meaningfully behind Alexa in the number of skills that the VPA oﬀers.

HomeKit: Apple's current smart home solution remains hardware focused

While we believe the future smart home will be controlled by voice, there are currently a number of app and software-based oﬀerings that allow consumers

to control aspects of their home through a software interface. In Apple's case, their solution is HomeKit, a home automation platform that integrates all of a user's iOS-compatible home devices into one location on your iPhone or iPad. This reliance on hardware, and HomeKit persists in the HomePod, as voice commands for home devices are channeled through the HomeKit platform. However, initial reviews of the HomePod suggest that many compatibilities and features are still lacking. HomePod can control devices that are linked to Apple's software, but older HomeKit devices may not be compatible with the HomePod, as Apple HomeKit is not backward compatible with devices created in the past.

Apple released HomeKit in 2015 to allow developers and manufacturers of smart home products to be integrated with iOS devices. The platform allowed iOS users to access connected home devices through third-party apps on their iPhone or iPad, or through Siri. In June 2016 at its World Wide Developers Conference, Apple debuted iOS 10, which included the Home app. The Home app provided iOS users with one location for managing and interacting with all of their HomeKit- enabled smart home devices. Similar to Amazon, the Home app allows diﬀerent devices to be grouped together into scenes, which can be triggered by a single command like "good morning." The Home app can also be set to perform actions at a set time, like turning oﬀ the lights and the TV at a speciﬁc time every evening.

There are many smart home products that are compatible with Apple’s HomeKit and, therefore, Siri. Devices that are compatible with HomeKit come with a MFi (Made for iPhone) label and include lights, switches, outlets, thermostats, cameras, and locks. Some current compatible device manufacturers are Philips Hue, Nest, Honeywell, and Lutron. While there are numerous devices that do work with HomeKit, the list is not as extensive as the number of products that are compatible with Amazon’s Alexa, which may be due to the strict requirements Apple has for HomeKit-certiﬁcation. Historically, Apple would require that a special chip be included in every compatible smart device in order to be HomeKit- certiﬁed, which increased the bill-of-material cost for device manufacturers. This has changed recently, however, with Apple announcing at its 2017 World Wide Developer Conference that smart home devices would be authentication through software.

# Virtual personal assistants

Virtual or voice-based personal assistants (VPA) are software programs that respond to written or spoken words with requested information or by performing a requested task. The majority of currently available VPAs respond to a user’s request for basic information such as a current weather forecast, directions to a speciﬁc location, or the playback of a speciﬁc song. These systems may also be capable of accessing and integrating a user’s data across devices with examples including calling someone listed in an address book or making an appointment in a linked calendar. Examples of currently available VPA programs include Apple’s Siri, Amazon’s Alexa, and Google Assistant.

VPA devices or intelligent assistant devices are standalone products for use in the home. These devices utilize a voice-based VPA software program to answer consumer’s queries, access a user’s data, or perform other tasks in the home. Examples of these devices include the Amazon Echo, Google Home, and Apple HomePod.

While the ubiquity of mobile phones means that there are more people who can access VPAs through a smartphone, according to a recent study by Accenture usage and satisfaction of VPAs on smart speakers, is typically higher than on mobile phones. VPA devices, like the Amazon Echo or the Google Home, are also starting to change user behavior. In a study of standalone VPA device owners across the U.S., Brazil, China, India and Mexico, Accenture found that two-thirds of consumers used their smartphone for fewer activities following the purchase of a VPA device. As VPA technology improves, and users can accomplish more tasks with their voice, we would expect the shift from touch-based devices, like smartphones, towards voice-enabled VPA devices to continue.

Nearly one in ﬁve U.S. adults have access to a smart speaker or VPA device, according to a March 2018 study by Voicebot.ai. The most common locations for these devices are the living room (46%) and kitchen (41%), followed by the bedroom (37%) and home oﬃce (11%). Consumers are using their VPAs daily, with the top use cases being (1) asking questions, (2) streaming music, and (3) checking the weather. Other uses, in order, were: setting a timer, listening to the radio, setting an alarm, listening to news or sports, playing games or answering trivia, and ﬁnding recipes or cooking instructions. People are also increasingly using their VPAs to shop. A recent Google study of U.S. VPA device owners found that 44% of regular users had purchased a product through their device in the last week, while 62% said they would like to buy something through their device in the next month. Interestingly, 52% of users indicated that they would like to hear information on deals, sales and promotions from brands through their device, pointing to future revenue opportunities for vendors.

## VPA history and key vendors

The ﬁrst voice-activated assistant to be introduced on a consumer device was Apple’s Siri, which debuted on the iPhone 4s in 2011. The following year, Google introduced its Google Now assistant, followed two years later by the debut of Microsoft’s Cortana. In 2014, Amazon was the ﬁrst company to introduce a VPA device, with the release of the Amazon Echo. Two years later, Google began shipping its Google Home device. At the Worldwide Developer Conference

(WWDC) in June, Apple debuted its HomePod intelligent speakers, which was expected to begin shipping in fall 2017 but was delayed until February 2018.

There are now a handful of VPAs available as either standalone apps or as part of a smart device. While the accuracy and skill sets of current assistants vary, they all feature four key abilities: speech recognition, natural language understanding, processing, and response.

## VPAs bring artiﬁcial intelligence to the home

Virtual assistants are designed to listen, process, and respond to requests, artiﬁcially imitating a human interaction. The ability to simulate human interactions places VPAs under the category of artificial intelligence (AI). AI can be separated into two broad categories: general AI and task-based AI. General AI is the ability of a program to respond to any task a human could perform, essentially replacing a human. Applied or task-based AI is the ability of a program to perform speciﬁc tasks that it has been designed to address. Examples of task-based AI are IBM’s Deep Blue for chess or Google’s AlphaGo for the game Go. Today’s AI programs are all task-based, with IDC noting in a January 2017 report on intelligent assistants that “There is currently no such thing as general AI – everything that is being done today is task-based AI, with a conversational veneer.”

Task-based AI skills currently fall under a few broad use cases, with the most common ones being image, object, and speech recognition. VPAs fall under the category of speech recognition or natural language processing (NLP), which is the ability of a computer to listen to, process, and then respond to human speech. The technology analyzes word count, word order, and syntax, and uses probability to establish the context of words to assist in comprehension. Current natural language processing does not understand meaning in language, but instead processes word order based on pre-programed algorithms. These algorithms enable the system to learn to recognize patterns and make predictions on its own, a process called machine learning.

Machine learning is a subset of artiﬁcial intelligence and is based on a core program as a starting point, but the program is then able to learn and train itself to increase its knowledge and understanding. Deep learning, based on neural networks, is a further subset of machine learning, which uses vast amounts of

*Artiﬁcial intelligence (AI) is a branch of computer science described as the study and design of systems capable of intelligent behavior. AI systems are constructed to emulate human thinking and reasoning. Since the ﬁeld’s early days in the 1950s, AI has evolved into a multi-disciplinary study of cognition, language, vision, logic, and robotics.*

data to train itself using a model similar to a human-decision making tree where an answer is binary (i.e., yes or no).

VPAs are a more advanced form of chatbots, and are designed using machine learning to improve their comprehension and usefulness. Chatbots were ﬁrst developed at MIT in 1964 and are founded on rule-based systems that use pattern recognition or basic AI technology. Rule-based systems are a rudimentary form of task-based AI involving hard-coded responses to certain speciﬁc inputs to achieve desired results. Chatbot programs deliver automated content or customer support through a conversational interface.

## VPA market size and growth

VPA programs ship across a number of diﬀerent categories, the most signiﬁcant of which is the smartphone. With the global popularity of smartphones, embedded VPAs like Siri, and Google Assistant account for the majority of unit shipments each year. IDC data suggests that smartphones account for over 80% of VPA-embedded devices. PCs account for the next largest segment, with IDC estimating that PCs accounted for roughly 10% of total VPAs shipped in the U.S. in 2017. While still a small fraction of the overall VPA-embedded device market, standalone VPAs, such as the Amazon Echo and the Google Home, are seeing signiﬁcantly stronger growth rates than traditional consumer devices. However, the smartphone and PC markets are starting to experience slower growth, which suggests VPA shipments on these devices will also see slower growth going forward. Additionally, with standalone VPA devices becoming more mainstream and aﬀordable, we expect them to make up a larger portion of the total VPA market going forward.

Concrete data on the number of standalone VPA devices that have shipped to date are scarce. Most estimates suggest Amazon's installed base is about 3x larger than Google's and Amazon has disclosed that it has shipped "tens of millions" of devices. We estimate the company's total installed base is in the 30-35M range. Google revealed in January that it had sold more than one Google Home product ever second between October and December, which implies total shipments of 7.6M units. We believe this suggests Google's installed base is just under 10M. Supporting these estimates, a recent Voicebot.ai report on the smart speaker market estimated that 47.3M smart speakers had been sold to date, with Amazon holding 71.9% share (34M) and Google holding 18.4% share (8.7M). Within this market, Voicebot.ai estimates that Sonos One has 2.6% share, which equates to about 1.2M devices sold.

Both IDC and Gartner expect the standalone VPA market to see substantial growth over the next 5 years. Gartner estimates that the global standalone VPA device

market will grow to over $3.5B in annual sales by 2021, which would represent a 38% CAGR from 2016-2021, versus $720M in annual end-user spending in 2016. By 2021, the market is expected to be segmented, however, with high- end products accounting for 88% of sales at an ASP of $175. There is also expected to be a proliferation of lower-end products from Chinese vendors and simple, voice-only options to control the smart home. Gartner expects these to sell for less than $20 by 2021, but make up the majority of unit shipments. With the relative nascency of the standalone VPA market, we belive current industry forecasts, are likely to change meaningfully over time as the market matures. We do, however, believe that the standalone VPA market presents high-growth opportunities, which are likely to be concentrated around the top vendors.

## Google Assistant ranks as top VPA, but in voice-enabled speakers, Amazon leads

With VPAs still in their infancy and new capabilities being added frequently, we looked at a variety of third-party surveys and reviews to get a better idea of which products provide the best user experience. In accuracy, Google appears to be leading the ﬁeld. In April 2017, digital marketing agency Stone Temple Digital Marketing published the results of an extensive test of the top four VPA's everyday factual knowledge. The experiment asked the VPAs 5,000 fact-based questions to gauge their accuracy. Among Google Assistant, Cortana, Siri, and Alexa, the Google Assistant was found to be the most accurate, answering 68% of the questions asked, with 91% of the questions answered completely and correctly. Alexa came in last place, only providing answers for 21% of the questions, but had the second-highest level of accuracy at 87%. Siri answered the second-least number of questions at 22%, but had the lowest accuracy, only answering 62% of the questions completely and correctly. Cortana answered 57% of the questions with 82% accuracy.

In the VPA subcategory of voice-enabled speakers, which includes the Amazon Echo and the Google Home, Amazon appears to have a lead over its rival. In an analysis of 13 diﬀerent consumer review sites that we compiled, the Amazon Echo on average scored better than the Google Home, with an average score of

8.0 on a 10 point scale, compared to 7.5 for the Google Home.

## Smart home market

Today, most people interact with their smart home products through apps on their smartphones. Each home product has a speciﬁc app that users can download and use to control their device through a smartphone. Smart ecosystems are also being created where home owners can consolidate their diﬀerent products under an ecosystem like Amazon's Alexa, Google Assistant, or Apple's HomeKit. We think these combined ecosystems will be critical to the success of a smart

home platform in the future, with the smart home app as the primary means of interacting with the home remotely. However, with the rise of the standalone VPA, we think consumers' preference for interacting with their smart home ***while at home*** will shift from a touch-based interaction to a voice-based one. Standalone VPAs, such as Amazon’s Echo, Google Home and the Apple HomePod are in a prime position to become the brains of the smart home of the future, suggesting Amazon, Apple and Google will be the smart home ecosystem leaders.

We deﬁne the smart home ecosystem as a single software program, accessible through multiple devices, that allows consumers to control and monitor their homes locally or remotely. The seamless integration of the smart home requires a central ecosystem that ensures all of a home's smart devices work smoothly together, and allows for additional devices to be built to be compatible with the system. There are currently a number of diﬀerent smart home vendors and solutions, but we expect the market to consolidate to a few leading vendors, as developers and smart home product manufacturers focus their resources on making software and devices that are compatible with the most popular ecosystems.

While the concept of the connected or "smart home" has been around for a while, the penetration of these solutions remains low, with Gartner estimating adoption rates are in the 5-20% range. A March 2017 IDC survey of 1,500 U.S. consumers found that one out of eight homes had at least one home automation or monitoring application, but that interest in adopting smart home products was low. Surveys from both Gartner and IDC ﬁnd that home owners are the most interested in security and monitoring applications, while other smart home applications are viewed as too expensive and as not providing enough value. Control of the smart home remains a fragmented market with data from IoT consulting ﬁrm Park Associates showing that, as of C2Q-17, 23% of smart home devices were controlled by Amazon products, 22% by the Google Home and 13% by Apple's HomeKit.

# Amazon & Google: already leading the home race

We believe that Amazon and Google are currently the best positioned to dominate the smart home market over the next 10 years. This view is based on the ﬁrst- mover advantage these companies have in the market as well as their integration with top smart-home products and variety of price points for VPA devices. Of the 47.3M installed VPA devices, Amazon and Google combined hold more than 90% share of the market, with Amazon roughly 3x the size of Google. In the following section, we discuss how Google and Amazon will monetize the VPA and smart home market, their product oﬀerings, and the advantages and disadvantages of each solution.

## Amazon

Monetizing the home opportunity

Amazon is a $700B market cap company with retail gross merchandize value (GMV) estimated at more than $400B for 2018, according to FactSet. In contrast, the VPA devices market is insigniﬁcant, with Gartner expecting the market to reach $3.5B in sales by 2021. By most estimates, Amazon is selling its Echo products very near cost, essentially giving the devices away. If the VPA market is not expected to be a huge revenue or proﬁt driver in the future, why would Amazon invest its resources in the technology? We believe the motivation is to gain a dominant foothold into the home, which can then be tied back to the company's ecommerce platform.

Amazon's move into the home started in 2014 with the introduction of its Dash Wand, Dash Button, and the Echo speaker. All of these devices allow home consumers to wirelessly connect to the Amazon store while moving about their homes. The Dash Wand and Dash Button allow consumers to quickly re-order commonly-used household items, while the Alexa-enabled Echo device allows consumers to use their voice to order items from Amazon.com. All of these devices make it easier for consumers to order from Amazon, reducing friction in the process, and helping lock consumers into the Amazon ecosystem. In this way, Amazon is helping ensure that when a consumer needs anything, whether it be apples, batteries, or toilet paper, they are more likely to purchase it through Amazon than another retailer.

A recent survey from Consumer Intelligence Research Partners (CIRP) shows that Amazon's strategy is working and that consumers are likely to spend more on Amazon's marketplace if it is more convenient. According to a survey of 2,000

U.S. shoppers conducted over the 12 months ending in September 2017, Amazon Echo owners spent an average of $1,700 a year on Amazon's online store, while Prime members spent $1,300 per year. Both of these numbers are signiﬁcantly higher than the average for all Amazon customers, who spent roughly $1,000 a year according to CIRP. In our view, a key reason for the higher spend could simply be correlation, given Alexa owners are also likely to be early adopters with larger disposable incomes. This is also borne out from recent surveys that suggest that the use of voice assistants for shopping currently remains limited.

While Alexa's ﬁrst buyers may have been early adopters, the growth of Echo sales to an installed base of over 30M suggests that buying has moved beyond the early adopter group. We think increasing use of Alexa and Echo devices will (1) expand peoples’ notion of what they can do with Amazon, which could also help drive purchasing across more categories over the longer-term, and (2) make Prime stickier. As voice-based search for products and product information becomes more prevalent, we believe Alexa could become more of an ecosystem where people use it to shop in conjunction with other screens (desktop, tablets, and smartphones) depending on what is the most convenient form factor for that purchase.

The eighth most common VPA use case for consumers is asking for recipes and cooking help, and Amazon recently commented that, “Customers asked Alexa for cooking related advice more than 9x as much this year compared to last holiday season.” With the recent acquisition of Whole Foods, we believe Amazon will be able to create a whole new shopping experience for grocery products where consumers can order their groceries using the Alexa-enabled device in their homes, which can potentially be delivered in 1 to 2 hours. More broadly, we think voice is a good use case for grocery shopping.

We believe monetizing the company's ecommerce store is Amazon's primary motivation for moving into the home, though we think the data Amazon collects on users can also help its more nascent, but rapidly growing, advertising business. Theoretically, Alexa could know not only what order, but also what time you wake up, what things you are interested in, and where you live. All of this data has value as companies try to better understand and segment their target audience.

In addition to the data being created about consumers, Amazon is creating data and training its AI software to better answer and address consumers' needs. Over time, the AI software may be usable and monetizable for other uses. Finally, Alexa runs on Amazon's public cloud (AWS) and requests to connected smart home devices are routed through AWS. At the re:Invent in 2017, AWS launched Lex, a service for building conversational interfaces into any application using voice and text which leverages the same technology infrastructure as Alexa. Lex can be used to build better bots or integrated into messaging services that can oﬀer natural language-based interactions. Over time, there may be a way for Amazon to encourage smart home device makers to host their services on AWS, driving additional growth in AWS.

VPA products

Amazon was not the ﬁrst company to introduce a virtual personal assistant, but they were the ﬁrst to introduce the technology on a standalone hardware device, debuting the Echo device with Alexa in November 2014. Amazon has been able to leverage its ﬁrst-mover advantage and the signiﬁcant 2-year time gap before a competitive product was introduced, into a market-leading position in the VPA device market. While Amazon does not report the number of VPA devices it has sold, by our estimates, the company has sold roughly 30M VPAs to date. Supporting this estimate, in a rare update at the end of December 2017, Amazon said that it has sold tens of millions of Alexa-enabled devices during the holiday season, which would also include non-Echo devices like the Fire TV.

Since the release of the Echo, Amazon has integrated Alexa into other branded devices including the Tap, Dot, Fire TV and Echo Show. The company's products vary in price range from as low as $50 for the Echo Dot to $230 for the

video-playing Echo Show. Alexa is also integrated into third-party devices like Ford’s infotainment systems, Toyota/Lexus’ Enform platform, and LG’s smart refrigerator. Within the home itself, Alexa is embedded in smart home devices like products from Honeywell and GE, as well as home speakers from leading consumer electronics brands like Sonos and Pioneer. These speakers also add to the base of Alexa-enabled devices that could be linked to the Amazon retail accounts and solidify Alexa as a platform. This spring, Alexa was added as an app for a wide-range of new Windows 10 PCs, which could potentially bring millions of new users to the Alexa platform.



Figure 8: Amazon’s Alexa-enabled Echo



Figure 9: Amazon’s Alexa-enabled Echo Show

VPA capabilities

Amazon has continually added new functions to its Alexa-enabled products, adding voice calling in the spring of 2017 and video calling to the recently-released Echo Show product. Amazon's products are also compatible with third-party "skills," as the company opened up its software to developers in 2015. Skills are similar to apps for your smartphone and enable a VPA device to do certain things, with examples including, providing a summary of the news, ordering an Uber, playing games like Jeopardy!, or starting a guided meditation. According to website Voicebot, Alexa now has over 25,000 skills, which is signiﬁcantly higher than the number of skills available on other devices, and roughly 5x the number of skills Amazon claimed Alexa had just a year ago. Amazon has made it easy for third-party developers to create skills, using the company's skills kit. Skills are also easy to add to the device by either adding the skill to your Alexa app or by requesting the skill by asking Alexa to “enable skill X.”

Amazon gets its information and data from a variety of sources including direct partnerships with content providers, websites like Wikipedia, and a partnership with Microsoft to use their search engine Bing. Alexa is currently available in English, French, German and Japanese.

Integration with the Smart Home

Following the release of third-party skills compatibility in 2015, Amazon introduced a Smart Home Skill API in April 2016 which gave Alexa-powered devices the ability to control the home. Since the release of the API, smart home vendors have created a long list of devices that work with Alexa, including smart lights, outlets, thermostats, door locks, cameras, and doorbells. Key

device vendors that are Alexa compatible include Belkin, Philips, GE, Honeywell, Nest, Logitech and Ring. In December 2017, Amazon acquired Blink, which manufactures connected Wi-Fi home security cameras, as well as a video doorbell, which could also become Alexa enabled. In February of this year, Amazon purchased video-doorbell maker Ring, giving the company further credentials in the smart home market.

From our research of consumer review sites, we estimate that Alexa has the highest number of compatible smart home devices, which is likely due to Amazon's large installed base and ease of creating compatible products. To make a device compatible with Alexa, developers simply need to submit their software code to Amazon for review; no physical testing or additional hardware is needed in the smart device. Amazon does oﬀer a “Works with Alexa designation” for devices that undergo a more in-depth review process, where physical testing of the product is done, but this is not required for a simple Alexa-compatible designation.

Amazon also added "scenes" in September 2016, which allows users to set pre- conﬁgured states for their connected devices. For a bedtime scene for example, users might turn oﬀ lights in the living room, lower bedroom lights, reduce the thermostat temperature, and turn on a ceiling fan. Or in the morning, a user might set a "wake up" scene to turn on the coﬀee maker, turn up the thermostat, and turn on the kitchen lights. Scenes are conﬁgured through third-party apps that are then linked to the Amazon device. Once set up, the scene request is routed to the Smart Home Skill API where a direction is composed. This direction is then sent to the skill adapter, which is hosted in AWS Lambda (an Amazon Web Services compute service), and then sent on to the smart home device's cloud service.

What Amazon is doing better than competitors

Amazon is signiﬁcantly ahead of competitors in the VPA market due to its early, ﬁrst-mover advantage. The Echo was introduce roughly two years before Google's Home device, and more than three years before the release of Apple's HomePod. The Alexa device took oﬀ quickly and the company leaned into its success with early TV ad campaigns pressing its advantage. As a result, Amazon has been able to quickly capitalize on interest from developers and home appliance makers. Since Amazon decided to open up to third-party developers in 2015, the number of skills has increased signiﬁcantly, and now Alexa has over 25,000 diﬀerent skills.

Amazon's device capabilities also beneﬁt from having been out in the market for a number of years. VPAs are essentially AI-based voice-recognition devices that learn and adapt over time. Each consumer interaction with Alexa is a learning opportunity for the technology. Alexa has now had more than three years to learn and understand consumer requests in the home, giving it an advantage over newer devices that have not had as much learning time in the real world.

Amazon has also been smart in the pricing of its devices. When introduced, the Amazon Echo sold for $179, a relatively attainable price for most technology enthusiasts. In addition, Amazon has oﬀered frequent discounting on the device, including on Prime Day and other shopping holidays, essentially reducing the cost of the device to $130 or $140 during these sales. In March 2016, Amazon debuted the smaller Echo Dot, priced at roughly $50, signiﬁcantly opening up the company's addressable market to a broader audience. Amazon has continued to stay ahead of competitors on price, introducing a second-generation Echo device in September 2017 priced at $99. We believe these relatively low prices

for advanced home technology make it more likely that customers will purchase and experiment with the devices in their home. In addition, oﬀering a lower priced option like the Echo Dot makes it more likely that customers will install multiple devices in the home, further cementing Amazon's position as the market-leading VPA solution.

Amazon's disadvantages

While Amazon was the ﬁrst to market with a VPA device for the home, the company was not the ﬁrst to introduce a virtual personal assistant. Apple introduced Siri in 2011 and Google introduced its own assistant program in 2012. Both of these platforms originated on the smartphone, which is a more common location for personal assistant software, with IDC estimating that 80% of VPA software shipped on mobile phones in 2016. Because smartphones are so ubiquitous, VPAs on smartphones get used on an absolute basis more than standalone devices and these additional interactions could give these compeitive smartphone-based programs an advantage in their ability to learn and evolve. Alexa is available on Android and iOS as a standalone app, and has been added as the primary VPA on the Huawei Mate 9 phone, but there isn't any strong evidence that consumers are opting for Alexa over their pre-installed VPA.

## Google

Monetizing the home opportunity

The VPA market is a small market, but the amount of data these devices are creating about users is substantial. This data is extremely valuable to Google's Search business, as well as to Google's advertising customers. With a device in the home, Google is able to determine when a user wakes up, what they want to hear about in the news, what time they get home from work, and when they go to bed. In addition, all queries for information give Google further data on users, their interests, and their needs. While all of this data has considerable value to advertisers, it also provides data for further training Google's AI capabilities and enhancing its search engine.

We believe the company ideally wants all search activity to start with Google as the gatekeeper (and toll taker) in order to capture this data. Voice currently accounts for roughly 20% of Google searches, and is expected to represent 50% of all searches on Google by 2020. Given there currently are over 400M devices enabled with Google Assistant, it is not surprising that voice adoption in search is expected to grow rapidly. In emerging markets, we think the next 1B new Internet users could begin with voice as the primary interaction layer because it is less intimidating, it is ubiquitously available across a wide range of devices (cars, TVs, watches, smartphones, and smart homes). In addition, there are a number of diﬀerent applications that will run on the platform (e.g., travel booking, shopping, etc.), and Google’s translation capabilities leverage machine learning/ artiﬁcial intelligence.

Google also wants shopping searches to start on Google, not on Amazon, and rolling Google Shopping Express, the company's partnership with Wal-Mart, into Google Assistant could be an antidote to Amazon Alexa. Both the advertising and shopping opportunities on voice could become signiﬁcant over time; however, given Google has sold only a limited number of VPA devices, we think it is currently too early to estimate the added value to Google shareholders from the home devices.

VPA products

The Google Home standalone VPA device became available for sale in the U.S. in November 2016, roughly two years after Amazon introduced the Echo. The smart speaker features the company's Google Assistant voice-activated virtual personal assistant software, which was debuted at the company's developer conference in May 2016. At the same time, Google debuted its own smartphone, called the Pixel, which began shipping with Google Assistant in October 2016. While Google has not disclosed the number of Google Home devices it has shipped, in October, Consumer Intelligence Research Partners (CIRP) estimated that Google had sold 7M devices since the launch of the Google Home, which would be roughly a third of the sales of the Amazon Echo. Additionally, in January, Google said that it had sold more than one Google Home device every second since it started shipping the Google Home Mini in October, which would add a few million units to this previous CIRP estimate and make the number of devices sold closer to 10M.

The Google Home originally sold for $129, but Google recently reduced the cost of the device to $79 during the holiday season. On October 4, 2017, Google announced two new VPA devices, the Google Home Max and the Google Home Mini. The Max is a larger device with stereo speakers and a subwoofer which sells for $399. The Mini is a smaller 4-inch device which sells for $49, but was on sale during the holidays for $29, matching the sale price of the Amazon Echo Dot.

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*Source: Google Store*

*Source: Assistant.google.com*

Google has a long history on smartphones that continues with its Google Assistant software. Prior to the launch of Google Home and Google Assistant, the company had released a virtual personal assistant called Google Now. The software was ﬁrst available with Android 4.1 (a.k.a. Jelly Bean) and shipped on Samsung's Galaxy Nexus smartphone in July 2012. Through the Google Now VPA, the company has maintained a presence on smartphones since 2012, with versions of Google Now available for both Android and iOS. Google Now was also made available on personal computers through the Google Chrome web browser.

Since the 2016 debut of Google Assistant, the company has been phasing out Google Now as it transitions customers to Google Assistant. Google Assistant is available on Google's Pixel phones, and the company began rolling out Google Assistant on Android phones in February 2017 through an update for Android

7.0 (a.k.a. Nougat) and 6.0 (a.k.a. Marshmallow). Examples of smartphones that ship with Google Assistant include the Samsung Galaxy S9 and S9+, LG G6, HTC U11, and OnePlus 5. The software is also available on Android Wear 2.0 devices and Android TV devices, and is expected to be available through Android Auto infotainment systems in cars like Audi and Volvo. In addition, Google Assistant is also available for iPhones through an app.

Data from Google Assistant is derived from Google's search engine and the software supports English, German, French, and Japanese. In November 2017, Google announced that developers would be able to build apps in Spanish and Portuguese in addition to the original four supported languages. In January, Google disclosed that the Google Assistant was available on more than 400 million devices including smartphones, smart speakers, tablets, TVs, and watches. Google also added more features like Voice Match, Broadcast, and Hands-Free calling. Voice control is a big part of this and consumers can now use “Ok Google” or “Hey Google” on more than 1,500 compatible smart home devices from over 22 brands.

VPA capabilities *Google deﬁnes actions as the ability to*

Google Assistant’s abilities are similar to that of Siri and Alexa, and include sending text messages, retrieving pictures or emails, playing music, and providing basic contextual information. In December 2016, Google launched "Actions on Google," a third-party app developer platform that allows developers to integrate with the conversational interface of Google Assistant. In March 2017, Google introduced the Actions software developer kit (SDK) for hardware vendors to embed Google Assistant in their devices. Since that time, the number of actions, or skills, available on Google has increased. Based on scrapping from Google Assistant's skills platform, PC Magazine estimates that Google Assistant now has 1,800 skills, which would be a 6x increase in skills from 9 months prior. This is a smaller number of skills than the number available on Alexa, but likely reﬂects Google Home's more recent launch, and we would expect the company's skill set to continue to expand. All third-party developed actions for Google Home are automatically available to users and do not require enablement or activation, a point of diﬀerentiation versus the Amazon Echo. At the company’s developer conference in May 2017, Google announced that apps developed with Google Actions for Google Home will work on smartphones with Google Assistant, another unique feature.

Integration with the smart home

Google's integration with the smart home is done through the company's Actions SDK, which enables developers to design actions that are requested through Google Assistant and then enabled through a third-party app. Since the release of Google Home and the Actions SDK, developers have created a number of compatible products, including from third-party vendors like, Philips, GE, Hue, Honeywell, Belkin Logitech and TP-Link. Google Home also works with Google's Chromecast for TVs, and multiple music streaming services, like Spotify and Pandora, are also compatible with the Google Home. Google is also compatible with smart hubs, like Samsung's SmartThing Hub, which helps expand its device compatibility across non-Google supported devices.

While Google has been adding many actions to its capabilities, Google Home only recently added the ability to support "scenes," and it appears that the number of devices that are currently compatible with scenes is limited. In addition, Google Home originally had a more limited number of devices that could directly interact with the device, requiring a third-party app to control smart home devices.

*enable a user to interact with a product or service. In Google Assistant, actions capture the intent of the user through their voice- command and then fulﬁll the intent through either information or an action (e.g., like turning on the lights). Actions in Google are essentially the same as Amazon's "skills."*

However, with the further maturation of the product, the number of devices that can be controlled with Google Home has expanded.

Despite the Google Home being relatively new to the market, the company is not new to the smart home. Google spent $3.2B in 2014 to acquire Nest, a leader in smart home devices and maker of the highly popular Nest thermostat. In October 2017, Google announced that its Assistant could be used to control several Nest products, including the Nest thermostats and Nest cameras. Nest products have good brand recognition, as one of the ﬁrst mainstream smart devices, which could be a beneﬁt for Google as they move further into the smart home.

What Google is doing better than competitors

While Google Home was not released until 2016, Google has been active in the virtual personal assistant market since 2012, giving it similar levels of experience as Amazon in addressing users' requests. This likely accounts for Google Assistant receiving top marks for accuracy, scoring a 91% in completion and accuracy in Stone Temple’s test. According to MIT Technology Review, Google Assistant has a key leg up on peers through its search capabilities as it has "been working on technology that answers people’s questions for a long time, and has invested more heavily in machine learning than rivals.” In 2016, Google disclosed that it handles more than two trillion searches per year suggesting its skills in search are unparalleled. In addition, the company’s access to proprietary training data is a key advantage. Finally, Google is also leveraging its advanced translation capabilities to bring a personal translator to the Assistant.

Google's disadvantages

Google Home has been on the market for a more limited amount of time than Amazon's Echo, and as a result, the device has had more limited interoperability with third-party devices. However, at the CES in January, we saw an increasing number of device manufacturers adopt the Google Assistant, and as Google stated, consumers can now use “Ok Google” or “Hey Google” in more than 1,500 compatible smart home devices with over 22 brands.

# Other vendors to watch

## Microsoft’s Cortana

Microsoft introduced its virtual personal assistant Cortana in 2014 on its Windows

8.1 smartphone and in 2015 Cortana rolled out on all PCs running Windows 10. According to Microsoft, Cortana has more than 145M monthly active users, which would make it the second largest user base after Apple’s Siri VPA. Users can interact with Cortana either through text or voice, but Microsoft has not provided details on how many of the 145M monthly active users actually interact with Cortana through voice commands. Cortana has expanded its presence beyond Windows 10, adding the VPA to Xbox One and the app is available for Android and iOS devices. In late 2016, Microsoft announced that it was opening up Cortana to third-party developers to add skills, and allowing third-party devices to incorporate Cortana into non-Microsoft devices. The ﬁrst third-party device featuring Cortana, speakers from Harman Kardon, was released in the fall of 2017, with other companies like HP Inc. also working on devices that incorporate the VPA. Microsoft and Amazon have also indicated plans to integrate their platforms in the future, although the companies have not yet provided detail on how this will be done. Cortana is available in eight languages English, Spanish, French, German, Italian, Portuguese, Japanese, and what Microsoft terms "simpliﬁed Chinese."

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*Source: Microsoft.com*

*Source: Microsoft.com*

Positives

A major beneﬁt of the Cortana VPA is that it comes with Windows 10, an operating system that Microsoft says is currently being used by 500M users. While it's unclear how many of these Windows 10 owners use the software, having a potential user base this large provides a signiﬁcant opportunity for training. In addition, the software is free with a Windows 10 machine and does not require the purchase of a separate device.

Challenges

Similar to the issue that Alexa faces, Cortana does not come as the standard, factory installed assistant on any smartphone. While it is available as an app for Android and iOS, secondary add-on VPA programs do not appear to be gaining share over pre-installed VPAs. We believe that much of the interactions with Cortana are through text on a computer, as seen in Figure 12. This potential lack of verbal communication could also limit Cortana’s ability to learn and develop its natural language capabilities. Cortana was also behind Amazon and Google in opening up its system to third-party developers, and Apple has a very strong developer community. These factors suggest Cortana could remain behind the other VPAs in functionality for users. According to Microsoft's website, Cortana only has 230 skills, which signiﬁcantly trails other competitors in third-party capabilities.

## Viv and Bixby

After the sale of Siri to Apple, in 2012, Siri’s original creators began work on Viv, a virtual assistant platform based on an AI technique called dynamic program generation. One of Viv’s core attributes was the platform’s openness to third- party developers. Viv was acquired by Samsung in October 2016. We have not yet see any products that incorporate Viv, although Samsung is reportedly leveraging Viv’s technology for its Bixby 2.0 personal assistant, which the company is expected to release with the Galaxy Note 9 in the fall of 2018.

This spring, Samsung rolled out an English-speaking voice-based assistant called Bixby on the Galaxy S8 smartphone and the personal assistant received less- than-stellar reviews from tech blogs and customers. The problems included a three-month delay for the English version, poor voice recognition, and a limited ecosystem. Perhaps due to the lukewarm response to Bixby, Samsung replaced its head of development for Bixby in October 2017.

Samsung introduced Bixby 2.0 at its developer conference in late October 2017 and plans to release it at some point in fall 2018. The company did not provide many speciﬁcs on the changes from the original Bixby, but we do know that Bixby

2.0 will be open to third-party developers and will work across diﬀerent Samsung devices. Additionally, Bixby 2.0 will incorporate technology from Samsung’s Viv acquisition. In an interview with the Wall Street Journal at the 2018 Mobile World Congress, Samsung conﬁrmed its plans for its ﬁrst Bixby standalone speaker with an expected launch date in the second half of 2018.

## Facebook’s M

Facebook launched M in beta form in 2015. The assistant diﬀered from other VPAs in a few ways. First, M was a text-only VPA that works with the Facebook Messenger app. Additionally, M combined AI software along with the help of a team of human support staﬀ to complete tasks. The AI from M handled simpler tasks, while a human stepped in for more complicated requests, like booking a restaurant reservation or calling the cable company to schedule an appointment. However, according to the Verge, Facebook shut down the human-assisted M on January 19, 2018 with Facebook stating that they launched the project to learn about what people wanted from an assistant and that the company had learned a lot from the experiment.

A more limited AI software version of M called “M Suggestions” was rolled out to all U.S. Facebook users in the spring of 2017, oﬀering users fully automated

suggestions based on the content of their messages. The initial version only oﬀered very limited features, like oﬀering to call a ride-sharing app if a user is talking about going somewhere, and is much more limited than its competitors. In August, M Suggestions was brought to the U.K., but there have been no reported plans to roll out M Suggestions globally and we wonder what the future will hold for M Suggestions following the end of the M. Additionally, according to Bloomberg, Facebook has reportedly delayed the unveiling of a smart speaker as it deals with the blowback from its treatment of user data.

While Facebook appears well behind peers in the VPA space, the signiﬁcant size of the Facebook community makes it hard to count the company out of the market completely.

## Non-English VPAs

VPAs are highly reliant on natural language processing capabilities. Because much of this development has been done in the U.S., the majority of VPAs to- date have focused on creating a system for English-speaking consumers. While Siri supports over 20 languages and other VPAs often support more than just English, the most popular VPAs are still very U.S. and English centric. This creates an opportunity for tech companies in other countries, most notably in Asia, to release VPAs based on other countries' native languages. Competition in Asia, however, has begun to intensify and a few major tech players in China and the rest of Asia have released their own VPAs over the past two years.

Duer

Baidu, the largest search engine company in China, has taken advantage of the Chinese language void in VPAs, launching its Duer VPA in 2015. The assistant recognizes English or Mandarin Chinese and comes pre-installed on the Baidu Android search app. The VPA can be found on a variety of third-party devices, such as TVs and speakers from Harman Kardon. Baidu has also demonstrated Duer’s capabilities by adding it to small robots, including a robot at Kentucky Fried Chicken that will take orders. According to Gartner, Duer will integrate with other Baidu apps on smartphones, and will mine the web to ﬁnd answers to questions.

DingDong

Released in 2015, the DingDong was developed through a joint venture between Chinese e-commerce company JD.com and voice recognition company iFlytek. The VPA can be purchased for roughly $25-$115, depending on the model and comes in two versions, one that understands Mandarin and one that understands Cantonese. According to market research ﬁrm GFK, the DingDong accounted for two-thirds of the Chinese smart speaker market in 2016, but only made up 38% of the market from Jan-Aug 2017 as Alibaba entered the market in July.

Tmall Genie

In early July 2017, Alibaba entered the standalone VPA market with its Tmall Genie speaker. Currently, the VPA is only available in China in Mandarin at a cost of 499 yuan (roughly $73). In addition to home use, the speaker has been marketed to the retail, travel and hospitality industries. The device has a partnership with Marriott International to be placed in 100,000 hotel rooms beginning with hotels in the city of with Hangzhou.

Other Chinese vendors

Tencent, the largest Chinese company by market capitalization, is also working on a VPA products according to the BBC. In August, Xiaomi released its ﬁrst smart

speaker, the Mi, which retails for roughly $45, but the product is currently only available in China. Xiaomi released a mini version of the Mi in March 2018, called the Mi AI Speaker Mini that retails at roughly $27.

Clova

In Japan, messaging company Line released its ﬁrst VPA speaker called Clova in the fall of 2017. The device works within the Line messaging application and costs JPY14,000 (~$125). Clova will also be integrated into mobile devices through an app. Line is owned by Korean search company Naver and, according to The Verge, Clova will support multiple languages and hopes to expand throughout Asia with a focus on Japan, Korea, Indonesia, Thailand, and Taiwan.