

# AR/VR: Beyond Gaming to Enterprise Adoption

Augmented and Virtual Reality Industry Outlook Through 2022

Author: Ethan Harden

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## KEY TAKEAWAYS

- *Smartphones will lead initial AR/VR adoption while HMDs wait on more compact technological innovation.*
- *Content makers are hesitant to develop VR content without dominant platforms and consumers are reluctant to buy without content to experience.*
- *Given VR's technological progress and momentum VR will see more early success as compared to AR which has multiple use cases and displays higher overall potential.*

## BACKGROUND

The historical timeline of digestible content was previously created, shared and consumed predominantly via text. Technological innovations have driven content to video as the primary medium - evidenced by YouTube, Instagram stories, GIFs, mini-documentaries, and others. Virtual reality (VR) and augmented or mixed reality (AR) have been heralded as the “fourth platform shift” by DigiCap. This new medium is not a tweak to existing, but rather brand new technology that can engage our sense of sight, sound, and touch at a deeper and more complex level than any other computing technology before it.<sup>1</sup> DigiCap goes on to claim that as barriers like price, size and weight are reduced, these AR/VR platforms could form the basis for communication, commerce, and content.

This predicted shift of media consumption comes at a time when American adults have set new records by ingesting 10 hours and 39 minutes of media per day.<sup>2</sup> Already a seemingly high number, companies are seeking ways to connect and empower consumers continuously throughout their 17.2 waking hours per day.<sup>2</sup> As these numbers would suggest, North America has emerged as the largest

market for virtual reality and has accounted for the maximum share of total revenue generated in 2016.<sup>3</sup> Key players within the industry are Google, Qualcomm, Magic Leap, and Microsoft to name a few. Backed by tech giants, the market has seen large investments and acquisitions suggesting that these technologies will become increasingly integrated into the platforms where we consume content. Already, Apple has released ARKit and, quickly thereafter, Google with ARCore allowing developers a sandbox to begin experimenting with the technology for app development.

Early players are now focusing on developing compelling content offerings to draw users toward each of their platforms and, as a result, applications are emerging across industries for a variety of use cases. Initial adoption for AR/VR is projected to be within the marketing/advertising, medicine, film/entertainment, architecture, automotive, retail and manufacturing industries. Already enterprises and hospitals are testing AR/VR applications as a means to improve service delivery and reduce costs. Entrants in this industry face the typical challenges of new technology businesses - specifically device usability, overcoming user barriers, attracting content developers and identifying effective business models.<sup>4</sup>

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<sup>1</sup> <https://www.itproportal.com/features/legal-challenges-facing-ar-and-vr/>

<sup>2</sup> <http://adage.com/article/deloitte-digital/augmented-reality-marketing-s-trillion-dollar-opportunity/309678/>

<sup>3</sup> <https://globenewswire.com/news-release/2018/05/01/1494026/0/en/Global-VR-Virtual-Reality-Market-Size-Forecast-to-Reach-USD-26-89-Billion-by-2022.html>

<sup>4</sup> <https://www.pnewsire.com/news-releases/virtual-and-augmented-reality-vrar-market-opportunity-emerging-ecosystem-and-leading-use-cases-300623733.html>

AR/VR is pushing the boundaries to change how we create and experience content; allowing the consumer to be immersed in a world, rather than observing through a screen. Additionally, prototyping gains a major boost by eliminating production cycles including costly time requirements for assembly. When paired with 3D printing, the innovation cycle will be able to accelerate to unprecedented rates. Using this technology as a tool for empathy also holds a lot of potential as well. For example, a VR user could stream on-the-ground video within a natural disaster zone, or view the world through an underprivileged immigrant's eyes or differing race allowing a feeling of closeness and, in an ideal world, begin to break down preconceived notions and barriers while interacting with others.

Although there is a seeming multitude of applications, product companies seem reserved in pursuing their plans. A recent 2018 survey backs this up, finding that 51 percent of product companies haven't even started developing an initial plan while 99 percent with investments in the space say their plans are flexible to change with the market.<sup>5</sup> Samsung NEXT Ventures director Ajay Singh thinks there are too many developers conducting their experiments in the entertainment space, which he thinks is ill-advised. He goes on to argue that "there is no monetization unless there is an advertising model that comes in, because no consumer [...] wants to pay for anything."<sup>6</sup> All of this skepticism coalesces into content makers being hesitant to develop VR content without an installed base and the consumer base that is unwilling to pay for the content.

## **MARKET SIZE**

In 2016 alone, AR/VR has drawn in a combined \$2 billion in funding across 199 deals.<sup>7</sup> In Q1 of 2017, the space exploded with deals up 60 percent from the previous year. In terms of volume, VR has historically been the leading category but the first half of 2017 saw AR account for 42 percent of deal flow.<sup>7</sup>

Many leading market research firms vary widely on the predicted market size for the AR/VR space, but one consensus seems to hold true across the board; AR will grow at a higher CAGR than VR. According to Statistics MRC, the total AR/VR market value in 2015 was estimated to be around \$2.7 billion and expected to reach \$66.7 billion by 2022, representing a CAGR of 58.3 percent.<sup>8</sup> GlobalNewsWire expects the VR market, specifically, to grow at a CAGR of about 54 percent by 2021 whereas Zion Market Research and Markets expect the AR market to grow at around a CAGR of 80 percent in the same time period.<sup>9,10</sup>

Backing up this growth is the anticipated penetration of smartphones, providing brands with a platform to develop realistic AR and VR use cases while head mounted displays (HMD) and other technologies continue to be refined.

## **VIRTUAL REALITY**

Virtual reality can be defined as an immersive multimedia or simulated reality rendered to replicate an environment. The VR space can be broken down into three separate categories - head mounted displays, gesture control devices, and projectors or wall displays. The HMD device segment was the largest in terms

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<sup>5</sup> <https://medium.com/iotforall/whats-next-foraugmented-and-virtual-reality-technology-83fc154f467b>

<sup>6</sup> <http://samsungnext.com/whats-next/ar-industry-developer-pov/>

<sup>7</sup> <https://www.cbinsights.com/research/ar-vr-funding-trends/>

<sup>8</sup> <https://www.reuters.com/brandfeatures/venture-capital/article?id=9571>

<sup>9</sup> <https://globenewswire.com/news-release/2018/05/01/1494026/0/en/Global-VR-Virtual-Reality-Market-Size-Forecast-to-Reach-USD-26-89-Billion-by-2022.html>

<sup>10</sup> <https://next.reality.news/news/market-reality-outlook-for-augmented-mixed-reality-remains-favorable-0177875/>

of size in 2016 and is anticipated to maintain its dominance over the forecast period<sup>11</sup>. Many HMDs rely on smartphones to display content, and while a good introduction to VR, they have limited display resolution, lack a wide field of view, have low brightness, a short battery life and lack 3D sensing capabilities. Although the industry is trying to stretch the capabilities of these small machines, these devices weren't designed to be placed on your head.

VR devices that do not take advantage of a smartphone, like the Oculus Rift and HTC Vive carry a high price point of \$599 and \$799 respectively. Furthering this price point would be the technical issue of PCs today. Minimum requirements to run immersive VR are on the high end of computing power which includes more RAM and increased processors to render the video. A major breakthrough that is signaling a maturing market and price points facilitating wider adoption is the Oculus Go, HTC Vive Focus, and Google Daydream. These devices do not require tethering to a PC or mobile device, but have less processing power and battery life limitations due to size constraints within the headset.

Evaluating the projection period, it is anticipated that the software segment will dominate in terms of size, attributable to growing economies of scale of VR hardware components. As demonstrated above, the HMD segment is expected to push this technology into the future, but initial adoption will be limited due to the reliance on smartphones and bulkiness of the product. Many large players are looking to wait for a competitor to solve the business model and jump in afterwards, likely watching early entrants such as One Touch who is bringing a VR film experience to market.

## **AUGMENTED REALITY**

Augmented reality is defined as technology that superimposes a computer-generated image on a user's view of the real world therefore blending both the real world and a rendered one. The AR sector today is seen by insiders as being in transition due to problems yet to be solved and new technology on the horizon. Some of the major problems include 3D space rendering, or generating images and having them stay where they are pinned within a vector. Additionally, bulky headsets and battery life are the other hindrances to hold back the potential of the market.

Mid-2016 saw the biggest breakthrough in bringing AR to the mass market through Niantic's Pokemon GO. Boasting more daily average users than Candy Crush, at over 20 million, Niantic was able to bring working AR to the masses and provide initial consumer AR education within the industry.<sup>12</sup> Besides gaming applications, AR is poised to be initially adopted by the healthcare, logistics, cosmetic, construction, and retail industries. Further, it is touted to bring enterprise efficiency across all industries through decreased training time, accident prevention, and improved service delivery to name a few. Some enterprise applications already in use today are industrial repair processes, Amazon's AR view, virtual fitting rooms, and furniture visualization.

The highest ROI seen to date has been on industrial repairs where companies like Tsunami VR have recently run trials shortening repair and maintenance activities by up to 90 percent.<sup>13</sup> Aiding these applications are smart augmented reality glasses, similar to Google Glass. In 2016, 150 thousand shipments of AR glasses were made and that number is expected to rise to 22.8 million by 2022.<sup>14</sup> Overall

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<sup>11</sup> <https://www.grandviewresearch.com/industry-analysis/virtual-reality-vr-market>

<sup>12</sup> <http://www.businessofapps.com/data/pokemon-go-statistics/>

<sup>13</sup> <https://techcrunch.com/2017/11/05/whats-holding-back-vr/>

<sup>14</sup> <https://www.newgenapps.com/blog/6-vr-and-ar-statistics-shaping-the-future-of-augmented-reality-with-data>

the competition within this area is intense due to multiple players and factors such as low penetration, rapid advances in technology, and high fragmentation.

Unlike VR, AR applications requires lots of 3D components which is expensive leading to some sticker shock and unimaginatively scoped projects from enterprise clients. Similar to the smartphone, AR's path to success is its potential to be a versatile device, providing value through productivity, learning and entertainment applications.

## **POTENTIAL FOR ACCELERATION**

A majority of technology deployed for AR/VR applications is still in its infancy. While many large players have spent an immense amount of capital on development, other companies are on beginning iterations for most hardware products. The initial limitations are sure to decrease as battery and quantum computing technology begin to see major gains. This will allow HMDs to become less cumbersome with better weight distribution facilitating hardware that feels less like placing a computer on your face.

With the release of ARKit and ARCore in Q3 of 2017, it has moved the innovation process to independent developers where boundaries will be pushed and best-use cases will begin to arise. Additionally, these developer softwares allow the integration of machine learning and artificial intelligence platforms to be built into applications, significantly increasing iteration processes and aiding forward thinking adopters.

Many industry professionals have begun to build software applications based on how humans have interacted with technology traditionally. Meaning, gestures and graphics built, tested and utilized through smartphones and tablets are being brought in to AR/VR development today. Therefore, both proficiency and adoption across both young and older consumers should be quicker based on familiarity.

As the industry moves to fully stand-alone devices and more robust content offerings one piece of infrastructure that will be stretched to its limits are the wireless networks themselves. As alluded to in the needed increase in processing power above, streaming two different sets of data - one for each eye to envision a recreated 3D world - creates a tremendous amount of strain on networks. Most noticeably, latency factors currently inhibit much wireless use of AR/VR applications. Fortuitously, 5G, is being developed by ISPs with this in mind. ABI Research anticipates that 5G will bring about "a 10x decrease in latency, a 100x improvement in traffic capacity and a 100x improvement in network efficiency."<sup>15</sup> Mass 5G implementation is planned for initial rollout in 2020, with some trials currently occurring in Texas, Michigan, Indiana and Nevada, among others.<sup>16</sup>

Finally, as with any new technology, government subsidies can benefit both companies and consumers within this segment. Currently China is leading the way in state-paid subsidies as it pushes to be the leader in VR/AR. Keeping in mind that VR/AR production costs can easily run into the hundreds of thousands of dollars, forward-looking policy makers that are promoting subsidies are not only helping companies, but enticing VR talent from around the world to facilitate building community expertise.

## **BARRIERS**

Although this new technology has application potential across a wide variety of industries and use-cases, there are still major hurdles that must be overcome to see the exponential growth expected within this segment. To begin, only 24 million HMDs are expected to be sold in 2018, but that number is projected to

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<sup>15</sup> <https://5g.co.uk/guides/5g-virtual-reality-and-augmented-reality/>

<sup>16</sup> <https://medium.com/@arconaico/how-5g-will-change-the-augmented-reality-devices-and-services-20512c7c2833>

increase to 500 million by 2025. The relatively small number of HMDs moving through the market today is a direct correlation that most headsets on the market are not viable products. As TheNextWeb.com states, “no matter how comfortable a brick covered in a sleek, black, matte finish manages to be, it’s still a brick hanging off the front of your face.”<sup>17</sup>

Many companies looking to implement an AR/VR component into their business see how costly it is with a low ROI and even lower technical support. Although a company may be helped in the long-term, it must incur a large capital expenditure today to start using the technology. Because of that high price, the return on investments made is not satisfactory creating significant barriers to entry for small and medium sized businesses. Lastly, due to product infancy and the small amount of design expertise, maintaining a technical staff adds excessive burden on what must be a lean startup, driving up costs.

Privacy concerns related to traditional media are already surfacing in immersive content. A report by the World Economic Forum showed that 47 percent of people across 6 countries have stopped or avoided a service based on inadequate user controls. For the Chinese that number rises as high as 70 percent.<sup>18</sup> This suggests user privacy and data controls are a key concern shared across customer groups. Additionally, GDPR in Europe has led some developers to be unwilling to provide clear and agreeable terms of use, meaning regulators must step in in an arduous process, at best.

On the hardware side, there is much progress to be made for AR/VR which will significantly impact network performance requirements for ISPs. Battery life for untethered devices is currently inadequate, as is processing power for graphically-intensive applications. Pixel density and field-of-view are two other concerns limiting usability in AR and immersion in VR. To optimize this hardware, companies will have to get rid of most on-board computing and rely on receiving data from cloud services. To do this, all of the listed advantages of 5G will be needed.

Overall the AR/VR technology is still in transition phase, owing to various technical and other related issues that keep arising. Additionally, the whole market is still determining its customer base and product fit. One such theory is that the VR HMD high price bracket is as such to deter widespread gamer adoption which could lead to preconceived specific use-cases, public perception problems and ultimately hampering the enlargement of the VR industry.

## **OUTLOOK/IMPLICATIONS**

Although the AR/VR segment has seen a large increase in deal flow over the past year and a half, it is still a market in its infancy. Volatility within the market will be the one standard over the next 2 years as more use-cases begin to emerge. However, this volatility may also propel rapid feature expansion, lower price points, and more creative arrangements with vendors eager to partner with organizations. An investor or business will want to follow new technologies associated with this segment to help determine which companies are poised to turn it into a competitive advantage.

Currently, many developers are exploring the possibilities of this new medium rather than creating polished products. This creates a more difficult environment for developers and businesses to identify and scope projects. Additionally, not every company should rush into having an offering related to AR/VR because execution risk is a real threat - potentially turning off consumers. However, this allows investors to follow

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<sup>17</sup> <https://thenextweb.com/insider/2016/05/20/hurdles-virtual-reality-mainstream/>

<sup>18</sup> <https://www.mckinsey.com/industries/media-and-entertainment/our-insights/augmented-and-virtual-reality-the-promise-and-peril-of-immersive-technologies>

the market and identify companies who are targeting specific applications and have proven technical expertise within those areas.

Although Google, Apple, Microsoft and others are doing the heavy lifting of vector mapping, location logistics and other important components, there are still select parts of the market with opportunity. Initially, a standard method across developer tools to make or experience augmented reality is important instead of transcribing content for use across a variety of platforms. This will allow creators to focus on content, usability and other important aspects of their software. Second, a single place where people can publish, share and discover AR/VR experiences will drive this technology forward. In the same way that YouTube content exploded alongside the ubiquity of powerful smartphone cameras, accessible AR/VR tools will allow creators to outdo each other in a social engagement environment.

Mentioned throughout, the ability to drive down transistor sizes, ramp up vision-sensing technologies and adding both AI and 3D sound processing will be key to driving down costs, and creating the inflection point needed for mass adoption. In the interim, many expect the smartphone, with its motion sensing and graphic processing already built in, to be the introduction for many consumers into AR/VR. In Q1 of 2018 Aaron Shapiro, CEO of Huga, said that “until the technology dramatically shrinks in size, which is years from now, we’re not going to have wide spread adoption beyond the phone.” Companies who seek out and create content centered around phones and tablets, like Pokemon GO, have demonstrated potential. Additionally, translating those products into a full AR/VR headset application have the most opportunity in the short term. While many competitors are experimenting and waiting for other hardware and software to mature, the company will have a distinct market advantage.

In an industry obsessed with the right customer experience glasses, HMDs and other hardware are not delivering what’s been promised. It is expected to take a couple years to attain the technology upgrades required for these devices to gain popularity. Microsoft, Google, Apple and Magic Leap are leading the way within this segment but it will take time for dominant players to emerge. Once they do, expect third-party developers to begin to focus their efforts on building surrounding ecosystems. ABI Research expects AR smart glasses will reach 48 million units delivered and VR enabled devices will number over 200 million delivered globally in 2021.<sup>19</sup> In conjunction with upgraded functions across these devices, 5G is envisioned to bring higher capacity, uniform experience and lower latency - which are critical for untethered AR/VR applications over a network.

At this stage, the market sentiment is greater in the relative success of VR vs. AR given VR’s technological progress, momentum and early formation of an ecosystem of vendors. While both AR and VR need to advance technologically, AR is seen to have more significant hurdles to overcome due to real-time processing and calibration of the real-world physical environment. However as AR matures, there are stronger enterprise use cases emerging, due to AR enabling a consumer to see the physical environment whereas VR completely blocks it out.

**Ethan Harden**, MBA  
Venture Capital Analyst

913.530.8697  
[ethan.harden@gmail.com](mailto:ethan.harden@gmail.com)

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<sup>19</sup> <https://www.qualcomm.com/media/documents/files/augmented-and-virtual-reality-the-first-wave-of-5g-killer-apps.pdf>