NEXT MEGA TECH THEME IS VIRTUAL REALITY

Gene Munster
Senior Analyst
Internet
612 303-6452
gene.a.munster@pjc.com

Travis Jakel
Research Analyst
612 303-6530
travis.s.jakel@pjc.com

Doug Clinton
Research Analyst
Internet
612 303-6530
douglas.j.clinton@pjc.com

Erinn Murphy
Senior Analyst
Global Fashion &
   Lifestyle Brands
612 303-8356
erinn.e.murphy@pjc.com

- **The Next Mega Tech Theme is Virtual Reality** (**VR**). We believe virtual reality and augmented reality are the next mega tech themes through 2030. We liken the state of virtual and augmented reality today as similar to the state of mobile phones 15 years ago. It likely will take a decade before mainstream adoption as necessary improvements in displays and applications as well as lower pricing are needed to drive demand. The first phase will be virtual reality, which we believe will start over the next several years, and is the primary focus of this report; the second phase will be augmented reality.

- **How VR Will be Used.** Our optimism around the theme is based on consumers' insatiable appetite for new tech experiences: virtual and augmented reality are radically new tech experiences. On the virtual side, new immersive worlds will open up, including gaming, live sports, concerts, immersive cinema and social experiences. Down the road, users will be able to virtually attend an NFL or NBA live game with a 50-yard line seat, listen to a live concert of your favorite band with a front row seat, watch movies optimized for VR, or visit friends in far-away locations. Classrooms in small-town USA will be able to virtually (and relatively inexpensively) tour the Great Wall of China, Egyptian pyramids, Stonehenge, the Coliseum, or the inside of a factory or laboratory. The possibilities are endless.

- **Market Size.** We see market size, excluding hardware, from live sporting events, concerts, education, adult content, social experiences, movies and gaming reaching $5.4B by 2025. While a market size of $5.8B may seem small, this number is content only and excludes hardware, which we estimate to be $62B (500M headsets at a $125 ASP) in 2025.

- **The Winners & Losers.** We see Facebook, Google and Apple as the likely public company winners around this theme. While the private side is a bit like the Wild West, we see some of the better positioned private companies as Magic Leap, Next VR, Jaunt VR, Leap Motion, OTOY, Matterport, Linden Lab and Valve. In our view, losers include TV manufacturers, PC and mobile phone display manufacturers, the travel industry, and content companies that don't have a VR strategy.

Risks: The virtual reality theme is in its infancy. The two core risks are competition and consumer appetite for VR. We estimate there are hundreds of companies competing in the space with no clear leaders. Some of those companies are powerful, with Facebook, Google and Apple entering the market at varying speeds with a collective market cap of about $1.4 trillion that will be used to gain an edge in the market. On the consumer side, it's early. Consumers may not see value great enough to justify wearing a headset.

TABLE OF CONTENTS

INTRODUCTION

Virtual Reality First, Augmented Reality Second, Mixed Reality Third

This report focuses on virtual reality (VR), which we believe will take off first. We see VR as accounting for 30% of the overall money spent by consumers for virtual environments. The second theme of augmented reality (AR) will likely be bigger than VR, and we estimate that AR will account for the other 70% of the opportunity for virtual environments. Since this report does not focus on AR, here's a brief explanation: augmented reality is the seamless overlaying of a computing experience onto the real world. At a high level, AR will replace the screen as we know it – both PC and mobile. These experiences are visual and may include interacting with your computer in a way similar to the movie *Minority Report*. Even more futuristic, this could include never forgetting someone's name, look at a building and know what's inside, seeing a restaurant's menu just by looking at the building, or knowing directions somewhere as you drive down a street. The gaming experience will be taken to the next level with, for example, Call of Duty using your living room as an environment.

Virtual Reality + Augmented Reality ="Mixed Reality"

We believe virtual reality and augmented reality will start out on opposite ends of the spectrum but as technology progresses it will converge to form "mixed reality." We believe this convergance will happen because there are clear benefits to both technologies and the technology will get to a point where it won't be necessary to have two separate devices. Being completely immersed via virtual reality allows you to be in an alternate world when on a plane, in the back of a car, or anytime you want to block out reality. There are also clear benefits of not blocking out the surrounding world and instead layering information on top of your current reality.

Virtual reality will take time, but will profoundly change our lives. Facebook, Google, Samsung, Sony and HTC have already made moves in the space. The first major investment came from Facebook, which bought Oculus for $2.3 billion in March 2014 despite Oculus having no revenue. Even though that buy-out got the most attention, it isn't the only major move by companies to invest in VR. Sony and HTC have been working on VR headsets, now scheduled to debut late-2015 and mid-2016, respectively. Not to be outdone, Google last October invested $542M in Magic Leap, an AR platform working to solve the display problem.

Comments by: Mark Zuckerberg – CEO and founder of Facebook

Mark Zuckerberg, in an interview at Beijing's Tsinghua University talking about the next big things in tech, said, "When everyone is using mobile phones, I believe the next platform will be virtual reality. Oculus is the first product, but we hope there will be many products."

Comments by: Shuhei Yoshida – President of Sony Computer Entertainment Inc.

In a recent interview with Japanese publication *Famitsu*, Shuhei Yoshida, the head of PlayStation, said he was planning on retiring until he started working on Project Morpheus (Sony's VR Headset). In the interview he went on to compare the excitement of Project Morpheus to the excitement of the original PlayStation.

Comments by: Peter Jackson – Director of *The Lord of the Rings* Trilogy	In a recent interview with *Variety* talking about virtual reality, Peter Jackson said, "We're right on the cusp of a major upheaval of the entertainment world once that technology really kicks in." he said
Comments by Chris Milk – Music Video Director	Chris Milk gave a TED talk in March 2015 on how VR can create the ultimate empathy machine and noted, "It's not a video game peripheral, it connects humans to other humans in a profound way that I've never seen before in any other form of media and it can change the perception of each other and that's how I think virtual reality actually has a chance to change the world. It [VR] is a machine but through this machine we become more compassionate, we become more empathetic, and we become more connected and ultimately we become more human."
Why Virtual Reality is Gaining Steam	The concept of virtual reality has been around in variations of its current form for the past decade. As mentioned, two events and one technology shift over the past couple of years have accelerated the investment and progress in VR. The first was the March 2014 acquisition of Oculus Rift by Facebook. Facebook is the gold standard in social media, and Facebook's acquisition of Oculus added instant credibility to the VR space. Second, in October 2014, Google invested $542 million into a private company, Magic Leap. Magic Leap is a highly secretive company focused on a new paradigm in computing displays that is expected to more seamlessly merge the virtual and real worlds. We estimate Magic Leap's private valuation to be close to $3 - $5 billion based on speculation from private equity firms. Having Facebook and Google collectively invest close to $3 billion into the VR space has added instant credibility to the VR theme, in our view, and encouraged additional investment which has enabled the underlying technologies to make significant progress.
Technology Shift	Separately, a technology shift that is enabling the VR theme is centered on the growth of smartphones, which has dramatically lowered the price of key VR components –most notably processing power. Processing power is essential because every time a user moves their head in VR everything needs to be updated and rerendered to display the new point of view. The updating is done a couple hundred times a second to make everything appear smooth to the user. The more times per second tracking is updated, the smoother and more realistic VR seems to the user. And the more detailed the graphics are the more processing power it takes to rerender the image. We believe technology advances over the next 3-5 years will continue to drive down the cost of these technologies and enable significant improvement in tracking and rendering. For example, the iPhone 6 processor is roughly 8x faster than the iPhone 4 processor in single core benchmarks and costs about the same price. We expect VR pricing will gradually drop from an all-in entry cost of $800+ to a more reasonable $300+ for VR headsets that offer high levels of immersion.
Virtual Reality Outlook	We believe one of the adoption hurdles for VR headsets today is sharing how VR feels with someone who hasn't tried it yet–in other words, generating "buzz" or "word of mouth." In order to truly understand VR and its diverse applications people need to try it and at this point in time there aren't many consumer-ready VR headsets available. In April 2015, the Google Cardboard app surpassed a million downloads. Cardboard is extremely basic – a poor man's VR headset, which costs $20 and utilizes a phone to power the VR experience, much like the Oculus Gear VR. The low price of Google Cardboard helps people try VR and paves the way for a consumer ready version in the $200-$400 range. After an initial phase of slower growth we expect consumer awareness and interest to compound and expect hardware and content sales to uptick significantly. We also don't see events that

could cripple or stagnate VR adoption, such as negative publicity associated with violent games or movies. Although we are optimistic about VR's adoption rate, we realize some individuals are conservative (the late majority and laggards) and may be resistant to replace traditional ways of doing things much like many writers relied on typewriters years after word processing made them obsolete.

Exhibit 1

AVERAGE WEEKLY WIKIPEDIA PAGE VIEWS: OCULUS RIFT & VIRTUAL REALITY
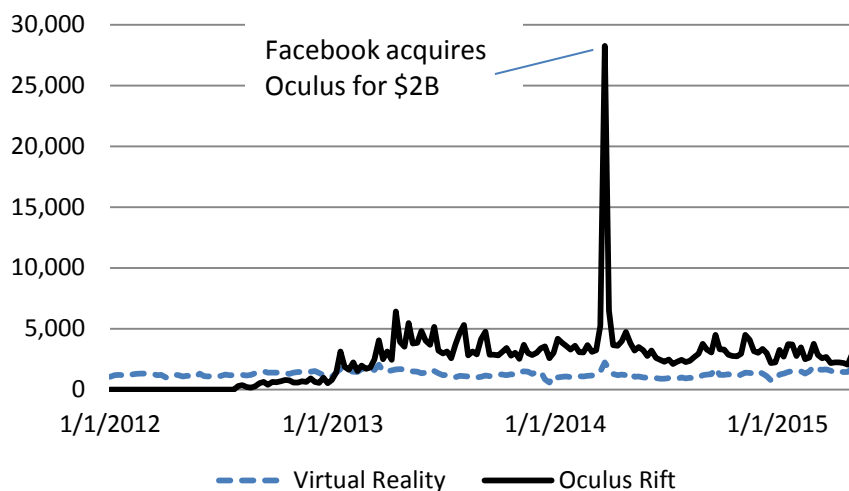
Source: Piper Jaffray & Wikipedia

Desire to Learn About Oculus & Virtual Reality

The Wikipedia pages for Oculus Rift and Virtual Reality on a weekly average are getting 2,500 and 1,500 page views, respectively. To put this in perspective, companies that are valued at around $2B get roughly 200 page views on average. We believe this signals two things:

1) People are excited about Oculus & Virtual Reality and awareness is growing.
2) Too much excitement can lead to overvaluation (e.g., technology bubble).

Exhibit 2

YOUTUBE SEARCH TRENDS: OCULUS RIFT & VIRTUAL REALITY
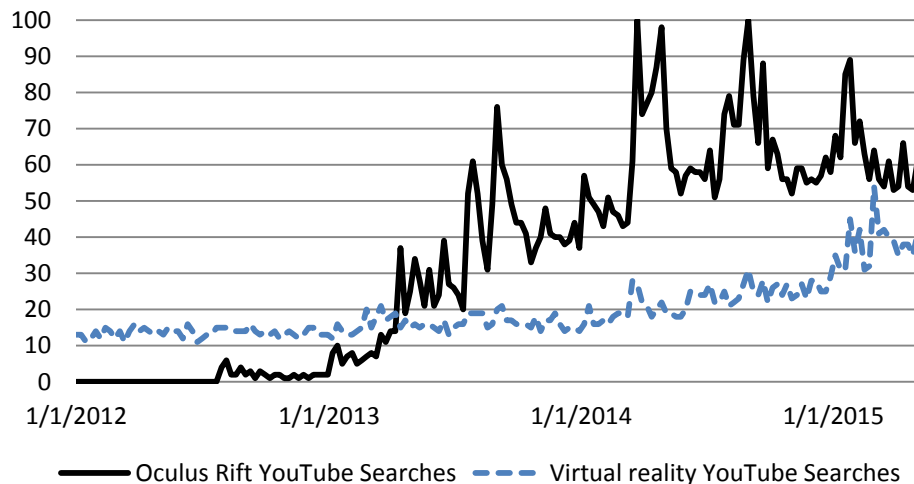
Source: Piper Jaffray & Google Trends

Consumer
Excitement Growing

Searches on YouTube are growing, which translates to growth in consumer awareness and is positive for the industry. It is, however, tough to convey virtual reality to consumers through YouTube and a live demo is needed. As we push forward towards consumer launches of VR devices we expect unique marketing schemes, such as VR headsets placed in movies, to help push consumers to their local Best Buy to try one out.

PAST, PRESENT AND FUTURE OF VIRTUAL REALITY TRAVEL

Is Virtual Reality New?

Virtual Reality is not new. People's minds wander constantly and use different avenues to pursue an alternative reality, whether it's using various forms of media, or even drugs. It goes without saying: virtual reality is the safest form of an alternative reality.

Advances in "Virtual Reality"

Story telling is the earliest form of an alternative reality. When there was no TV, radio, or electricity it was common place for people to gather around and get immersed in a story.

Graphics: When words are not enough, graphics were invented to enhance the stories. No longer did you have to imagine your alternative reality, it would be displayed for you.

Theater: People's imagination were be sparked by written stories, props, and actors, which allowed people to zone out of everyday life and enter a "virtual reality."

Radio: People gathered around a radio and listened to stories. As you listened you would be transported to another world and could imagine yourself in someone else's shoes.

Books: The Harry Potter books are an example of a virtual reality; the stories transported millions of readers from reality into Hogwarts and the world of magic.

Photography: When the first pictures were taken people had mixed feelings – some people loved it and others were scared of the technology – but regardless, a photo was a form of an alternate reality.

Cinematography: "*Arrival of a Train at La Ciotat*" by Auguste and Louis Lumière in 1895 is considered the first motion picture and shows a video of a train coming into a train station. There are rumors that many viewers were scared and fled the theater because they were afraid of the oncoming train. Although the viewers knew they couldn't be hit by the train, their bodies still reacted to what's known as an "involuntary virtual travel" where the primary senses are overwhelmed with sensory information that creates a sense of presence.

VR is Not New, it's Just a New Label

Life will likely be seamlessly altered to include a new, enhanced form of VR. When people talk on the phone and someone asks "Who is it?" you don't say, "It was Joe's digitized voice," but rather "It was Joe" because the high fidelity and clarity feels as if Joe was right next to you. Technology will likely soon provide visual fidelity similar to that of a telephone along with other realistic senses such as smell and feel, and reality and Virtual Reality will start to blend together. At first this will be disorienting, but humans will quickly adapt as we have with electricity, films, and the internet.

VIRTUAL REALITY HEAD MOUNTED DISPLAYS (HMD)

Technical Aspects of Virtual Reality

The key to making virtual reality "real" is tracking, rendering, and displaying. In order to feel a sense of presence in a virtual world you need to have tracking, which detects movements and tells the graphics to rerender. Tracking is typically done optically, magnetically or by ultrasound (depending on the installation). The tracking locates and stores data on the position and body orientation of your head or body. Tracking is important because it needs to know where you are looking and your point of view. Every time a user moves their head in VR everything needs to be updated and rerendered to display the new point of view. The updating is done a couple hundred times a second to make everything appear smooth to the user. The more times per second tracking is updated, the smoother and more realistic VR seems to the user. And the more detailed the graphics are the more processing power it takes to rerender the image. We believe technology advances over the next 3-5 years will drive down the cost of these technologies and enable significant improvement in tracking and rendering.

Latency 101

Latency is the time interval between the cause and the effect of some physical change. In a virtual world, it means when you move your head how fast does the image update to accommodate your head position? A latency of 50 milliseconds will feel responsive but noticeably "laggy." A latency of 20 milliseconds or less should provide the minimum latency deemed acceptable. Exhibit 1 looks at latency, field of view, and resolution for the current virtual reality headsets.

Exhibit 3

VR HEAD MOUNTED DISPLAYS OVERVIEW

Different Levels of Immersion	Virtual Reality Headset	Wireless?	Headtracking?	Bodytracking?	Field of View	*Latency	Consumer Launch
High Immersion	Oculus Rift Creasent Bay	No	Yes	Yes	110-degrees	<20 ms	Q4 2015
	Sony's Project Morpheus	No	Yes	Yes	100-degrees	<20 ms	Q2 2016
	HTC Vive VR	No	Yes	Yes	110-degrees	<20 ms	Q4 2015
Medium Immersion	Samsung Gear VR	Yes	No	No	96-degrees	<20 ms	Available
Low Immersion	Google Cardboard	Yes	No	No	<80-degrees	>30 ms	Available

Source: Piper Jaffray

Oculus Has Two Form Factors, With Different Goals

Currently, the best version of Oculus is called Crescent Bay, which has not been released but was shown off at CES 2015. Crescent Bay delivers a powerful interactive experience but requires a high graphics-powered computer to run it. The more consumer friendly version of Oculus is available through its Samsung Gear VR partnership; Gear VR became available in December 2014. The benefit of Gear VR is it is mobile, inexpensive ($200), and it does not require a computer but instead uses a Samsung Note 4, Galaxy S6, or Galaxy S6 Edge. As a point of reference, Samsung sold about 12M Galaxy S5s in the first three months following launch in March 2014, and we expect the S6 to have similar adoption. The current content for Oculus Gear VR is in the early stages, and today is more focused on 360 videos, cinema experiences and basic games with less interactivity compared to Crescent Bay.

Exhibit 4

OCULUS CRESENT BAY PROTOTYPE

Source: Oculus

Sony's Project
Morpheus

Sony's virtual reality headset, called "Project Morpheus," uses an OLED display similar to the Oculus Rift and Project Morpheus features 1920 x 1080 screens split vertically to deliver a resolution of 960 x 1080 to each eye. The field of view for Project Morpheus is slightly smaller than Oculus Rift Crescent Bay with a 100-degree field of vision (vs. 110 for Oculus). Project Morpheus has been under development for more than three years and will likely be available for purchase in Q2 2016.

Exhibit 5

SONY PROJECT MORPHEUS PROTOTYPE

Source: PlayStation

HTC Vive

The HTC Vive features two 1080 x 1200 screens, one for each eye, which is the highest resolution display of any current VR headset. The VR headset is expected to launch in Q4 of 2015 at a price point of $300-$500 and will need to be used in combination with a high powered computer. HTC has partnered with Valve, a gaming developer, to run Vive on Valve's gaming platform called Steam, which has 125 million active users.

Exhibit 6

HTC VIVE PROTOTYPE

Source: HTC

OSVR (Open Source VR) | OSVR is part of an open-source VR initiative to promote VR for gaming. Think of it as Android for VR, where not one company controls all the hardware and software. The developer kit should ship in July 2015 for $200 and its goal is to allow anyone to develop for VR.

Estimated Timeline:

Q3 2015   OSVR Developer Kit shipped by Razer and allows for more VR content to get developed

Q4 2015   HTC & Valve's VR headset called Vive starts shipping

Q1 2016   Oculus Rift Consumer Version 1 starts shipping
Oculus & Samsung Gear VR Consumer Version 1 starts shipping

Q2 2016   Project Morpheus starts shipping

IMMERSING YOUR BODY IN VIRTUAL REALITY

Virtual reality headsets immerse your mind in a virtual world. To feel fully immersed you need to be able to move freely, see your hands, and interact in a natural fashion. The first thing people typically do after putting on a VR headset is look for their hands. This is because the hands are an extremely important part of the way you interact with reality. The hands make up a large part of your neocortex and offer a lot of feedback to your perception of the space around you.

Hand and Feet Tracking – With Cameras & Inertial Sensors

We believe the next major step for virtual reality is putting your hands and feet in the virtual world and using your hands and feet to interact with virtual objects. To accomplish this companies like Leap Motion, Intel and Nimble VR, are using cameras that attach to the front of Oculus and other virtual reality headsets (Nimble VR was recently purchased by Oculus). An alternative and more expensive way to track limbs without cameras are with inertial sensors. Three companies that are using inertial sensors instead of cameras are: Control VR, PrioVR and Perception Neuron; all utilize sensors attached to key parts of the body.

Leap Motion CTO David Holz; Gives Physical Properties to Virtual Objects

In the link below, Leap Motion CTO David Holz gives a demo of Leap Motion's latest prototype of the hand tracking technology. In the video David is immersed in a virtual world using an Oculus headset with a Leap Motion hand tracking attached to the front. What David sees in his virtual world is on the right side of the screen while David can be seen on the left hand side of the screen drawing in thin air. He is bridging what he references as "The Uncanny Valley of VR Interaction;" in other words it doesn't look like he is interacting with a computer, but he is in fact interacting with physical objects. The result is an extremely immersive virtual world which has the ability to trick your mind into thinking you are interacting with physical objects.

Leap Motion Prototype Video

Password to video: pjcvirtual521
https://vimeo.com/pjcresearch/review/128500819/e082115404

Hand Tracking is Difficult

In order to achieve hand tracking shown in the video above the company couldn't use a physics engine or a game engine to create the interaction between the block and his hand; it had to use a whole new engine which Leap Motion calls "The Interaction Engine," which allows for fine physical interactions within the virtual world. Although there are a wide array of people working on implementing hand tracking we recognize there are a wide range of challenges to being consumer ready. Since your hands are key to feeling immersed, any slight tracking error will break presence and ultimately disrupt the experience. Another problem to be overcome is figuring out what the user interface will look like. There isn't a standard VR interface at this point and we believe there will eventually be a standard interface that will be controlled with the hands.

Virtual Reality Controllers 1st Gen, Hands 2nd Gen	Due to the difficulty of hand tracking we believe the first consumer generation devices from Oculus, HTC and PlayStation won't have hand tracking. We believe instead they will utilize controllers that will allow you to interact with the virtual world around you. The video in the link below shows how a controller might be used intially to interact in a virtual environment.We believe hands will be implemented into the 2nd generation VR head mounted displays in 2016 and 2017, which will open up many more applications along with an enhanced feeling of presence.
Video: Controller for a Virtual World	The video in the link below shows Sixense's STEM system in action and how controllers will be used to interact with virtual environments. **Password to video: pjcstem** https://vimeo.com/pjcresearch/review/128621367/54e48ef70c
Haptics	Once full movement and tracking of limbs are accomplished the next step is to accurately capture what one hears and feels in the virtual world. KOR-FX has created a gaming vest that transforms audio coming from games into pinpointed haptic feedback, which allows the user to feel onscreen action and environmental factors. Similarly, HapTech creates peripherals that react to your input – for instance, when shooting a gun in the game you will feel the gun recoil. Other areas under development for peripherals include smart gloves, which transmit electric signals to the skin. Incorporating electric signals into a smart glove would allow for virtual sensations that would fool the brain into feeling everything from texture to temperature. A company by the name of Dexta Robotics has developed a mechanical exoskeleton called "Dexo" that captures hand motion as well as force feedback to simulate the sensation of picking up objects in a virtual world. A company by the name of Ultrahaptic uses ultrasound waves to enable users to receive tactile feedback without needing a glove or touch a surface.
Freedom of Movement in VR	Two companies, Virtuix Omni and Cyberith Virtualizer, create 360-degree "treadmills" that allow the user to walk, run, crouch and jump in all directions. Both companies allow movement around in a virtual environment, which creates a further sense of immersion. The Virtuix Omni is priced at $699 and is planned to ship in August 2015, while Cyberith's Virtualizer is $749 and will also likely ship in August 2015. Both platforms will initially be adopted by serious gamers and developers, in our view, but once the consumer version of Oculus and Sony's Morpheus get launched we expect to see prices drop and unit volumes to increase

THE RISE OF VIRTUAL REALITY CONTENT

YouTube Supports 360 Degree Video

On March 13, 2015, YouTube announced that it will now support 2D 360 degree videos. We believe in the near future YouTube will enable a VR mode that would include a side-by-side view for each eye and head tracking support for view control. We believe Google, which owns YouTube, will continue to push towards VR as the company recognizes that VR is likely the next disruptive space.

VR Content on YouTube

We expect a significant amount of VR content on YouTube over the next few years. YouTube is an excellent platform to preview and test VR content offerings such as sports and concert highlights. The NBA has indicated they plan to be an early adopter of VR and prior to streaming courtside seats to VR headsets we expect the NBA to release VR courtside seat highlights onto YouTube, which would enable fans with VR headsets to get a taste of future VR broadcasts.

Building Compelling Live Content: NextVR

Although YouTube will support VR content in the near future, we believe an important aspect to this is content capture. NextVR, a private company, is making headlines in the VR content space. In late March, NextVR announced a partnership with Fox Sports and NASCAR, which we believe will result in live streaming sports in the first half of 2016. We note NextVR has already done testing for live event streaming with the NBA, NHL and NASCAR. We believe live sports, music and theatrical events are compelling experiences that will help drive consumers to pick up Virtual Reality headsets. From the NBA, NHL, NASCAR and, we believe, eventually all major sporting leagues, this would create an "infinite seat" - a seat that could be sold an infinite number of times.

Estimated Streaming Sports Timeline:

October 2015	NBA VR highlights available on YouTube and other platforms
May 2016 (2015-16 NBA Playoffs)	NBA VR first full game available to stream
Live Sports Next 5 Years	Testing for NHL purposes is currently underway and although nothing is publicly in the works for Football and Soccer, we believe both sports are likely to be adopters of the technology in the next 5 years as we believe fans of both sports will pressure them to adopt virtual reality.

Exhibit 7

NEXTVR TESTING COURTSIDE NBA SEAT

Source: NextVR

Consumer Generated Content

As consumers start to see professionally created VR content of sports, music, events and experiences we believe they will inevitably want to create content themselves. Two companies, Theta and VSN, currently have 360 degree cameras available for purchase. We also expect GoPro to enter the space in the next couple of years given their April 2015 acquisition of a video stitching company called "Kolor." (*GoPro is followed by Piper Jaffray Senior Analyst Erinn Murphy.*) Instead of sending a picture to friends and family, consumers will send "immersive pictures" or "immersive video" that replicate the feeling of being in that exact place and time. We see GoPro as a long-time winner in VR and expect it to continue to be acquisitive in this arena.

Live Social Experiences

A video by Samsung which shows a father attending the birth of his son in VR from thousands of miles away is a powerful example of how VR can change lives. Other potential social applications range from interaction with loved ones who live in other cities to birthdays or weddings. High fidelity audio (phones) will now be paired with high fidelity visuals (VR) to give you a feeling of presence at an important social event in real time.

Virtual Reality Experiences (Movies)

Although there is a lot of buzz around VR movies we believe it will take off after gaming, but simultaneously with sports and concerts. Although gaming is in a better position to grow faster initially, we believe VR movies will be common in the future. VR movie creation is still in its infancy and major industry players have entered into creation of VR content with 11 VR projects making their debut at the recent Sundance Film Festival. We recognize that a major challenge film directors have is that if you record content in 360 degrees it means the director and anyone else who shouldn't be in the shot has to be out of sight. Also, you have to get the consumer who is viewing the content to look at the right place at the right time.

Oculus Story Studio

A recent example of VR experience creation is Oculus' Story Studio (owned by Facebook), which is an in-house production team dedicated to exploring the potential of what Oculus calls "Immersive Cinema." According to Oculus' website, the studio is made up of roughly

10 people including several veterans of Pixar Animation Studios and Lucasfilm Ltd. We believe the expansion into immersive cinema is a step in the right direction and although early in development, it broadens the consumer appeal beyond games. Oculus has given detail on five short VR films, namely: *Lost* (debuted at Sundance), *Bullfighter*, *Kabloom*, *Henry* and *Dear Angelica*. Initially, the studio will use the five VR experiences to help them explore and learn about storytelling in VR.

Jaunt Studios

Jaunt Studios is a recently launched division of Jaunt VR which is dedicated to creating live-action virtual reality experiences. The studio is headed by Cliff Plumer, former CEO of Digital Domain and former chief technology officer of Lucasfilm. Jaunt Studios looks to collaborate with Hollywood storytellers and will look to integrate computer graphics and visual effects alongside shooting with cameras.

OTOY – OctaneRender

Creation of computer graphics (CG) and rendering is done quickly via OTOY's latest software called OctaneRender. It operates by using the graphics card in a computer to render photo-realistic images super fast. This will allow users to create VR experiences quickly and thus allow for more VR experiences to be created.

The Virtual Reality Company

The VR Company is a newly formed content studio that creates VR experiences by combining the best in technology, art and storytelling. The studio was formed by four Hollywood players and is prepping content with directors such as Ridley, Scott and Steven Spielberg.

Combining Virtual Reality and Physical Environments

Instead of heading to a movie, arcade or theme park, people will head to a "VR Experience Center" that will combine virtual reality and physical environments to allow for both mental and physical immersion. A project called "The Void" looks to offer such VR experience in the near future to the consumer. VRCade, Survios, and Kenzan are three companies that specialize in combining physical environments with VR in hopes of creating realistic experiences that people will pay for to escape reality.

Exhibit 8

COMBINING PHYSICAL ENVIRONMENTS AND VIRTUAL REALITY

Source: Roadtovr.com & Kenzan

VIRTUAL REALITY APPLICATIONS

VR Gaming

The obvious application of VR is gaming. We expect virtual reality to take off first in gaming due to the nature of gamers being technologically savvy and often the "early adopters", wanting to feel immersed, and wanting the best experience. In 2014, $68 billion was spent world wide on gaming software and this is expected to grow to $81 billion by 2016 according to Statista and our forecasts. We also recognize that gamers already have existing hardware (such as a high powered laptop or PS4) to support VR headsets that will be coming to market. Along with VR headsets come a dizzying array of peripherals to help immerse gamers in VR. Peripherals range from omni directional treadmills to guns with recoil.

Difficulties of Leveraging Existing Franchises

Although we believe gamers will be early adoptors of VR, there are challenges to leveraging existing game franchises. Namely, there is a lot of psychology and physiology behind how people move their head. For instance, if you are in a VR headset playing *Call of Duty* the developers have to start from scratch with controls to keep people from getting nauseated while moving through a map. Although new controls, user interfaces and movement need to be used, we have seen a lot of unique solutions and ideas to solve these types of issues. We believe these difficulties may allow smaller game developers to quickly catch up to big game studios and the first emerging VR game title might come from a relatively unknown developer.

Gaming: Oculus CV1 vs. HTC Vive vs. PlayStation Project Morpheus

At this point in time no decisive winner has yet emerged and each platform has a variety of pros and cons. From a hardware perspective, we believe each VR headset will meet the technical requirements to play games with low latency and realistic head tracking. Hardware "X-factors" that will impact consumer adoption include body tracking, hand tracking and content support. Each VR headset should have body tracking though final details on tracking range aren't announced for consumer devices. Hand tracking isn't expected to be incorporated into the initial launch of any of the devices but we expect this in next generation VR headsets.

Oculus currently has the most games and developers because the Oculus developer kit has been out for three years. The wider array of content that will be available at launch (compared to other platforms) enables users to start playing a wide variety of games. We believe this is a positive, however, it remains to be seen if there will be enough content to bring PS4 and Xbox One users over to PC gaming. Key games that should be available at launch include: Project Nemesis, Disc Arena, Ship Spinner, EVE: Valkyrie and The Workshop.

Sony's Project Morpheus is expected to hit the market around six months after Oculus, but boasts a larger consumer base of 20.1 million PS4s sold as of March 2015. There are currently only 19 games in development with Project Morpheus support; however, PlayStation has the weight within the gaming industry to encourage game content owners to optimize existing franchises for VR like Call of Duty, Grand Theft Auto and Madden NFL.

Although HTC has gotten a late start compared to Oculus, HTC has partnered with Valve, a gaming developer, to run Vive on Valve's gaming platform called Steam, which has 125 million active users. HTC started shipping free developer kits on April 22, 2015, to select developers and will have seven months to build out applications. We expect game developers will jump at the opportunity to leverage the massive user base and we expect a modest range of titles available at launch.

Virtual Friends and Virtual Interactions

There are currently around 1 million active users in an online virtual world called "Second Life." Although the world is virtual, people still network and share social experiences to feel connected. Another virtual world that should see a revival from VR is *The Sims* games, which have sold over a 100 million units over the past decade. A major draw is that in the virtual world you can appear however you would like. Being alone for extended periods of time is distressing and we seek out other people and even settle for virtual friends. The lack of social contact is what is important and so people socialize with computers and virtual objects in a similar to human interaction. For example, Microsoft's Office Assistant was named "Clippy the paper clip" and people attached feelings (either good or bad) to it because of its human-like characteristics. Similarly, humans interact with avatars in a virtual world as if the avatar were a real person and humans keep personal space, make eye contact and are influenced by herding behavior. VR companies looking to utilize virtual social interactions include AltspaceVR, Linden Lab (Second Life), Improbable and NextGalaxy (CEEK Platform).
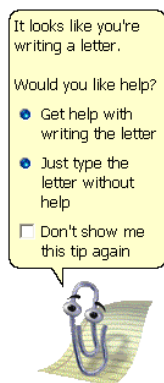
Clippy the paper clip asking if you need assistance

Source: Microsoft

Perceived Realism of Avatars and Theory of Mind

Below are key elements that must be met to allow virtual interactions with avatars in order to have an emotional impact similar to real world interactions.

Critical To Believing Virtual Interaction
Movement realism – How well do an avatar's virtual body parts move (e.g., waving of hands)? Do they behave properly?
Anthropometric realism – Do the avatars have all the right body parts to communicate (e.g., hands, mouth, shoulders)?

Not as Critical
Photographic realism – How much do the avatars look human? People still interact with outlines of people as long as they have the right body parts and they behave like they should.

Education

Virtual reality may also enable students to perform a wide range of activities from taking virtual field trips through the solar system or to Gettysburg to getting hands-on with a car engine, for example. Virtual reality gives hands on view points which may help people to better understand and retain a topic, and to learn to perform new tasks. In an interview with Edweek, a weekly news site on education topics, Mr. Firstname Jacobson of PublicVR predicts that affordable virtual-reality headsets will quickly find a niche because "a substantial body of research from industry and the military shows that immersive virtual-reality experiences can serve as effective training tools to help people learn to perform new tasks." We believe VR can bring change to the kind of highly specialized training that requires a lot of hours in the lab or out in the field.

VR in the Work Place	The British government has announced they will be using Oculus Rift to prepare medics for realistic battlefield situations. The British government has also started to use VR for recruiting people for the British Army Reserves and invite members of the public to try out their VR experience. Similarly, the US Armed Forces and NASA use VR in their training routines. Among others that use VR are Caterpillar, which has its own "Immersive Visualization Center" for getting customer feedback during the development of new equipment and training people to use their equipment. General Motors has also recently joined in using virtual reality; VR allows GM to render a vehicle and make adjustments on the fly; it also allows GM to create, design and test the safety of the products before putting them to production. A company called Worldviz currently provides VR solutions to the work place and according to their website, "VizMove solutions are the only turnkey virtual reality systems on the market. Each system enables a cost-effective, high-performance platform for experiencing complex environments and simulations at scale. VizMove is well suited for a broad range of applications including design visualization, architectural walk-throughs, industrial training, and behavioral research."
VR in Court Rooms	Lawyers and judges will likely have access to virtual reality, which enables a variety of useful applications – a major one being able to recreate a crime scene with great detail including weather conditions and vantage points. VR could enable lawyers to discredit or enhance credibility to witnesses by recreating the scene of a crime. It would also allow for witnesses to return to the crime scene or create a lineup in the setting where the crime originally occurred.
VR in College Football	A report from FOX Sports' Bruce Feldman outlines a use case for VR where NFL and collegiate football players review practice plays in first person point of view using VR. The only football player that has trained with VR is Stanford quarterback Kevin Hogan, who trained with an Oculus headset during the last part of the 2014-15 football season. The FOX report goes on to state that "… Kevin Hogan went from completing 64 percent of his passes up to 76 percent after the Stanford quarterback started using this headset regularly for about 20 minutes before games." Feldman also points out "…that the team finished the year scoring on every one of its last 27 trips to the Red Zone when their first two units were on the field, which would seem even more jaw-dropping when you consider the team was scoring just around 50 percent inside the 20-yard-line before that." He's shown off his VR training to many current and former NFL players on has had positive feedback.
VR in Healthcare	In Healthcare a wide range of uses exist where VR may be useful, such as surgery simulation, robotic surgery, skills training, phobia treatment and patient/doctor interaction.
Surgery and Skills Training	VR promises healthcare professionals the potential to learn new skills as well as refreshing old skills. Rémi Rousseau (a virtual reality expert) teamed up with French surgeon Dr Thomas Gregory to film a hip replacement surgery that he was performing in 3D using a pair of GoPro cameras, and turn it into a virtual reality surgery using an Oculus Rift VR headset to play it back. The video is used to train surgeons and help surgeons prepare under conditions that simulate surgery but don't have the repercussions of real surgery.
Phobia Treatment	Virtual reality may have use in treating phobias, with a specialty medical center called "The Virtual Reality Medical Center" geared towards treating a variety of conditions. The centers currently use virtual reality exposure therapy (3D computer simulation) in combination with physiological monitoring and feedback to treat panic and anxiety disorders. According to the company's site the conditions they treat include phobias such as the fear of flying, driving, heights, public speaking, and thunderstorms as well as claustrophobia, agoraphobia, arachnophobia, social phobia, panic disorder,

and posttraumatic stress disorder due to motor vehicle accidents. General stress management and relaxation skills are taught with VR for stress-related disorders.

Patient to Doctor Interactions	Costly and time consuming doctor visits could be replaced by streaming live video footage of the patient and doctor.
Rehabilitation	According to MindMaze, it has developed highly accurate motion capture sensors that provide position and orientation to enable real time mapping onto a virtual character (avatar), while being compatible with different postures (lying, sitting and standing) irrespective of the environment. In addition body sway and posture are monitored to optimize the visual feedback to the patient. Post session analysis is provided by the system to track a patient's performance evolution.

Exhibit 9

PATIENT REHIBLITATES USING MINDMAZE MOTION CAPTURE

Source: Mindmaze

VR for Treating Lazy Eye and Cross Eye – Vivid Vision	Over 20 million people in the US have a lazy eye. In those affected, one of their eyes is weaker than the other causing diplopia (double vision), amblyopia (lazy eye), and loss of vision in one or both eyes. Vivid Vision is a company focused on creating virtual reality games designed for people who have lazy eye and strabismus (crossed eye(s)). As a player plays the game they begin to train their brain to pickup signals from the weaker eye which allows for gradual restoration of normal function. VR may be extremely good for these conditions because it can present the same object differently to both eyes which allows for training of the weaker eye. The company plans to roll out two versions: an in-office system for optometrists and a consumer product that patients can use at home. Although clinical testing is still underway, early data suggests that improvement in vision occurs after 4 weeks of use.
Adult Entertainment Industry	The adult entertainment industry helped bring VHS past beta testing and led the charge on streaming. Many in the adult industry are pursuing VR content and believe it could revolutionize an industry that has been stagnant for many years. Once consumer ready VR headsets hit the market we expect the adult industry to bolster adoption rates.

A VIRTUAL REALITY FUTURE

We believe VR will change a variety of landscapes over the next 5 to 10 years. The diverse applications of VR in combination with accelerating technological improvements will lead to mainstream adoption over the next 10 years. As mentioned, we compare today's VR landscape to that of smartphones 15 years ago.

For the context of our projections we separate out three types of VR headsets: Wired headsets vs. Wireless headsets vs. Low Immersion.

Wired Headsets: Run on high powered graphics computers/consoles (currently Oculus Rift, Project Morpheus and HTC Vive). Over the next several years we expect wired headsets to utilize new sensors to perform eye tracking, hand tracking, body tracking, head tracking, object tracking, mouth tracking, environment tracking and seemless voice recognition.

Wireless Headsets: Wireless headsets currently run on a phone (currently Gear VR), but in the next 3-5 years we believe it will switch to all-in-one wireless headsets with a built in display. We expect this change because next generation sensors will be available along with, custom displays and custom optics which make VR headsets portable and fashionable. We believe battery technology will be a limiting factor, similar to that of smart phones today. Smartphones will no longer be an ideal platform because head mounted displays will need VR specific cameras which have a large field of view with multiple cameras and senors which smartphones aren't designed to carry.

Low Immersion Headsets: Google Cardboard and low end headsets that don't provide anything except lenses aren't considered in our analysis because it is not likely such a device would be used for more than 10 minutes at a time. Although they aren't considered in our analysis we still believe they are an important driver for consumer adoption of virtual reality. The low price of Google Cardboard and similar headsets help people try VR and pave the way for adoption of wireless and wired VR headsets.

Average Selling Price

Based on reports from Oculus, Sony and HTC we expect high immersive VR headsets to have an ASP of ~$400 and medium immersive VR headsets to have an ASP of `$200 ASP for the first couple of years. We note that

Why VR Will
Become Cheaper

We believe technology advances over the next 3-5 years will continue to drive down the cost of these technologies and enable significant improvement in tracking and rendering. We expect CPUs and GPUs of computers to continue along Moore's Law which should enable cheaper computers to eventually run wired headsets headsets. We expect VR will gradually drop from an all in entry cost of $1000+ (VR headset $400 + high powered computer $1,000) to a more reasonable $500+ (VR headset $250 + computer $300) for VR headsets that offer high levels of immersion. Estimates are based on expected ASPs for wired VR headsets and high performance computers in 2016 and 2025.

Why It Won't Be
Incredibly Cheap

Although the existing technology is getting cheaper, there will be offsetting price increases due to VR headsets incorporating more immersive features (e.g., inclusion of hands, feet, and eye tracking).

Buy a Phone, Get a
Low Immersion VR
Headset Free

LG is currently giving away a Google Cardboard-esque VR headset when purchasing an LG G3. We expect low end VR headsets to be given away alongside the purchase of most flagship phones over the next 3-5 years. In the next couple years we believe the Gear VR headset will be given away free with the purchase of a high end Samsung phone, and a new version of Gear VR headset with improved immersion capabilities or an all in one headset will likely replace the current headset at the $200 price point.

Exhibit 10

AVERAGE SELLING PRICE OF VR HEADSET
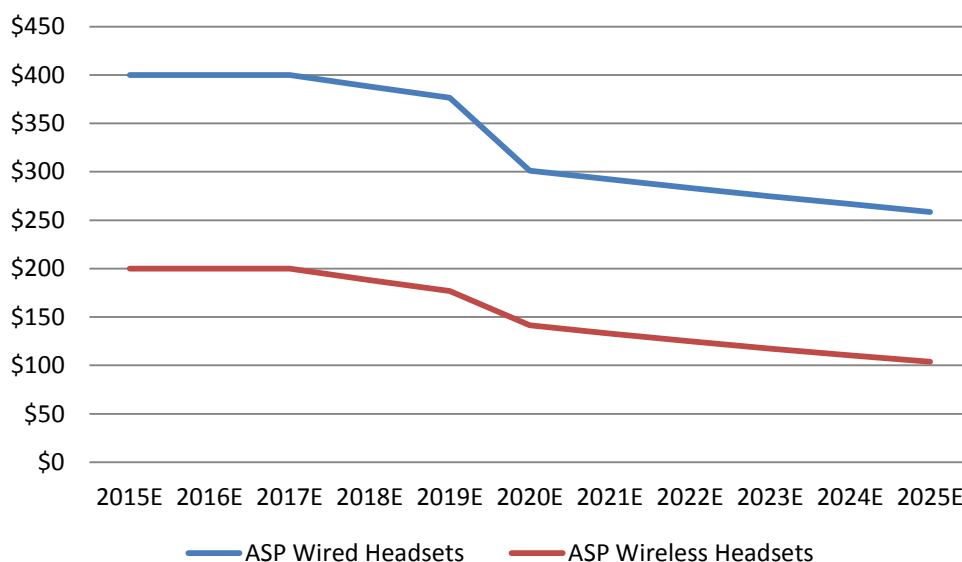
Source: Piper Jaffray estimates

VR Head Mounted Display Sales

Exhibit 11

VIRTUAL REALITY HEADSET SALES
(In Millions)

We expect sales to ramp as compelling content becomes available

■ Wired VR Headsets   ■ Wireless VR Headsets
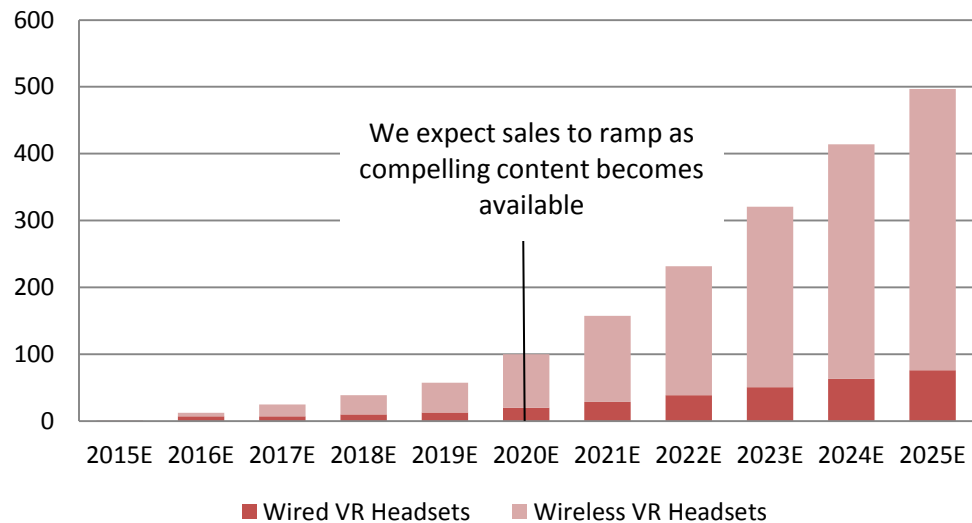
Source: Piper Jaffray estimates

Piper Jaffray VR Outlook / VR Catalysts

2015 – The HTC Vive is slated to lanuch Q4 2015. Also. the first consumer VR headsets from Oculus (Oculus Rift and Gear VR) are expected to be on preorder.

2016 – PlayStation releases their Project Morpheus for the PS4. We estimate an attach rate of around 10%. To put that into context Halo, an extremely successful video game, had an attach rate of 30%. The first consumer versions of Oculus Rift and Gear VR are expected to be launched Q1 2016.

2017 – Upgraded displays, sensors, and lowering of cost allow for major improvements in all-in-one wireless headsets. We expect Apple to release a VR headset in combination with the iPhone 7 or possibly release an all-one-headset.

2018 – We believe extremely useful, engaging content starts to emerge along with light weight headsets.

2019 – Upgrade sensors and displays should allow for VR headsets that look similar to sunglasses.

2020 – Based on other technology we estimate 2020 to be the year where growth in VR will pickup.

2025 – We believe VR & AR in 2025 will significantly alter the way we communicate and engage with our surroundings.

Revenue Growth of VR Applications

VIRTUAL REALITY REVENUE BY INDUSTRY
(In Millions)
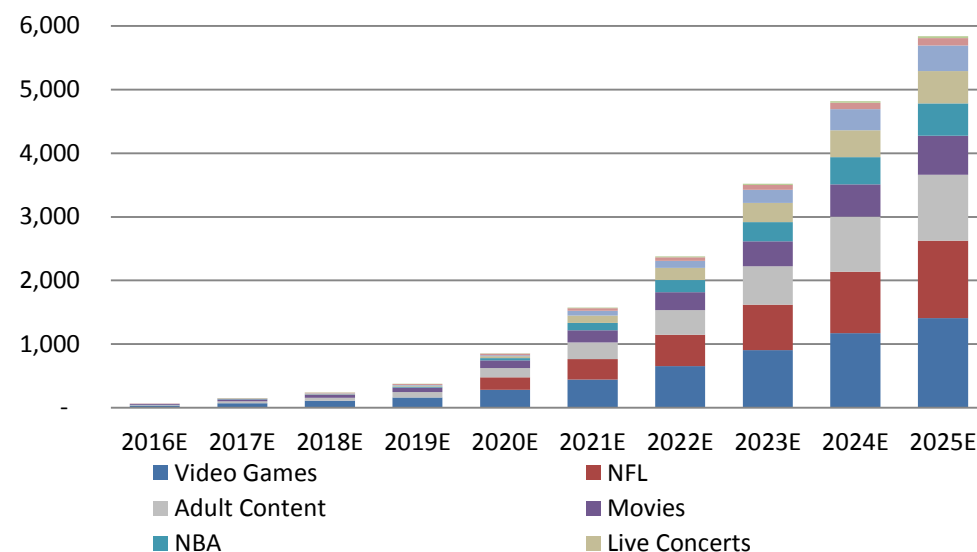
Source: Piper Jaffray estimates

Video Games. The video game software market is a $68 billion market (40% Computer, 33% Console, 27% Mobile), according to Statista. We estimate there to be 1.2 billion gamers worldwide and on a per person basis it comes out to an average spend of $56.66 per person. We expect gamers to be early adopters of VR and we estimate around 5% of people will spend on average $56.66 on games yielding a $35M market in 2016. Keeping assumptions the same except using 2025 VR headset sales estimates we project a $1.4 billion VR video game market in 2025.

NFL. Today, the average NFL fan generates about $30 per year in advertising revenue, or about $1.50 per game. We believe the monetization of VR will be similar regardless if it's an advertising or a subscription model. We expect the NFL to offer VR seats in 2020. In 2020 we estimate the average NFL fan will generate about $48 in ad revenue per year (increases by 10% per year). That implies $3.20 of ad revenue per event in 2020. In 2020 we estimate there will be 100 million VR headsets. Our market size assumes 3% if the available games (100m x 20 weeks = 2 billion views. 3% of those views implies 60M viewed events at $3.20) are viewed through VR. This assumes total NFL VR revenue in 2020 of $60M. Going forward, we assume an unchanged view rate of 3%, off of an accelerating base of headsets. This implies a $1.23 billion market in 2025. The math is 500M headsets x 20 weeks x 3% viewing events x $4.08 (which implies a 5% annual price increase from 2020 to 2025.

Adult Content. Currently, Adult Content is globally a $25 billion market (Online and Video), according to according to Kassia Wosick, assistant professor of sociology at New Mexico State University. Not surprisingly, adult content is predominately male driven. Of the roughly 3.6 billion men in the world we assume 5% of men (180 million) pay for adult content. If we divide the Adult Content market by 180 million, it comes to an average spend of $139 per person per year. Assuming 3% of VR users purchase adult content in 2016, and

assuming VR adult content average spend per year is 25% of total adult content spend, or $35 per year, this equates to a $13 million market in 2016. Assuming instead that 50% of adult content spending will be on VR adult content this implies a $1 billion VR adult content market in 2025.

Movies. Today 310 million movie tickets are sold in the US at an average cost per ticket of $8.19 for total box office revenues of $2.5 billion. We believe some VR movie content will exist by 2016. In 2016 we expect 12.2M VR units and we expect 15% of VR headset owners to spend $8.19 on average for VR movies for the year. Based on these assumptions we expect $15 million in VR movie revenue in 2016. In 2025 we expect 500 million VR units and assume spending by VR headset owners to remain similar to 2016. Based on these assumptions we expect the VR movie segment to generate $610 million in VR movie revenue in 2025.

NBA. Today, the average NBA fan generates about $34 per year in advertising revenue, or $0.41 per game. We expect NBA to start offering virtual tickets in 2017. We estimate there will be 25 million headsets in 2017. We expect in 2017, there are 2.1 billion events (games x headsets). We believe 0.5% of the events (82 regular season games) will be purchased as a virtual seat. These 10.2 million viewed events will monetize at $0.41/game (unchanged from 2015), or $4.1 million in NBA VR revenue in 2017. Moving the game viewing attach rate to 1%, and revenue per game to $1.25, equates $512 million in 2025.

Soccer. Fox Sports announced in May 2015that the English Premier League agreed upon a three-year domestic television rights deal and when added to international TV rights will total $2.6 billion per season. The Premier League features 168 matches per season and the Premier League site estimates 642 million fans tuned in, which translates to each household generating roughly $4 in TV revenue for a season, or $0.024 per match. We expect the English Premier League to offer VR seats in 2017. In 2017 we estimate 25 million VR headsets. We assume .05% of the available games are viewed through VR with 642 million views at $0.024 a piece off a base of 25 million headsets, which gets us to $2 million market in 2017. Holding assumptions the same but growing the attach rate to 5% in 2025 gets us to a $400 million market in 2025 for the English Premier League.

Live Concerts. As a rough start, we assume a similar timing, usage and revenue per events as the NBA. This yields a $4 million market in 2017 and a $512 million market by 2025.

Social Experiences. High fidelity audio (phones) will now be paired with high fidelity visuals (VR) to give you a feeling of presence at an important social event. We assume VR social experiences will follow a similar adoption rate and revenue model as Skype. In 2009 Skype had 145 million users with 8.8 million, or 6%, of them being paying users generating $97 per paying user in revenue. If we assume 4% of all VR users use social experiences and 6% of them pay on average $97 we arrive at a $2.8M market in 2016 and $115 million market by 2025.

Education. According to Furturesource Consulting, global spending on education hardware technology is currently $13 billion with $8 billion (or 62% of the total) spent on laptops, tablets and netbooks. Large sales volumes will initially be limited due to cost; however, we expect sales of cheaper VR devices to schools to start in 2017. If we assume 3% of devices are used for education in 2017 and on average $2 is spent on content per device (25M headsets x 3% x $2) equates to a $1.5 million market in 2017. Keeping the same assumptions except using 2025 VR headset sales estimates implies a $30 million market in 2025.

VR INDUSTRY OVERVIEW BY CATEGORIES

VR INDUSTRY OVERVIEW BY CATEGORIES

Head Mounted Displays (HMD)	Avegant	**Social**	AltspaceVR
	Fove		Improbable
	HTC & Valve		Mediaspike
	Immersion		NextGalaxy
	Magic Leap		Second Life – Linden Lab
	Mindmaze		
	Oculus (Facebook)	**Application Store**	Google Cardboard
	PhaseSpace		Milk VR (Samsung)
	Playstation		Oculus
	Razer		Unimersiv
	Samsung		WEARVR
	Sensics		
	Wearality	**3D Engines for VR Content Development**	Crytek CryEngine
			Epic Unreal Engine
Processing Power	Intel		OTOY Octane Renderer
	Nvidia		Unity 3D
	Qualcomm		Valve Source Engine
Peripherals / Haptics	Control VR	**VR Content: Studios & Live Events**	HypeVR
	Cyberith		Jaunt VR
	Dextra Robotics		LiveLike
	KOR-FX		NextVR
	Leap Motion		Oculus Story Studio
	Perception Neuron		Otoy
	PrioVR		Reel FX
	Sixense		
	SMI	**Medical**	Psious
	Virtuix		The Virtual Reality Medical Center
Cameras / VR Content Capture	GoPro	**VR Game Studios**	CCP Games
	Lucid		E McNeil
	Matterport		Fierce Kaiju
	Occipital		IMGNATION Studios
	Pelican Imaging		nDreams
	Theta 360		Nestoss corp
			Starship
Shopping / Fashion	Prizmiq		VR-bits
	Sixense		VRSE

Source: Piper Jaffray

COMPANY OVERVIEWS

Apple Inc.	Founded: 1976

Founded: 1976
Ownership: Ticker: AAPL
Category: Head Mounted Displays (HMD)
Domain: apple.com
CEO: Tim Cook

Based on conversations with industry contacts within the virtual and augmented reality spaces, we believe Apple will join Facebook and Google in pursuing the VR and AR industry, and they have a small team working and exploring the augmented reality space. While augmented reality (as opposed to VR) is likely 10 years away from broader consumer adoption, we believe it has the potential to be as profound a technology platform as the smartphone today. Given the theme around augmented reality is so early, it is difficult to size the opportunity; however, we believe Apple's early involvement in the space suggests the company is preparing for the next evolution of computing. Additionally, we believe Apple's evolving fashion advantage means that they can uniquely develop products that consumers will actually want vs prototype style offerings today.

Source: Piper Jaffray

AltspaceVR

Founded: 2013
Ownership: Private
Category: Social Application
Domain: altvr.com
Founder and CEO: Eric Romo

Company Description: AltspaceVR intends to connect friends and enthusiasts in shared virtual spaces and let them interact in a natural way online. This brings the web into shared virtual spaces, enabling groups to watch Netflix, YouTube, Twitch, and other content together on massive screens in VR. Their software renders your avatar and allows you to communicate in real time with others in a virtual world. AltspaceVR is aiming to create shared experiences anywhere the Internet can reach.

Source: AltspaceVR

Avegant

Founded: 2012
Ownership: Private
Category: Head Mounted Displays (HMD)
Domain: avegant.com
CEO: Joerg Tewes

Company Description: Avegant is focusing on next generation of near-eye displays. Its core, patented technology takes advantage of micromirror arrays to create pixel-free images for applications that range from mobile media consumption to virtual and augmented reality. Avegant believes its technology delivers quality and clarity with low latency to deliver a compelling experience for its consumers. The core technology can be scaled across multiple applications including virtual and augmented reality. Avegant expects to launch its first consumer product in fall 2015 called the Glyph.

Source: Avegant

CCP Games

Founded: 1997
Ownership: Private
Category: VR Game Studios
Domain: ccpgames.com
CEO: Hilmar Veigar Petursson

Company Description: CCP was founded in the summer of 1997 with the goal of becoming a leading massively multiplayer game company. With the launch of EVE Online in May 2003, CCP has established itself as one of the leading companies in the field. In the near future CCP will release the game called EVE: Valkyrie™. In the game, the useris in command of a heavily armed fighter in the most realistic dogfighting game available on any platform, according to the company. Immersive VR technology puts users in the cockpit for visceral team-based action. It is expected to be available on a wide variety of VR hardware, including Oculus Rift and Sony's Project Morpheus.

Source: CCP Games

Control VR

Founded: 2014
Ownership: Private
Category: Peripherals / Haptics / Tracking
Domain: controlvr.com
CEO: Alex Sarnoff

Company Description: Control VR is a next-generation wearable technology that turns a user's hands into an intuitive controller for PCs, VR and beyond. Control VR allows for a fully Immersive Virtual Reality experience that allows presence, control and exploration. It allows for replacement of the Mouse and Keyboard, using hands to control the PC instead. According to Control VR, this patented technology far exceeds predecessors by utilizing the smallest inertial sensors, ultra low- latency and ergonomic design.

Source: Control VR

Crytek

Founded: 1999
Ownership: Private
Category: 3D Engines for VR Content Development
Domain: crytek.com
CEO: Amir Harel

Company Description: Cyrtek is the developer of the CryENGINE® 3, which is a solution for the creation of VR games, movies, high-quality simulations and interactive applications. According to Crytek, the third iteration of its proprietary engine is the only all-in-one game development solution for the PC, Xbox 360™, and PlayStation®.

Source: Crytek

Cyberith	Founded: 2014
	Ownership: Private
	Category: Peripherals / Haptics / Tracking
	Domain: cyberith.com
	CEO: Tuncay Cakmak

Company Description: Cyberith is a VR startup, currently focused on the Virtualizer, which is a locomotion device for virtual reality that allows the user to move through infinite virtual environments using his own natural body movements. Being able to walk through virtual worlds without reaching the limitations of the actual room the user is in affords freedom of movement. The company expects the Virtualizer's high precision sensor system will make the device an indispensable piece of professional training simulations, arcade gaming setups and the consumer's home VR setup.

Since locomotion and movement are necessities for a wide range of virtual reality experiences, the Virtualizer seems to be the logical next step after the success of Head Mounted Displays like the Oculus Rift.

Source: Cyberith

Dextra Robotics	Founded: 2014
	Ownership: Private
	Category: Peripherals / Haptics / Tracking
	Domain: dextrarobotics.com
	CEO: Aler Gu

Company Description: Dextra Robotics is the creator of Dexmo, a wearable mechanical exoskeleton that captures hand motion and provides force feedback. Dexmo is aiming to bridge the barrier between the digital and real world and gives users a sense of touch, and it is designed with the principle of being dexterous, accurate and affordable, according to the company. While conventional hand motion capturing approaches generally costs thousands of dollars, Dexmo uses inexpensive rotational sensors instead of expensive sensors like IMUs and flex sensors, and along with injection molded plastic parts the company believes the cost of the device can be greatly reduced.

Source: Dextra Robotics

E McNeill	Founded: 2012
	Ownership: Individual
	Category: VR Game Studios
	Domain: emcneill.com
	CEO: E McNeill

Company Description: E McNeil is an indie game designer from San Diego. He is the creator of Darknet, a cyberpunk hacking game on Gear VR, which won the Grand Prize in the Oculus VR Jam and Best Gameplay at the 2014 Proto Awards.

Source:E McNeill

Epic Unreal Engine	Founded: 1998 Ownership: Private Category: 3D Engines for VR Content Development Domain: unrealengine.com CEO: Paul Meegan

Company Description: Unreal Engine is a suite of game development tools made by game developers for game developers. Support for all the latest VR hardware including Oculus Rift, Samsung Gear VR, Steam VR, Leap Motion, and Sony Project Morpheus.

Source: Epic Unreal Engine

Oculus Rift (Owned by Facebook)	Founded: 2014 Ticker: FB Category: Head Mounted Displays (HMD) Domain: fb.com CEO: Mark Zuckerberg

Facebook jump started the VR space in March of 2014 with the acquisition of Oculus Rift for $2.3 billion. Details about Oculus Rift are limited, but we estimate there are about 300 employees. The company announced Oculus Story Studio in January of 2015, to create content for Oculus. On the hardware side, Facebook has announced that Oculus hardware will be available in the first quarter of 2016. Longer term we believe Facebook's goal with Oculus is to be a combination of hardware and a platform technology to enable VR. In five years, we expect Facebook will charge a toll for third party hardware manufacturers and developers to access the platform to sell games, experiences and products.

Source: Piper Jaffray

FOVE	Founded: 2014 Ownership: Private Category: Head Mounted Displays (HMD) Domain: getfove.com CEO: Yika Kojima

Company Description: Fove Creator is a consumer-oriented headmount display to use eye tracking. Its custom headset and software track exactly where the eyes are looking and take action based on that. Right now that means gaming actions such as shooting a gun at a target, but eventually it could be used to set focus in film scenes and make VR a more natural experience.

Source: FOVE

GoPro	Founded: 2002 Ownership: Public Category: Cameras / VR Content Capture Domain: gopro.com CEO: Nick Woodman

Company Description: GoPro recently announced that it has purchased Kolor, a French company specializing in virtual reality software. Kolor's employees will join the GoPro staff with operations remaining in Savoie, France.

Kolor's software lets users to combine multiple photographs or videos to make 360-degree panoramas and videos, or "spherical content" as the company calls it. The ability to create interactive content is something that GoPro hasn't been able to directly offer its customers until now, even though many virtual reality content creators are using the company's cameras. Kolor's solutions enable users to combine multiple photographs or videos to produce high-resolution panoramic or spherical content that can be viewed on mobile devices, the web or in a virtual reality environment.

Note: GoPro is followed by Piper Jaffray Senior Analyst Erinn Murphy.

Source: GoPro

Google

Founded: 1998
Ownership: Ticker: GOOG
Category: Head Mounted Displays (HMD)
Domain: google.com
CEO: Larry Page

We believe Google can win in augmented reality with both hardware and services. On the hardware side, Google will take Google Glass to the next level, in our view, in part with its $542 million investment (fall of 2014) in Magic Leap. On the services side, we believe virtual and augmented applications will power the next wave of computing, and Google's data will be core to enabling those experiences.

Source: Piper Jaffray

HypeVR

Founded: 2014
Ownership: Private
Category: VR Content: Studios & Live Events
Domain: hypevr.com
CEO: Tonaci Tran

Company Description: HypeVR is focused on developing next generation live action software tools and 3D capture systems to enable the capture and broadcast of live content. Within the VR live broadcast they plan to allow you to lean into your environment with head tracking to make it feel like you are at the live event.

Source: HypeVR

IMGNATION Studios

Founded: 2007
Ownership: Private
Category: VR Game Studios
Domain: imgnation.com.br/
Owner/Creative Director: Orlando Fonseca Jr.

Company Description: Imgnation Studios provides professional motion capture, 3D animation and pre-visualization for commercials, TV, film and game industries. The company believes its motion capture studio and experienced team's quality and service allow for project integration from pre-production to final delivery.

Source: Imgnation

Immerz	Founded: 2008 Ownership: Private Category: Peripherals / Haptics / Tracking Domain: korfx.com CEO: Seth Fandetti

Company Description: Immerz is the creator of the KOR-FX gaming vest that transforms audio coming from a game or media into a physical feeling (e.g., an explosion rattles the user). The company's technology creates environmental realism for virtual reality users and users can fine-tune how much—or little—of the game they want to experience.

Source: Korfx.com

Improbable	Founded: 2012 Ownership: Private Category: Social Application Domain: Improbable.io/ CEO: Herman Narula

Company Description: Improbable is developing an operating environment that makes the construction of simulated worlds possible. The environment will host people's avatars as they interact among each other. The enviroment they are building is open sourced so anyone can build upon a world or render an environment someone else created..

Source: Improbable.io

Intel	Founded: 1968 Ownership: Ticker: INTC Category: Peripherals / Haptics / Tracking Domain: Intel.com CEO: Brian Krzanich

Company Description: Intel's hand tracking solution called "RealSense" tracks your hands in virtual reality. Intel also makes high powered GPUs which are necessary to run wired VR headsets. They hold patents around VR and AR and are expected to continue to pursue both fields.

Note: Intel is followed by Piper Jaffray Senior Analyst Ruben Roy.

Source: Piper Jaffray

Jaunt VR	Founded: 2013 Ownership: Private Category: VR Content: Studios & Live Events Domain: jauntvr.com CEO: Jens Christensen

Company Description: Jaunt creates immersive cinematic VR experiences. By employing 360-degree stereoscopic 3D imagery with ambisonic audio, Jaunt provides audiences with access to a variety of interesting and realistic experiences. Their VR experiences bring you to concerts, sporting events and story telling experiences. Jaunt has created an end-to-end system, developing the hardware, software, tools, and distribution channels to enable the

creation of cinematic VR experiences. Jaunt's goal is to give content creators access to the necssary tools to create interesting and entertaining VR experiences.

Source: JauntVR

Leap Motion

Founded: 2010
Ownership: Private
Category: Peripherals / Haptics / Tracking
Domain: leapmotion.com
CEO: Michael Buckwald

Company Description: Co-founders Michael Buckwald (CEO) and David Holz (CTO) created Leap Motion with the mission to eliminate barriers between people and technology. The company creates motion-control software and hardware that enables people to interact with computer applications by converting their hand and finger movements into 3D input. According to Leap, the technology tracks hand movements with sub-millimeter accuracy and virtually no latency, and works without gloves or other handheld accessories.

Leap Motion launched their first product, the Leap Motion Controller, in 2013, and in 2014 introduced formal support around virtual reality and augmented reality experiences. The company is currently working with a variety of OEMs and startups to embed their technology into upcoming VR and AR devices. With a network of over 160,000 developers along with Fortune 500 OEM partners, Leap Motion believes its products are used worldwide. The company is privately funded and headquartered in San Francisco, CA.

Source: Leap Motion

LiveLike

Founded: 2015
Ownership: Private
Category: VR Content: Studios & Live Events
Domain: livelikevr.com
CEO: Andre Lorenceau

Company Description: Livelike VR application takes the user into the stadium with friends and family to enjoy sports. Livelike is a full consumer-ready solution developed to be as comfortable as it is immersive.

Source: LiveLike

Linden Lab

Founded: 1999
Ownership: Private
Category: Social Application
Domain: lindenlab.com
CEO: Ebbe Altberg

Company Description: Linden Lab is the creator of Second Life, which is a 3D virtual world. It's a space where the user can be whoever they like, they can build and sell whatever can be imagined, and interact with others from all over the globe while exploring unique virtual environments, listening to live music performances, playing games and shopping in the world's largest user-generated virtual goods economy, for example.

Source: Linden Lab

Lucid	Founded: 2014

Ownership: Private
Category: Cameras / VR Content Capture
Domain: lucidcam.com
CEO: Han Jin

Company Description: Over the years, camera technology has evolved from complex mechanical and electrical solutions to simpler hardware design and development, but stronger software complexity and support. Lucid has created a consumer friendly camera which shoots pictures / videos with a field of view of 180 degrees. The "immersive pictures" taken by their camera can be looked at with a phone, VR headset, or computer. Even though current 3D 360 degree videography is facing many challenges in sharing huge files, video shooting techniques and storytelling at this early stage, we believe this immersive content has the potential to replace pictures and videos in the long run. The US camera industry is expected to trend higher following improvements in broad economic conditions, particularly at the consumer level. The US 2D Camera industry revenue grew at an annualized rate of 0.9% to $6.1 billion over the last five years to 2015, lifted by an estimated 0.4% increase in 2015, while the US 3D Camera industry is expected to reach $7.7 million growing at a CAGR of 39.4% from 2014 to 2020.

Source: Lucid

Magic Leap

Founded: 2010
Ownership: Private
Category: Head Mounted Displays (HMD)
Domain: magicleap.com
CEO: Rony Abotiz

Company Description: Magic Leap is considered the leader in developing an AR headset that consumers will actually want to use. Overall, we see Magic Leap as a critical cog in achieving the potential of AR and VR as the technology places realistic holograms in your field of vision through the use of discreet glasses. In the fall of 2014, Google invested $542M into Magic Leap, and we estimate Magic Leap's total valuation is around $3 billion. The company has about 250 employees. The goal of Magic Leap is building a next generation Google Glass to replace the desktop, PC and TV screens. Magic Leap hopes to have a developer kit out later this year, but we believe that is optimistic.

Source: Magic Leap

Matterport

Founded: 2010
Ownership: Private
Category: Cameras / VR Content Capture
Domain: matterport.com
CEO:Bill Brown

Company Description: Matterport uses its Pro 3D Camera to map out a building, room or environment using a 360 field of view camera to take pictures of its surroundings. Once pictures are taken the software stitches the photos together to create a 3D virtual environment which can be explored in VR.

Source: Matterport

MediaSpike	Founded: 2011 Ownership: Private Category: Social Application Domain: mediaspike.com CEO: Blake Commagere

Company Description: MediaSpike is building social apps for the emerging medium of virtual reality. Along the way, they also are building out a set of tools for developers, including a native monetization platform, which they originally developed for mobile gaming and then recently adapted to virtual reality. The platform reaches over 200 million monthly active users across a large network of publishers.

MediaSpike has raised over $5 million from institutional investors including Andreessen Horowitz and Google Ventures, prominent angel investors Naval Ravikant and Rick Marini, as well as celebrity investors Robert Downey Jr. and Nas.

Source: MediaSpike

MindMaze	Founded: 2012 Ownership: Private Category: Head Mounted Displays (HMD) Domain: mindmaze.ch/ CEO: Tej Tadi

Company Description: MindMaze is a spin off from the Swiss Federal Institute of Technology (EPFL). The company brings together a mix of computer scientists, neuroscientists, physicists and roboticists driven by a passion to enhance the quality of life of brain injury survivors. In less than three years the MindMaze team has developed and launched medical grade virtual reality products to stimulate neural recovery. MindMaze is now translating VR and Neuroscience expertize into new fields of consumer health and technology.

Source: MindMaze

nDreams	Founded: 2006 Ownership: Private Category: VR Game Studios Domain: ndreams.com CEO: Patrick O'Luanaigh

Company Description: nDreams, based in Farnborough, UK, is a game developer and publisher specializing in virtual worlds and virtual reality. The company was founded by former Eidos Creative Director, Patrick O'Luanaigh in 2006 and is best known for being a global publisher in the PlayStation Home virtual world, and for creating two alternate reality games (ARGs): Xi and Lewis Hamilton: Secret Life, both of which had over half a million active players. Over the last five years the company has had a free-to-play floating archipelago with over 14 million visits to date from over 1.4 million unique players. More recently, the company has been working on VR games, with an early demo for the first VR project, SkyDIEving.

Source: nDreams

Next Galaxy	Founded: 2010 Ownership: Ticker: NXGA Category: Social Application Domain: Nextgalaxycorp.com CEO: Mary Spio

Company Description: Next Galaxy's CEEK VR Application is a social hub for accessing virtual reality experiences. Their CEEK application offers VR developers a chance to distribute 3D Content, 360 Videos and other entertainment, educational and enterprise experiences in immersive virtual environment. The back-end video management system can be added for easy VR content encoding, delivery and syndication.

Source: Next Galaxy

NextVR	Founded: 2009 Ownership: Private Category: VR Content: Studios & Live Events Domain: nextvr.com Co-founder: David Cole Co-founder: DJ Roller

Company Description: NextVR believes it is the technology leader in the market for live-action VR. NextVR captures and broadcasts 360-degree stereoscopic live-action content directly to any consumer VR headset using a low-bandwidth (including mobile) internet connection. The company is establishing a global network of content partners, including major sports leagues and teams, broadcasters, musicians, and digital media and distribution companies to deliver events to the largest fan bases in the world. NextVR generates revenues from fees for live and on-demand broadcasts (PPV and subscription), sponsorships and advertising and expects additional revenue opportunities as the consumer VR market matures.

Source: NextVR

Nvidia	Founded: 1993 Ownership: Ticker: NVDA Category: Processing Power Domain: nvidia.com CEO: Jen-Hsun Huang

Company Description: Nvidia creates GPUs which will power next generation VR & AR headsets. They hold several patents around VR & AR and are expected to continue to pursue this industry.

Source: Nvidia

Occipital	Founded: 2008 Ownership: Private Category: Cameras / VR Content Capture Domain: occipital.com Co-founder: Jeffrey Powers Co-founder: Vikas Reddy

Company Description: Occipital is the creator of Skanect, a technology that enables fast, easy and low-cost 3D scanning, capturing a full color 3D model of an object, a person or a room. According to the company, Skanect can transform a Microsoft Kinect or Asus Xtion camera into an ultra-low cost 3D scanner able to create 3D meshes out of real scenes in a few minutes.

Source: Occipital

OTOY

Founded: 2010
Ownership: Private
Category: VR Content: Studios & Live Events
Domain: otoy.com
Co-founder and CEO: Jules Urbach
Co-founder and President: Alissa Grainger

Company Description: OTOY is a cloud graphics company that specializes in the delivery of 3D digital content to next generation virtual and augmented reality devices. From capture to render to stream, OTOY's technology provides an integrated pipeline for authoring and delivering CG content. It holds potential to be an ideal format for deploying cinematic experiences targeting consumer VR and AR devices with position tracking, as well as emerging light field display hardware.

Source: OTOY

Pelican Imaging

Founded: 2008
Ownership: Private
Category: Cameras / VR Content Capture
Domain: pelicanimaging.com
President & CEO: Christopher Pickett

Company Description: Pelican Imaging has developed a small, super-thin array camera that captures in 3D. The Pelican depth-sensing array calculates the depth of the scene and simultaneously marries the depth information with the RGB images of the primary camera in a mobile device. Users will use the array camera to capture 3D images and video from their handheld device, giving them the ability to produce their own 3D content for a wide range of applications: 3D selfies, 3D printing, gaming, virtual reality, etc.

Source: Pelican Imaging

Perception Neuron

Founded: 2011
Ownership: Private
Category: Peripherals / Haptics / Tracking
Domain: neuronmocap.com
CEO: Dr. Haoyang Liu

Company Description: Perception Neuron's PERCEPTION™ is a motion capture system based on inertial sensors. It is capable of providing accurate motion capture data from single or multiple characters; and is suitable for applications in the fields of film, animation, game making, virtual reality, sport analysis and medical rehabilitation.

Source: Neuronmocap

PhaseSpace

Founded: 1994
Ownership: Private
Category: Head Mounted Displays (HMD)
Domain: PhaseSpace.com
CEO: Tracy McSheery

Company Description: PhaseSpace working with Mark Bolas from USC's Institute for Creative Technology to produce a VR/AR/CR hybrid for the US Navy and Marine Corps. According to the company, the technology will be split off to a new company this year to sell Smoke; a headset utilizing a phone and unique optics to create a wide field of view and a large eyebox which allows glasses.

Source: PhaseSpace

PrioVR

Founded: 2007
Ownership: Private
Category: Peripherals / Haptics / Tracking
Domain: priovr.com
CEO: Paul Yost

Company Description: PrioVR allows the user to capture their movements in Virtual Reality via inertial sensors to provide 360 degrees of low-latency, real-time motion tracking without the need for cameras, optics, line-of-sight, or large, awkward equipment. PrioVR's sensors are placed on key points of the body to capture movements and translate them on-screen in real-time. PrioVR is wireless, allows for multiple simultaneous users, and will work anywhere - indoors or out, to capture spaces of any size.

Source: PrioVR

Prizmiq

Founded: 2013
Ownership: Private
Category: Shopping / Fashion
Domain: prizmiq.com
CEO: Darrick Morrison

Company Description: Prizmiq pairs scalable, photo-realistic 3D product scanning with a customizable interactive viewing experience online and in VR/AR. Prizmiq offers online brands and retailers the ability to increase customer engagement, increase conversions and reduce returns. The platform allows shoppers to see the product from any angle on any browser or device, making it simple for brands to integrate and start breaking free from poor online product representation. The platform includes built-in support for fully immersive online virtual reality shopping environments for Oculus Rift, Samsung Gear VR, Hololens and other virtual/augmented reality headsets of the future.

Source: Prizmiq

Psious	Founded: 2013
	Ownership: Private
	Category: Medical
	Domain: psious.com
	CEO: Xavier Palomer

Company Description: Psious provides realistic audiovisual resources designed by psychologists to use in exposure treatments: Virtual Environments, Augmented Reality, 3D Videos and Audios. The goal is to use VR for treatments addressing fear of flying, fear of needles, acrophobia, claustrophobia, agoraphobia, fear of public speaking, relaxation, fear of driving and fear of bugs.

Source: Psious

Qualcomm	Founded: 1985
	Ownership: Ticker: QCOM
	Category: Processing Power
	Domain: qualcomm.com
	CEO: Steven Mollenkopf

Company Description: Qualcomm builds processors for mobile phones which go into wireless VR headsets. Their venture capital team is reported to be active in the VR and AR, suggesting that the company looks to stay involved in this field.

Source: Qualcomm

Razer	Founded: 1998
	Ownership: Private
	Category: Head Mounted Displays (HMD)
	Domain: razerzone.com
	Co-founder & CEO: Min-Liang Tan
	Co-founder & Presdient: Robert Krakoff

Company Description: Razor is part of the Open-Source Virtual Reality (OSVR) ecosystem, which is working to push the VR gaming experience forward and support the venture with the OSVR Hacker Dev Kit, a virtual reality device and open-source software that enables programming for any variety of VR technology.

Source: Razer

Reel FX	Founded: 2009
	Ownership: Private
	Category: Head Mounted Displays (HMD)
	Domain: reelfx.com
	Director of Digital Interactive: Dan Ferguson

Company Description: ReelFX is a design, visual effects, animation and entertainment studio based in Dallas, Texas, and Santa Monica, California.

Source: Reel FX

Samsung	Founded: 1938 Ownership: Public: KRX: 005930 Category: Head Mounted Displays (HMD) Domain: Samsung.com CEO: Jong-Kyun Shin **Company Description:** Samsung has partnered with Oculus to create the Gear VR. Over the coming years we expect them to continue their partnership with Oculus on updates to Gear VR headsets. Source: Piper Jaffray
Sensics	Founded: 1996 Ownership: Private Category: Head Mounted Displays (HMD) Domain: sensics.com CEO: Yuval Boger **Company Description:** Founded in 2003, Sensics is a leader in professional-grade virtual reality goggles and other near-eye devices. Sensics' products offer a wide spectrum of training, medical, consumer and research applications. The verticals of focus include electro-optics, ergonomics, sensors, software and mechanical design. Source: Sensics
SensoMotoric Instruments	Founded: 1991 Ownership: Private Category: Peripherals / Haptics / Tracking Domain: smivision.com Founder: Dr. Winfried Teiwes **Company Description:** Founded in 1991, SMI focuses on computer vision applications. The company has more than 20 years' experience in developing and marketing application-specific gaze and eye tracking systems. More than 6,000 eye tracker systems are in operation worldwide. Source: SMI
Sixense	Founded: 2007 Ownership: Private Category: Peripherals / Haptics / Tracking Domain: sixense.com CEO: Amir Rubin **Company Description:** Sixense develops technology and software to deliver full-body "presence" in virtual reality for all head-mounted displays (both mobile and desktop). Sixense's VR platform enables intuitive interaction with the virtual world, ensuring that the user always feels fully present in the experience, with the ability to move and use the hands naturally. Sixense views virtual reality as a platform to enhance from entertainment to training and education to health to commerce. Source: Sixense

Starship-Group	Founded: 2013 Ownership: Private Category: VR Game Studios Domain: Starship-group.com CEO: Martin Kenwright **Company Description:** Starship is a VR gaming company for hardware such as the Oculus Rift, Sony Morpheus, Samsung Gear VR, Google Cardboard, and SteamVR, and Microsoft's AR headset Hololens. Some of the biggest titles for the company include Cybercook (a VR cooking game). Source: Starship Group
Theta 360	Ownership: Private Category: Cameras / VR Content Capture Domain: theta360.com Founder: Saiyati Gohil **Company Description:** Theta 360 creates a consumer friendly camera which takes 360 degree photos and stiches them together to create what we call an "immersive picture." It similarly does the same thing with video all of which can be viewed using VR, a phone, or computer. Source: Theta 360
The Virtual Reality Medical Center	Ownership: Private Category: Medical Domain: vrphobia.com Executive Director: Brenda Wiederhold **Company Description:** The Virtual Reality Medical Center (VRMC) has been treating patients with anxiety disorders for the past 20 years. With clinics in California, Brussels, Belgium, and Qingdao, China, VRMC has designed, developed, tested and clinically validated specialty treatments for Posttraumatic Stress Disorder (PTSD), Specific Phobias, Panic Disorder and Agoraphobia and Chronic Pain Management. According to VRMC, success rates overall exceed 90% in most types of anxiety disorders, and it has treated over 1,000 patients (over 10,000 treatment sessions) with anxiety disorders and has seen successful results. VRMC estimates that about 20% of the U.S. population has anxiety disorders. Source: The Virtual Reality Medical Center
Unimersiv	Founded: 2014 Ownership: Private Category: Application Store Domain: universiv.com CEO: Baptiste Greve **Company Description:** Is an education VR app developer for Oculus Rift or Samsung Gear VR. The educational content apps published on Universiv allows student to interact with the virtual environments in person and manipulate the various objects within it. This supports "learning by doing" and also results in creativity by constructionism. Experiences

that can be explored on Oculus Rift include Titans of Space, which takes you into space to teach you everything about our solar system, or Apollo 11 in which you become Neil Armstrong on the way to the moon.

Source: Unimersiv

Unity Technologies

Founded: 2004
Ownership: Private
Category: 3D Engines for VR Content Development
Domain: Unity3D.com

Company Description: Unity Technologies is the creator of Unity a platform to create VR experiences. Unity's core engine and editor serve as the foundation for developers and designers to build games or apps and easily bring them across multiple platforms: mobile devices, home entertainment systems, personal computers, and embedded systems. A majority of content built for VR has been built on Unity and they have partnered with Oculus to introduce a new Oculus add-on for both the free and Pro versions of the Unity platform that the Unity community of 3.3 million developers.

Source: Unity3D

Valve

Founded: 1996
Ownership: Private
Category: 3D Engines for VR Content Development
Domain: valvesoftware.com
CEO: John Riccitiello

Company Description: Steam is a game playing platform, and is the world's largest online gaming platform. Steam guarantees instant access to more than 1,800 game titles and connects its 35 million active users. Through Steam you can buy, play, share, modify, and build communities around Valve products as well as titles from other independent game studios. Steam is available in 237 countries and 21 different languages

Source: Valve

Virtuix

Founded: 2013
Ownership: Private
Category: Peripherals / Haptics / Tracking
Domain: Virtuix.com
Founder & CEO: Jan Goetgeluk

Company Description: The Virtuix Omni is an omni directional treadmill compatible with the Oculus Rift, Samsung Gear VR, or any other head mounted VR displays. The Omni enables you to walk around naturally and fully immerse yourself in virtual reality; it places your mind and body in the video game. Rather than the old experience of sitting down and pushing buttons on a keyboard or a gamepad, you are standing up and walking around in another world.

Source: Virtuix

VR-Bits	Founded: 2013 Ownership: Private Category: VR Game Studios Domain: VR-Bits.com CEO: Mark Schramm
	Company Description: VR-Bits is creating immersive Virtual Reality content in cooperation with VR industry leaders such as Oculus VR, Samsung and Google. VR titles include Darkfield VR, Nighttime Terror and StrandedVR. Source: VR-Bits

VRSE	Founded: 2014 Ownership: Private Category: VR Game Studios Domain: vrse.com CEO: Chris Milk
	Company Description: VRSE.works is a specialized and focused production company that supports the world's leading creative innovators in Virtual Reality spherical filmmaking. The VRSE.works collective utilizes custom built tools and proprietary technology to craft and curate original immersive experiences. Source: VRSE

Wearality	Founded: 2014 Ownership: Private Category: Head Mounted Displays (HMD) Domain: wearality.com CEO: Michael Jones
	Company Description: Wearality uses special lenses developed for virtual reality to enable a wider field of view in virtual reality. Wearality leverages existing apps in Google Cardboard's VR app store for your phone. Source: Wearality

WEARVR	Founded: 2014 Ownership: Private Category: Application Store Domain: wearvr.com Co-founder: Nic Mitham CTO & Co-founder: Matthew Warneford
	Company Description: WEARVR is an app store for virtual reality. WEARVR was launched in July 2014 and achieved 100,000 downloads in its first five months. WEARVR has completed a $1.5 million fund-raising round to improve the site and grow its user base. Source: WEARVR

COVERED COMPANIES DISCUSSED IN THIS REPORT

AAPL $129.62

Overweight rating with a $162 Price Target (19x CY16E EPS of $8.52)
Risks include trends in end-markets; component pricing; competitive pressures.

FB $79.33

Overweight rating with a $92 Price Target (30x CY15E EV/EBITDA, includes $11.2b cash & 2.836b shares/out)
Risks include changes to advertiser spend in social, competing social platforms, shift to smartphones.

GOOG $532.32

Overweight rating with a $631 Price Target (19x CY16E PF EPS of $33.20)
Risks include competition, increasing traffic acquisition costs, loss of key partnerships, and slowing ad/search growth.

GPRO $53.41

Overweight rating with a $ $66 Price Target (34x our FY16 EPS of $1.93)
Risks include competition, reliance on key management and technological obsolescence.

Closing prices as of 05/26/2015.

NOTES

NOTES

Important Research Disclosures

Rating and Price Target History for: Apple, Inc. as of 05-26-2015

| 10/25/12 OW:$128 | 01/10/13 OW:$125 | 01/24/13 OW:$109 | 04/16/13 OW:$98 | 05/09/13 OW:$93 | 09/11/13 OW:$91 | 05/28/14 OW:$105 | 09/02/14 OW:$120 | 11/20/14 OW:$135 | 02/16/15 OW:$160 | 04/27/15 OW:$162 |

Created by BlueMatrix

Rating and Price Target History for: Facebook, Inc. as of 05-26-2015

| 06/27/12 I:OW:$41 | 11/19/12 OW:$38 | 08/05/13 OW:$46 | 10/07/13 OW:$57 | 01/29/14 OW:$67 | 04/23/14 OW:$76 | 07/24/14 OW:$90 | 10/29/14 OW:$82 | 01/28/15 OW:$84 | 03/23/15 OW:$92 |

Created by BlueMatrix

Rating and Price Target History for: Google Inc. as of 05-26-2015

| 07/20/12 OW:$358.5 | 10/15/12 OW:$417 | 10/19/12 OW:$387.5 | 01/22/13 OW:$414 | 03/01/13 OW:$469 | 04/18/13 OW:$467.5 | 07/19/13 OW:$487.5 | 10/17/13 OW:$492.5 | 12/10/13 OW:$631.5 | 01/30/14 OW:$645 | 10/17/14 OW:$630 |

| 04/23/15 OW:$631 |

Created by BlueMatrix

Rating and Price Target History for: GoPro, Inc. as of 05-26-2015

07/21/14 I:OW:$48	09/05/14 OW:$60	09/29/14 OW:$90	10/07/14 N:$90	02/05/15 N:$55	04/14/15 T:OW:$55	04/28/15 OW:$66

Created by BlueMatrix


Notes: The boxes on the Rating and Price Target History chart above indicate the date of the Research Note, the rating, and the price target. Each box represents a date on which an analyst made a change to a rating or price target, except for the first box, which may only represent the first Note written during the past three years.

Legend:
I: Initiating Coverage
R: Resuming Coverage
T: Transferring Coverage
D: Discontinuing Coverage
S: Suspending Coverage
OW: Overweight
N: Neutral
UW: Underweight
NA: Not Available
UR: Under Review

	Distribution of Ratings/IB Services **Piper Jaffray**				
				IB Serv./Past 12 Mos.	
Rating	**Count**	**Percent**		**Count**	**Percent**
BUY [OW]	377	61.40		98	25.99
HOLD [N]	222	36.16		15	6.76
SELL [UW]	15	2.44		0	0.00

Note: Distribution of Ratings/IB Services shows the number of companies currently in each rating category from which Piper Jaffray and its affiliates received compensation for investment banking services within the past 12 months. FINRA rules require disclosure of which ratings most closely correspond with "buy," "hold," and "sell" recommendations. Piper Jaffray ratings are not the equivalent of buy, hold or sell, but instead represent recommended relative weightings. Nevertheless, Overweight corresponds most closely with buy, Neutral with hold and Underweight with sell. See Stock Rating definitions below.

Important Research Disclosures

Analyst Certification — **Gene Munster, Sr Research Analyst**

— **Travis S. Jakel, Analytics Specialist**

— **Douglas J. Clinton, Research Analyst**

— **Erinn E. Murphy, Sr Research Analyst**

The views expressed in this report accurately reflect my personal views about the subject company and the subject security. In addition, no part of my compensation was, is, or will be directly or indirectly related to the specific recommendations or views contained in this report.

Complete disclosure information, price charts and ratings distributions on companies covered by Piper Jaffray Equity Research can be found on the Piper Jaffray website: http://piperjaffray.com/researchdisclosures or by writing to Piper Jaffray, Equity Research Department, 800 Nicollet Mall, Minneapolis, MN 55402

Research Disclosures

Piper Jaffray was making a market in the securities of Apple, Inc. at the time this research report was published. Piper Jaffray will buy and sell Apple, Inc. securities on a principal basis.

Piper Jaffray was making a market in the securities of Facebook, Inc. at the time this research report was published. Piper Jaffray will buy and sell Facebook, Inc. securities on a principal basis.

Within the past 3 years Piper Jaffray participated in a public offering of, or acted as a dealer manager for, Facebook, Inc. securities.

Piper Jaffray was making a market in the securities of Google Inc. at the time this research report was published. Piper Jaffray will buy and sell Google Inc. securities on a principal basis.

Piper Jaffray was making a market in the securities of GoPro, Inc. at the time this research report was published. Piper Jaffray will buy and sell GoPro, Inc. securities on a principal basis.

Piper Jaffray has received compensation for investment banking services from or has had a client relationship with GoPro, Inc. within the past 12 months.

Within the past 12 months Piper Jaffray was a managing underwriter of a public offering of, or dealer manager of a tender offer for, the securities of GoPro, Inc. or the securities of an affiliate.

Within the past 3 years Piper Jaffray participated in a public offering of, or acted as a dealer manager for, GoPro, Inc. securities.

Rating Definitions

Stock Ratings: Piper Jaffray ratings are indicators of expected total return (price appreciation plus dividend) within the next 12 months. At times analysts may specify a different investment horizon or may include additional investment time horizons for specific stocks. Stock performance is measured relative to the group of stocks covered by each analyst. Lists of the stocks covered by each are available at www.piperjaffray.com/researchdisclosures. Stock ratings and/or stock coverage may be suspended from time to time in the event that there is no active analyst opinion or analyst coverage, but the opinion or coverage is expected to resume. Research reports and ratings should not be relied upon as individual investment advice. As always, an investor's decision to buy or sell a security must depend on individual circumstances, including existing holdings, time horizons and risk tolerance. Piper Jaffray sales and trading personnel may provide written or oral commentary, trade ideas, or other information about a particular stock to clients or internal trading desks reflecting different opinions than those expressed by the research analyst. In addition, Piper Jaffray offers technical research products that are based on different methodologies, may contradict the opinions contained in fundamental research reports, and could impact the price of the subject security. Recommendations based on technical analysis are intended for the professional trader, while fundamental opinions are typically suited for the longer-term institutional investor.

- **Overweight (OW):** Anticipated to outperform relative to the median of the group of stocks covered by the analyst.

- **Neutral (N):** Anticipated to perform in line relative to the median of the group of stocks covered by the analyst.

- **Underweight (UW):** Anticipated to underperform relative to the median of the group of stocks covered by the analyst.

Other Important Information

The material regarding the subject company is based on data obtained from sources we deem to be reliable; it is not guaranteed as to accuracy and does not purport to be complete. This report is solely for informational purposes and is not intended to be used as the primary basis of investment decisions. Piper Jaffray has not assessed the suitability of the subject company for any person. Because of individual client requirements, it is not, and it should not be construed as, advice designed to meet the particular investment needs of any investor. This report is not an offer or the solicitation of an offer to sell or buy any security. Unless otherwise noted, the price of a security mentioned in this report is the market closing price as of the end of the prior business day. Piper Jaffray does not maintain a predetermined schedule for publication of research and will not necessarily update this report. Piper Jaffray policy generally prohibits research analysts from sending draft research reports to subject companies; however, it should be presumed that the fundamental equity analyst(s) who authored this report has had discussions with the subject company to ensure factual accuracy prior to publication, and has had assistance from the company in conducting diligence, including visits to company sites and meetings with company management and other representatives.

Notice to customers: This material is not directed to, or intended for distribution to or use by, any person or entity if Piper Jaffray is prohibited or restricted by any legislation or regulation in any jurisdiction from making it available to such person or entity. Customers in any of the jurisdictions where Piper Jaffray and its affiliates do business who wish to effect a transaction in the securities discussed in this report should contact their local Piper Jaffray representative. **Europe:** This material is for the use of intended recipients only and only for distribution to professional and institutional investors, i.e. persons who are authorised persons or exempted persons within the meaning of the Financial Services and Markets Act 2000 of the United Kingdom, or persons who have been categorised by Piper Jaffray Ltd. as professional clients under the rules of the Financial Conduct Authority. **United States:** This report is distributed in the United States by Piper Jaffray & Co., member SIPC, FINRA and NYSE, Inc., which accepts responsibility for its contents. The securities described in this report may not have been registered under the U.S. Securities Act of 1933 and, in such case, may not be offered or sold in the United States or to U.S. persons unless they have been so registered, or an exemption from the registration requirements is available.

This report is produced for the use of Piper Jaffray customers and may not be reproduced, re-distributed or passed to any other person or published in whole or in part for any purpose without the prior consent of Piper Jaffray & Co. Additional information is available upon request.

15-0015

PiperJaffray

MINNEAPOLIS - Headquarters
800 Nicollet Mall, Suite 800
Minneapolis, MN 55402
+1 612 303-6000
+1 800 333-6000

BOSTON
265 Franklin Street, Suite 710
Boston, MA 02110
+1 617 654-0721

CHICAGO
Hyatt Center, 24th Floor
71 South Wacker Drive
Chicago, IL 60606
+1 312 920-3200

LONDON
88 Wood Street
13 Floor
London EC2V 7RS
+44 20 7796 8400

LOS ANGELES
444 South Flower Street, Suite 1675
Los Angeles, CA 90071
+1 213 629-1030

NEW YORK
345 Park Avenue, Suite 1200
New York, NY 10154
+1 212 284-9300

SAN FRANCISCO
50 California Street, Suite 3100
San Francisco, CA 94111
+1 415 616-1600

ZURICH
Claridenstrasse 20
CH-8002 Zurich
+41 44 204 2424

www.piperjaffray.com